Request for Amendment 1 for the Sunstone Solar Project

October 2025

Prepared for

PINE GATE RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar, LLC
a subsidiary of Pine Gate Renewables, LLC

Prepared by

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Acronyms and Abbreviations

ASC	Application for Site Certificate
BESS	battery energy storage system
Certificate Holder	Sunstone Solar, LLC, a subsidiary of Pine Gate Renewables, LLC
Certificate Holder Owner	Pine Gate Renewables, LLC
Council	Energy Facility Siting Council
Facility	Sunstone Solar Project
kV	kilovolt
MW	megawatts
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
ODOE	Oregon Department of Energy
ORS	Oregon Revised Statutes
RFA 1	Request for Amendment 1
SS1	Sunstone Solar Project 1
SS2	Sunstone Solar Project 2
SS3	Sunstone Solar Project 3
SS4	Sunstone Solar Project 4
SS5	Sunstone Solar Project 5
SS6	Sunstone Solar Project 6
UEC	Umatilla Electric Cooperation

1.0 Introduction

1.1 Project Summary and Request

Sunstone Solar Project (Facility) is a photovoltaic solar energy generation and battery energy storage system (BESS) facility approved by the Energy Facility Siting Council (Council) with a capacity to generate 1,200 megawatts (MW), located in Morrow County, Oregon. The Facility has yet to begin construction, and was approved to be constructed in six phases of approximately 200 MW each. Sunstone Solar, LLC (Certificate Holder) a wholly owned subsidiary of Pine Gate Renewables, LLC (Certificate Holder Owner) is submitting Request for Amendment 1 (RFA 1) to the Facility Site Certificate to split the approved Facility components, Site Boundary, and maximum footprint into six facilities each with their own Site Certificate. Therefore, there would be six new Site Certificates that would be the binding agreement to construct, operate, and retire portions of the approved Facility as follows:

1. **Sunstone Solar Project 1 (SS1) –** Solar energy facility in Morrow County, including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 1, LLC and Certificate Holder Owner will remain the same.
2. **Sunstone Solar Project 2 (SS2) –** Solar energy facility in Morrow County, including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 2, LLC and Certificate Holder Owner will remain the same.
3. **Sunstone Solar Project 3 (SS3) –** Solar energy facility in Morrow County, including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 3, LLC and Certificate Holder Owner will remain the same.
4. **Sunstone Solar Project 4 (SS4) –** Solar energy facility in Morrow County, including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 4, LLC and Certificate Holder Owner will remain the same.
5. **Sunstone Solar Project 5 (SS5) –** Solar energy facility in Morrow County, including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 5, LLC and Certificate Holder Owner will remain the same.
6. **Sunstone Solar Project 6 (SS6) –** Solar energy facility in Morrow County, including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 6, LLC and Certificate Holder Owner will remain the same.

To implement the splitting of the Facility, the Certificate Holder proposes three additional modifications, all of which occur within the existing Site Boundary and would result in similar or reduced impacts as previously considered and approved.

First, the Certificate Holder proposes to reduce the approved transmission line and associated corridor (within the approved Site Boundary, by rerouting the line farther within the Site Boundary), from 9.5 miles of 230-kilvolt (kV) transmission line to 5.1 miles of 230-kV transmission line; note that the approved maximum corridor width of 1,000 feet will be retained. This relocation will provide a physical break between the proposed projects. This proposed shorter, less impactful transmission line will be more electrically optimized, more cost-effective, and will create additional distance from neighboring properties outside of the Facility Site Boundary. Internalizing the transmission line corridor into the Site Boundary will reduce the electrical connector lengths and the noise impacts of the transformers. It also enables a transmission line protection design that requires fewer high-voltage breakers, which reduces procurement risks. The transmission line corridor will be retained as related/supporting infrastructure for SS1, but will be shared with SS2 through SS6.

Second, one of the two approved switchyards is proposed to be removed from the approved Site Boundary and will no longer be considered related or supporting infrastructure for SS1 through SS4 and SS6. The remaining 3-acre switchyard will be reconfigured and retained as related/supporting infrastructure for SS5, but will be shared as a potential future interconnection point for all projects [to then interconnect to the existing Umatilla Electric Cooperative (UEC) 230-kV Blue Ridge Line]. As a result, the Site Boundary will be reduced by approximately 18 acres. That excluded property will be deeded to UEC for development of its own switchyard and will be outside the purview of this amendment process. By relocating the remaining switchyard from SS1 to SS5, it allows future interconnection flexibility.

Third, one of the previously approved substations is proposed to be relocated from the proposed SS5 Site Boundary to the proposed SS1 Site Boundary (i.e., within the previously approved Site Boundary). This substation is proposed to be increased in size, from 1.6 acres of permanent impacts to 7.3 acres of permanent impacts, a 5.7-acre increase, However, the associated characteristics such as transformers (quantity and capacity), transformer noise, and maximum height are anticipated to remain the same as previously approved in the Site Certificate. Further, with the reduced impacts of the transmission line and switchyard reconfiguration, overall impacts are anticipated to be similar to what was previously approved. With this proposed update, the substations will be distributed evenly across all six projects (per 200 MW block/per project, as previously approved in the Site Certificate), with one substation per project, thus providing increased electrical optimization and more equitable distribution of associated impacts.

Please note that the previously reviewed/approved development exclusion areas will be retained within the proposed project site boundaries as part of RFA 1.

Once the amendment process is complete, each project will be a stand-alone facility, but may share related or supporting facilities with one another, similar to other projects approved by the Council. In addition, RFA 1 would add specific, non-contingent dates to the construction schedules for each of the six facilities to implement the facilities' separation. This addition would not extend the construction timeline under the previously approved Facility Site Certificate. Rather, it simply adds specific dates that fit within the already approved timeline. As part of preconstruction compliance, site plans and relevant analyses will be updated at that time to reflect these updates.

In sum, RFA 1 does not propose to expand the Site Boundary or maximum footprint or add new facility components. It proposes only a minor change to the approved switchyard(s), one of the substations, transmission line/corridor that combined, and construction date language, which will result in similar overall impacts as previously approved. Section 3 provides a more detailed overview of how the approved Facility will be split by facility component and location. Each project would have its own maximum footprint within the previously approved Site Boundary and maximum footprint. The facilities will have some shared related or supporting facilities reflective of the approved Facility. The Certificate Holder Owner will remain the parent company for all projects and a shared facilities agreement will govern how the six certificate holders will share related or supporting facilities under their Site Certificates. Therefore, the facilities will be constructed, operated and retired consistent with the Council's previous approval of the Facility, including the conditions to address the potential impact of the Facility features within the approved Site Boundary and maximum footprint.

1.2 Procedural History

See Diagram 1 for the procedural history of the Sunstone Solar Project. The Site Certificate for the Facility was issued and approved on November 18, 2024. The proposed changes in RFA 1 will split the Facility into six new Site Certificates. See Figure 1 for the approved Facility location and Figures 2 through 7 for the six proposed project locations. Figure 8 displays all proposed project locations overlaid on the permitted Site Boundary.

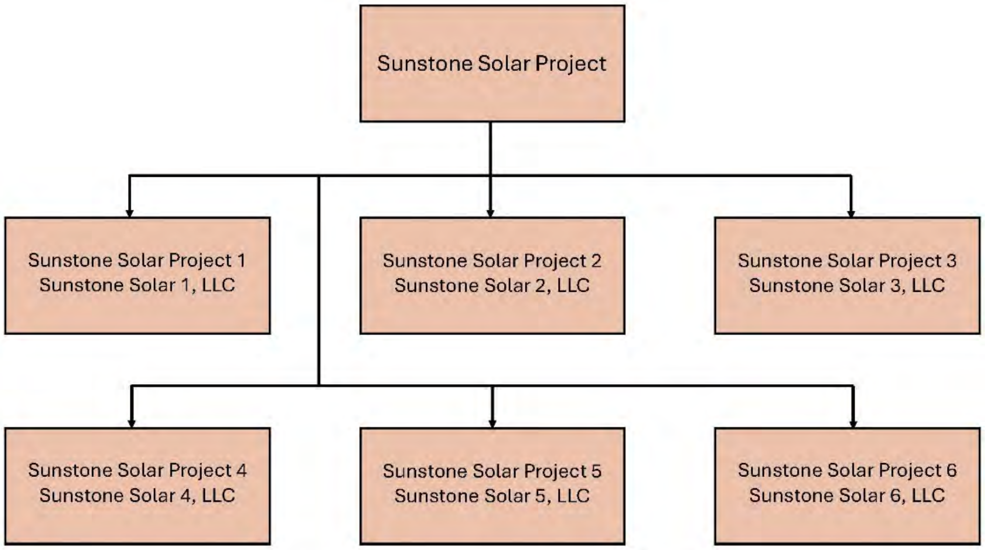

Diagram 1. Sunstone Solar Site Certificate History

2.0 Certificate Holder Information – OAR 345-027-0360(1)(a)

> *(1) To request an amendment to the site certificate required by OAR 345-027-0350(3) or (4), the certificate holder must submit a written preliminary request for amendment to the Department that includes the following:*
>
> > *OAR 345-027-0360(1)(a) The name of the facility, the name and mailing address of the certificate holder, and the name, mailing address, email address and phone number of the individual responsible for submitting the request;*

2.1 Name of the Facility

The current name of the Facility is Sunstone Solar Project, and the Certificate Holder is Sunstone Solar, LLC. RFA 1 is requesting to split the Facility into six separate facilities--therefore, six new Site Certificates:

1. Sunstone Solar Project 1 (SS1); the Certificate Holder will be Sunstone Solar 1, LLC.
2. Sunstone Solar Project 2 (SS2); the Certificate Holder will be Sunstone Solar 2, LLC.
3. Sunstone Solar Project 3 (SS3); the Certificate Holder will be Sunstone Solar 3, LLC.
4. Sunstone Solar Project 4 (SS4); the Certificate Holder will be Sunstone Solar 4, LLC.
5. Sunstone Solar Project 5 (SS5); the Certificate Holder will be Sunstone Solar 5, LLC.
6. Sunstone Solar Project 6 (SS6); the Certificate Holder will be Sunstone Solar 6, LLC.

Pine Gate Renewables, LLC will remain the Certificate Holder Owner for all facilities.

2.2 Name and Mailing Address of the Certificate Holders

Charlene Mortyn

Director, Project Development

Sunstone Solar, LLC

130 Roberts Street

Asheville, NC 28801

(855) 969 3380

cmortyn@pgrenewables.com

2.3 Current Parent Company of Certificate Holders

Pine Gate Renewables, LLC

130 Roberts Street

Asheville, NC 28801

2.4 Name and Mailing Address of the Individuals Responsible for Submitting the Request

Charlene Mortyn

Director, Project Development

Sunstone Solar, LLC

130 Roberts Street

Asheville, NC 28801

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cmortyn@pgrenewables.com

3.0 Detailed Description of the Proposed Change – OAR 345-027-0360(1)(b)

OAR 345-027-0360(1)(b) A detailed description of the proposed change, including:

As noted above, the Certificate Holder seeks Council approval to split the approved facility components, Site Boundary and maximum footprint into six facilities with their own respective Site Certificate. Therefore, the Certificate Holder proposes to split the current Site Certificate and create six new Site Certificate to construct, operate, and retire Facility components as follows:

1. **Sunstone Solar Project 1 –** Solar energy facility in Morrow County including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 1, LLC and Certificate Holder Owner will remain the same.
2. **Sunstone Solar Project 2 –** Solar energy facility in Morrow County including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 2, LLC and Certificate Holder Owner will remain the same.
3. **Sunstone Solar Project 3 –** Solar energy facility in Morrow County including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 3, LLC and Certificate Holder Owner will remain the same.
4. **Sunstone Solar Project 4 –** Solar energy facility in Morrow County including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 4, LLC and Certificate Holder Owner will remain the same.

5. **Sunstone Solar Project 5 –** Solar energy facility in Morrow County including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 5, LLC and Certificate Holder Owner will remain the same.
6. **Sunstone Solar Project 6 –** Solar energy facility in Morrow County including solar arrays and related or supporting facilities, with a total generating capacity up to 200 MW. The Certificate Holder will be changed to Sunstone Solar 6, LLC and Certificate Holder Owner will remain the same.

Table 1 provides a more detailed description of how the Facility would be split per the description in the Site Certificate. The facilities would have some shared, related or supporting facilities.

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Table 1. Proposed Descriptions of the Partitioned Facilities

Infrastructure Type	Approved Site Certificate Description	SS1 Description	SS2 Description	SS3 Description	SS4 Description	SS5 Description	SS6 Description	Explanation
Total Generating Capacity	The Facility includes photovoltaic solar energy generation components, with related or supporting facilities. The energy generation capacity of the Facility, with photovoltaic solar components, at full build out by the specified construction completion deadline is 1,200 MW.	SS1 includes photovoltaic solar energy generation components with related or supporting facilities. The total generating capacity of this facility will not exceed 200 MW of solar energy.	SS2 includes photovoltaic solar energy generation components with related or supporting facilities. The total generating capacity of this facility will not exceed 200 MW of solar energy.	SS3 includes photovoltaic solar energy generation components with related or supporting facilities. The total generating capacity of this facility will not exceed 200 MW of solar energy.	SS4 includes photovoltaic solar energy generation components with related or supporting facilities. The total generating capacity of this facility will not exceed 200 MW of solar energy.	SS5 includes photovoltaic solar energy generation components with related or supporting facilities. The total generating capacity of this facility will not exceed 200 MW of solar energy.	SS6 includes photovoltaic solar energy generation components with related or supporting facilities. The total generating capacity of this facility will not exceed 200 MW of solar energy.	The total generating capacity for photovoltaic solar energy for the facilities combined will be 1,200 MW, as previously approved by the Council.
Battery Energy Storage System (BESS)	The Facility will include up to a 7,200 MW hours of BESS capacity, designed as either a direct current coupled system (i.e., distributed through the Facility near solar inverter/transformer stations), or as an alternating current system (i.e., concentrated at locations near the switchyards and/or substations). Either design will be located within the approved array area and Site Boundary. Up to 14,946 zinc battery containers and 12,000 lithium-ion battery containers approved.	SS1 includes up to 1,200 MW hours, 2,491 zinc and 2,000 lithium-ion battery containers.	SS2 includes up to 1,200 MW hours, 2,491 zinc and 2,000 lithium-ion battery containers.	SS3 includes up to 1,200 MW hours, 2,491 zinc and 2,000 lithium-ion battery containers.	SS4 includes up to 1,200 MW hours, 2,491 zinc and 2,000 lithium-ion battery containers.	SS5 includes up to 1,200 MW hours, 2,491 zinc and 2,000 lithium-ion battery containers.	SS6 includes up to 1,200 MW hours, 2,491 zinc and 2,000 lithium-ion battery containers.	The BESS at SS1 through SS6 will be distributed or centrally located, and will not exceed 7,200 MW hours of capacity, and 14,946 zinc/12,000 lithium-ion containers, as previously approved by the Council.
Electrical Collection System	The Facility will include up to 81.7 miles of underground 34.5-kV collector lines. Approximately 4.3 miles (5 percent of the total 86 miles) of aboveground collector line is estimated to be required in situations where a buried cable is infeasible.	Electrical collection system includes up to 12.9 miles of underground and 0.7 miles of aboveground 34.5-kV collector lines (if aboveground is required).	Electrical collection system includes up to 12.9 miles of underground and 0.7 miles of aboveground 34.5-kV collector lines (if aboveground is required).	Electrical collection system includes up to 7.7 miles of underground and 0.7 miles of aboveground 34.5-kV collector lines (if aboveground is required).	Electrical collection system includes up to 12.4 miles of underground and 0.7 miles of aboveground 34.5-kV collector lines (if aboveground is required).	Electrical collection system includes up to 22.8 miles of underground and 0.7 miles of aboveground 34.5-kV collector lines (if aboveground is required).	Electrical collection system includes up to 13 miles of underground and 0.7 miles of aboveground 34.5-kV collector lines (if aboveground is required).	Total length will not exceed 81.7 miles of underground line, and 4.3 miles of aboveground line as previously approved by Council.

Infrastructure Type	Approved Site Certificate Description	SS1 Description	SS2 Description	SS3 Description	SS4 Description	SS5 Description	SS6 Description	Explanation
Communication and Supervisory Control and Data Acquisition (SCADA) System	The SCADA system will be included in the operations and maintenance (O&M) buildings.	The SCADA system will be included in the O&M buildings, which will be shared among SS1 through SS6.	The SCADA system will be included in the O&M buildings, which will be shared among SS1 through SS6.	The SCADA system will be included in the O&M buildings, which will be shared among SS1 through SS6.	The SCADA system will be included in the O&M buildings, which will be shared among SS1 through SS6.	The SCADA system will be included in the O&M buildings, which will be shared among SS1 through SS6.	The SCADA system will be included in the O&M buildings, which will be shared among SS1 through SS6.	The SCADA systems connect to the O&M buildings. SS1 through SS6 will share the O&M buildings (see O&M discussion below).
Collector Substations	The Facility will include up to six substations.	SS1 will include up to 1 substation.	SS2 will include up to 1 substation.	SS3 will include up to 1 substation.	SS4 will include up to 1 substation.	SS5 will include up to 1 substation.	SS6 will include up to 1 substation.	All projects will include at least one substation for interconnection purposes.
Transmission Line	The Facility will include two overhead 230 kV transmission lines extending 9.5 miles in combined length.	SS1 will include one overhead 230 kV transmission line extending 5.1 miles in length; SS1 through SS6 will share the transmission line.	SS1 through SS6 will share the transmission line.	SS1 through SS6 will share the transmission line.	SS1 through SS6 will share the transmission line.	SS1 through SS6 will share the transmission line.	SS1 through SS6 will share the transmission line.	SS1 will include the transmission line, otherwise, SS1 through SS6 will share the 5.1-mile 230-kV transmission line. Total length will not exceed 5.1 miles, which is less than the 9.5 miles previously approved by Council.
Switchyards and Interconnection Facilities	The Facility will include up to two switchyards, to interconnect with the transmission line and existing Umatilla Electric Cooperative 230-kV Blue Ridge Line.	SS1 through SS6 will share the single switchyard for interconnection.	SS1 through SS6 will share the single switchyard for interconnection.	SS1 through SS6 will share the single switchyard for interconnection.	SS1 through SS6 will share the single switchyard for interconnection.	SS5 will include one switchyard. SS1 through SS6 will share the single switchyard for interconnection.	SS1 through SS6 will share the single switchyard for interconnection.	SS5 will include one switchyard; SS1 through SS6 will share that switchyard for interconnection purposes.
O&M Buildings	The Facility will include up to four O&M buildings.	SS1 includes 1 O&M building. SS1 through SS6 will share the O&M buildings.	SS2 includes 1 O&M building. SS1 through SS6 will share the O&M buildings.	SS3 includes 1 O&M building. SS1 through SS6 will share the O&M buildings.	SS4 will share the O&M buildings with SS1 through SS6.	SS5 includes 1 O&M building. SS1 through SS6 will share the O&M buildings.	SS6 will share the O&M buildings with SS1 through SS6.	The total maximum number of O&M buildings is four, which may be shared by SS1 through SS6. Therefore, the permitted O&M buildings will not exceed the amount previously approved by Council.
Replacement Solar Panel Storage	The Facility may include up to 50 storage containers to be distributed throughout the Facility (if storage at O&M buildings is not sufficient).	SS1 include 8-9 containers. SS1 through SS6 will share the storage containers, if required.	SS2 include 8-9 containers. SS1 through SS6 will share the storage containers, if required.	SS3 include 8-9 containers. SS1 through SS6 will share the storage containers, if required.	SS4 include 8-9 containers. SS1 through SS6 will share the storage containers, if required.	SS5 include 8-9 containers. SS1 through SS6 will share the storage containers, if required.	SS6 include 8-9 containers. SS1 through SS6 will share the storage containers, if required.	SS1 through SS6 will share the storage containers (if required) and will not exceed 50 containers as previously approved by the Council.
Access and Service Roads	The Facility will include up to 55 miles of new access roads.	SS1 includes up to 7.0 miles of new access roads. Some roads will be shared among SS1 through SS6.	SS2 includes up to 7.4 miles of new access roads. Some roads will be shared among SS1 through SS6.	SS3 includes up to 7.3 miles of new access roads. Some roads will be shared among SS1 through SS6.	SS4 includes up to 7.9 miles of new access roads. Some roads will be shared among SS1 through SS6.	SS5 includes up to 17.4 miles of new access roads. Some roads will be shared among SS1 through SS6.	SS6 includes up to 6.8 miles of new access roads. Some roads will be shared among SS1 through SS6.	Total length will not exceed 55 miles as previously approved by Council.

Infrastructure Type	Approved Site Certificate Description	SS1 Description	SS2 Description	SS3 Description	SS4 Description	SS5 Description	SS6 Description	Explanation
Security Fencing and Gates	The Facility will include up to 58 miles of security fencing and 52 gates.	SS1 includes up to 15.9 miles of fencing, and up to 8-9 gates.	SS2 includes up to 2.2 miles of fencing, and up to 8-9 gates.	SS3 includes up to 2 miles of fencing, and up to 8-9 gates.	SS4 includes up to 2.7 miles of fencing, and up to 8-9 gates.	SS5 includes up to 28.1 miles of fencing, and up to 8-9 gates.	SS6 includes up to 7 miles of fencing, and up to 8-9 gates.	Total length will not exceed 58 miles of fencing and 52 gates as previously approved by Council.
Temporary Construction Areas	The Facility will include up to 54 temporary construction areas (including up to 5 aboveground diesel tanks and one temporary aboveground gasoline tank).	SS1 includes 14 temporary construction yards. SS1 through SS6 will share the temporary construction yards, and in turn the aboveground fuel tanks.	SS2 includes 3 temporary construction yards. SS1 through SS6 will share the temporary construction yards, and in turn the aboveground fuel tanks.	SS3 includes 2 temporary construction yards. SS1 through SS6 will share the temporary construction yards, and in turn the aboveground fuel tanks.	SS4 includes 4 temporary construction yards. SS1 through SS6 will share the temporary construction yards, and in turn the aboveground fuel tanks.	SS5 includes 27 temporary construction yards. SS1 through SS6 will share the temporary construction yards, and in turn the aboveground fuel tanks.	SS6 includes 4 temporary construction yards. SS1 through SS6 will share the temporary construction yards, and in turn the aboveground fuel tanks.	The total maximum number of temporary construction yards is 54 temporary construction yards (including aboveground fuel tanks), which may be shared by SS1 through SS6. Therefore, the permitted temporary construction yards will not exceed the amount previously approved by Council.

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3.1 Effect of Proposed Changes on Facility – OAR 345-027-0360(1)(b)(A)

> *(A) A description of how the proposed change affects the facility;*

The Facility, once split, will be constructed and operated substantially in the same manner as previously approved by the Council, with imposed conditions, as necessary, that considered micrositing needs, potential impacts, and public and reviewing agencies' comments. The partitioned facilities will generally operate as approved and would not affect any physical impacts from Facility construction, operation, or retirement previously reviewed by the Council. RFA 1 provides the maximum efficiency in terms of use of space for renewable energy facilities and available technology, while providing maximum flexibility for potential customers to deliver the renewable energy to the market. The Certificate Holder demonstrates herein that the six partitioned facilities, as proposed, will meet all applicable Council standards and will be constructed and operated substantially in the same manner as previously approved by the Council.

3.2 Applicable Laws and Council Rules – OAR 345-027-0360(1)(b)(B)

> *(B) A description of how the proposed change affects those resources or interests protected by applicable laws and Council standards, and*

The proposed changes do not affect the resources or interests protected by applicable laws and Council standards in a substantially different way than what has already been approved by the Council (Section 6). Compliance with applicable laws is integrated into the Site Certificate conditions, including conditions related to preconstruction habitat and wildlife surveys, noise analysis, setback verification, the National Pollutant Discharge Elimination System 1200-C permit, consultation with the Oregon Department of Fish and Wildlife (ODFW), and the Oregon Department of Geology and Mineral Industries, among others.

The Facility's proposed partition and Site Certificate split does not alter the Certificate Holder's ability to comply with the Site Certificate conditions for the Facility. Sections 4 and 6 further demonstrate how the proposed changes are consistent with the Council's previous findings. The physical components of the Facility, Site Boundary, and maximum footprint will not be changed as a part of this RFA, except for a proposed reduction of the transmission line route/corridor, removal/relocation of the switchyard within the approved Site Boundary, and relocation/modification of one of the substations; therefore, there are no new areas or resources that were not previously evaluated. The Facility, following its partition under this Amendment, will be constructed and operated in substantially the same manner as already approved by the Council.

3.3 Location of the Proposed Change – OAR 345-027-0360(1)(b)(C)

> *(C) The specific location of the proposed change, and any updated maps and/or geospatial data layers relevant to the proposed change;*

This RFA does not seek to expand the approved Site Boundary or maximum footprint, nor add new or changes to the approved physical components of the Facility beyond the reduction of the transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of one of the substations (within the approved Site Boundary). Figures 2 through 7 show how the Facility will be divided into each project from SS1 through SS6. Figure 8 displays all proposed project locations overlaid on the permitted Site Boundary as well as the infrastructure changes as proposed by RFA 1. Related geospatial data layers have been provided to ODOE concurrently with this request.

4.0 Division 21 Requirements – OAR 345-027-0360(1)(c)

> *OAR 345-027-0360(1)(c) References to any specific Division 21 information that may be required for the Department to make its findings;*

The Council approved the Facility Site Certificate under the former organization of Division 21 exhibits. Under the reorganization effective April 2, 2025, former Division 21 exhibit requirements are now embedded in Division 22. However, given the limited nature of the proposed changes, new exhibits (now included in Division 22) are not necessary for this RFA because the relevant information is already provided, as detailed in Table 2 below. Further, due to the limited nature of the proposed changes, the new Division 21 required Background Information Exhibit is not necessary for this RFA because this RFA document also fulfills the needs of the Division 21 requirements. Table 2 provides a cross-walk between the revised Division 21 requirements and where those provisions are addressed in this RFA.

Table 2. Applicable Division 21 Requirements to RFA 1

Current 345-021-0010(3) Background Information Exhibit	Location
Information about the Proposed Facility **345-021-0010(3)(a);** Facility Location **345-021-0010(3)(b)**	Addressed by Division 027-0360(1)(b)(A-C); see Sections 1.0, 2.0 and 3.0.
Property Owner Information **345-021-0010(3)(c)**	Addressed by Division 027-0360(1)(f); see Section 7.0.
Applicable Statutes, Rules, and Local Government Ordinances **345-021-0010(3)(d)**	No changes to former Exhibit CC. Section 6 includes discussion of how the proposed Facility continues to meet the requirements of the applicable statutes, administrative rules and ordinances.
Materials Analysis **345-021-0010(3)(d)**	No changes to former Exhibit G. Section 4.2 addresses Materials Analysis as applicable to this RFA.

Current 345-021-0010(3) Background Information Exhibit	Location
Specific Standards **OAR 345-021-0010(3)(e)**	No changes to content in former Exhibit AA (EMF) or Exhibit DD (Specific Standards). Section 6.2 addresses specific standards applicable to the Facility.
NEPA Related Document **OAR 345-021-0010(3)(f)**	Section 4.4 addresses NEPA compliance as applicable.
Exhibit Table of Contents **OAR 345-021-0010(3)(g)**	Not applicable; Due the limited nature of the proposed changes, the Certificate Holder proposes that new exhibits are not necessary for this RFA.
Submittal Requests **OAR 345-021-0010(3)(h)**	An electronic copy of the RFA shall be submitted to ODOE.
Project Order Requests **OAR 345-021-0010(3)(i)**	Not applicable.

4.1 Applicable Statutes, Rules, and Local Government Ordinances – OAR 345-021-0010(3)(d)

> *(d) Identification, by legal citation, of all state statutes and administrative rules and local government ordinances containing standards or criteria that the proposed facility must meet for the Council to issue a site certificate, other than statutes, rules and ordinances identified in Exhibit E, and identification of the agencies administering those statutes, administrative rules and ordinances. The applicant must identify all statutes, administrative rules and ordinances that the applicant knows to be applicable to the proposed facility, whether or not identified in the project order. To the extent not addressed by other materials in the application, the applicant must include a discussion of how the proposed facility meets the requirements of the applicable statutes, administrative rules and ordinances.*

Section 6 includes discussion of how the Facility, with the proposed modifications in this RFA, continues to meet the requirements of the applicable statutes, administrative rules and ordinances.

4.2 Materials Analysis

> *(A) An inventory of substantial quantities of industrial materials flowing into and out of the proposed facility during construction and operation;*

Construction materials for the proposed changes will be similar to those approved for construction of the Facility as previously approved by the Council (due to the transmission line/corridor reduction, removal/relocation of the switchyard, and relocation/modification of one of the substations). In general, the proposed changes in RFA 1 will not significantly change or increase the amount of solid waste and wastewater generated by the Facility, and will not modify the procedures and practices used for handling these materials. The respective certificate holders will continue to comply with Site Certificate conditions related to materials and waste management.

4.3 Specific Standards – OAR 345-021-0010(3)(e)

> *OAR 345-021-0010(3)(e) If the proposed facility is a facility for which the Council has adopted specific standards, information about the facility providing evidence to support findings by the Council as required by the following rules:*
>
> > *(A) For wind energy facilities, OAR 345-024-0010 and 345-024-0015;*
> >
> > *(B) For surface facilities related to underground gas storage reservoirs, OAR 345-024-0030, including information required by OAR 345-024-0030(3);*
> >
> > *(C) For any transmission line under Council jurisdiction, OAR 345-024-0090; and*
> >
> > *(D) For a fossil-fueled power plant or other facility that emits carbon dioxide, OAR 345-024-0500 to 345-024-0720.*

Section 6.2 includes specific standards that are relevant to the Facility.

4.4 NEPA Related Documents – OAR 345-021-0010(3)(f)

OAR 345-21-0010(1)(e)(B) Documents prepared in connection with an environmental assessment or environmental impact statement for the proposed facility under the National Environmental Policy Act of 1970, if any, may contain some of the information required under section (1) of this rule. The applicant may copy relevant sections of such documents into the appropriate exhibits of the site certificate application. The applicant may otherwise submit full copies of those documents and include, in the appropriate exhibits of the site certificate application, cross-references to the relevant sections of those documents. The applicant may use such documents only to avoid duplication. The applicant must include additional information in the site certificate application as needed to meet the requirements of section (1) of this rule.

Not applicable.

5.0 Site Certificate Revisions – OAR 345-027-0360(1)(d)

> *OAR 345-027-0360(1)(d) The specific language of the site certificate, including conditions, that the certificate holder proposes to change, add, or delete through the amendment;*

Redlined Site Certificates are included in Attachment 1 for SS1, SS2, SS3, SS4, SS5, and SS6, respectively. The following changes to the original Facility Site Certificate are required:

- Amend Site Certificate Condition GEN-GS-02 to reflect specific, non-contingent dates to the construction schedules for each of the six facilities to implement the facilities' separation.
- Amend Site Certificate Condition GEN-GS-06 to reflect the revised transmission line length and location.

- Modify Site Certificate Facility Descriptions for the SS1, SS2, SS3, SS4, and SS6 Site Certificates, to reflect that the switchyard is only supporting/related infrastructure for SS5 (no associated Site Certificate Conditions).
- Delete Site Certificate Conditions GEN-GS-06, GEN-TL-01, and PRE-LU-02 from the SS2, SS3, SS4, SS5, and SS6 Site Certificates, to reflect that the transmission line is only supporting/related infrastructure for SS1.
- Modify Site Certificate Facility Descriptions for the SS4 and SS6 Site Certificates, to reflect that the O&M buildings are only supporting/related infrastructure for SS1, SS2, SS3, and SS5 (no associated Site Certificate Conditions).
- Add Site Certificate Condition GEN-GS-07 to reflect the sharing of related or supporting facilities between SS1, SS2, SS3, SS4, SS5, and SS6.
- Amend Site Certificate Conditions GEN-LU-02 and PRE-LU-07 to reflect the splitting of the compliance responsibility between the proposed Certificate Holders and corresponding projects.
- Amend PRE-RF-01 to reflect the updated decommissioning costs for SS1, SS2, SS3, SS4, SS5, and SS6.

6.0 Council Standards and Laws Applicable to the Proposed Change – OAR 345-027-0360(1)(e)

> *OAR 345-027-0360(1)(e) A list of all Council standards and other laws, including statutes, rules and ordinances, applicable to the proposed change, and an analysis of whether the facility, with the proposed change, would comply with those applicable laws and Council standards. For the purpose of this rule, a law or Council standard is "applicable" if the Council would apply or consider the law or Council standard under OAR 345-027-0375(2); and*

Council standards relevant to RFA 1 include Division 22 (General Standards for Siting Facilities) and Division 24 (Specific Standards for Siting Facilities). Division 23, which applies to non-generating facilities, does not apply to solar power-generating facilities. Similarly, inapplicable provisions of Divisions 22 and 24 (e.g., standards applicable to gas plants, gas storage, non-generating facilities, wind facilities, evaporative cooling towers) are not discussed.

Ultimately, the Facility will be constructed and operated substantially in the same manner as previously approved by the Council, which imposed conditions, as necessary, to comply with applicable laws and standards. Table 3 identifies Council standards and laws reviewed as part of RFA 1, their applicability to RFA 1, and the Site Certificate conditions that govern Facility compliance for each standard. Because there will be new Site Certificates created by the Facility split, all standards apply even though there will be no new areas of Site Boundary, maximum footprint, or new physical components of the Facility considered as a part of this RFA, other than the reduced transmission line route, removal/relocation of the switchyard, and relocation/modification of one of the substations.

Table 3. Standards and Laws Relevant to Proposed Amendment

Standard	Applicability & Compliance	Related Site Certificate Conditions[1]
OAR 345-022-0000 General Standard of Review	Applicable and complies. The Council previously found that the Facility complies with the General Standard of Review. Oregon's Renewable Portfolio Standard establishes a requirement for how much of Oregon's electricity must come from renewable resources like solar. The current Oregon Clean Energy Targets bill (Oregon Legislative Assembly 2021)[2] requires electricity providers to reduce the greenhouse gas emissions associated with electricity sold in Oregon to 100 percent below baseline emissions levels by 2040. RFA 1 is another step toward the Facility contributing to meeting this requirement. RFA 1 does not alter the basis for the Council's prior findings regarding the General Standard of Review and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. For RFA 1, the requirements of OAR 345-022-0000 are addressed in the findings, analysis, and conclusions discussed in Section 6.1.1.	GEN-GS-01 GEN-GS-02 GEN-GS-03 GEN-GS-04 GEN-GS-05 GEN-GS-06 PRE-GS-01 PRE-GS-02 OPR-GS-01 OPR-GS-02
OAR 345-022-0010 Organizational Expertise	Applicable and complies. The Council previously found that the Facility complies with the Organizational Expertise Standard. The Certificate Holder and Pine Gate Renewables have extensive experience in the development, financing, construction, and operation of renewable energy generation and energy storage facilities, including over 100 active solar sites in Oregon and throughout the U.S. Although there will be an LLC change for SS1 through SS6, the Certificate Holder Owner will remain the same (Pine Gate Renewables) and organizational resources will be deployed to effectively operate the split facilities. RFA 1 does not alter the basis for the Council's prior findings regarding the Organizational Expertise Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.2.	GEN-OE-01 GEN-OE-02 GEN-OE-03 GEN-OE-04 PRE-OE-01 PRE-OE-02 PRE-OE-03 PRE-OE-04 CON-OE-01 CON-OE-02 PRO-OE-01 OPR-OE-01
OAR 345-022-0020 Structural Standard	Applicable and complies. The Council previously found that the Facility complies with the Structural Standard. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal the of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Structural Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.3.	GEN-SS-01 GEN-SS-02 GEN-SS-03 GEN-SS-04 PRE-SS-01
OAR 345-022-0022 Soil Protection	Applicable and complies. The Council previously found that the Facility would comply with the Soil Protection Standard. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Soil Protection Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.4.	PRE-SP-01 PRE-SP-02 PRE-SP-03 CON-SP-01 CON-SP-02 CON-SP-03 PRO-SP-01 PRO-SP-02 OPR-SP-01

Standard	Applicability & Compliance	Related Site Certificate Conditions[1]
OAR 345-022-0030 Land Use	Applicable and complies. The Council previously found that the Facility complies with the Land Use Standard. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, additional disturbance areas, or authorized uses of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Land Use Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.5.	GEN-LU-01 GEN-LU-02 PRE-LU-01 PRE-LU-02 PRE-LU-03 PRE-LU-04 PRE-LU-05 PRE-LU-06 PRE-LU-07 CON-LU-01 OPR-LU-01
OAR 345-022-0040 Protected Areas	Applicable and complies. The Council previously found that the Facility complies with the Protected Areas Standard. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Protected Areas Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.6.	N/A
OAR 345-022-0050 Retirement and Financial Assurance	Applicable and complies. The Council previously found that the Facility complies with the Retirement and Financial Assurance Standard. The Certificate Holder Owner and new proposed Certificate Holders are still able to restore the site to a useful, nonhazardous condition following permanent cessation of construction or operation of the Facility as partitioned; Each of the six LLCs will pursue their own bond or letter of credit during preconstruction compliance. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Retirement and Financial Assurance Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.7.	GEN-RF-01 PRE-RF-01 CON-RF-01 OPR-RF-01 RET-RF-01 RET-RF-02
OAR 345-022-0060 Fish and Wildlife Habitat	Applicable and complies. The Council previously found that the Facility complies with the Fish and Wildlife Habitat Standard. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. Therefore, all areas have been reviewed and surveyed for fish and wildlife habitat and will be protected per relevant Site Certificate conditions. RFA 1 does not alter the basis for the Council's prior findings regarding the Fish and Wildlife Habitat Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.8.	PRE-FW-01 PRE-FW-02 PRE-FW-03 PRE-FW-04 CON-FW-01 CON-FW-02 OPR-FW-01 OPR-FW-02 OPR-FW-03
OAR 345-022-0070 Threatened and Endangered Species	Applicable and complies. The Council previously found that the Facility complies with the Threatened and Endangered Species Standard. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. Therefore, impacts to threatened and endangered species have already been reviewed and will be protected per relevant Site Certificate conditions. RFA 1 does not alter the basis for the Council's prior findings regarding the Threatened and Endangered Species Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.9.	PRE-TE-01 CON-TE-01

Standard	Applicability & Compliance	Related Site Certificate Conditions[1]
OAR 345-022-0080 Scenic Resources	Applicable and complies. The Council previously found that the Facility complies with the Scenic Resources Standard. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Scenic Resources Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.10.	N/A
OAR 345-022-0090 Historic, Cultural and Archaeological Resources	Applicable and complies. The Council previously found that the Facility complies with the Historic, Cultural and Archaeological Resources Standard. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. Therefore, all areas have been reviewed and surveyed for historic, cultural and archaeological resources and will be protected per relevant Site Certificate conditions. RFA 1 does not alter the basis for the Council's prior findings regarding the Historic, Cultural and Archaeological Resources Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.11.	PRE-HC-01 CON-HC-01 OPR-HC-01
OAR 345-022-0100 Recreation	Applicable and complies. The Council previously found that the Facility complies with the Recreation Standard. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Recreation Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.12.	N/A
OAR 345-022-0110 Public Services	Applicable and complies. The Council previously found that the Facility complies with the Public Services Standard. The proposed changes are not anticipated to increase the demand of public services generated by the Facility. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Public Services Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.13.	PRE-PS-01 PRE-PS-02 CON-PS-01 CON-PS-02
OAR 345-022-0115 Wildfire Prevention and Risk Mitigation	Applicable and complies. The Council previously found that the Facility complies with the Wildfire Prevention and Risk Mitigation Standard. RFA 1 is not anticipated to increase the amount of wildfire risk generated by the Facility. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Wildfire Prevention and Risk Mitigation Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.14.	PRE-WF-01 CON-WF-01 PRO-WF-01 OPR-WF-01
OAR 345-022-0120 Waste Minimization	Applicable and complies. The Council previously found that the Facility complies with the Waste Minimization Standard. RFA 1 is not anticipated to increase the amount of solid waste and wastewater generated by the Facility. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Waste Minimization Standard and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.15.	PRE-WM-01 CON-WM-01 CON-WM-02 PRO-WM-01 OPR-WM-01 OPR-WM-02

Standard	Applicability & Compliance	Related Site Certificate Conditions[1]
OAR 345-022-0160 State and Local Laws and Regulations	(1)(a) Removal-Fill Law (OAR Chapter 141) Applicable and complies. The Council previously found that the Facility complies with the Removal-Fill Law. DSL provided concurrence that no removal-fill permit will be required for the Facility. RFA 1 does not alter the basis for the Council's prior findings regarding Removal-Fill Law and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.16.1. (1)(b) Anticipated Water Use and Water Rights (OAR Chapter 690) Applicable and complies. The Council previously found that the Facility complies with the Water Rights regulations. There will be the same water volumes and sources as previously approved by Council for use during construction and operation of the Facility. RFA 1 does not alter the basis for the Council's prior findings regarding Water Rights regulations and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.16.2. (2) Noise Control Regulations (OAR 340-035-0035) Applicable and complies. The Council previously found that the Facility complies with the Noise Control Regulations. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Noise Control Regulations and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.1.16.3.	PRE-WL-01 * PRE-WR-01 CON-WR-01 PRO-WR-01 OPR-WR-01 * PRE-NC-01
OAR 345-024-0090 Siting Standards for Transmission Lines	Applicable and complies. The Council previously found that the Facility complies with the Siting Standards. There will be no changes to the Site Boundary, maximum footprint, new infrastructure, or additional disturbance areas of the Facility considered as a part of this RFA that would change these findings. As detailed in Section 3, the reduction of the approved transmission line will result in a shorter line with less impacts, as will the removal/relocation of the switchyard, located within the approved Site Boundary. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. RFA 1 does not alter the basis for the Council's prior findings regarding the Siting Standards and does not alter the Certificate Holder's ability to comply with the Site Certificate conditions. See Section 6.2.1.	GEN-TL-01

1. For Site Certification Condition definitions, please see the Final Approved Site Certification: https://www.oregon.gov/energy/facilities-safety/facilities/Facilities%20library/2024-11-18-SSPAPP-Site-Certificate-Signed.pdf.
2. Oregon Legislative Assembly. 2021. Enrolled House Bill 2021 (HB 2021-C). https://olis.oregonlegislature.gov/liz/2021R1/Downloads/MeasureDocument/HB2021/Enrolled.

6.1 Applicable Division 22 Standards

All Division 22 Standards were among the rules updated in April 2025 to migrate Energy Facility Siting Council (EFSC) application information requirements from Division 21 to Divisions 22-24. As part of this update, requirements for all exhibits from OAR 345-021-0010 were moved to this Division. Due to the minor, predominantly administrative nature of these changes, they do not impact the Council's previous determinations for any of the standards.

6.1.1 General Standard of Review – OAR 345-022-0000

The Council has previously found that the Facility complies with the General Standard of Review under OAR 345-022-0000[1]. OAR 345-022-0000 imposes the general review and evidentiary standards by which the Council considers site certificate decisions. This rule has not changed since the ASC was approved by the Council in November 2024. The information presented in the following sections demonstrates that the minor, predominantly administrative changes proposed in RFA 1 do not change the Facility's ability to comply with the Council's general or evidentiary siting standards, including those in OAR 345-022-0000. In this amendment request, the requirements of OAR 345-022-0000 are addressed in the findings, analysis, and conclusions discussed in the following Section 6.1, as previously determined in the Council's findings of fact and conclusions of law in the Final Order.

Under this standard, the Council previously adopted Site Certificate Conditions GEN-GS-01 through 06, PRE-GS-01, PRE-GS-02, OPR-GS-01, and OPR-GS-02. The Certificate Holder proposes to add one new general condition (i.e., GEN-GS-07, to reflect the sharing of related or supporting facilities between SS1, SS2, SS3, SS4, SS5, and SS6), otherwise, proposed updates to the Site Certificate conditions are outlined in Section 5, to reflect the changes proposed in this amendment request (e.g., amend GEN-GS-06 to reflect the revised transmission length and location). The Certificate Holder does not propose changes to the balance of Site Certificate Conditions.

In addition, the sections below demonstrate that RFA 1 does not change the Facility's ability to comply with requirements of the siting statutes and standards adopted by the Council and imposed in the Site Certificate. This amendment request also demonstrates how the Facility complies with relevant Oregon statutes and administrative rules including those identified in the Final Order on the ASC. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with OAR 345-022-0000.

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[1] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 36-37

6.1.2 Organizational Expertise – OAR 345-022-0010

6.1.2.1 Organizational Expertise – OAR 345-022-0010(1)-(4)

The Council has previously found that the Facility complies with the Organizational Expertise Standard under OAR 345-022-0010[2]. Currently, the Certificate Holder is Sunstone Solar, LLC and the Certificate Holder Owner is Pine Gate Renewables, LLC. The Council previously found that the current Certificate Holder and Pine Gate Renewables have the ability to design, construct, operate, and retire the proposed Facility in a manner that protects public health and safety, subject to Site Certificate Conditions GEN-OE-01 through 04, PRE-OE-01 through 04, CON-OE-01, CON-OE-02, PRO-OE-01, and OPR-OE-01.

With the proposed changes in RFA 1, six new Certificate Holders (new project LLCs) will operate. The current and proposed Certificate Holders' information, including contact information, is included in Section 2.

Third party permits will be obtained for construction of each project by the construction firm selected to build each project. The Certificate Holder anticipates that these third-party permits may include permits for obtaining aggregate and other construction materials, transporting materials to the site, and other building-related permits that are typically obtained immediately prior to construction activities.

RFA 1 does not affect the Certificate Holder Owner or newly formed Certificate Holders' organizational expertise. As reflected in the Final Order, the current Certificate Holder relied upon the organizational expertise and financial assurance of its parent company, Certificate Holder Owner Pine Gate Renewables, LLC, to demonstrate organizational expertise, and the Council concluded that reliance was justified and demonstrated the Certificate Holder's organizational expertise.[3] Similarly here, under RFA 1, the Certificate Holder Owner will retain ownership of and support the organizational expertise of each new Certificate Holder and the six new Site Certificates, each of which will remain subject to the requirements of the Site Certificate conditions applicable to the organizational expertise standard (see Table 3). Based upon compliance with these existing conditions, the Council can find that the new Certificate Holders and Certificate Holder Owner retain sufficient organizational expertise and the ability to access resources or services provided by the third-party permit. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with OAR 345-022-0010(1)-(4).

6.1.2.2 Applicant Information – OAR 345-022-0010(5)(a)(A)

See Section 2 and the following subsections.

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[2] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 45

[3] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 39-45

6.1.2.3 Other Participants – OAR 345-022-0010(5)(a)(B)

No other participants are anticipated at this time, with the exception of potential third-party permits that have been obtained by the construction firm selected to build the Facility and potential third-party permits for build-out of the Facility. These third-party permits include permits for obtaining aggregate and other construction materials, transporting materials to the site, and other building-related permits that are typically obtained immediately prior to construction activities. As confirmed through preconstruction Site Certificate compliance, these permits meet the facility standards adopted by the Council.

6.1.2.4 Other Affiliations – OAR 345-022-0010(5)(a)(C) through (G)

Sunstone Solar, LLC including Sunstone Solar 1, LLC, Sunstone Solar 2, LLC, Sunstone Solar 3, LLC, Sunstone Solar 4, LLC, Sunstone Solar 5, LLC, and Sunstone Solar 6, LLC are wholly-owned, indirect subsidiaries of Pine Gate Renewables, LLC. The full name and address of Pine Gate Renewables, LLC is provided in Section 2.

6.1.2.5 Limited Liability Company Information – OAR 345-022- 0010(5)(a)(H)

The articles of incorporation for all projects are provided in Attachment 2.[4] The cover letter accompanying this amendment request serves as a written consent for filing this application.

6.1.2.6 Organizational Expertise – OAR 345-022-0010(5)(b)

As discussed in Section 6.1.2.1, the Council previously found the current Certificate Holder and the Certificate Holder Owner demonstrated an ability to construct, operate, and retire the Facility in compliance with Council standards and conditions of the Site Certificate as reviewed during the Application for Site Certification for Sunstone Solar[5]. The current Certificate Holder is a wholly-owned, indirect subsidiary of Pine Gate Renewables, LLC (i.e., Certificate Holder Owner). Headquartered in Asheville, North Carolina, the Certificate Holder Owner develops and finances utility-scale solar facilities, creating value throughout the project lifecycle. The Certificate Holder Owner works with landowners, investors, corporations, and utilities across the country and prides itself on being strategic, creative, innovative, and trustworthy problem-solvers. From greenfield to commercial operations, PGR teams are committed to "get solar done."[6]

The current Certificate Holder and Certificate Holder Owner, a 100 percent American-owned independent power producer, have extensive experience in the development, financing, construction, and operation of renewable energy generation and energy storage facilities. Founded in 2014, Certificate Holder Owner is a leader in the solar industry and has closed more than $6.5B

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[4] Note that the Articles of Incorporation lists Chaye Besherse and Benjamin Catt as individuals who formed the business; Chaye Besherse is the Senior Director of Corporate Governance of Pine Gate Renewables, LLC and Benjamin Catt is the Chief Executive Officer of Pine Gate Renewables, LLC.

[5] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024

[6] https://pinegaterenewables.com/pine-gate-home/

in project financing and capital investment to date. An innovator in the movement for clean energy solutions, Certificate Holder Owner and its affiliates have developed a vertically integrated Engineering, Procurement, and Construction management model ensuring oversight of all engineering, procurement, construction, and management throughout the project lifecycle. Certificate Holder Owner's operational fleet includes over 100 active solar sites, 17 of which are generating 89.75 MW of clean, domestic energy in the state of Oregon. Currently accounting for more than 1.9 gigawatts (GW) of operating capacity, and with more than 21 GW in active development, Certificate Holder Owner's fleet is on pace to reach 200 facilities by 2028.

The current Certificate Holder and its parent company, Certificate Holder Owner, have experience working with a multitude of seasoned contractors trusted in the development and construction of renewable energy generation facilities. The Certificate Holder Owner establishes critical relationships with Engineering, Procurement, and Construction providers, manufacturers, and other professional firms to effectively design and execute projects at scale. While the Certificate Holder has not yet selected an architect, engineer, major component vendor, or prime contractor, the Certificate Holder Owner is committed to selecting highly qualified candidates to partner with.

With one of the nation's largest operating fleets and project pipelines, Pine Gate Renewables currently has more than 275 employees based across the United States with 2 GW of operating facilities and over 30 GW in currently in development. Pine Gate Renewables has owned and led numerous grid-tied solar facilities through the construction and operational phases and has a strong record of regulatory compliance across more than 100 operational facilities. For the eight facilities where Pine Gate Renewables has received administrative notices, the company has worked proactively with notifying entities to bring about timely resolution, resulting in no enforcement actions to date:

1 and 2. Wyse Fork Solar and Trent River Solar, NC – Each project received a North Carolina Department of Environmental Quality (NCDEQ) violation regarding project vegetation conditions; issues were promptly remedied; no further action required.

3. Pelham Solar, NC – Received NCDEQ violation regarding land disturbing activities and erosion control; remedial actions promptly began, including reassigning erosion work to a different contractor, and continue today; Follow up inspections confirm progress.

4. Highest Power Solar, NC – Received two administrative notices: one from the county after the contractor staged tank and storage containers not shown on the zoning permit plan (contractor removed equipment; no further action required), another from NCDEQ as to late permit fee payment (fee was waived; issue closed).

5. West River Solar, NC – Received an August 2025 violation from the county due to certain delayed sediment and erosion control measures; Pine Gate Renewables has proposed a corrective action plan to be completed in January 2026; response pending.

6. Rio Lago Solar, TX – Texas Commission on Environmental Quality issued four construction permit violations related to site inspection plans, stormwater, and sediment controls; Pine Gate promptly resolved the violations, which have been closed.

7. Glover Creek Solar, KY – Received Kentucky Department for Environmental Protection violation after some visual screening trees died and waste materials were not timely removed from the site. Pine Gate Renewables remedied the conditions and proposed a fall 2025 re-planting.

8. Mill Creek Solar – 3 MW project in Sheridan, OR – Participating landowner received a notice of violation from the county after certain vegetative buffer trees died; response was provided, proposing a fall replanting schedule; county has approved.

There are no circumstances that would alter the basis for the Council's earlier findings regarding Pine Gate Renewables' organizational expertise. Those findings concluded that the current Certificate Holder, based on its parent company's resources and experience, had the organizational expertise to support the Facility. Here too, the six new Certificate Holders would be subsidiaries of and fully supported by Pine Gate Renewables and its strong track record in renewable energy development and operation. Therefore, Council's previous findings that Pine Gate Renewables has the organizational expertise to construct, operate, and retire the Facility in compliance with Council standards and Site Certificate conditions apply with equal force to RFA 1 and the new Certificate Holders.

6.1.2.7 Required Permits – OAR 345-022-0010(5)(c)

Exhibit E of the ASC identified the federal, state, and local government permits related to the siting of the Facility, which were incorporated into Site Certificate conditions as necessary. The proposed changes do not require any new permits, nor any new Site Certificate conditions for permits, which were not previously considered by the Council. Where applicable, each new Certificate Holder will obtain the necessary permit(s) for each respective project during preconstruction compliance, and permits will not be shared between the proposed/respective projects.

6.1.3 Structural Standard – OAR 345-022-0020

The Council previously found that the Facility complies with the Structural Standard under OAR 345-022-0020.[7] The Structural Standard generally requires the Council to evaluate whether the Certificate Holder has adequately characterized the potential seismic, geological, and soil hazards within the Site Boundary, and that the Certificate Holder can design, engineer, and construct the Facility to avoid dangers to human safety and the environment from these hazards. The Certificate Holder provided information regarding the seismic characteristics within the Site Boundary, as well as an assessment of seismic and geologic hazards and other requirements of the Structural Standard in Exhibit H of the ASC (May 2024).

The proposed division of the Facility into the six facilities does not significantly alter the approved infrastructure or configuration (and in turn structural changes) of the Facility. As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and

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[7] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 53

other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts.

The proposed changes do not affect the Certificate Holder's ability to design, engineer, and construct the Facility to avoid dangers to human safety and the environment that are presented by seismic hazards affecting the Site Boundary. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions GEN-SS-01 through 04, and PRE-SS-01 to address the potential for seismic and non-seismic geologic hazards at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0020 or any structural conditions (see Table 3) in the Site Certificate. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with OAR 345-022-0020.

6.1.4 Soil Protection – OAR 345-022-0022

The Council previously found that the Facility complies with the Soil Protection Standard under OAR 345-022-0022.[8] The Soil Protection Standard requires the Council to find that, after taking mitigation into account, the design, construction, and operation of a facility will not likely result in a significant adverse impact to soils. The Certificate Holder provided information regarding erosion control and soil protection measures within the Site Boundary, as well as an assessment soil types and other requirements of the Soil Protection Standard in Exhibit I of the ASC (May 2024). The proposed division of the Facility into SS1 through SS6 does not significantly alter the approved infrastructure or configuration (and in turn soil disturbance impacts) of the Facility. As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts.

The proposed changes do not affect the Certificate Holder's ability to design, construct, and operate the Facility to prevent impacts to soils within the Site Boundary. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions PRE-SP-01 through 03, CON-SP-01 through 03, PRO-SP-01, PRO-SP-02, and OPR-SP-01 to address soil protection measures at the Facility (see Attachment 3 for updated Dust Control Plans for each of the proposed six projects); all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0022 or any soil protection conditions

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[8] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 59

(see Table 3) in the Site Certificate. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with OAR 345-022-0022.

6.1.5 Land Use – OAR 345-022-0030

The Council previously found that the Facility complies with the Land Use Standard under OAR 345-022-0030.[9] The Land Use Standard requires the Council to find that the proposed facility complies with the statewide planning goals adopted by the Land Conservation and Development Commission. The Certificate Holder provided information regarding land use and measures within and applicable to the analysis area (i.e., 0.5 miles). The proposed division of the Facility into SS1 through SS6 does not change authorized land uses, or significantly alter the approved infrastructure or configuration of the Facility. As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. Note that the Certificate Holder has notified the Morrow County Planning Department regarding the removal and exclusion of the switchyard area from the Site Boundary.

There have been no changes to the Morrow County Zoning Ordinance[10] and Morrow County Comprehensive Plan (applicable to all projects) since approval of the ASC (November 2024) that would affect the Council's previous findings of compliance with the Land Use Standard. The Certificate Holder will pursue a Conditional Use Permit with Morrow County (and any other requirements imposed by the Site Certificate conditions outlined below) prior to construction of all projects. The Council granted a Goal 3 exception for the approved Facility Site Boundary as justified under OAR 345-022-0030(4)(c) and Oregon Revised Statutes (ORS) 469.504(2)(c)[11]. RFA 1 proposes no changes to the approved Goal 3 exception area, solar facility components or maximum footprint that would affect the approved Goal 3 exception. The Certificate Holder will otherwise continue to comply with all applicable substantive criteria.

The proposed changes do not affect the Certificate Holder's ability to adhere to the Land Use Standard. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions GEN-LU-01, GEN-LU-02, PRE-LU-01 through 07, CON-LU-01, and OPR-LU-01 to address land use protection measures at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). One amendment is proposed to Site Certificate Conditions GEN-LU-02 and PRE-LU-07 to reflect the splitting of the compliance responsibility between the proposed Certificate Holders and corresponding projects (see Section 5 and Attachment 1 for further detail). Any amendments will not conflict with the Council's findings on the Agricultural Mitigation Plan as stated in Section 12 of the Memorandum of Agreement (MOA), and relevant reports and notifications as required by the MOA will be provided

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[9] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 128

[10] Note that the Zoning Ordinance was updated in 2025 post submittal of pRFA, but none of the changes affect the Council's previous findings of compliance with the Land Use Standard.

[11] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 128

in coordination with the County. The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0030. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Land Use Standard.

6.1.6 Protected Areas – OAR 345-022-0040

The Council previously found that the Facility complies with the Protected Areas Standard under OAR 345-022-0040.[12] The Protected Areas standard requires the Council to find that, taking into account mitigation, the design, construction, and operation of a facility are not likely to result in significant adverse impacts to any protected area as defined by OAR 345-001-0010. OAR 345-022-0040 was amended in December 2022. The definition of "protected area," which was formerly located in OAR 345-022-0040, was replaced and amended in OAR 345-001-0010. The amendment in OAR 345-001-0010 includes updating the categories of protected areas, removing specific area references and replacing them with references to authorizing law or statute for designation; expanding the list to include Wilderness Study Areas, Special Interest Areas, and special resource management areas administered by a Federal Agency other than the Bureau of Land Management; and additional editorial changes for clarity and consistency.

The Certificate Holder provided information regarding protected areas within the analysis area (i.e., 12 miles, as established in the Project Order[13]). The proposed division of the Facility into SS1 through SS6 does not change protected area impacts, or significantly alter the approved infrastructure or configuration of the Facility. As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts.

The Council previously found that the Facility will not result in significant adverse impacts for any protected area. There are three defined protected areas within the analysis area. No new protected areas have been added within the analysis area since ASC approval (November 2024).

The proposed changes do not affect the Certificate Holder's ability to adhere to the Protected Areas Standard. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. There are no previously imposed Council Site Certificate Conditions for the Protected Areas Standard. The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0040. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Protected Areas Standard.

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[12] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 140

[13] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 128

6.1.7 Retirement and Financial Assurance – OAR 345-022-0050

6.1.7.1 Retirement and Site Restoration – OAR 345-022-0050(1) and (2)

The Council previously found that the Facility complies with the Retirement and Financial Assurance Standard under OAR 345-022-0050.[14] The Retirement and Financial Assurance Standard requires the Council to find that, taking into account mitigation, the site can be restored to a useful, non-hazardous condition following permanent cessation of construction or operation of the Facility, and the Certificate Holder has a reasonable likelihood of obtaining a bond or letter of credit in a form and amount satisfactory to the Council. The current Certificate Holder provided information regarding retirement and financial assurances applicable to the Site Boundary, as well as an assessment of retirement costs and other requirements of the Retirement and Financial Assurance Standard in Exhibit X of the ASC (May 2024).

The proposed division of the Facility into SS1 through SS6 does not significantly alter the approved infrastructure or configuration, and in turn does not significantly alter the overall retirement costs of the Facility. As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. Prior to beginning construction of each project, each proposed Certificate Holder will provide a cost estimate and bond in an amount equal to the net costs of the Facility retirement, calculated for final design and in an amount approved by ODOE (previously approved for $117.945 million [first-quarter 2023 dollars]). The current Certificate Holder has provided updated cost estimates for SS1, SS2, SS3, SS4, SS5, and SS6 (see Attachment 4; $24.2 million fourth quarter 2025 dollars, $23.5 million fourth quarter 2025 dollars, $23.4 million fourth quarter 2025 dollars, $23.4 million fourth quarter 2025 dollars, $25.0 million fourth quarter 2025 dollars, and $23.4 million fourth quarter 2025 dollars, respectively). The Certificate Holder Owner shall remain the same.

Therefore, the proposed changes do not affect the Certificate Holder's ability to adhere to the Retirement and Financial Assurance Standard. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions GEN-RF-01, PRE-RF-01, CON-RF-01, OPR-RF-01, RET-RF-01, and RET-RF-02 to address retirement and financial assurance measures at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). One amendment is proposed to Site Certificate Condition PRE-RF-01, to reflect the updated decommissioning costs for SS1, SS2, SS3, SS4, SS5, and SS6 (see Section 5 and Attachment 1 for further detail). Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Retirement and Financial Assurance Standard.

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[14] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 148

6.1.7.2 Financial Capability – OAR 345-022-0050(3) and (4)

Attachment 5 includes the opinion from Pine Gate Renewable's legal counsel indicating that Sunstone Solar 1, LLC, Sunstone Solar 2, LLC, Sunstone Solar 3, LLC, Sunstone Solar 4, LLC, Sunstone Solar 5, LLC, and Sunstone Solar 6, LLC, have the legal authority to construct and operate without violating their articles of incorporation or similar agreements.

The Council previously found that the current Certificate Holder has a reasonable likelihood of obtaining a bond or letter of credit in an amount necessary to retire and restore the Facility, originally calculated at $117.945 million (first-quarter 2023 dollars)[15]. The Council also previously approved a letter from a financial institution demonstrating that the current Certificate Holder has a reasonable likelihood to obtain one or more bonds in an amount equal to or greater than the cost of Facility retirement and restoration[16]. Prior to beginning construction of each project, each proposed Certificate Holder will provide a bond or letter of credit in amounts equal to the net costs of each respective project's retirement, calculated for final design and in amounts that are approved by ODOE. These bonds ensure that adequate funds exist for the retirement of the facilities constructed and for restoration of the site to a useful, non-hazardous condition. The bonds will be adjusted annually for inflation according to the Gross Domestic Product Implicit Price Deflator Index.

6.1.8 Fish and Wildlife Habitat – OAR 345-022-0060

The Council previously found that the Facility complies with the Fish and Wildlife Habitat Standard under OAR 345-022-0060.[17] The Fish and Wildlife Habitat Standard requires the Council to find that the design, construction, and operation of the facility, taking into account mitigation, are consistent with ODFW's habitat mitigation goals and standards, as set forth in OAR 635-415-0025. This rule creates requirements for mitigating impacts to fish and wildlife habitat, based on the functional quantity and quality of the habitat impacted, as well as the nature, extent, and duration of the impact. The Certificate Holder provided information regarding fish and wildlife habitat (and relevant survey reports) within and applicable to the analysis area (i.e., 0.5 miles), mitigation plans, as well as an assessment of habitat impacts and other requirements of the Fish and Wildlife Habitat Standard in Exhibit P of the ASC (May 2024). The proposed division of the Facility into SS1 through SS6 does not change fish and wildlife habitat impacts, or significantly alter the approved infrastructure, or configuration of the Facility. As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. Approval of the amendment would not result in any impacts to fish and wildlife habitat that have not previously been addressed by the Council. There have been no changes to fish and wildlife habitat within the analysis area since ASC approval (November 2024). The entire Facility Site Boundary has been surveyed for fish and wildlife habitat (per survey reports provided/approved in Exhibit P of

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[15] Final Order on Application for Site Certificate for Sunstone Solar Project, November 2024, pp. 146
[16] Final Order on Application for Site Certificate for Sunstone Solar Project, November 2024, pp. 147
[17] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 165

the ASC) and the proposed changes would not affect the Council's previous findings of compliance with the Fish and Wildlife Habitat Standard. Draft mitigation plans for each of the six projects are included in Attachment 3. These mitigation plans will be updated, as necessary, during preconstruction compliance based on final layout impact calculation(s).

The proposed changes do not affect the Certificate Holder's ability to adhere to the Fish and Wildlife Habitat Standard. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions PRE-FW-01 through 04, CON-FW-01, CON-FW-02, and OPR-FW-1 through 03 to address fish and wildlife habitat protection measures at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0060. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Fish and Wildlife Habitat Standard.

6.1.9 Threatened and Endangered Species – OAR 345-022-0070

The Council previously found that the Facility complies with the Threatened and Endangered Species Standard under OAR 345-022-0070.[18] The Threatened and Endangered Species Standard requires the Council, after consultation with appropriate state agencies, to ensure the design, construction, and operation of the proposed facility, taking into account mitigation, will not cause a significant reduction in the likelihood of survival or recovery of Oregon Department of Agriculture or ODFW-listed species. The Certificate Holder provided information regarding threatened and endangered species (and relevant survey reports) within and applicable to the analysis area (i.e., 5 miles), as well as an assessment of species impacts and other requirements of the Threatened and Endangered Species Standard in Exhibit Q of the ASC (May 2024). The proposed division of the Facility into SS1 through SS6 does not change threatened and endangered species impacts, or significantly alter the approved infrastructure, or configuration of the Facility; As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. The Council previously found that the Facility will not result in significant adverse impacts to Oregon Department of Agriculture or ODFW-listed species. There have been no changes to the threatened and endangered species within the analysis area since ASC approval (November 2024). The entire Facility Site Boundary has been surveyed for threatened and endangered species (per survey reports provided/approved in Exhibit Q of the ASC (November 2024) and the proposed changes would not affect the Council's previous findings of compliance with the Threatened and Endangered Species Standard.

The proposed changes do not affect the Certificate Holder's ability to adhere to the Threatened and Endangered Species Standard. Best management practices will continue to be implemented for the

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[18] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 169

facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions PRE-TE-01 and CON-TE-01 to address threatened and endangered species protection measures at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0070. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Threatened and Endangered Species Standard.

6.1.10 Scenic Resources – OAR 345-022-0080

The Council previously found that the Facility complies with the Scenic Resources Standard under OAR 345-022-0080.[19] The Scenic Resource Standard requires the Council to determine that the design, construction, and operation of the proposed Facility will not have a "significant adverse impact" to any significant or important scenic resources in the analysis area. OAR 345-022-0080 was amended in December 2022, with the following changes: removal of a reference to the analysis area, addition of scenic resources identified as significant or important under state or multi-jurisdictional land management plans, and additional editorial changes for clarity and consistency.

The Certificate Holder provided information regarding scenic resources and relevant management plans within and applicable to the analysis area (i.e., 10 miles, per OAR 345-001-0010(35)(b)), as well as an assessment of visual impacts and other requirements of the Scenic Resources Standard in Exhibit R of the ASC (May 2024). The proposed division of the Facility into SS1 through SS6 does not change scenic resource impacts, or significantly alter the approved infrastructure, or configuration of the Facility. As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. The Council previously found that while Facility components will result in a change to the existing viewshed of the scenic resources, the visual impacts of construction and operation of the Facility will not likely result in a significant adverse impact to any scenic resource due to the distance, low impact to users, lack of specified management of scenic or visual qualities (or designated views or viewsheds) outside the scenic resources, and the presence of obstructions or similar structures within the existing viewshed. There is one defined important scenic resource and nine land management plans applicable to the analysis area[20]. No new important scenic resources or land management plans have been added within the analysis area since ASC approval (November 2024).

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[19] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 176

[20] Note that ONHT high-potential sites and segments were deemed by ODOE to not qualify as scenic resources for the recently reviewed Leaning Juniper II B Wind Power Facility (Proposed Order on Request for Site Certificate Amendment 3 for Leaning Juniper IIB Wind Power Facility, July 2025), therefore, it is proposed that the previously identified Wells Springs ONHT high-potential site no longer be considered a scenic resource for the purposes of this and future Facility amendments (as applicable).

The proposed changes do not affect the Certificate Holder's ability to adhere to the Scenic Resources Standard. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. There are no previously imposed Council Site Certificate Conditions for the Scenic Resources Standard. The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0080. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Scenic Resources Standard.

6.1.11 Historical, Cultural and Archaeological Resources – OAR 345-022-0090

The Council previously found that the Facility complies with the Historical, Cultural and Archaeological Resources Standard under OAR 345-022-0090.[21] The Historical, Cultural and Archaeological Resources Standard requires the Council to find that the construction and operation of the facility, taking into account mitigation, are not likely to result in significant adverse impacts to historic, cultural or archaeological resources. The Certificate Holder provided information regarding historic, cultural and archaeological resources (and relevant survey reports) within the analysis area (i.e., 2 miles), as well as an assessment of resource impacts and other requirements of the Historical, Cultural and Archaeological Resources Standard in Exhibit S of the ASC (May 2024). The proposed division of the Facility into the six facilities does not change historic, cultural and archaeological resource impacts, or significantly alter the approved infrastructure, or configuration of the Facility. As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. The Council previously found that the Facility will not result in significant adverse impacts to historic, cultural or archaeological resources that have been listed on, or would likely be listed on the National Register of Historic Places or other archaeological objects or sites identified under OAR 345-022-0090. There have been no changes to the historic, cultural and archaeological resources within the analysis area since ASC approval (November 2024). The entire Facility Site Boundary has been surveyed for historic, cultural and archaeological resources (per survey reports provided/approved in Exhibit S of the ASC and the proposed changes would not affect the Council's previous findings of compliance with the Historical, Cultural and Archaeological Resources Standard.

The proposed changes do not affect the Certificate Holder's ability to adhere to the Historical, Cultural and Archaeological Resources Standard. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions PRE-HC-01, CON-HC-01, and OPR-HC-01 to address historic, cultural, and archaeological resource protection measures at the Facility (see Attachment 3 for updated Inadvertent Discovery Plans for each of the proposed six projects); all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor,

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[21] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 186

removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0090. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Historical, Cultural and Archaeological Resources Standard.

6.1.12 Recreation – OAR 345-022-0100

The Council previously found that the Facility complies with the Recreation Standard under OAR 345-022-0100.[22] The Recreation Standard requires the Council to find that the design, construction, and operation of a facility will not likely result in significant, adverse impacts to important recreational opportunities. Therefore, the Council's Recreation Standard applies to only those recreation areas that the Council deems important. OAR 345-022-0100 was amended in December 2022, with editorial changes for clarity and consistency. The changes also specify that the amended standards only apply to applications or RFAs filed on or after the effective date of this amendment.

The Certificate Holder provided information regarding recreation areas within the analysis area (i.e., 5 miles, per OAR 345-001-0010(35)(d)), as well as an assessment of indirect/direct, noise, traffic, and visual impacts and other requirements of the Recreation Standard in Exhibit T of the ASC (May 2024). The proposed division of the Facility into six facilities does not change recreational opportunity impacts, or significantly alter the approved infrastructure, or configuration of the Facility; As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. The Council previously found that the Facility will not result in direct or indirect loss of any of the recreational opportunities identified as important. There are two defined recreational sites within the analysis area; no new recreational sites have been added within the analysis area since ASC approval (November 2024).

The proposed changes do not affect the Certificate Holder's ability to adhere to the Recreation Standard. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. There are no previously imposed Council Site Certificate Conditions for the Recreation Standard. The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0100. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Recreation Standard.

6.1.13 Public Services – OAR 345-022-0110

The Council previously found that the Facility complies with the Public Services Standard under OAR 345-022-0110.[23] The Council's Public Services Standard requires the identification of likely, significant, adverse impacts caused by the Facility on the ability of public and private service

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[22] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 192-193

[23] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 203

providers to supply sewer and sewage treatment, water, stormwater drainage, solid waste management, housing, traffic safety, police and fire protection, health care, and schools. The Certificate Holder provided information regarding public service providers and measures within and applicable to the analysis area (i.e., 15 miles, 60-minutes commuting distance for the housing and traffic analyses), and other requirements of the Public Services Standard in Exhibit U of the ASC (May 2024). The proposed division of the Facility into six facilities does not change public service impacts, or significantly alter the approved infrastructure, or configuration of the Facility; As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. The previously evaluated peak number of workers needed during construction will continue to represent a worst-case scenario related to impacts to public services.

The proposed changes do not affect the Certificate Holder's ability to adhere to the Public Services Standard. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions PRE-PS-01, PRE-PS-02, CON-PS-01, and CON-PS-02 to address public service measures at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0110 or any public service conditions (see Table 3) in the Site Certificate. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Public Services Standard.

6.1.14 Wildfire Prevention and Risk Mitigation – OAR 345-022-0115

The Council previously found that the Facility complies with the Wildfire Prevention and Risk Mitigation Standard under OAR 345-022-0115.[24] The Council's Wildfire Prevention and Risk Mitigation Standard requires wildfire risk at the Facility to be adequately characterized and requires the Facility to operate in compliance with a Council-approved construction and operations wildfire mitigation plans. The Certificate Holder provided information regarding wildfire risk and measures within and applicable to the analysis area (i.e., 0.5 miles) and other requirements of the Public Services Standard in Exhibit V of the ASC (May 2024). The proposed division of the Facility into six facilities does not change wildfire risk, or significantly alter the approved infrastructure (including best management practices/measures/procedures), or configuration of the Facility; As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. There are no new potential sources of wildfire that will be generated from the construction and operation of the Facility that were not previously reviewed by the Council for the Facility.

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[24] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 227

The proposed changes do not affect the Certificate Holder's ability to adhere to the Wildfire Prevention and Risk Mitigation Standard. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions PRE-WF-01, CON-WF-01, PRO-WF-01, and OPR-WF-01 to address wildfire prevention measures at the Facility (see Attachment 3 for updated Wildfire Mitigation Plans for each of the proposed six projects); all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0115 or any wildfire prevention conditions (see Table 3) in the Site Certificate. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Wildfire Prevention and Risk Mitigation Standard.

6.1.15 Waste Minimization – OAR 345-022-0120

The Council previously found that the Facility complies with the Waste Minimization Standard under OAR 345-022-0120.[25] The Council's Waste Minimization Standard requires that solid waste and wastewater are minimized during construction and operation of the Facility, and that plans are enforced to recycle, reuse, and properly manage waste generated at the Facility. The Certificate Holder provided information regarding waste types and control measures applicable to the Site Boundary and other requirements of the Waste Minimization Standard in Exhibit W of the ASC (May 2024). The proposed division of the Facility into SS1 through SS6 does not change waste production or sources or significantly alter the approved infrastructure or configuration of the Facility; As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. The Facility will continue to adhere to requirements imposed by the Morrow County Solid Waste Management Ordinance, specifically those applicable to post-construction projects, including covering and securing of waste products hauled during operations and providing waste amounts/types to the Morrow County Watershed. There are no new types of solid waste that will be generated from the operation of the Facility that were not previously reviewed by the Council for the Facility.

The proposed changes do not affect the Certificate Holder's ability to adhere to the Waste Minimization Standard. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions PRE-WM-01, CON-WM-01, CON-WM-02, PRO-WM-01, OPR-WM-01, and OPR-WM-02 to address waste minimization measures at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-022-0120 or any waste minimization conditions (see Table 3) in the Site Certificate.

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[25] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 231

Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Waste Minimization Standard.

6.1.16 State and Local Laws and Regulations – OAR 345-022-0160

6.1.16.1 Wetlands and Other Jurisdictional Waters– OAR 345-022-0160(1)(a)

The Council previously found that the Facility complies with the Removal-Fill Law.[26] The Oregon Removal-Fill Law (ORS 196.795 through ORS 196.990) and Oregon Department of State Lands regulations (OAR Chapter 141) require a removal-fill permit if 50 cubic yards or more of material is removed, filled, or altered within any "waters of the state." The Certificate Holder provided information regarding the need for a removal-fill permit, as well as an assessment of jurisdictional waters and other requirements of the Water Rights regulations in Exhibit J of the ASC (May 2024); A removal-fill permit was determined to not be required for the Facility because the Facility, including with the proposed changes, will not temporarily or permanently impact waters of the state such that a removal-fill permit is required.

The proposed changes do not affect the Certificate Holder's ability to adhere to the Removal-Fill Law. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions PRE-WL-01 to address removal-fill measures at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with Removal-Fill conditions (see Table 3) in the Site Certificate. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Removal-Fill Law.

6.1.16.2 Water Requirements – OAR 345-022-0160(1)(b)

The Council previously found that the Facility complies with the Water Rights regulations.[27] Under ORS Chapter 537 and OAR Chapter 690, the Oregon Water Resources Department administers the appropriation of water rights and regulates the use of the water resources of the state. The Certificate Holder provided information regarding water quantities and sources within the Site Boundary and other requirements of the Water Rights regulations in Exhibit O of the ASC (May 2024). The proposed division of the six facilities, reduction of the transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change construction or operation water usage or sources approved for use at the Facility.

The proposed changes do not affect the Certificate Holder's ability to adhere to the Water Rights regulations. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions PRE-WR-01, CON-WR-01, PRO-WR-01 and OPR-WR-01 to

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[26] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 244

[27] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 248

address water usage measures at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with the Water Rights regulations or conditions (see Table 3) in the Site Certificate (and does not require a groundwater permit, surface water permit, or water right transfer). Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Water Rights regulations.

6.1.16.3 Noise Control Regulations – OAR 345-022-0160(2)

The Council previously found that the Facility complies with the Noise Control Regulations under OAR 340-035-0035.[28] The proposed division of the Facility into SS1 through SS6 does not significantly alter the approved infrastructure or configuration (and in turn noise sources/sound levels) of the Facility, with the exception of the approved transmission line/corridor, which will be shortened (thus reducing impacts) and relocated to be more internal within the approved Site Boundary amongst other approved, noise-emitting infrastructure (e.g., solar arrays/inverters/transformers, BESS, and substations). Similarly, one of the switchyards will be removed from the approved Site Boundary and no longer considered Facility related or supporting infrastructure for SS1 – SS4 and SS6, and thus will result in less Facility noise impacts. The relocated/modified substation will also be within the approved Site Boundary and, combined with reduction of the transmission line and removal the of one of the switchyards, will still result in similar overall impacts as previously approved as well as a smaller Site Boundary. The Certificate Holder provided noise control sources and measures within and applicable to the Site Boundary as well as an assessment of noise levels and addressed compliance with the Oregon Department of Environmental Quality noise regulations in Exhibit X of the ASC (May 2024).

The proposed changes do not affect the Certificate Holder's ability to adhere to the Noise Control Regulations. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions PRE-NC-01 to address noise control measures at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 340-035-0035 or any noise control conditions (see Table 3) in the Site Certificate. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Noise Control Regulations.

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[28] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 243

6.2 Applicable Division 24 Standards

6.2.1 Siting Standards for Transmission Lines – OAR 345-024-0090

The Council previously found that the Facility complies with the Siting Standards for Transmission Lines under OAR 345-024-0090.[29] The Certificate Holder provided information regarding transmission lines and safety measures within and applicable to the Site Boundary, as well as an assessment electric and magnetic fields and other requirements of the Siting Standards for Transmission Lines in Exhibit AA of the ASC (May 2024). The proposed division of the Facility into SS1 through SS6 does not significantly alter the approved infrastructure or configuration of the Facility; As detailed in Section 3, the proposed changes will result in a shorter transmission route, one less switchyard, and other configuration efficiencies that will result in a smaller overall Site Boundary and similar or reduced overall impacts. The proposed changes do not affect the Certificate Holder's ability to adhere to the Siting Standards for Transmission Lines. Best management practices will continue to be implemented for the facilities, as proposed, as required through the relevant Site Certificate Conditions. The Council previously adopted Site Certificate Conditions GEN-TL-01 to address the transmission line measures at the Facility; all conditions or portions of the conditions are applicable to all facilities as proposed (as listed in Table 3). The proposed split of the Facility, reduced transmission line/corridor, removal/relocation of the switchyard, and relocation/modification of the substation does not change the Facility's compliance with OAR 345-024-0090 or any transmission line siting conditions (see Table 3) in the Site Certificate. Therefore, the Council may find that the Facility, as amended by RFA 1, will continue to comply with the Siting Standards for Transmission Lines.

7.0 Property Owners Located within or Adjacent to the Site of the Facility – OAR 345-027-0360(1)(f)

> *OAR 345-027-0360(1)(f) A list of the names and mailing addresses of property owners, as described in this rule:*
>
> *(A) The list must include all owners of record, as shown on the most recent property tax assessment roll, of property located:*
>
> *(i) Within 100 feet of property which the subject of the request for amendment, where the subject property is wholly or in part within an urban growth boundary;*
>
> *(ii) Within 250 feet of property which is the subject of the request for amendment, where the subject property is outside an urban growth boundary and not within a farm or forest zone; or*

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[29] Final Order on Application for Site Certificate for the Sunstone Solar Project, November 2024, pp. 235

> > *(iii) Within 500 feet of property which is the subject of the request for amendment, where the subject property is within a farm or forest zone; and*
>
> *(B) In addition to incorporating the list in the request for amendment, the applicant must submit the list to the Department in an electronic format acceptable to the Department.*

A list of the names and mailing addresses of property owners located within 500 feet of the property underlying the area subject to RFA 1 is provided in Attachment 6. The Certificate Holder requested the most recent property tax assessment roll from the Morrow County assessor offices on June 27, 2025 and the property owner information provided in Attachment 6 reflects information received on July 8, 2025.

8.0 Analysis Areas – OAR 345-027-0360(3)

> *OAR 345-027-0360(3) For any Council standard that requires evaluation of impacts within an analysis area, the analysis area is the larger of either the study areas, as defined in OAR 345-001-0010(59), or the analysis areas described in the project order for the application for site certificate, unless otherwise approved in writing by the Department following a pre-amendment conference.*

RFA 1 does not seek to enlarge the existing Site Boundary, maximum footprint, or most physical components of the Facility, and there is no change to the previously approved facilities from what was originally authorized for the Facility. RFA 1 seeks to reduce the transmission line route, remove/relocate one of the switchyards, relocate/modify one of the substations, and divide the Facility into six separate facilities within the approved Site Boundary. Therefore, the various analysis areas/study areas that were utilized and approved for the ASC (see Section 1.2) will remain unchanged.

9.0 Relevant Evidence Previously Submitted to ODOE – OAR 345-027-0360(4)

> *OAR 345-027-0360(4) The certificate holder may incorporate, by specific reference, evidence previously submitted to the Department in the application for site certificate or previous request for amendment, or evidence that is otherwise included in the Department's record on the facility.*

The Certificate Holder incorporates by reference the Application for Site Certificate, for supplemental information as specifically referenced in the standards compliance discussions provided in Sections 3 through 8 of this RFA.

10.0 Conclusion

This amendment request demonstrates that the proposed division of the Facility complies with all applicable laws and Council standards. For the reasons stated above, the Certificate Holder respectfully requests approval of RFA 1.

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Figures

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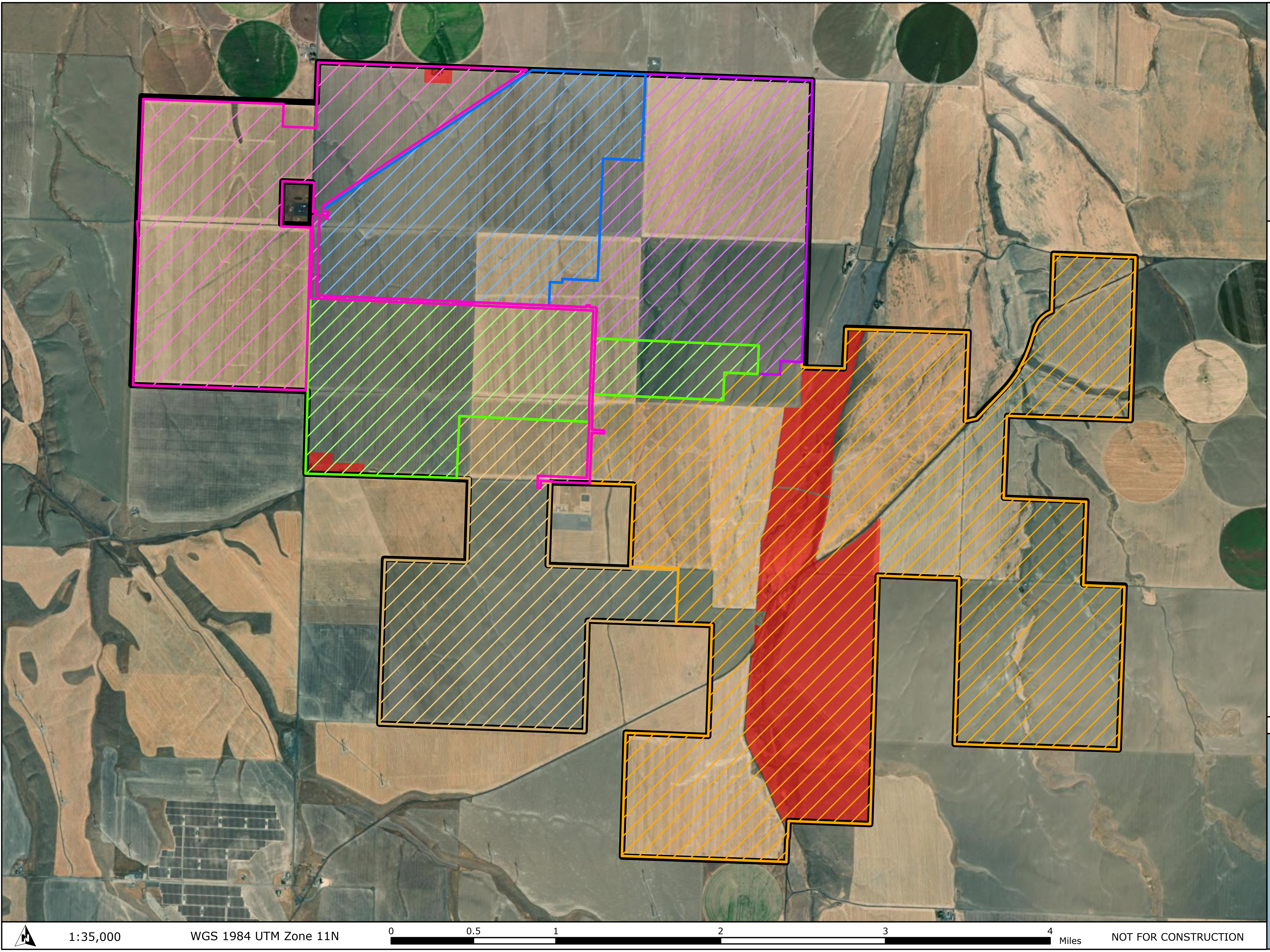
Sunstone Solar Project

Figure 1
Sunstone Solar Project Site Boundary

MORROW COUNTY, OR



▬ ASC Approved Site Boundary

🟥 Excluded from Development

Proposed Boundaries

- ▨ SS 1 Site Boundary
- ▨ SS 2 Site Boundary
- ▨ SS 3 Site Boundary
- ▨ SS 4 Site Boundary
- ▨ SS 5 Site Boundary
- ▨ SS 6 Site Boundary

TETRA TECH

Reference Map

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Sunstone Solar Project

Figure 2
Sunstone Solar Project 1 Proposed Site Boundary

MORROW COUNTY, OR

▬	ASC Approved Site Boundary
🟥	Excluded from Development
▨	SS 1 Site Boundary

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Reference Map

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NOT FOR CONSTRUCTION

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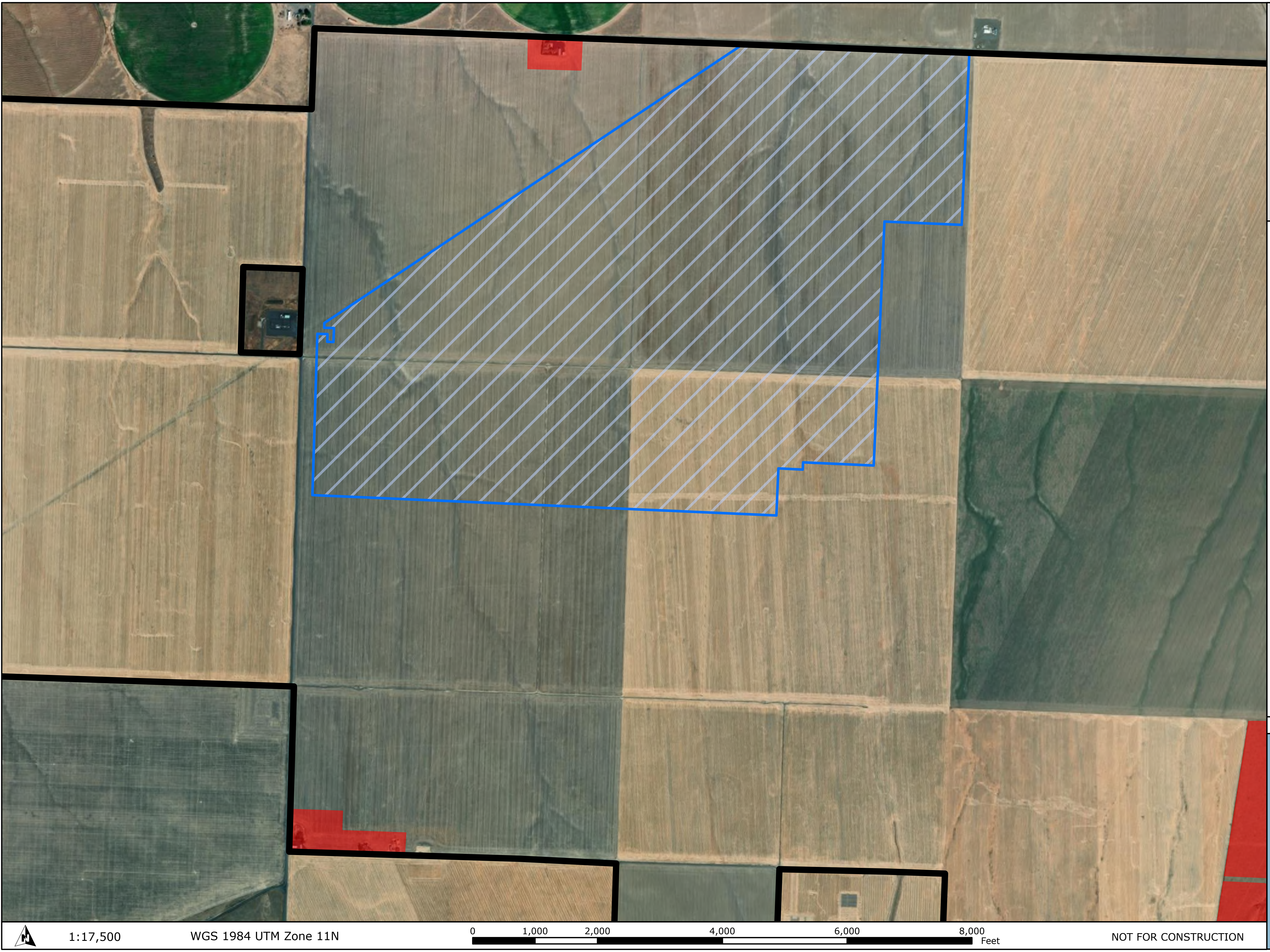
Sunstone Solar Project

Figure 3
Sunstone Solar Project 2 Proposed Site Boundary

MORROW COUNTY, OR



▬ ASC Approved Site Boundary

🟥 Excluded from Development

▭ SS 2 Site Boundary

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Reference Map

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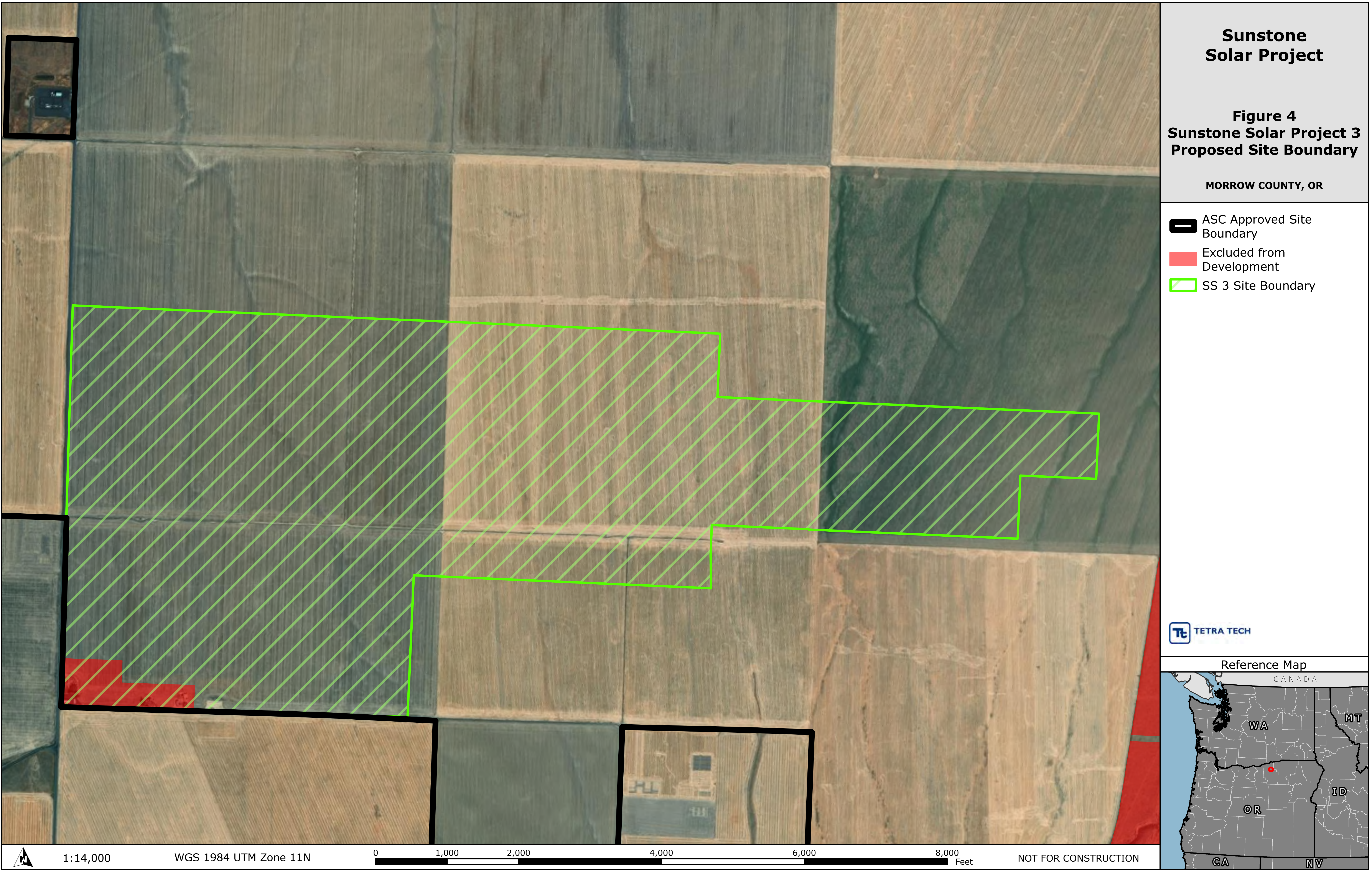

Sunstone Solar Project

Figure 4
Sunstone Solar Project 3 Proposed Site Boundary

MORROW COUNTY, OR

- ▬ ASC Approved Site Boundary
- 🟥 Excluded from Development
- ▨ SS 3 Site Boundary

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Sunstone Solar Project

Figure 5
Sunstone Solar Project 4 Proposed Site Boundary

MORROW COUNTY, OR

- ▬ ASC Approved Site Boundary
- 🟥 Excluded from Development
- ▨ SS 4 Site Boundary

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Reference Map

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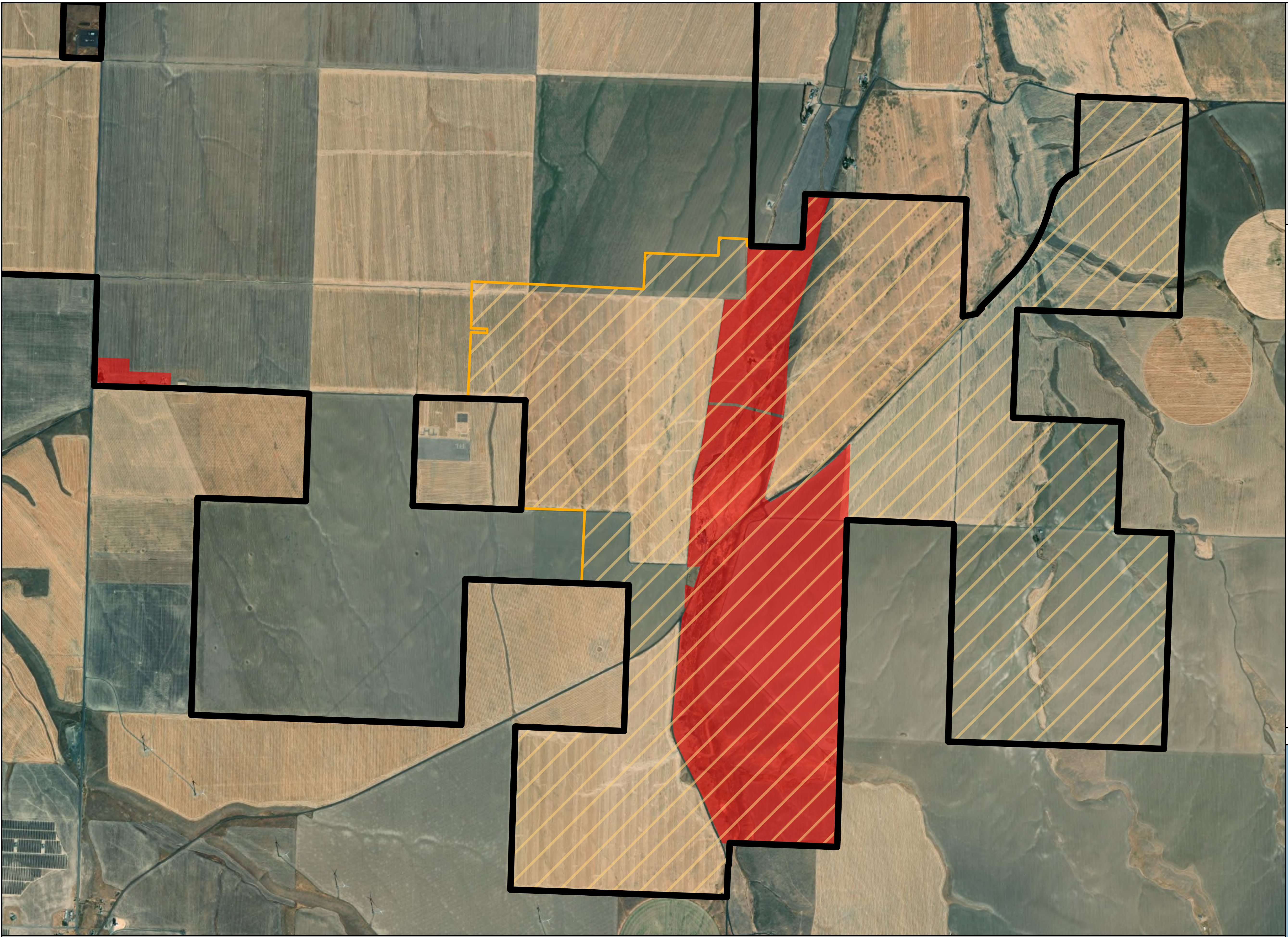
Sunstone Solar Project

Figure 6
Sunstone Solar Project 5 Proposed Site Boundary

MORROW COUNTY, OR



▬ ASC Approved Site Boundary

🟥 Excluded from Development

▭ SS 5 Site Boundary

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Reference Map

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Sunstone Solar Project

Figure 7
Sunstone Solar Project 6 Proposed Site Boundary

MORROW COUNTY, OR

- ▬ ASC Approved Site Boundary
- 🟥 Excluded from Development
- ▨ SS 6 Site Boundary

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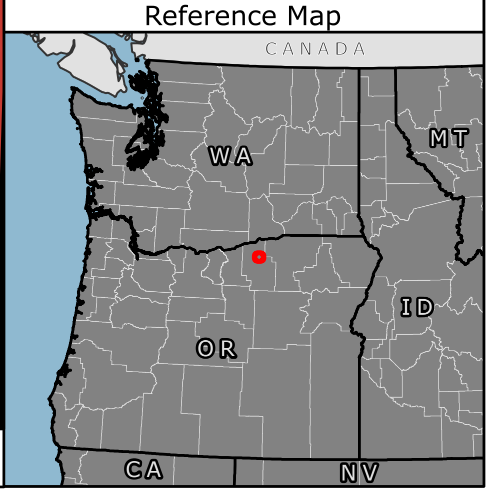
NOT FOR CONSTRUCTION

Reference Map



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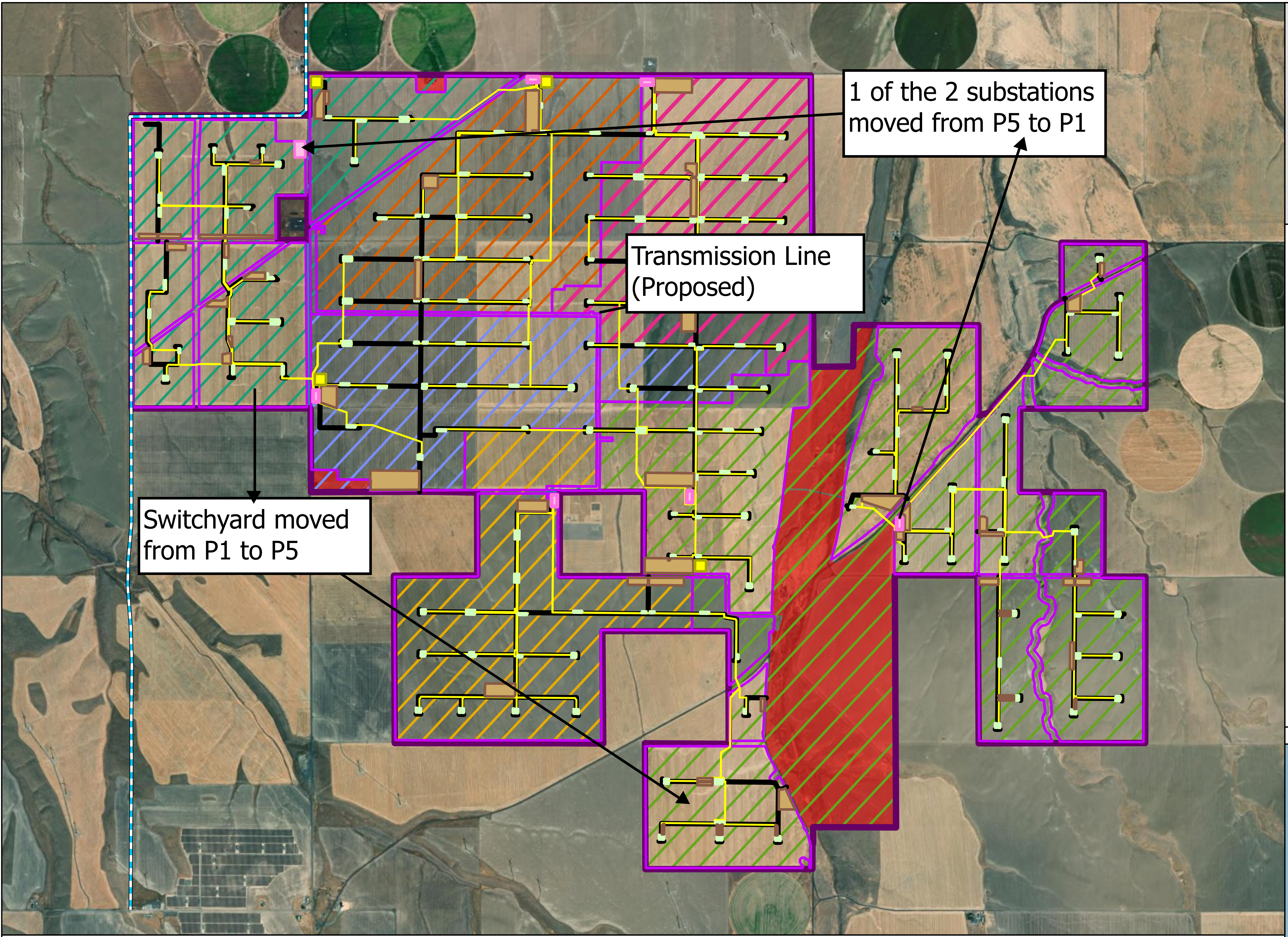
Sunstone Solar Project

Figure 8 Project Boundaries Overlaid on Permitted Site Layout

MORROW COUNTY, OR



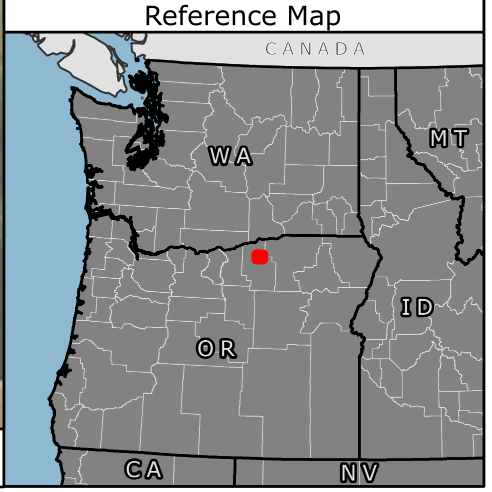
- ▬ ASC Approved Site Boundary
- 🟥 Excluded from Development
- ☐ Fence Line (Maximum)
- ▬ Access Road
- ― Collection Line (34.5-kV)
- 🟩 Inverter/Transformer/ BESS Sites
- 🟫 Laydown Yard
- 🟨 O&M Area
- ▭ Collector Substation
- ┅ In Service Transmission Line

Proposed Boundaries

- ▨ SS 1 Site Boundaries
- ▨ SS 2 Site Boundaries
- ▨ SS 3 Site Boundaries
- ▨ SS 4 Site Boundaries
- ▨ SS 5 Site Boundaries
- ▨ SS 6 Site Boundaries

TETRA TECH

Reference Map



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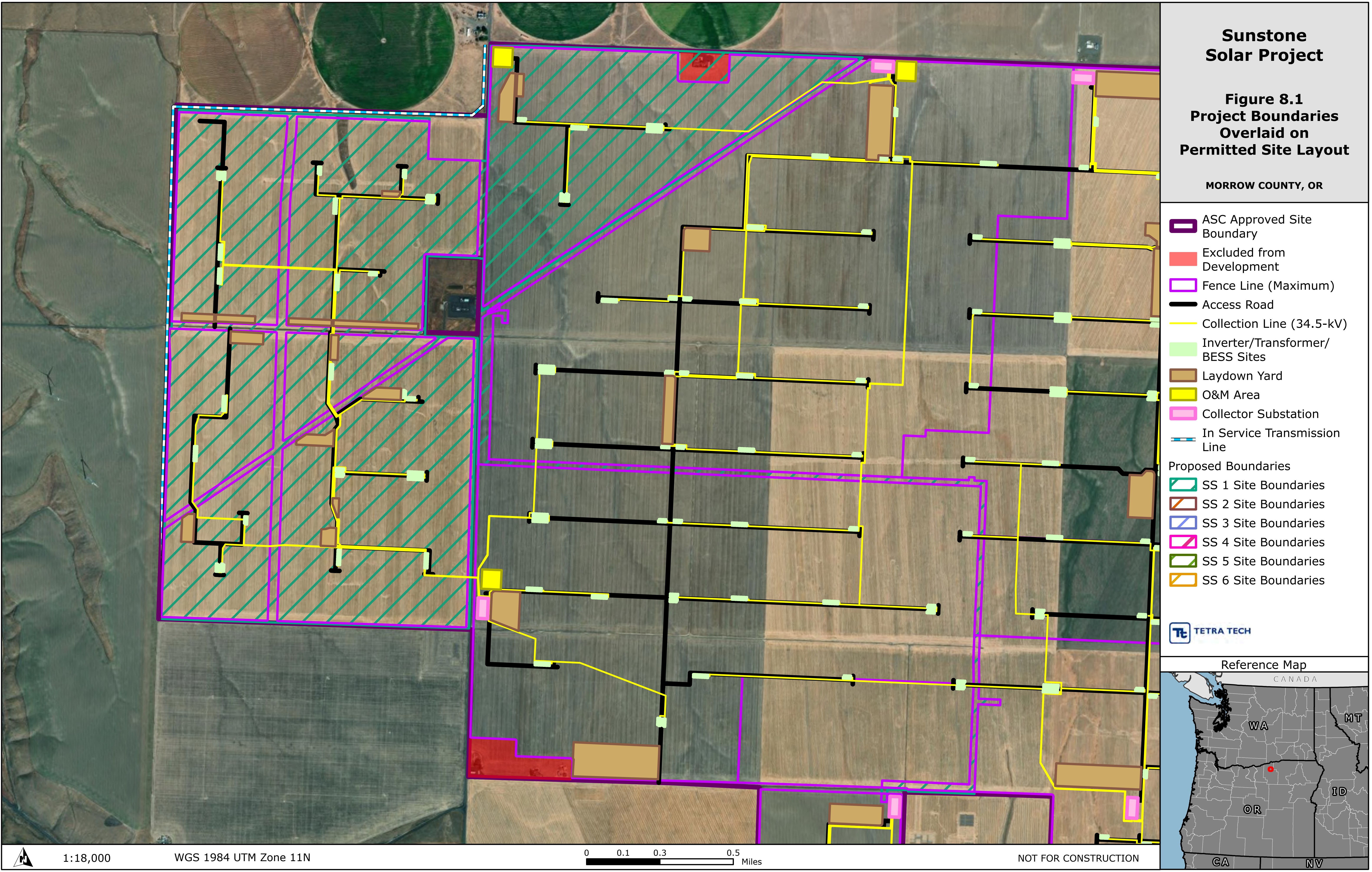
Sunstone Solar Project

Figure 8.1 Project Boundaries Overlaid on Permitted Site Layout

MORROW COUNTY, OR



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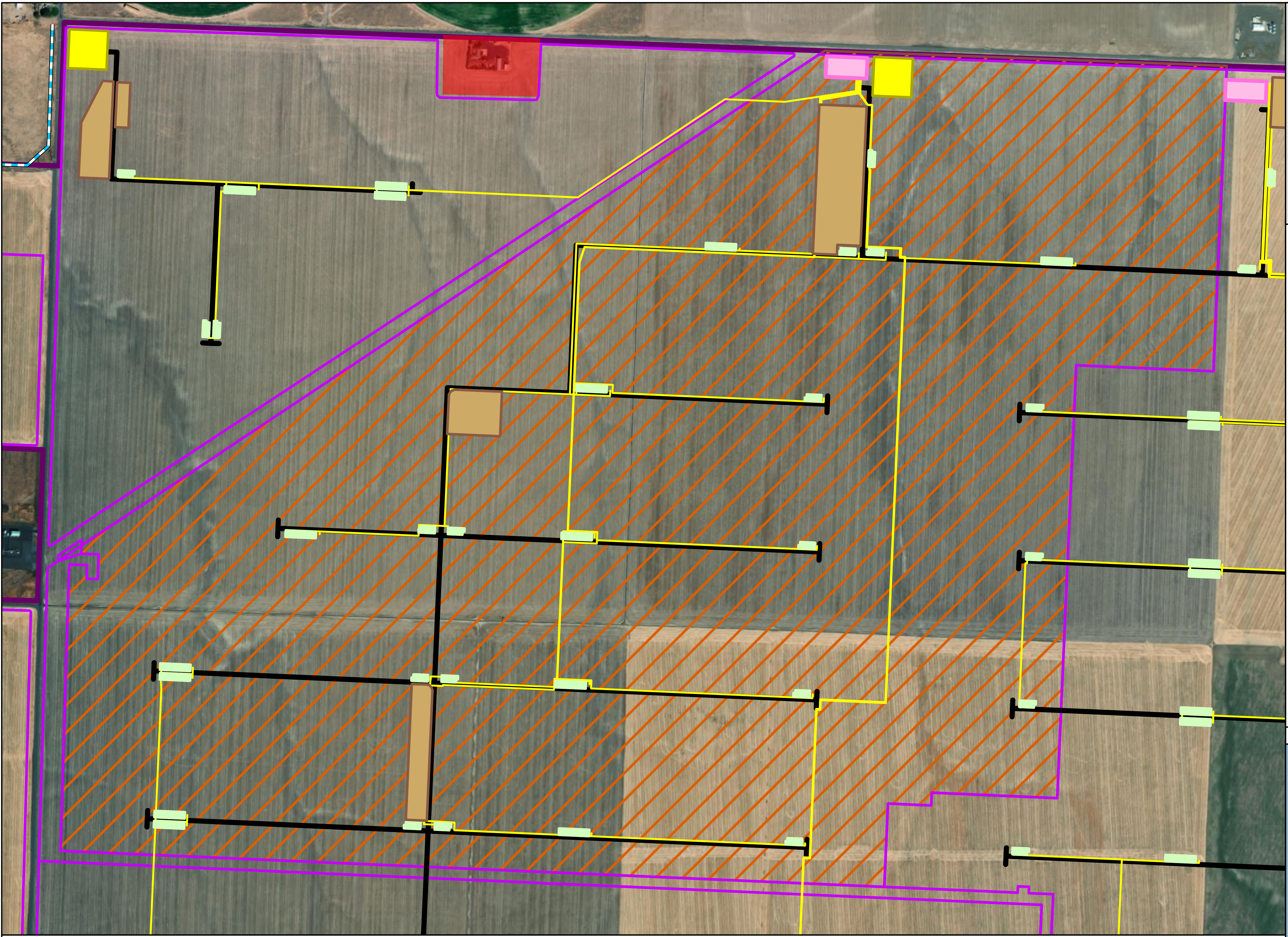
Sunstone Solar Project

Figure 8.2 Project Boundaries Overlaid on Permitted Site Layout

MORROW COUNTY, OR

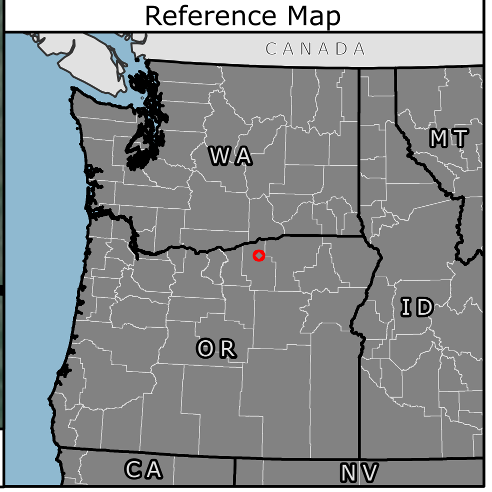


ASC Approved Site Boundary
Excluded from Development
Fence Line (Maximum)
Access Road
Collection Line (34.5-kV)
Inverter/Transformer/BESS Sites
Laydown Yard
O&M Area
Collector Substation
In Service Transmission Line

Proposed Boundaries
SS 1 Site Boundaries
SS 2 Site Boundaries
SS 3 Site Boundaries
SS 4 Site Boundaries
SS 5 Site Boundaries
SS 6 Site Boundaries

TETRA TECH

Reference Map



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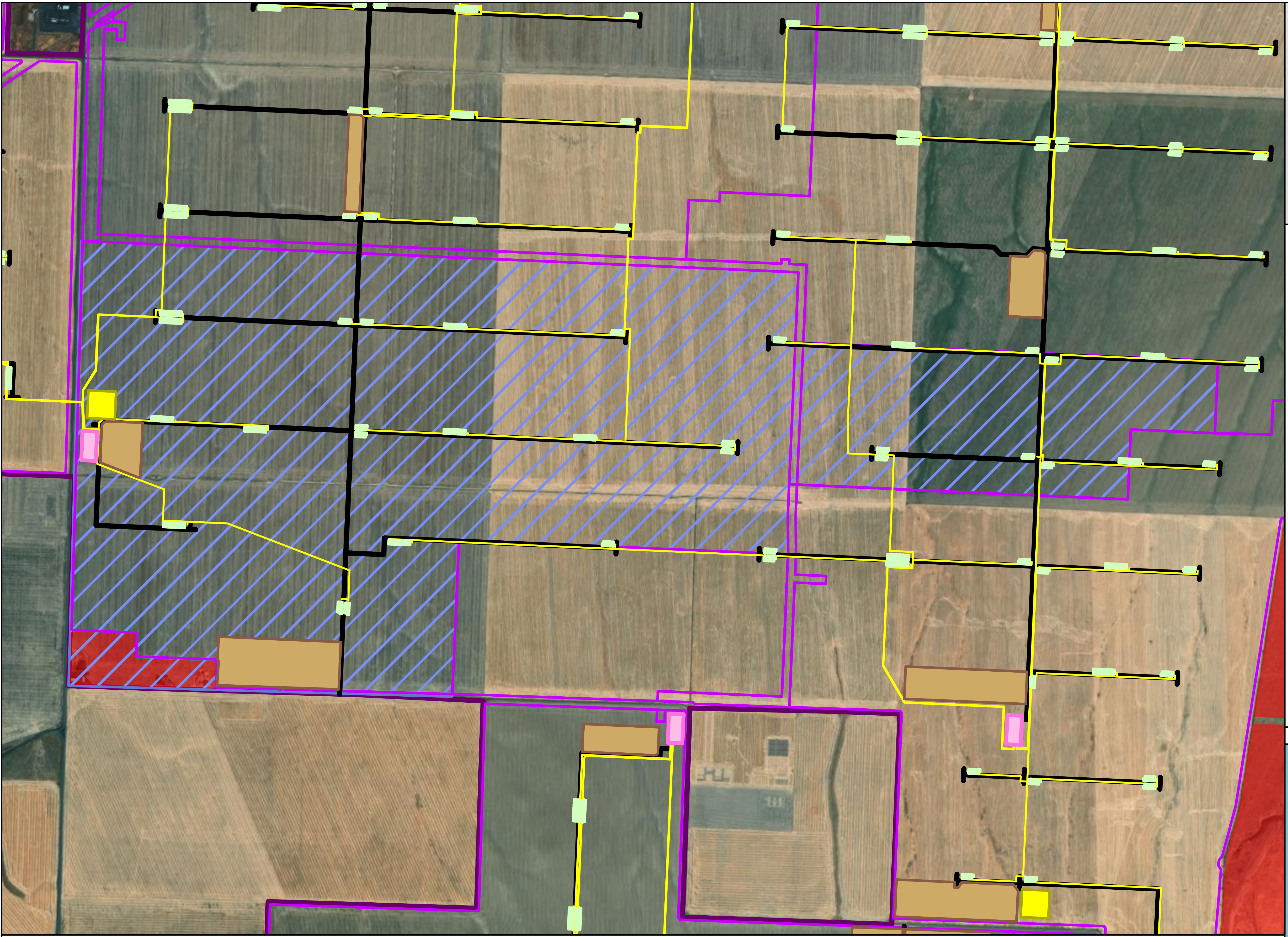

Sunstone Solar Project

Figure 8.3 Project Boundaries Overlaid on Permitted Site Layout

MORROW COUNTY, OR

▭ ASC Approved Site Boundary
🟥 Excluded from Development
▭ Fence Line (Maximum)
━ Access Road
━ Collection Line (34.5-kV)
🟩 Inverter/Transformer/ BESS Sites
🟫 Laydown Yard
🟨 O&M Area
▭ Collector Substation
━ In Service Transmission Line

Proposed Boundaries
▨ SS 1 Site Boundaries
▨ SS 2 Site Boundaries
▨ SS 3 Site Boundaries
▨ SS 4 Site Boundaries
▨ SS 5 Site Boundaries
▨ SS 6 Site Boundaries

TETRA TECH

Reference Map

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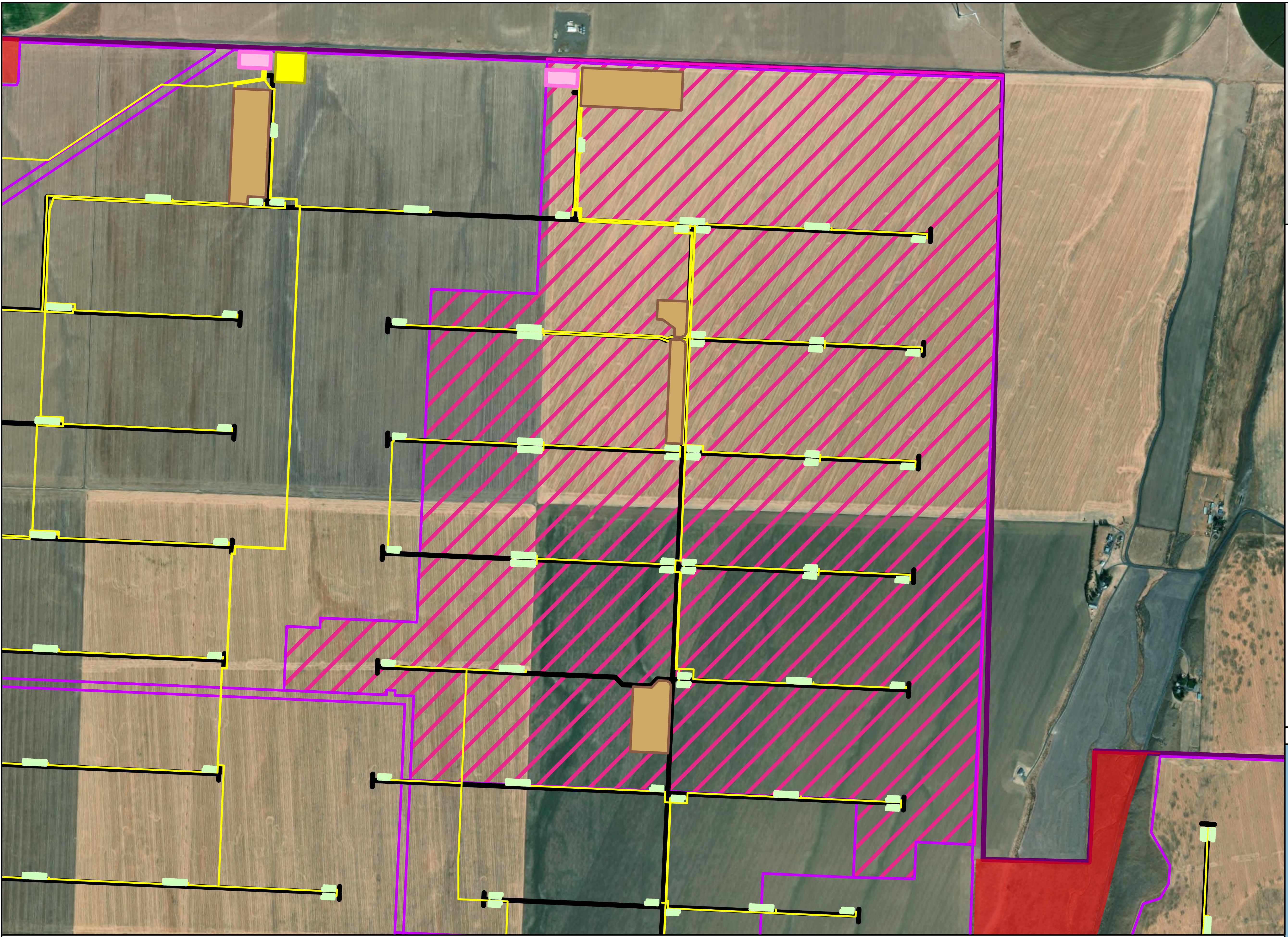

Sunstone Solar Project

Figure 8.4 Project Boundaries Overlaid on Permitted Site Layout

MORROW COUNTY, OR

- ▭ ASC Approved Site Boundary
- 🟥 Excluded from Development
- ▭ Fence Line (Maximum)
- ━ Access Road
- ━ Collection Line (34.5-kV)
- 🟩 Inverter/Transformer/BESS Sites
- 🟫 Laydown Yard
- 🟨 O&M Area
- 🟪 Collector Substation
- ━ In Service Transmission Line

Proposed Boundaries

- ▨ SS 1 Site Boundaries
- ▨ SS 2 Site Boundaries
- ▨ SS 3 Site Boundaries
- ▨ SS 4 Site Boundaries
- ▨ SS 5 Site Boundaries
- ▨ SS 6 Site Boundaries

TETRA TECH

Reference Map

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WGS 1984 UTM Zone 11N

0 0.1 0.3 0.5 Miles

NOT FOR CONSTRUCTION

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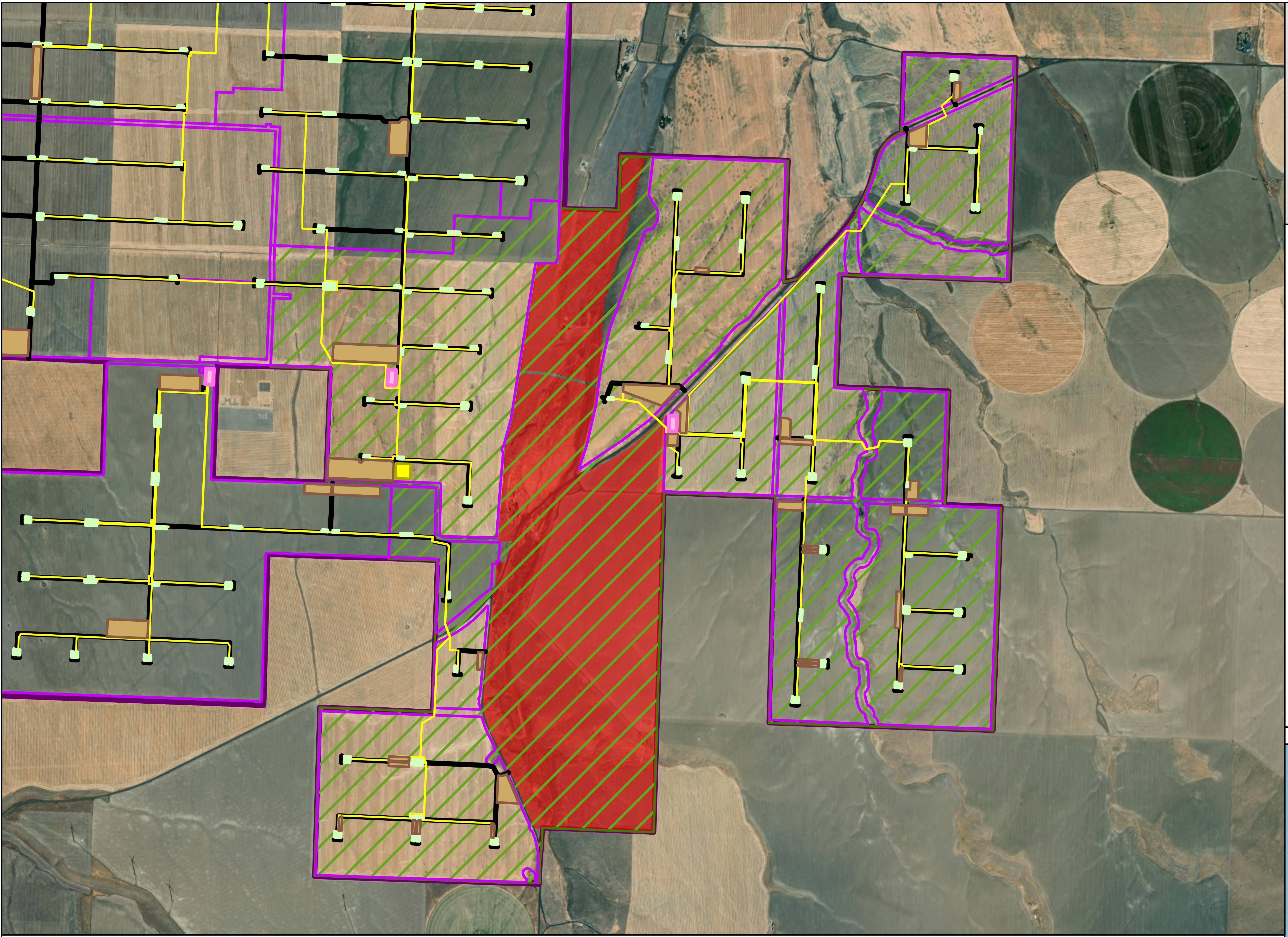
Sunstone Solar Project

Figure 8.5 Project Boundaries Overlaid on Permitted Site Layout

MORROW COUNTY, OR



▭	ASC Approved Site Boundary
🟥	Excluded from Development
▭	Fence Line (Maximum)
━	Access Road
━	Collection Line (34.5-kV)
🟩	Inverter/Transformer/ BESS Sites
🟫	Laydown Yard
🟨	O&M Area
🟪	Collector Substation
━	In Service Transmission Line

Proposed Boundaries

▨	SS 1 Site Boundaries
▨	SS 2 Site Boundaries
▨	SS 3 Site Boundaries
▨	SS 4 Site Boundaries
▨	SS 5 Site Boundaries
▨	SS 6 Site Boundaries

TETRA TECH

Reference Map

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0 0.1 0.3 0.5 Miles

NOT FOR CONSTRUCTION

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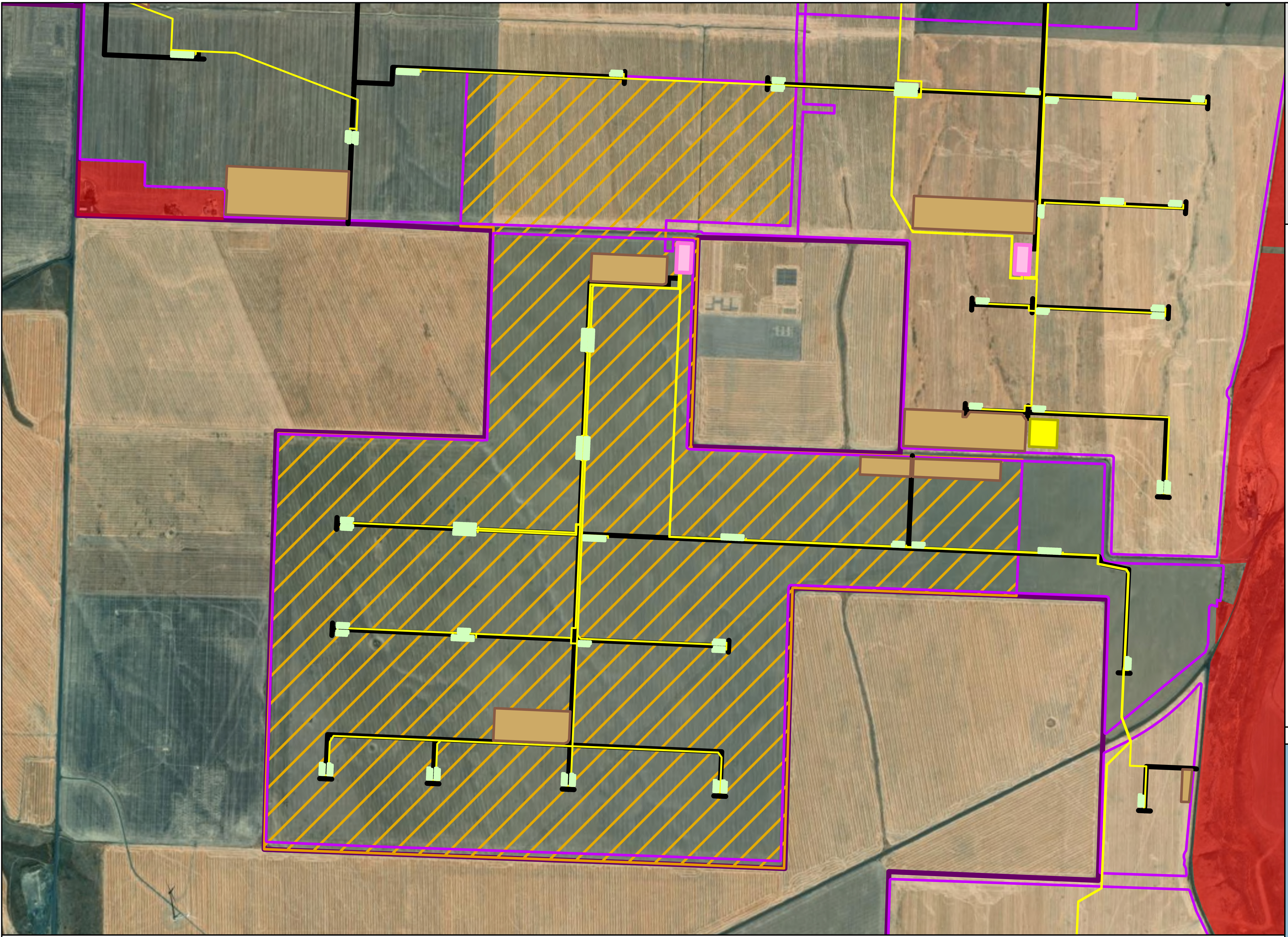
Sunstone Solar Project

Figure 8.6
Project Boundaries Overlaid on Permitted Site Layout

MORROW COUNTY, OR



- ▭ ASC Approved Site Boundary
- 🟥 Excluded from Development
- ▭ Fence Line (Maximum)
- ━ Access Road
- ─ Collection Line (34.5-kV)
- 🟩 Inverter/Transformer/BESS Sites
- 🟫 Laydown Yard
- 🟨 O&M Area
- ▭ Collector Substation
- ┅ In Service Transmission Line

Proposed Boundaries

- ▨ SS 1 Site Boundaries
- ▨ SS 2 Site Boundaries
- ▨ SS 3 Site Boundaries
- ▨ SS 4 Site Boundaries
- ▨ SS 5 Site Boundaries
- ▨ SS 6 Site Boundaries

TETRA TECH

Reference Map

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0 0.1 0.3 0.5 Miles

NOT FOR CONSTRUCTION

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Attachment 1. Redlined Site Certificates

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Sunstone Solar Project 1

ENERGY FACILITY SITING COUNCIL
OF THE STATE OF OREGON

SITE CERTIFICATE FOR THE
SUNSTONE SOLAR PROJECT

1

ISSUE DATE
NOVEMBER 18, 2024

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Table of Contents

1.0 Introduction and Site Certification

This site certificate is a binding agreement between the State of Oregon (State), acting through the Energy Facility Siting Council (EFSC or Council), and Sunstone Solar 1, LLC (certificate holder), owned by Pine Gate Renewables, LLC (parent company). Both the State and certificate holder must abide by local ordinances, state law, and the rules of the Council in effect on the date this site certificate is executed. However, upon a clear showing of a significant threat to public health, safety, or the environment that requires application of later-adopted laws or rules, the Council may require compliance with such later-adopted laws or rules (ORS 469.401(2)).

This site certificate binds the State and all counties, cities and political subdivisions in Oregon as to the approval of the site and the construction, operation, and retirement of the facility as to matters that are addressed in and governed by this site certificate (ORS 469.401(3)). Each affected state agency, county, city, and political subdivision in Oregon with authority to issue a permit, license, or other approval addressed in or governed by this site certificate, shall upon submission of the proper application and payment of the proper fees, but without hearings or other proceedings, issue such permit, license or other approval subject only to conditions set forth in this site certificate. In addition, each state agency or local government agency that issues a permit, license or other approval for this facility shall continue to exercise enforcement authority over such permit, license or other approval (ORS 469.401(3)). For those permits, licenses, or other approvals addressed in and governed by this site certificate, the certificate holder shall comply with applicable state and federal laws adopted in the future to the extent that such compliance is required under the respective state agency statutes and rules (ORS 469.401(2)).

This site certificate does not address, and is not binding with respect to, matters that are not included in and governed by this site certificate, and such matters include, but are not limited to: employee health and safety; building code compliance; wage and hour or other labor regulations; local government fees and charges; other design or operational issues that do not relate to siting the facility (ORS 469.401(4)); and permits issued under statutes and rules for which the decision on compliance has been delegated by the federal government to a state agency other than the Council (ORS 469.503(3)).

The obligation of the certificate holder to report information to the Department or the Council under the conditions listed in this site certificate is subject to the provisions of ORS 192.502 *et seq.* and ORS 469.560. To the extent permitted by law, the Department and the Council will not publicly disclose information that may be exempt from public disclosure if the certificate holder has clearly labeled such information and stated the basis for the exemption at the time of submitting the information to the Department or the Council. If the Council or the Department receives a request for the disclosure of the information, the Council or the Department, as appropriate, will make a reasonable attempt to notify the

certificate holder and will refer the matter to the Attorney General for a determination of whether the exemption is applicable, pursuant to ORS 192.450.

Council shall have continuing authority over the site and may inspect, or direct the Oregon Department of Energy (Department) to inspect, or request another state agency or local government to inspect, the site at any time in order to ensure that the facility is being operated consistently with the terms and conditions of this site certificate (ORS 469.430).

The duration of this site certificate shall be the life of the facility, subject to termination pursuant to OAR 345-027-0110 or the rules in effect on the date that termination is sought, or revocation under ORS 469.440 and OAR 345-029-0100 or the statutes and rules in effect on the date that revocation is ordered. The Council shall not change the conditions of this site certificate except as provided for in OAR Chapter 345, Division 27.

In interpreting this site certificate, any ambiguity will be clarified by reference to the following, in order, incorporated herein by this reference: 1) *Final Order on the Application for Site Certificate for the Sunstone Solar Project* issued on November 18, 2024 (hereafter, *Final Order on the ASC*); 2) the record of the proceedings that led to the Final Order on the ASC.

The definitions in ORS 469.300 and OAR 345-001-0010 apply to the terms used in this site certificate, except where otherwise stated, or where the context clearly indicates otherwise.

2.0 Facility Location and Site Boundary

The facility is located within an approximately 1,538.8~~10,960~~-acre (2.4 ~~17~~ sq. mile) site in Morrow County. The site is located on both sides of State Route 207 and is approximately 15 miles northeast of the Town of Lexington and approximately 4.5 miles west of Butter Creek Junction. The site is approximately 3 miles west of the Umatilla County line at its closest point. Table 1 below provides the Township, Range, and Sections occupied wholly, or in part, by the site. Up to 1,479acres~~9,442~~ of land within the site boundary would be occupied by facility components. The regional location of the facility site boundary, transmission line corridor, and ~~approximately 1,518 acres~~ areas within the site boundary ~~are~~ excluded from development, as applicable, are~~as~~ shown on Attachment 1~~ASC Exhibit C, Figures C- 2, and C-2.1 to C-2.3, attached~~ to this site certificate ~~as Attachment 1~~.

Table 1: Township, Range, and Section for Areas Occupied by the Site Boundary

Township	Range	Sections
1N	26E	~~1, 2, 3,~~ 4~~, 5, 8, 9, 10, 11, 12, 14, 15~~
2N	26E	~~27,~~ 28, 29, 30, 31, 32, 33~~, 34, 35, 36~~
Reference: SSPAPPDoc25-03 ASC Exhibit C Project Location, Table C-1. 2024-05-15.		

3.0 Facility Description

The energy facility is approved to include the components presented in Table 2 below. Additional details regarding specific components, and discussion of alternative designs or technologies under consideration are provided in the sections that follow.

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Site Boundary		
Site Boundary	1,538.8~~10,960~~	acres
Maximum Footprint	1,479 ~~9,442~~	acres
Permanent Impacts[1]	1,479 ~~9,442~~	acres
Solar Components		
PV Solar Modules		
Approx. total number	656,256~~3,937,536~~	modules
Max Height at full-tilt	15	feet
Posts		
Approx. total number (assumes concrete foundation)	89,176~~535,056~~	posts
Cabling		
Combiner Boxes	10,254~~61,524~~	each
Inverter Step Up (ISU) Transformer Units		
Approx. total number	54 ~~319~~	each
Noise level	89	dBA
Transformer oil-containing capacity	800	gallons
Related or Supporting Facility Components		
34.5 kV Collection System		
Collector line length, belowground	12.9 ~~82~~	miles
Collector line length, overhead (OH)	0.7 ~~4.3~~	miles
Wood Monopoles (max estimate for OH)	26 ~~151~~	each
Collector Substations		
Substations w SCADA; GSU transformers ~~per~~ each	1~~6~~; 1	each
Site size	7.3 ~~1.6~~	acres
Transformer oil-containing capacity	16,000	gallons~~/each~~
Transformer noise level	100	dBA
Max height of structures	45	feet
~~Switchyards~~		

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[1] The energy facility would occupy approximately 1,479 ~~9,442~~ acres ~~within up to 20 separately fenced areas~~. Most related or supporting facilities will be located within the energy facility's footprint; however, portions of the overhead 34.5 kV collector and 230-kV transmission lines running between solar array areas would result in additional temporary and permanent disturbance areas.

Table 2: Facility Component Summary

~~Component and Design Standard~~	~~No.~~	~~Unit~~
~~Stations; Transformers per each~~	~~2; 0~~	~~each~~
~~Site size (northern and/or within solar fence line); with foundations and graveled areas~~	~~3~~	~~acres~~
230 kV Transmission Line		
Length ~~(total; northern line; southern line)~~	5.1~~9.5; 3.2; 6.3~~	miles
Structures: Type (Wood or Galvanized Steel); quantity	H-frame; 31~~50~~	each
Height of structures	70- 180	feet
Battery Energy Storage System (Lithium-ion/Zinc)		
Zinc		
Approx. total battery containers on foundations with fans/heating systems; SCADA	2,491~~14,946~~	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	9.5 x 8 x 20	H x W x L; feet
Noise level (broadband)	66	dBA
Lithium-ion		
Approx. total battery containers on foundations with HVAC and fire suppression systems; SCADA	~~1~~2,000	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	11.25 x 8.1 x 5.2	H x W x L; feet
Noise level (broadband)	66	dBA
O&M Building		
Quantity	1~~4~~	each
Site size	2.8	acres
Height	20	feet
Appurtenances	On-site well, septic system, SCADA System	
Storage for Replacement Solar Panels		
Containers	8-9~~50~~	each
Approx. container dimensions	8.5 x 8 x 40	H x W x L; feet
Location	Dispersed within fence line if not next to O&M, gravel base	
Facility Roads		
Length	7.0 ~~55~~	miles
Width	10- 20	feet
Perimeter Fence		
Length	15.9 ~~58~~	miles
Height	7-8	feet

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Access/gates	8-9~~52~~	each
Temporary Construction Areas		
Quantity	14~~54~~	each
Site size	5	acres
Description	Gravel base; diesel/gas storage; within fence line	

Energy Facility

The facility includes a solar photovoltaic power generation facility with up to ~~1,~~200 MW of electric generation capacity. ~~The energy facility consists of up to 20 separately fenced solar arrays organized into six 200 MW blocks.~~

Photovoltaic Modules

Solar photovoltaic modules, or solar panels, convert sunlight into DC electric power. The typical module contains crystalline silicon photovoltaic cells arranged within glass panels equipped with an anti-reflective coating, a metal frame, and wire connectors.

Racking System

The photovoltaic modules are connected in series into strings and then mounted on a racking system. Each rack would contain 2 strings of 32 modules mounted on a single-axis tracking system. Multiple racks are organized into rows between 200 and 400 feet in length depending on topography. Rows would be spaced at least 10 feet apart and at least 15 feet from perimeter fencing to provide vehicle access.

Posts

Each row of tracker mounted modules is supported by multiple hollow, screw pile, or pile-type steel posts. Posts are typically installed to a depth of 6-8 feet below surface and extend 5 feet above grade. Posts at the end of rows may be installed at greater depths to withstand wind uplift. Posts may be installed directly in the ground or concrete backfill may be required in some soil conditions.

DC Cabling System

Combiner boxes or a Big Lead Assembly (BLA) harness system is used to aggregate the DC output of the photovoltaic modules for transmission to an inverter by low-voltage DC cables. Using the combiner boxes, strings of modules are connected to a pad-mounted combiner box installed at each row, which in turn, are connected to the inverters by low voltage DC cables

that are either mounted to the tracking system, installed in trays, or buried underground. Using the BLA system, strings are connected directly to a rack-mounted cabling system.

Inverters and Inverter Step Up (ISU) Transformers

Inverters convert the DC output of the photovoltaic modules to AC power that can be transmitted to the electric grid. A typical inverter in utility scale solar facilities converts the 900 to 1,500 volt DC module output to 660 volt AC output. After conversion, the output is sent to an inverter step-up (ISU) transformer to increase the voltage to 34.5 kV power for transmission to the collector substation via the electrical collector system. Inverters and ISU transformers are collocated on concrete slabs near each module block.

Related or Supporting Facilities

Related or supporting facilities include a battery energy storage system, ~~an interconnection substation, up to~~ one~~six~~ collector substation~~s~~, one~~up to four~~ operations and maintenance building, and other structures.

Battery Energy Storage System

The battery energy storage system (BESS) is designed to provide up to 1~~7~~.2 gigawatt-hours (GWh) of storage capacity. The BESS may use either Lithium-Ion (Li-ion) or Zinc-based battery technology. Under either technology, batteries are contained in pre-constructed modular containers, or “segments,” placed on concrete slab foundations.
The battery storage system includes, but is not limited to, the following elements:

- Batteries and containers, inverters, isolation transformers, and switchboards;
- Balance of plant equipment, which may include medium-voltage and low-voltage electrical systems, fire suppression and HVAC systems (for Li- ion technology, if selected), building auxiliary electrical systems, and network/SCADA systems;
- Cooling system, which may include a separate chiller plant located outside the battery racks with chillers, pumps, and heat exchangers (Li-ion only, if selected); zinc batteries will have fans and a heating unit for climate control; and
- High-voltage (HV) equipment, including a step-up transformer, circuit breaker, current transformers and voltage transformers, a packaged control building for the breaker and transformer equipment, towers, structures, and cabling.

The batteries and associated equipment may be oversized or periodically augmented in accordance with the manufacturer’s recommendations to ensure a minimum of 1~~7~~,200 MWh of energy storage capability over the life of the BESS, taking into account natural degradation of the batteries over time.

Li-ion batteries are currently the most common battery type used in utility-scale battery energy storage systems. If a Li-ion battery technology is used at the facility, it would use Li-ion phosphate batteries, which are more thermally stable than Li-ion cathode batteries.
Each module contains approximately 10 hermetically sealed battery cells filled with a gel or liquid electrolyte. The module containers serve as secondary containment for the cells. Each container holds approximately 840 cells with a combined capacity of approximately 740 kilowatt-hour AC, and approximately ~~1~~2,000 containers would be required to meet the capacity needs of the facility.

The electrolyte used in Li-ion batteries is flammable and susceptible to overheating and vaporization, so Li-ion Battery Systems typically require cooling, ventilation, and fire suppression systems included in each container. If Li-ion battery technology is used at the site, it would implement the following design features and fire prevention and control methods to minimize fire and safety risks:

- Batteries would be stored in completely contained, leak-proof modules.
- Ample working space would be provided around the BESS for maintenance and safety purposes.
- An off-site, 24-hour monitoring system with shutdown capabilities would be implemented.
- Batteries would be transported in accordance with Department of Transportation Pipeline and Hazardous Material Administration regulations under 49 CFR 173.185
- Battery systems would be designed in accordance with applicable Underwriters Laboratories, National Electric Code, and National Fire Protection Association Standards, including but not limited to, UL 1642, 1741, 1973, and 9540A, and NFPA 855.
- An advanced and proven battery management system would be employed;
- Battery Containers would be equipped with:
  - Heating, ventilation, and air conditioning (HVAC) systems to maintain optimal battery temperatures;
  - Fire control panels with 24-hour battery backup;
  - Fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems;
  - Doors equipped with a contact that will shut down the battery container if opened;
  - Fire extinguishing and thermal insulation sheets between each individual battery cell;
  - Locks and fencing to prevent entry of unauthorized personnel;
  - Remote power disconnect switches with clear and visible signs identifying their location.[2]

Li-ion battery modules under consideration for this facility have an expected useful life of 20 years and it is expected that every module at the facility would need to be replaced at least once during the life of the facility. Used Li-ion batteries are generally considered to be

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[2] SSPAPPDoc25-02 ASC Exhibit B Project Description 2024-05-15, Section 2.7.1.

hazardous waste by the EPA and must be transported and disposed of according to the most current guidelines at end of life.

A typical zinc-based BESS container includes 144 zinc-hybrid cathode powered batteries with a combined 700 kWh capacity. Zinc batteries are estimated to have a lifespan of at least 20 years. Zinc battery systems can operate across a higher range of temperatures and only require cooling fans rather than a full HVAC system. Zinc batteries have a lower fire-risk than lithium-ion batteries and do not require fire suppression systems to be included in the container design.

The BESS may be designed either as a DC-coupled system, with containers distributed throughout the energy facility site near inverter/transformer station sites, or as an AC-coupled system with containers concentrated in a single area near the ~~switchyards~~ substation. In either case, the containers and other BESS equipment are located within the fenced solar array areas and may have their own additional fencing.

34.5 kV Electrical Collection System

The facility includes up to 12.9~~86~~ miles of 34.5 kV electrical collector lines that connects energy facility components to the collector substation~~s~~ described below. The majority of the collector lines are buried underground; however, overhead lines are installed at long "home run" stretches, stream or canyon crossings, and other areas where burial is infeasible. The collector lines are generally located within the energy facility footprint except at road crossings and crossings between fenced solar array areas.

Communication and SCADA System

The facility includes a system of fiber optic and copper communication lines that connect the solar arrays, BESS, and substation~~s~~ to Supervisory Control and Data Acquisition (SCADA) system control rooms within the~~each~~ collector substation (to be shared with all projects, see below). The communication lines are collocated with the 34.5 kV electrical collection system described above. The SCADA system monitors meteorological conditions, critical operating parameters, and power output, for each solar string, battery energy storage system, and substation. The SCADA system is monitored by a remote operations center. Smoke and fire detectors placed around the site also connect to the SCADA system and will contact local emergency responders in the event of a fire at the site.

Collector Substations

The facility includes up to one~~six~~ collector substation~~s~~ at the site. The~~Each~~ substation includes a generator-step up (GSU) transformer and control building, and may also include circuit-breakers and fuses, transmission line termination structures, power transformers, bus bars and insulators, disconnect switches, relaying, battery and charger, surge arresters, AC and DC

supplies, control systems, metering equipment, grounding, a lightning protection system and associated control wiring.

The GSU transformer~~s~~ increases the 34.5-kV ISU transformer output to 230-kV power. The GSU transformer~~s~~ is a~~are~~ ground-mounted unit~~s~~ constructed on a concrete pad~~s~~. The single~~Each of the six~~ GSU transformer is~~s are~~ filled with up to 16,000 gallons of non-toxic oil such as mineral or seed oil.

The~~Each~~ GSU transformer is equipped with a secondary spill containment catchment system designed to minimize the possibility of accidental leakage. The concrete catchment system is sized to contain approximately 1.25 times the amount of oil inside the transformer.

All substation structures and components are surrounded by a graveled area and enclosed by an 8-foot-tall chain-link fence with three strands of barbed wire one foot above the top. Access to the substation site~~s~~ is limited with a locked gate.

230-kV Transmission Line

The facility includes one~~up to two~~ 230-kV overhead transmission line~~s~~ that connects the collector substations to the ~~two primary interconnection switchyards located at the~~ point of interconnection. The transmission line~~s~~ is~~are~~ supported by steel or wood monopole or H-Frame structures, spaced approximately 1,000 feet between structures, and has~~ve~~ a ~~combined~~ length of approximately 5.1~~9.5~~ miles (to be shared with all projects, see below). ~~The northern line connects two collector substations along the south side of Alpine Lane to the switchyard and extends approximately 3.2 miles. The southern line connects four collector substations across the southern portion of the site and extend approximately 6.3 miles. The two lines run in parallel for approximately 1-mile between Bombing Range Road and the switchyards.~~

The transmission line~~s~~ is~~are~~ located within the fenced solar array areas except where the line~~s~~ spans roads or corridors between areas ~~and between the switchyards~~ and the point of interconnection. All transmission line components are sited within the facility lease boundary.

No new or expanded right-of-way will be required, but some portions of the transmission line~~s~~ is~~are~~ located within existing public rights-of-way. A portion of the transmission line that runs along the western boundary of energy facility footprint is within the public right-of-way on the east side of Bombing Range Road. Additionally, portions of the transmission line that connect solar array areas in the southern portion of the site run along Grieb Lane~~cross Doherty Road and the Lexington-Echo Highway~~.

~~Project Switchyards and~~ Interconnection Facilities

The facility interconnects with the existing Umatilla Electric Cooperative 230kV Blue Ridge Line at the northwest corner of the facility where the shared switchyard is located (see below). ~~Two switchyards are approved to be located within a separately fenced site either within or adjacent to the energy facility footprint, each~~

~~approximately 3 acres. The interconnection switchyards do not contain transformers and are constructed on foundations with surrounding gravel areas.~~

Operations and Maintenance Buildings

The facility includes one~~up to four~~ operations and maintenance (O&M) building~~s~~, ~~each~~ including a utility room, storage for maintenance supplies and equipment, and a SCADA control room. The building~~s each~~ has~~ve~~ an on-site well and septic system. Power is supplied by a local service provider using overhead and/or underground lines. The~~Each~~ O&M building site also has a graveled parking and storage area~~s~~. The O&M building may be shared with all projects, see below.

Small quantities of chemical materials, including cleaners, insecticides or herbicides, paint, lubricants, degreasers, and solvents, may be stored at the O&M building~~s~~ during construction and operation of the facility. No extremely hazardous materials would be stored on site; other chemicals will be handled in accordance with label instructions as well as state and federal standards.

The facility includes an aboveground fuel storage tank with capacity to store up to 500 gallons of diesel fuel or gasoline at the~~each~~ O&M building site.

The O&M building~~s~~ is~~are~~ equipped with basic firefighting equipment for use on-site during maintenance activities, such as shovels, beaters, portable water for hand sprayers, fire extinguishers, and other equipment.

Replacement Solar Panel Storage

To store spare solar panels and associated equipment, the facility is approved to store materials either at the O&M building site~~s~~ or within approximately 50 locked Conex storage containers distributed throughout the site (to be shared with all projects, see below). The containers may be placed directly on the ground or on gravel pads. The containers would store up to the approximately 204,720 replacement panels needed over the life of the facility.

Access and Service Roads

The facility includes up to 7.0~~55~~ miles of new roads (graded and graveled to meet load requirements for all equipment) to provide access to facility component; some roads will be shared with all projects, see below. Corridors between module racking are at least 10 feet wide and racking are no closer than 15 feet from perimeter fencing. Some new road construction is required to access site features. Roads will be 10 to 20 feet in width, with some exceptions, including access to the substation~~s~~ and main travel corridors where two-way traffic is required. In these cases, roads will be 20 feet wide. A 5-foot maintained vegetative surface or noncombustible base, approved by the fire code official, will be maintained along the fenced perimeter of the site boundary. Use of the roads may continue

after construction, or new roads may be removed and the land reclaimed to pre-construction conditions.

Security Fencing and Gates

The facility includes approximately 15.9 ~~58~~ miles of security fence to enclose each solar array area, and substation~~, and switchyard site~~. The perimeter fencing has lockable vehicle and pedestrian access gates to provide access to the site.

Temporary Construction Areas

The facility includes up to 14~~54~~ temporary construction areas within the energy facility footprint to support construction, store supplies and equipment, and facilitate the delivery and assembly of materials and equipment. Each area consists of a 5-acre site that would be cleared and graveled prior to construction.

Up to five above-ground diesel tanks and one temporary above-ground gasoline tank may be stored in the temporary construction areas (to be shared with all projects, see below). The tanks each hold up to 1,000 gallons of fuel. Most fuel containers have self-contained secondary containment (e.g., double-walled containers) that provide capacity for the entire container plus precipitation, but in some cases may be placed in a constructed secondary containment area that is impervious and is diked or otherwise contained to provide the required fuel and precipitation capacity.

Shared Related or Supporting Facilities

The certificate holder is authorized to share related or supporting facilities between the Sunstone Solar Projects 1-6, including the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary constructions areas (including fuel tanks). These related or supporting facilities are split accordingly between the Sunstone Solar Projects 1-6, as demonstrated in their associated site certificates. Similarly, compliance with site certificate conditions and EFSC standards which apply to these shared related or supporting facilities are also split accordingly between Sunstone Solar Projects’ 1-6 site certificates and certificate holders. In accordance with Condition GEN-GS-07 if either certificate holder substantially modifies a shared related or supporting facility or ceases facility operation, the applicable/relevant certificate holder is obligated to submit an amendment determination request or request for amendment to the Department to determine the appropriate process for evaluating the change and ensuring full regulatory coverage under each site certificate, or remaining site certificate if either is terminated, in the future. Additionally, each certificate holder is obligated to demonstrate to the Department that a “Common Facilities Agreement” or similarly legally binding agreement has been fully executed between certificate holders to ensure approval and agreement of access to the shared resources has been obtained prior to operation of shared facilities.

4.0 Facility Development

4.1 Construction

The initial applicant proposed to construct the originally permitted~~proposed~~ facility in six phases, with each phase including approximately 200 MWs of generating capacity, one of which is the subject of this Site Certificate.

Portions of the site, including the substation~~sites~~, inverter and battery energy storage system sites, and access roads will be cleared and graded, prior to construction of the applicable facility components. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems in the energy facility footprint are left intact during construction to the maximum extent practicable to minimize soil and erosion impacts, and that grading in solar arrays is limited to those areas where the slope and gradient are outside of panel and racking tolerances. Typical grading tolerances within the array are 10% maximum on North slopes and 15% maximum in other directions. Following construction, operational requirements include long-term site stabilization and revegetation of disturbed areas.

Adherence to the requirements of a Fugitive Dust Control Plan is required under Condition PRE-SP-02. Measures implemented under this plan include maintaining existing vegetative root systems, applying dust suppressants, and restricting traffic speeds on-site. Typically, water is

applied as a dust suppressant on access roads, but under drought conditions, alternative dust suppressants including synthetic polymer emulsions, chemical suppressants, organic glues, and wood fiber materials may be applied at the site by qualified vendors.

Construction of the originally permitted facility for all six projects will generate 910 commuting trips and 250 truck trips per day over approximately 1,224 construction workdays. At the peak of construction, it is estimated a maximum of approximately 1,266 commuting trips per day and 250 truck trips per day. The primary route to the site would be Bombing Range Road via Interstate Highway 84 (I-84) at the I-84/Irrigon Junction. Alternate routes would be via OR-207 via I-84 south of Hermiston.

4.2 Operations and Maintenance

Operation and maintenance activities include routine inspections, replacement of solar modules and battery components, panel washing, and vegetation management. Up to 10 permanent employees would operate and maintain the facility (to be shared by all six projects), with occasional delivery truck accessing the site during operations depending on the type of maintenance activity.

Individual batteries associated with the BESS will be inspected according to the manufacturer's recommendations and will need to be replaced approximately every 20 years, and every battery will be replaced during the life of the facility. Each type of electrical facility component would have routine inspections as designated in the operational Wildfire Mitigation Plan. The solar panels may require periodic washing during operations, and other incidental water use for sanitation and equipment washing.

Vegetation will be cleared and maintained along access roads to provide a vegetation clearance area for fire safety. This includes mowing to a height of no more than 12 inches. Use of the roads may continue after construction, or new roads may be removed, and the land reclaimed to pre-construction conditions.

An aboveground 500-gallon fuel storage tank sized may be installed at each O&M building. Secondary containment and refueling procedures for on-site fuel storage during operations will continue to follow the SPCC Plan and requirements for secondary containment. No extremely hazardous materials are expected to be produced, used, stored, transported, or disposed of at the facility during operation.

4.3 Retirement

The estimated useful life of the proposed facility is 40 years. Operational jobs would be eliminated after the facility ceased operating; however, some short-term contract jobs to monitor restored areas may be added to facilitate retirement activities. Decommissioning requires similar workforce numbers as required for the construction of the originally permitted facility/six projects in total and is estimated to require a similar duration of up to 47 months.

Final retirement activities will be designated in a retirement plan but would begin with disconnecting all electrical equipment disassembling equipment and components such and the battery storage units, solar panels and transformers. Larger containers and equipment would be removed, trucked off-site and recycled and disposed of. Solar panels would be disconnected, and piles would be removed including the excavation of any concrete foundations. Gravel and foundations from the inverters and transformers, O&M building, substation~~s~~, and battery unit~~s~~ would be removed by trenching and excavation. The facility site would then be restored through grading, filling, and revegetation with plants or seed mix consistent with applicable plans and conditions discussed in this order or landowner interests.

5.0 Site Certificate Conditions

The conditions of this Site Certificate are organized and coded to indicate the phase of implementation, the standard the condition is required to satisfy, and an identification number (1, 2, 3, etc.).[3] The table below presents a "key" for phase of implementation:

Key	Type of Conditions/Phase of Implementation
GEN	General Conditions: Design, Construction and Operation
PRE	Pre-Construction Conditions
CON	Construction Conditions
PRO	Pre-Operational Conditions
OPR	Operational Conditions
RET	Retirement Conditions

To align with the phased construction approach, preconditions requiring applicant actions prior to construction allow for phased compliance. These apply specifically to the area in which the phased activities would occur, rather than the entirety of the site.

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[3] The identification number is not representative of an order that conditions must be implemented; it is intended only to represent a numerical value for identifying the condition.

5.1 General (GEN) Conditions: Design, Construction and Operations

Condition Number	General (GEN) Conditions
STANDARD: GENERAL STANDARD OF REVIEW (GS) [OAR 345-022-0000]	
GEN-GS-01	The certificate holder must design, construct, operate and retire the facility: a. Substantially as described in the site certificate; b. In compliance with the requirements of ORS Chapter 469, applicable Council rules, and applicable state and local laws, rules and ordinances in effect at the time the site certificate was issued; and c. In compliance with all applicable permit requirements of other state agencies. [Mandatory Condition OAR 345-025-0006(10); General Standard Condition 1; Final Order on ASC]
GEN-GS-02	The certificate holder must begin and complete construction of the facility ~~or facility phase~~ by the following dates: a. Construction of the facility ~~or first facility phase~~ must begin on or before November 18, 2027. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site. ~~b. Construction of the final facility phase must begin on or before November 18, 2028. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site.~~ c. All facility construction must be completed on or before November 18, 2030~~within 2 years after the date construction of the final facility phase (under (b)) begins~~. Within 7 days after completing construction, the certificate holder shall provide the Department written verification that it has met the deadline. [General Standard Condition 2; Final Order on ASC]
GEN-GS-03	If the certificate holder becomes aware of a significant environmental change or impact attributable to the facility, the certificate holder must, as soon as possible, submit a written report to the Department describing the impact on the facility and any affected site certificate conditions. [Mandatory Condition OAR 345-025-0006(6); General Standard Condition 3; Final Order on ASC]
GEN-GS-04	The certificate holder must prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder. [Mandatory Condition OAR 345-025-0006(7); General Standard Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-GS-05	Upon completion of construction, the certificate holder must restore vegetation to the extent practicable and must landscape all areas disturbed by construction in a manner compatible with the surroundings and proposed use. Upon completion of construction, the certificate holder must remove all temporary structures not required for facility operation and dispose of all timber, brush, refuse and flammable or combustible material resulting from clearing of land and construction of the facility. [Mandatory Condition OAR 345-025-0006(11); General Standard Condition 6; Final Order on ASC]
GEN-GS-06	The certificate holder is authorized to construct the 230 kV transmission line~~s~~ anywhere within the approved transmission line corridor~~s~~, subject to the conditions in the site certificate. The approved transmission line corridor includes~~:~~ 5.1 miles of line, extending between the point of interconnection and substation(s) a. ~~Southern transmission line: Approximately 6.3 miles, extending between the facility switchyard to four collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~b. Northern transmission line: Approximately 3.2 miles, extending between the facility switchyard to two collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ [Site Specific Condition OAR 345-025-0010(5); General Standard Condition 7; Final Order on ASC]
GEN-GS-07	The certificate holder may operationally share the following related or supporting facilities between Sunstone Solar Projects 1-6: the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary construction areas, subject to the following: a. Within 30 days of use by certificate holders of the shared facilities, the certificate holder must provide evidence to the Department that the certificate holders of the shared facilities have an executed agreement for shared use of any constructed shared facilities. The Shared Use Agreements must allow operation and maintenance personnel and contractors access to the shared facilities of Sunstone Solar Projects 1-6.
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
GEN-OE-01	Before any transfer of ownership of the facility or ownership of the site certificate holder, the certificate holder must inform the Department of the proposed new owners. The requirements of OAR 345-027-0400 apply to any transfer of ownership that requires a transfer of the site certificate. [Organizational Expertise Condition 1; Final Order on ASC]
GEN-OE-02	Any matter of non-compliance under the site certificate is the responsibility of the certificate holder. Any notice of violation issued under the site certificate will be issued to the certificate holder. Any civil penalties under the site certificate will be levied on the certificate holder. [Organizational Expertise Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-OE-03	The certificate holder must notify the Department within 72 hours of any occurrence of the following: a. There is an attempt by anyone to interfere with the facility's safe operation. b. There is a significant nature event such as a fire, earthquake, flood, tsunami or tornado, or human-caused event such as a fire or explosion. c. There is any fatal injury at the facility. [Organizational Expertise Condition 5; Final Order on ASC]
GEN-OE-04	The certificate holder shall, as soon as reasonably possible: a. Report incidents or circumstances that may violate the terms or conditions of the site certificate, terms or conditions of any order of the Council, or the terms or conditions of any order issued under OAR 345-027-0230, to the Department. In the report to the Department, the certificate holder shall provide all pertinent facts including an estimate of how long the conditions or circumstances existed, how long they are expected to continue before they can be corrected, and whether the conditions or circumstances were discovered as a result of a regularly scheduled compliance audit; b. Initiate and complete appropriate action to correct the conditions or circumstances and to minimize the possibility of recurrence; c. Submit a written report within 30 days of discovery to the Department. The report must refer to the language in (d) of the condition and contain: i. A discussion of the cause of the reported conditions or circumstances; ii. The date of discovery of the conditions or circumstances by the responsible party; iii. A description of immediate actions taken to correct the reported conditions or circumstances; iv. A description of actions taken or planned to minimize the possibility of recurrence; and v. For conditions or circumstances that may violate the terms or conditions of a site certificate, an assessment of the impact on the resources considered under the standards of OAR Chapter 345 Divisions 22 and 24 as a result of the reported conditions or circumstances. d. Upon receipt of the written report in sub(c) of this condition, the Department may review the facility record for incidents or circumstances reported or reportable under sub(a) related to public health and safety, the environment, or other resources protected under Council standards. If these incidences are determined by the Department to impact the adequacy of the facility decommissioning cost, the Department or Council may adjust the contingencies identified in Final Order on ASC Table 4 and shall request and receive an updated bond or letter of credit from certificate holder in the adjusted amount. [Organizational Expertise Condition 6; Final Order on ASC]
STANDARD: Structural Standard (SS) [OAR 345-022-0020]	

Condition Number	General (GEN) Conditions
GEN-SS-01	The certificate holder must design, engineer and construct the facility to avoid dangers to human safety and the environment presented by seismic hazards affecting the site that are expected to result from all maximum probable seismic events. “Seismic hazards” include ground shaking, ground failure, landslide, liquefaction triggering and consequences (including flow failure, settlement buoyancy, and lateral spreading), cyclic softening of clays and silts, fault rupture, directivity effects and soil-structure interaction. [Mandatory Condition OAR 345-025-0006(12); Structural Standard Condition 1; Final Order on ASC]
GEN-SS-02	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if site investigations or trenching reveal that conditions in the foundation rocks differ significantly from those described in the application for a site certificate. After the Department receives the notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(13); Structural Standard Condition 2; Final Order on ASC]
GEN-SS-03	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if shear zones, artesian aquifers, deformations or clastic dikes are found at or in the vicinity of the site. After the Department receives notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(14); Structural Standard Condition 3; Final Order on ASC]
GEN-SS-04	The certificate holder shall design, engineer, and construct the facility in accordance with the versions of the International Building Code, Oregon Structural Specialty Code, and local building codes in effect at the time of construction. [Structural Standard Condition 5; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
GEN-LU-01	The certificate holder shall provide evidence to the Department of coordination with the owners of adjacent lands dedicated to agricultural use. Coordination must include information about the facility that could impact agricultural activities. The certificate holder must document any recommendations made by adjacent landowners regarding measures to reduce or avoid any adverse impacts to farm practices on surrounding lands and to avoid any increase in farming costs as well as any responses made to these recommendations. [Land Use Condition 9; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-LU-02	The certificate holder must adhere to the terms of the Memorandum of Agreement for Agricultural Mitigation Fund included in Attachment F of the Final Order on the ASC, or subsequently amended. It is the certificate holder's responsibility to ensure that the Council and Department receive all reports and notifications required by the agreement. [Land Use Condition 12; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
GEN-RF-01	The certificate holder shall prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder.
	[Mandatory Condition OAR 345-025-0006(7); Retirement and Financial Assurance Condition 1; Final Order on ASC]
STANDARD: Siting Standards for Transmission Lines (TL) [OAR 345-024-0090]	
GEN-TL-01	The certificate holder shall: a. Design, construct and operate the transmission lines in accordance with the requirements of the National Electrical Safety Code as approved by the American National Standards Institute; and b. Develop and implement a program that provides reasonable assurance that all fences, gates, cattle guards, trailers, or other objects or structures of a permanent nature that could become inadvertently charged with electricity are grounded or bonded throughout the life of the line. [Siting Standards for Transmission Line Condition 1; Final Order on ASC]

5.3 Pre-Construction (PRE) Conditions

Condition Number	Preconstruction (PRE) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
PRE-GS-01	Except as necessary for the initial survey, the certificate holder may not begin construction of the facility or phase, or create a clearing on any part of the site of the facility or phase, as applicable, until the certificate holder has the legal right to engage in construction activities on the relevant parts of the site for the facility or phase. [Mandatory Condition OAR 345-025-0006(5); General Standard Condition 5; Final Order on ASC]
PRE-GS-02	At least 90 days prior to construction of the facility or phase, as applicable (unless otherwise agreed to by the Department), the certificate holder shall submit to the Department a compliance plan documenting and demonstrating actions completed or to be completed to satisfy the requirements of all site certificate terms and conditions and applicable statutes and rules. The plan shall be provided to the Department for review and compliance determination for each requirement. The Department may request additional information or evaluation deemed necessary to demonstrate compliance. [OAR 345-026-0048, General Standard Condition 8; Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRE-OE-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall notify the Department of the identity and qualifications of the major design, engineering and construction contractor(s). The certificate holder shall select contractors that have substantial experience in the design, engineering and construction of similar facilities. The certificate holder shall report to the Department any changes of major contractors. [Organizational Expertise Condition 2; Final Order on ASC]
PRE-OE-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall select a construction contractor with a low rate of historic environmental and safety compliance citations. Certificate holder shall provide the following documentation to the Department: a. Qualifications and contact information of the of the major design, engineering and construction contractor(s) and subcontractors, as applicable. b. Construction contractor compliance history. c. Contract excerpt affirming that contractors are required to comply with the terms and conditions of the site certificate, including selecting design layout and construction materials that minimize impacts to resources protected under Council standards. [Organizational Expertise Condition 7; Final Order on ASC]
PRE-OE-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide to the Department the qualifications and contact information of the certificate holder's construction manager.

Condition Number	Preconstruction (PRE) Conditions
	[Organizational Expertise Condition 8; Final Order on ASC]
PRE-OE-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Provide the Department a list of federal, state and local permits, including any third-party permits related to facility siting; and a schedule for obtaining identified permits. b. Once obtained, provide copies of all permits, including third-party permits, required for facility siting to the Department. [Organizational Expertise Condition 12; Final Order on ASC]
STANDARD: Structural (SS) [OAR 345-022-0020]	
PRE-SS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a site-specific geotechnical investigation report, consistent with the Oregon State Board of Geologist Examiners Guideline for Preparing Engineering Geologic Reports, or newer guidelines if available to the Department, for review in consultation with its third-party consultant. [Structural Standard Condition 4; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRE-SP-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide a Vegetation and Grading Plan that demonstrates contractors are required to adhere to the following: a. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems shall be left intact to the maximum extent practicable. b. Grading within solar arrays shall be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically 10% maximum on North slopes and 15% maximum in other directions). [Soil Protection Condition 1; Final Order on ASC]
PRE-SP-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Obtain a NPDES 1200-C Permit from DEQ. A copy of the approved permit and attached Erosion and Sediment Control Plan (ESCP) must be submitted to the Department. b. Finalize the Fugitive Dust Control Plan, as provided in the Final Order on ASC Attachment D. Finalization includes verification of names and contact information of individuals responsible for implementation, measures to be implemented and forms to be used for monitoring and reporting. [Soil Protection Condition 3; Final Order on ASC]
PRE-SP-03	Prior to construction of the facility or phase, as applicable, the certificate holder must submit to the Department a Construction Spill Prevention Countermeasures and Control (SPCC) Plan. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-01	Prior to construction of the facility or phase, as applicable, the certificate holder must provide to the Department a copy of the approved Conditional Use Permit and applicable Zoning Permit(s). [Land Use Condition 1; Final Order on ASC]
PRE-LU-02	Prior to construction of the 230 kV transmission lines, the certificate holder shall demonstrate to the Department that the transmission lines will be sited within the exiting road rights-of-way, unless Morrow County Public Works Department and Oregon Department of Transportation, as applicable, confirm that use of the existing road rights-of-way is not feasible. [Land Use Condition 2; Final Order on ASC]
PRE-LU-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the draft Noxious Weed Control Plan, as provided in the Final Order on ASC Attachment E, and submit to the Department for review and approval in consultation with the Morrow County Weed Department. [Land Use Condition 3; Final Order on ASC]
PRE-LU-04	Prior to construction of the facility or phase, as applicable, the certificate holder must submit an executed document prohibiting the certificate holder, and the certificate holder's successors in interest, from pursuing a claim for relief or cause of action alleging injury from farming or forest practices as defined in ORS 30.930(2) and (4), and provide evidence that the document has been recorded in the deed records for Morrow County. [Land Use Condition 6; Final Order on ASC]
PRE-LU-05	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the final design adheres to the following setbacks: a. All facility structures and above-ground components except the perimeter fenceline must be sited: 1. At least 20 feet from a property line fronting the right-of-way of a local minor collector or marginal access street, including but not limited to Sand Hollow Road, Grieb Lane, Alpine Lane, Doherty Road, or Melville Road. 2. At least 30 feet from a property line fronting the right-of-way, of a major collector, including but not limited to, Bombing Range Road. 3. At least 80 feet from a property line fronting the right-of-way for an arterial road, including but not limited to State Highway 207. b. All facility structures, and all on-site septic systems or other sewage disposal systems must be set back at least 100 feet from delineated waterways. [Land Use Condition 7; Final Order on ASC]
PRE-LU-06	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a final site plan that includes all information required by MCZO 4.165.E to the County and the Department. The Department may defer review and approval to the County. [Land Use Condition 8; Final Order on ASC]

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-07	Prior to construction of the facility or phase, as applicable, the certificate holder must complete the preconstruction requirements identified in the Memorandum of Agreement for Agricultural Mitigation Fund, as provided in the Final Order on ASC Attachment F, or subsequently amended. [Land Use Condition 11; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
PRE-RF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit to the State of Oregon, through the Council, a bond or letter of credit naming the State of Oregon, acting by and through the Council, as beneficiary or payee. The approved bond or letter of credit amount of $24,197,939.27~~117,945,000~~ (Q4~~1~~ 2025~~3~~ dollars) may be adjusted based on the design configuration of the facility, or phase of the facility, as provided in Sub(a) and adjusted to the year and quarter of issuance as provided under Sub(b). a. The bond or letter of credit amount may be adjusted based on actual design/number of components of the facility or phase, as applicable, and shall use the same unit costs and contingencies presented in the Final Order on the ASC Table 8. b. Adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. c. The bond or letter of credit must be issued by a financial institution that is included on the Council's pre-approved financial institution list. The certificate holder may request to have a financial institution added to the list at any time. d. The bond or letter of credit must be prepared using the most recent Council-approved template. [Retirement and Financial Assurance Condition 4; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
PRE-FW-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Revegetation and Reclamation Plan, based on Attachment G of the Final Order on the ASC, and submit to the Department for review and approval. [Fish and Wildlife Habitat Condition 1]
PRE-FW-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit the draft legal agreement for review and approval by the Department, in consultation with ODFW. The legal agreement shall ensure that payment provided for long-term management and enhancement of the mitigation area is adequate to cover the permanent habitat loss from the facility.

Condition Number	Preconstruction (PRE) Conditions
	[Fish and Wildlife Condition 4, Final Order on ASC]
PRE-FW-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Habitat Mitigation Plan, as provided in Attachment H of the Final Order on ASC, based on the impacts associated with the final facility design and the legal agreement, as approved by the Department. [Fish and Wildlife Condition 5, Final Order on ASC]
PRE-FW-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide evidence to the Department that the design measures included in the Construction Wildlife Monitoring Plan (Final Order on ASC Attachment I) have been included in the final facility design and construction contractor contracts, as applicable. [Fish and Wildlife Condition 7; Final Order on ASC]
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
PRE-TE-01	If construction commences after April 2025, certificate holder shall, prior to construction of the facility or phase, as applicable, conduct protocol-level Washington ground squirrel (WAGS) surveys within areas of planned facility construction that are within suitable WAGS habitat. The certificate holder shall: a. Submit a protocol-level survey plan for surveys to be conducted within suitable WAGS habitat, for review and approval by the Department in consultation with ODFW. At a minimum, the survey plan shall specify the survey area (all areas of suitable habitat within 1,000 feet of ground disturbing activities except where there is a habitat barrier (e.g., a paved road) or access restrictions); and survey timing (February 15 to May 31, unless otherwise approved by ODFW). b. Complete protocol-level WAGS surveys based on the protocol approved per (a). c. Submit survey reports to the Department and ODFW. The certificate holder shall not begin construction within 1,000 feet of Category 1 or Category 2 WAGS habitat until the identified boundaries of Category 1 WAGS habitat have been approved by the Department, in consultation with ODFW. Category 1 habitat includes a 785-foot buffer from an identified active burrow, and the area within the perimeter of multiple active burrows. Category 2 WAGS habitat consists of a 4,136-foot buffer from the exterior boundary of all Category 1 WAGS habitat. The survey results are valid for 3-years. d. Develop maps and worker training materials to inform of sensitive Category 1 and Category 2 habitat. Submit to the Department final facility design maps demonstrating that Category 1 habitat, including 785-buffer from any colonies identified per (b), is avoided. e. Install flagging or other demarcation, as appropriate, to inform workers of sensitive WGS habitat and of avoidance requirement. [Threatened and Endangered Species Condition 1; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	

Condition Number	Preconstruction (PRE) Conditions
PRE-HC-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall update the contact information provided in the Final Order on ASC Attachment K, Inadvertent Discovery Plan. [Historic, Cultural and Archeological Condition 1; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
PRE-PS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall execute a final Road Use Agreement, based on Final Order on ASC Attachment N, and provide a copy to the Department. [Public Services Condition 1, Final Order on ASC]
PRE-PS-02	At least 180-days prior to construction of any phase, the certificate holder shall provide to the Department and Morrow County a temporary housing plan for the construction workforce. The plan shall provide for coordination with contractors and local officials on housing options and strategies to minimize impacts to local housing supply based on an ongoing evaluation of patterns of uses and potential shortages or changes in housing demand. [Public Services Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRE-WF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Construction Wildfire Mitigation Plan, as provided in Attachment L to the Final Order on ASC. The final Construction Wildfire Mitigation Plan shall be submitted to the Department for review and approval. [Wildfire Prevention and Risk Mitigation Condition 1; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRE-WM-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall require contractors to develop and submit to the Department for review and approval, Construction Waste Management Plan(s) that, at a minimum, include the following: a. All sources and quantities of construction waste and wastewater, including damaged or dysfunctional energy facility components, and where feasible, estimated quantities that can be recycled. b. Process for disposal and recycling, including use of licensed haulers and disposal/recycling facilities; names and locations of licensed recycling and disposal facilities; collection, hauling and tracking requirements. c. Process for requesting a permit exemption from DEQ pursuant to OAR 340-093-0080 to ensure that concrete washout materials reused in foundation backfill are substantially the same as clean fill. d. Process for training workers and tracking compliance with the requirements of the plan. [Waste Minimization Condition 1; Final Order on ASC]
STANDARD: Noise Control Regulations (NC) [OAR 340-035-0035]	

Condition Number	Preconstruction (PRE) Conditions
PRE-NC-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the operational noise levels comply with OAR 345-035-0035(1)(b), based on an updated acoustic modeling analysis using final design/layout and equipment specifications. [Noise Control Condition 1; Final Order on ASC]
STANDARD: Other – Removal-Fill (WL)	
PRE-WL-01	Prior to construction of the facility, facility component or phase, as applicable, the certificate holder must provide documentation of a valid jurisdictional determination from the Oregon Department of State Lands demonstrating that no waterways subject to the State Removal-Fill law under ORS 196.795 through 196.990 are present within areas to be disturbed during construction or operation. [Removal-Fill Condition 1, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
PRE-WR-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Identify all water-related needs and estimate daily and annual water demand for each construction phase, as applicable. b. Provide, to the Department, a contract or purchase agreement demonstrating that adequate water supply to meet construction demand has been secured from sources with valid water rights. [Water Rights Condition 1, Final Order on ASC]

5.4 Construction (CON) Conditions

Condition Number	Construction (CON) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
CON-OE-01	The certificate holder shall contractually require all contractors and subcontractors to comply with all applicable laws and regulations and with the terms and conditions of the site certificate. The contractual obligation shall be required of each contractor and subcontractor prior to that firm working on the facility. Such contractual provisions shall not operate to relieve the certificate holder of responsibility under the site certificate. [Organizational Expertise Condition 3; Final Order on ASC]
CON-OE-02	During construction, the certificate holder shall: a. Maintain an onsite construction manager. b. Require that the construction manager implement and monitor all applicable construction related site certificate conditions. c. Within six months after beginning construction, and every six months thereafter during construction of the energy facility and related or supporting facilities, the certificate holder shall submit a semiannual construction progress report to the Department. In each construction progress report, the certificate holder shall describe any significant changes to major milestones for construction. The certificate holder shall report on the progress of construction and shall address the following: i. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. ii. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. iii. Compliance Report: A report describing the certificate holder’s compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate. iv. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0050. [Organizational Expertise Condition 9; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	

Condition Number	Construction (CON) Conditions
CON-SP-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Vegetation and Grading Plan. [Soil Protection Condition 2; Final Order on ASC]
CON-SP-02	During construction of the facility or phase, as applicable, the certificate holder shall: a. Conduct all work in compliance with the NPDES 1200-C Permit and Erosion and Sediment Control Plan (ESCP) or revised ESCP if applicable. The ESCP shall be revised if determined necessary by the certificate holder, certificate holder's contractor(s) or the Department. Any Department-required ESCP revisions shall be implemented within 14-days, unless otherwise agreed to by the Department based on a good faith effort to address erosion issues. b. Conduct all work in compliance with the Fugitive Dust Control Plan. The Fugitive Dust Control Plan may be amended, as needed, to ensure that control measures are effective at the site. [Soil Protection Condition 4; Final Order on ASC]
CON-SP-03	During construction, the certificate holder shall require that all onsite contractors and personnel adhere to the requirements of the SPCC Plan. Any SPCC revisions and updates shall be reported to the Department. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
CON-LU-01	During construction, the certificate holder shall implement and adhere to the Noxious Weed Control Plan required under Condition PRE-LU-02. [Land Use Condition 4, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
CON-RF-01	During construction, the certificate holder shall: a. Describe the status of the bond or letter of credit in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. b. If construction extends for more than 12 months, the certificate holder shall adjust the amount of the bond or letter of credit on an annual basis thereafter as described in under Condition PRE-RF-01. c. The Department and Council reserve the right to adjust the contingencies, as necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 5; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
CON-FW-01	During construction, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan, as applicable. [Fish and Wildlife Habitat Condition 2, Final Order on ASC]
CON-FW-02	During construction, the certificate holder shall adhere to the requirements of the Construction Wildlife Monitoring Plan (Attachment I of the Final Order on the ASC). Monitoring records shall be maintained throughout construction and included in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 8; Final Order on ASC]

Condition Number	Construction (CON) Conditions
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
CON-TE-01	Prior to and during construction of the facility or phase, as applicable, any incidentally identified occurrence(s) of Lawrence's milkvetch shall be avoided using a 100-foot buffer via mapping and flagging. [Threatened and Endangered Species Condition 2; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
CON-HC-01	During construction, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan, as submitted to the Department under PRE-HC-01. [Historic, Cultural and Archeological Condition 2; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
CON-PS-01	During construction, the certificate holder shall adhere to the terms and conditions of the Road Use Agreement executed under PRE-PS-01. [Public Services Condition 2; Final Order on ASC]
CON-PS-02	During construction, the certificate holder shall report to the Department the outcomes of the work completed under the temporary housing plan required under PRE-PS-02. The report shall be included in the construction progress report required under CON-OE-02, and shall include, at a minimum: a. Outcome of coordination with construction contractors to identify housing options for incoming workers, including aggregate data on the location (i.e. city) and type of housing used by workers. b. Documentation of coordination with local officials such as the Morrow County Planning Department, nearby cities and towns such as Lexington and Ione, the Lexington Community Development Group, the Ione Community Agri-Business Organization, the Boardman Community Development Association, the Willow Creek Valley Economic Development Group, and other housing providers to identify housing options and strategies to minimize that impacts to local housing supply. [Public Services Condition 4; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
CON-WF-01	During construction of the facility of phase, as applicable, the certificate holder shall implement and require all onsite contractors and employees to adhere to the Construction Wildfire Mitigation Plan required under Condition PRE-WF-01. Updates to the Wildfire Mitigation Plan may be required if determined necessary by the certificate holder, certificate holder's contractor(s), or the Department to address wildfire hazard to public health and safety. Any Department required updates shall be implemented within 14 days, unless otherwise agreed to by the Department based on a good faith effort to address wildfire hazard. [Wildfire Prevention and Risk Mitigation Condition 2; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	

Condition Number	Construction (CON) Conditions
CON-WM-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Construction Waste Management Plan(s) and maintain records of employee training and tracking compliance onsite and available upon Department request. [Waste Minimization Condition 2; Final Order on ASC]
CON-WM-02	During construction, on-site concrete washwater disposal is prohibited unless DEQ approval of a permit exemption for materials substantially similar to clean fill is obtained. If DEQ approval of a permit exemption is obtained, concrete washwater must be disposed of onsite via infiltration and evaporation in accordance with the DEQ-issued NPDES 1200-C permit required under Condition CON-SP-02. [Waste Minimization Condition 3; Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
CON-WR-01	During construction: a. All water used for construction activities shall be appropriated and used in accordance with the applicable provisions of ORS chapter 537 and OAR chapter 690. b. The certificate holder shall report the source and amount of water used during each month of construction under Condition CON-OE-02. The certificate holder shall maintain records adequate to substantiate reports (e.g., written logs and photographs of well meter readings, copies of invoices from water sources) and make such records available to the Department upon request. c. If a water right, limited water use license, or water rights transfer is needed and would not be obtained by a third-party, the certificate holder shall submit and obtain approval of the applicable water permit through the site certificate amendment process. [Water Rights Condition 2; Final Order on ASC]

5.5 Pre-Operational (PRO) Conditions

Condition Number	Pre-Operational (PRO) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRO-OE-01	Prior to operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 10; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRO-SP-01	Following the termination of the 1200-C, the certificate holder shall update the requirements of the Revegetation and Reclamation Plan, specific to the areas within the fenceline not occupied by facility infrastructure. Certificate holder shall provide evidence to the Department that the permit was terminated by DEQ. [Soil Protection Condition 5; Final Order on ASC]
PRO-SP-02	Prior to operation, the certificate holder shall submit to the Department an Operational Spill Prevention Control and Countermeasures (SPCC) Plan. [Soil Protection Condition 8; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRO-WF-01	Prior to operation, the certificate holder shall finalize the operational Wildfire Mitigation Plan (WMP) included as Attachment M to the Final Order on ASC. [Wildfire Prevention and Risk Mitigation Condition 3; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRO-WM-01	Prior to operation, the certificate holder shall develop an Operational Recycling Plan or protocol requiring that damaged or nonfunctional panels and lithium-ion batteries be recycled to the extent practicable. The certificate holder shall report in its annual report to the Department the quantities of panels and lithium-ion batteries recycled, reused or disposed of in a landfill. Requirements for lithium-ion battery recycling do not apply if the BESS is not constructed. [Waste Minimization Condition 4; Final Order on ASC]
STANDARD: Other - Water Rights (WR)	
PRO-WR-01	Prior to operation, the certificate holder shall provide, to the Department, a copy of the map, well log and all other information it provided to OWRD pursuant to ORS 537.545 and ORS 537.765 to qualify for an exempt ground water use for any onsite exempt wells. [Water Rights Condition 3; Final Order on ASC]

5.6 Operational (OPR) Conditions

Condition Number	Operational (OPR) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
OPR-GS-01	The certificate holder must submit a legal description of the site to the Department within 90 days after beginning operation of the facility. The legal description must include a description of metes and bounds or a description of the site by reference to a map and geographic data that clearly and specifically identify the outer boundaries that contain all parts of the facility. [Mandatory Condition OAR 345-025-0006(2); General Standard Condition 9]
OPR-GS-02	After January 1 but no later than April 30 of each year after beginning operation of the facility, the certificate holder shall submit an annual report to the Department. The Council Secretary and the certificate holder may, by mutual agreement, change the reporting date. a. The annual report must include the following information for the calendar year preceding the date of the report: 1. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. 2. Reliability and Efficiency of Power Production: For electric power plants, the plant availability and capacity factors for the reporting year. The certificate holder shall describe any equipment failures or plant breakdowns that had a significant impact on those factors and shall describe any actions taken to prevent the recurrence of such problems. 3. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. 4. Monitoring Report: A list and description of all significant monitoring and mitigation activities performed during the previous year in accordance with site certificate terms and conditions, a summary of the results of those activities and a discussion of any significant changes to any monitoring or mitigation program, including the reason for any such changes. 5. Compliance Report: A report describing the certificate holder's compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate.

Condition Number	Operational (OPR) Conditions
	6. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0350. b. To the extent that information required by this rule is contained in reports the certificate holder submits to other state, federal or local agencies, the certificate holder may submit excerpts from such other reports to satisfy this rule. The Council reserves the right to request full copies of such excerpted reports. [Mandatory Condition 345-026-0080(1); General Standard Condition 10, Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
OPR-OE-01	During operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 11; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
OPR-SP-01	During operation, the certificate holder shall adhere to the requirements of the Operational SPCC Plan. Any SPCC updates shall be described and included in the Annual Report to the Department. Certificate holder shall report spill and cleanup activities to the Department within 72 hours and shall make inspection records available to the Department upon request. [Soil Protection Condition 9; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
OPR-LU-01	Following the fifth year of monitoring under the Noxious Weed Control Plan required under PRE-LU-03, the certificate holder shall submit a Long-term Noxious Weed Monitoring Plan to the Department, for review and approval. The certificate holder shall implement the plan for the remainder of the facility's operating life. [Land Use Condition 5, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
OPR-RF-01	During operation, the certificate holder shall: a. Annually adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. b. Any changes to the template made by the Council must be incorporated into the bond or letter or letter of credit whenever the amount is adjusted under Sub(a). c. The Department and Council reserve the right to adjust the contingencies, as

Condition Number	Operational (OPR) Conditions
	necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 6; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
OPR-FW-01	During operation, as applicable, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan. [Fish and Wildlife Habitat Condition 3, Final Order on ASC]
OPR-FW-02	During operation, the certificate holder shall provide reports from The Nature Conservancy on the status of long-term management and enhancement of the habitat mitigation area, consistent with the Habitat Mitigation Plan. [Fish and Wildlife Condition 6, Final Order on ASC]
OPR-FW-03	During operation, the certificate holder shall adhere to the requirements of the Operational Wildlife Monitoring Plan (Attachment J of the Final Order on the ASC). Monitoring records shall be maintained throughout operation and included in the annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 9; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
OPR-HC-01	During operations, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan (IDP), as provided for Condition PRE-HC-01. The IDP shall be reviewed and updated annually for current contact information. [Historic, Cultural and Archeological Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
OPR-WF-01	During operation, the certificate holder shall: a. Implement the Operational Wildfire Mitigation Plan finalized under Condition PRO-WF-01. b. Every 5 years after the first operational year, review and update the evaluation of wildfire risk under OAR 345-022-0115(1)(b) and submit the results in the annual report required under Condition CON-OE-02 for that year. c. Submit an updated Operational Wildfire Mitigation Plan to the Department if substantive changes are made to the plan because of the review under sub (b) of this condition, or at any other time substantiative revisions are made. [Wildfire Prevention and Risk Mitigation Condition 4; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
OPR-WM-01	During operation, the certificate holder shall adhere to the requirements of the Operational Recycling Plan or protocol developed under Condition PRO-WM-01. [Waste Minimization Condition 5; Final Order on ASC]
OPR-WM-02	During operation, the certificate holder shall: a. Prohibit use of chemicals, soaps, detergents and heated water unless Chemical Safety Data Sheets for low volatile organic compound/biodegradable cleaning chemicals and solvents are submitted to the Department for review and approval prior to use.

Condition Number	Operational (OPR) Conditions
	b. Ensure that washing is conducted in a manner that does not remove paint or other finishes. c. Discharge wash water through evaporation and infiltration only. [Waste Minimization Condition 6, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
OPR-WR-01	During operation, the certificate holder shall verify that any onsite exempt wells do not use more than 5,000 gallons of ground water a day, collectively, and shall monitor the volume of groundwater used on a daily basis, maintain a record of such use and make the monitoring records available to the Department upon request. [Water Rights Condition 4; Final Order on ASC]

5.7 Retirement (RET) Conditions

Condition Number	Retirement (RET) Conditions
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
RET-RF-01	The certificate holder must retire the facility if the certificate holder permanently ceases construction or operation of the facility. The certificate holder must retire the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410. The certificate holder must pay the actual cost to restore the site to a useful, non-hazardous condition at the time of retirement, notwithstanding the Council's approval in the site certificate of an estimated amount required to restore the site. [Mandatory Condition OAR 345-025-0006(9); Retirement and Financial Assurance Condition 2; Final Order on ASC]
RET-RF-02	If the Council finds that the certificate holder has permanently ceased construction or operation of the facility without retiring the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410, the Council must notify the certificate holder and request that the certificate holder submit a proposed final retirement plan to the Department within a reasonable time not to exceed 90 days. If the certificate holder does not submit a proposed final retirement plan by the specified date, the Council may direct the Department to prepare a proposed final retirement plan for the Council's approval. Upon the Council's approval of the final retirement plan, the Council may draw on the bond or letter of credit described in Condition PRE-RT-01 to restore the site to a useful, non-hazardous condition according to the final retirement plan, in addition to any penalties the Council may impose under OAR chapter 345, division 29. If the amount of the bond or letter of credit is insufficient to pay the actual cost of retirement, the certificate holder must pay any additional cost necessary to restore the site to a useful, non-hazardous condition. After completion of site restoration, the Council must issue an order to terminate the site certificate if the Council finds that the facility has been retired according to the approved final retirement plan. [Mandatory Condition OAR 345-025-0006(16); Retirement and Financial Assurance Condition 3; Final Order on ASC]

6.0 Successors and Assigns

To transfer this site certificate or any portion thereof or to assign or dispose of it in any other manner, directly or indirectly, the certificate holder shall comply with OAR 345-027-0400.

7.0 Severability and Construction

If any provision of this agreement and certificate is declared by a court to be illegal or in conflict with any law, the validity of the remaining terms and conditions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the agreement and certificate did not contain the particular provision held to be invalid.

8.0 Execution

This site certificate may be executed in counterparts and will become effective upon signature by the Chair of the Energy Facility Siting Council and the authorized representative of the certificate holder.

IN WITNESS THEREOF, this site certificate has been executed by the State of Oregon, acting by and through the Energy Facility Siting Council and Sunstone Solar, LLC (certificate holder).

ENERGY FACILITY SITING COUNCIL
Kent Howe
By: Kent Howe (Nov 19, 2024 16:21 PST)
Kent Howe, Chair
Date: 19-Nov-2024

SUNSTONE SOLAR, LLC
Jon Saxon
By: Jon Saxon (Nov 19, 2024 16:26 EST)
Jon Saxon, Authorized Representative
Date: 19-Nov-2024

Sunstone Solar Project 2

ENERGY FACILITY SITING COUNCIL
OF THE STATE OF OREGON

SITE CERTIFICATE FOR THE SUNSTONE SOLAR PROJECT

2

ISSUE DATE
NOVEMBER 18, 2024

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Table of Contents

1.0 Introduction and Site Certification

This site certificate is a binding agreement between the State of Oregon (State), acting through the Energy Facility Siting Council (EFSC or Council), and Sunstone Solar 2, LLC (certificate holder), owned by Pine Gate Renewables, LLC (parent company). Both the State and certificate holder must abide by local ordinances, state law, and the rules of the Council in effect on the date this site certificate is executed. However, upon a clear showing of a significant threat to public health, safety, or the environment that requires application of later-adopted laws or rules, the Council may require compliance with such later-adopted laws or rules (ORS 469.401(2)).

This site certificate binds the State and all counties, cities and political subdivisions in Oregon as to the approval of the site and the construction, operation, and retirement of the facility as to matters that are addressed in and governed by this site certificate (ORS 469.401(3)). Each affected state agency, county, city, and political subdivision in Oregon with authority to issue a permit, license, or other approval addressed in or governed by this site certificate, shall upon submission of the proper application and payment of the proper fees, but without hearings or other proceedings, issue such permit, license or other approval subject only to conditions set forth in this site certificate. In addition, each state agency or local government agency that issues a permit, license or other approval for this facility shall continue to exercise enforcement authority over such permit, license or other approval (ORS 469.401(3)). For those permits, licenses, or other approvals addressed in and governed by this site certificate, the certificate holder shall comply with applicable state and federal laws adopted in the future to the extent that such compliance is required under the respective state agency statutes and rules (ORS 469.401(2)).

This site certificate does not address, and is not binding with respect to, matters that are not included in and governed by this site certificate, and such matters include, but are not limited to: employee health and safety; building code compliance; wage and hour or other labor regulations; local government fees and charges; other design or operational issues that do not relate to siting the facility (ORS 469.401(4)); and permits issued under statutes and rules for which the decision on compliance has been delegated by the federal government to a state agency other than the Council (ORS 469.503(3)).

The obligation of the certificate holder to report information to the Department or the Council under the conditions listed in this site certificate is subject to the provisions of ORS 192.502 *et seq.* and ORS 469.560. To the extent permitted by law, the Department and the Council will not publicly disclose information that may be exempt from public disclosure if the certificate holder has clearly labeled such information and stated the basis for the exemption at the time of submitting the information to the Department or the Council. If the Council or the Department receives a request for the disclosure of the information, the Council or the Department, as appropriate, will make a reasonable attempt to notify the

certificate holder and will refer the matter to the Attorney General for a determination of whether the exemption is applicable, pursuant to ORS 192.450.

Council shall have continuing authority over the site and may inspect, or direct the Oregon Department of Energy (Department) to inspect, or request another state agency or local government to inspect, the site at any time in order to ensure that the facility is being operated consistently with the terms and conditions of this site certificate (ORS 469.430).

The duration of this site certificate shall be the life of the facility, subject to termination pursuant to OAR 345-027-0110 or the rules in effect on the date that termination is sought, or revocation under ORS 469.440 and OAR 345-029-0100 or the statutes and rules in effect on the date that revocation is ordered. The Council shall not change the conditions of this site certificate except as provided for in OAR Chapter 345, Division 27.

In interpreting this site certificate, any ambiguity will be clarified by reference to the following, in order, incorporated herein by this reference: 1) *Final Order on the Application for Site Certificate for the Sunstone Solar Project* issued on November 18, 2024 (hereafter, *Final Order on the ASC*); 2) the record of the proceedings that led to the Final Order on the ASC.

The definitions in ORS 469.300 and OAR 345-001-0010 apply to the terms used in this site certificate, except where otherwise stated, or where the context clearly indicates otherwise.

2.0 Facility Location and Site Boundary

The facility is located within an approximately 1,233.7 ~~10,960~~-acre (1.9 ~~17~~ sq. mile) site in Morrow County. The site is located on both sides of State Route 207 and is approximately 15 miles northeast of the Town of Lexington and approximately 4.5 miles west of Butter Creek Junction. The site is approximately 3 miles west of the Umatilla County line at its closest point. Table 1 below provides the Township, Range, and Sections occupied wholly, or in part, by the site. Up to 1,230.9 acres~~9,442~~ of land within the site boundary would be occupied by facility components. The regional location of the facility site boundary~~, transmission line corridor,~~ and ~~approximately 1,518 acres~~ areas within the site boundary ~~are~~ excluded from development, as applicable, areas shown on Attachment 1~~ASC Exhibit C, Figures C- 2, and C-2.1 to C-2.3, attached~~ to this site certificate ~~as Attachment 1~~.

Table 1: Township, Range, and Section for Areas Occupied by the Site Boundary

Township	Range	Sections
~~1N~~	~~26E~~	~~1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 14, 15~~
2N	26E	~~27,~~ 28, 29~~, 30, 31,~~ 32, 33~~, 34, 35, 36~~
Reference: SSPAPPDoc25-03 ASC Exhibit C Project Location, Table C-1. 2024-05-15.		

3.0 Facility Description

The energy facility is approved to include the components presented in Table 2 below. Additional details regarding specific components, and discussion of alternative designs or technologies under consideration are provided in the sections that follow.

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Site Boundary		
Site Boundary	1,233.7~~10,960~~	acres
Maximum Footprint	1,230.9 ~~9,442~~	acres
Permanent Impacts[1]	1,230.9 ~~9,442~~	acres
Solar Components		
PV Solar Modules		
Approx. total number	656,256~~3,937,536~~	modules
Max Height at full-tilt	15	feet
Posts		
Approx. total number (assumes concrete foundation)	89,176~~535,056~~	posts
Cabling		
Combiner Boxes	10,254~~61,524~~	each
Inverter Step Up (ISU) Transformer Units		
Approx. total number	54 ~~319~~	each
Noise level	89	dBA
Transformer oil-containing capacity	800	gallons
Related or Supporting Facility Components		
34.5 kV Collection System		
Collector line length, belowground	12.9 ~~82~~	miles
Collector line length, overhead (OH)	0.7 ~~4.3~~	miles
Wood Monopoles (max estimate for OH)	26 ~~151~~	each
Collector Substations		
Substations w SCADA; GSU transformers ~~per~~ each	1~~6~~; 1	each
Site size	1.6	acres
Transformer oil-containing capacity	16,000	gallons~~/each~~
Transformer noise level	100	dBA
Max height of structures	45	feet
~~Switchyards~~		

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[1] The energy facility would occupy approximately 1,230.9 ~~9,442~~ acres ~~within up to 20 separately fenced areas~~. Most related or supporting facilities will be located within the energy facility's footprint; however, portions of the overhead 34.5 kV collector and 230-kV transmission lines running between solar array areas would result in additional temporary and permanent disturbance areas.

Table 2: Facility Component Summary

~~Component and Design Standard~~	~~No.~~	~~Unit~~
~~Stations; Transformers per each~~	~~2; 0~~	~~each~~
~~Site size (northern and/or within solar fence line); with foundations and graveled areas~~	~~3~~	~~acres~~
~~230 kV Transmission Line~~		
~~Length (total; northern line; southern line)~~	~~9.5; 3.2; 6.3~~	~~miles~~
~~Structures: Type (Wood or Galvanized Steel); quantity~~	~~H-frame; 50~~	~~each~~
~~Height of structures~~	~~70–180~~	~~feet~~
Battery Energy Storage System (Lithium-ion/Zinc)		
Zinc		
Approx. total battery containers on foundations with fans/heating systems; SCADA	2,491~~14,946~~	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	9.5 x 8 x 20	H x W x L; feet
Noise level (broadband)	66	dBA
Lithium-ion		
Approx. total battery containers on foundations with HVAC and fire suppression systems; SCADA	~~1~~2,000	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	11.25 x 8.1 x 5.2	H x W x L; feet
Noise level (broadband)	66	dBA
O&M Building		
Quantity	1~~4~~	each
Site size	2.8	acres
Height	20	feet
Appurtenances	On-site well, septic system, SCADA System	
Storage for Replacement Solar Panels		
Containers	8-9~~50~~	each
Approx. container dimensions	8.5 x 8 x 40	H x W x L; feet
Location	Dispersed within fence line if not next to O&M, gravel base	
Facility Roads		
Length	7.4 ~~55~~	miles
Width	10- 20	feet
Perimeter Fence		
Length	2.2 ~~58~~	miles
Height	7-8	feet

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Access/gates	8-9~~52~~	each
Temporary Construction Areas		
Quantity	3~~5~~4	each
Site size	5	acres
Description	Gravel base; diesel/gas storage; within fence line	

Energy Facility

The facility includes a solar photovoltaic power generation facility with up to ~~1,~~200 MW of electric generation capacity. ~~The energy facility consists of up to 20 separately fenced solar arrays organized into six 200 MW blocks.~~

Photovoltaic Modules

Solar photovoltaic modules, or solar panels, convert sunlight into DC electric power. The typical module contains crystalline silicon photovoltaic cells arranged within glass panels equipped with an anti-reflective coating, a metal frame, and wire connectors.

Racking System

The photovoltaic modules are connected in series into strings and then mounted on a racking system. Each rack would contain 2 strings of 32 modules mounted on a single-axis tracking system. Multiple racks are organized into rows between 200 and 400 feet in length depending on topography. Rows would be spaced at least 10 feet apart and at least 15 feet from perimeter fencing to provide vehicle access.

Posts

Each row of tracker mounted modules is supported by multiple hollow, screw pile, or pile-type steel posts. Posts are typically installed to a depth of 6-8 feet below surface and extend 5 feet above grade. Posts at the end of rows may be installed at greater depths to withstand wind uplift. Posts may be installed directly in the ground or concrete backfill may be required in some soil conditions.

DC Cabling System

Combiner boxes or a Big Lead Assembly (BLA) harness system is used to aggregate the DC output of the photovoltaic modules for transmission to an inverter by low-voltage DC cables. Using the combiner boxes, strings of modules are connected to a pad-mounted combiner box installed at each row, which in turn, are connected to the inverters by low voltage DC cables

that are either mounted to the tracking system, installed in trays, or buried underground. Using the BLA system, strings are connected directly to a rack-mounted cabling system.

Inverters and Inverter Step Up (ISU) Transformers

Inverters convert the DC output of the photovoltaic modules to AC power that can be transmitted to the electric grid. A typical inverter in utility scale solar facilities converts the 900 to 1,500 volt DC module output to 660 volt AC output. After conversion, the output is sent to an inverter step-up (ISU) transformer to increase the voltage to 34.5 kV power for transmission to the collector substation via the electrical collector system. Inverters and ISU transformers are collocated on concrete slabs near each module block.

Related or Supporting Facilities

Related or supporting facilities include a battery energy storage system, ~~an interconnection substation,~~ one~~up to six~~ collector substation~~s~~, one~~up to four~~ operations and maintenance building, and other structures.

Battery Energy Storage System

The battery energy storage system (BESS) is designed to provide up to 1~~7~~.2 gigawatt-hours (GWh) of storage capacity. The BESS may use either Lithium-Ion (Li-ion) or Zinc-based battery technology. Under either technology, batteries are contained in pre-constructed modular containers, or "segments," placed on concrete slab foundations.
The battery storage system includes, but is not limited to, the following elements:

- Batteries and containers, inverters, isolation transformers, and switchboards;
- Balance of plant equipment, which may include medium-voltage and low-voltage electrical systems, fire suppression and HVAC systems (for Li- ion technology, if selected), building auxiliary electrical systems, and network/SCADA systems;
- Cooling system, which may include a separate chiller plant located outside the battery racks with chillers, pumps, and heat exchangers (Li-ion only, if selected); zinc batteries will have fans and a heating unit for climate control; and
- High-voltage (HV) equipment, including a step-up transformer, circuit breaker, current transformers and voltage transformers, a packaged control building for the breaker and transformer equipment, towers, structures, and cabling.

The batteries and associated equipment may be oversized or periodically augmented in accordance with the manufacturer's recommendations to ensure a minimum of 1~~7~~,200 MWh of energy storage capability over the life of the BESS, taking into account natural degradation of the batteries over time.

Li-ion batteries are currently the most common battery type used in utility-scale battery energy storage systems. If a Li-ion battery technology is used at the facility, it would use Li-ion phosphate batteries, which are more thermally stable than Li-ion cathode batteries.
Each module contains approximately 10 hermetically sealed battery cells filled with a gel or liquid electrolyte. The module containers serve as secondary containment for the cells. Each container holds approximately 840 cells with a combined capacity of approximately 740 kilowatt-hour AC, and approximately ~~1~~2,000 containers would be required to meet the capacity needs of the facility.

The electrolyte used in Li-ion batteries is flammable and susceptible to overheating and vaporization, so Li-ion Battery Systems typically require cooling, ventilation, and fire suppression systems included in each container. If Li-ion battery technology is used at the site, it would implement the following design features and fire prevention and control methods to minimize fire and safety risks:

- Batteries would be stored in completely contained, leak-proof modules.
- Ample working space would be provided around the BESS for maintenance and safety purposes.
- An off-site, 24-hour monitoring system with shutdown capabilities would be implemented.
- Batteries would be transported in accordance with Department of Transportation Pipeline and Hazardous Material Administration regulations under 49 CFR 173.185
- Battery systems would be designed in accordance with applicable Underwriters Laboratories, National Electric Code, and National Fire Protection Association Standards, including but not limited to, UL 1642, 1741, 1973, and 9540A, and NFPA 855.
- An advanced and proven battery management system would be employed;
- Battery Containers would be equipped with:
  - Heating, ventilation, and air conditioning (HVAC) systems to maintain optimal battery temperatures;
  - Fire control panels with 24-hour battery backup;
  - Fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems;
  - Doors equipped with a contact that will shut down the battery container if opened;
  - Fire extinguishing and thermal insulation sheets between each individual battery cell;
  - Locks and fencing to prevent entry of unauthorized personnel;
  - Remote power disconnect switches with clear and visible signs identifying their location.[2]

Li-ion battery modules under consideration for this facility have an expected useful life of 20 years and it is expected that every module at the facility would need to be replaced at least once during the life of the facility. Used Li-ion batteries are generally considered to be

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[2] SSPAPPDoc25-02 ASC Exhibit B Project Description 2024-05-15, Section 2.7.1.

hazardous waste by the EPA and must be transported and disposed of according to the most current guidelines at end of life.

A typical zinc-based BESS container includes 144 zinc-hybrid cathode powered batteries with a combined 700 kWh capacity. Zinc batteries are estimated to have a lifespan of at least 20 years. Zinc battery systems can operate across a higher range of temperatures and only require cooling fans rather than a full HVAC system. Zinc batteries have a lower fire-risk than lithium-ion batteries and do not require fire suppression systems to be included in the container design.

The BESS may be designed either as a DC-coupled system, with containers distributed throughout the energy facility site near inverter/transformer station sites, or as an AC-coupled system with containers concentrated in a single area near the ~~switchyards~~ substation. In either case, the containers and other BESS equipment are located within the fenced solar array areas and may have their own additional fencing.

34.5 kV Electrical Collection System

The facility includes up to 12.9~~86~~ miles of 34.5 kV electrical collector lines that connects energy facility components to the collector substation~~s~~ described below. The majority of the collector lines are buried underground; however, overhead lines are installed at long "home run" stretches, stream or canyon crossings, and other areas where burial is infeasible. The collector lines are generally located within the energy facility footprint except at road crossings and crossings between fenced solar array areas.

Communication and SCADA System

The facility includes a system of fiber optic and copper communication lines that connect the solar arrays, BESS, and substation~~s~~ to Supervisory Control and Data Acquisition (SCADA) system control rooms within the~~each~~ collector substation (to be shared with all projects, see below). The communication lines are collocated with the 34.5 kV electrical collection system described above. The SCADA system monitors meteorological conditions, critical operating parameters, and power output, for each solar string, battery energy storage system, and substation. The SCADA system is monitored by a remote operations center. Smoke and fire detectors placed around the site also connect to the SCADA system and will contact local emergency responders in the event of a fire at the site.

Collector Substations

The facility includes up to one~~six~~ collector substation~~s~~ at the site. The~~Each~~ substation includes a generator-step up (GSU) transformer and control building, and may also include circuit-breakers and fuses, transmission line termination structures, power transformers, bus bars and insulators, disconnect switches, relaying, battery and charger, surge arresters, AC and DC

supplies, control systems, metering equipment, grounding, a lightning protection system and associated control wiring.

The GSU transformer~~s~~ increases the 34.5-kV ISU transformer output to 230-kV power. The GSU transformer~~s~~ is a~~are~~ ground-mounted unit~~s~~ constructed on a concrete pad~~s~~. The single~~Each of the six~~ GSU transformer is~~s are~~ filled with up to 16,000 gallons of non-toxic oil such as mineral or seed oil.

The~~Each~~ GSU transformer is equipped with a secondary spill containment catchment system designed to minimize the possibility of accidental leakage. The concrete catchment system is sized to contain approximately 1.25 times the amount of oil inside the transformer.

All substation structures and components are surrounded by a graveled area and enclosed by an 8-foot-tall chain-link fence with three strands of barbed wire one foot above the top. Access to the substation site~~s~~ is limited with a locked gate.

~~230-kV Transmission Line~~

~~The facility includes up to two 230-kV overhead transmission lines that connect the collector substations to the two primary interconnection switchyards located at the point of interconnection. The transmission lines are supported by steel or wood monopole or H-Frame structures, spaced approximately 1,000 feet between structures, and ve a combined length of approximately 9.5 miles. The northern line connects two collector substations along the south side of Alpine Lane to the switchyard and extends approximately 3.2 miles. The southern line connects four collector substations across the southern portion of the site and extend approximately 6.3 miles. The two lines run in parallel for approximately 1-mile between Bombing Range Road and the switchyards.~~

~~The transmission lines are located within the fenced solar array areas except where the lines span roads or corridors between areas and between the switchyards and the point of interconnection. All transmission line components are sited within the facility lease boundary.~~

~~No new or expanded right-of-way will be required, but some portions of the transmission lines are located within existing public rights-of-way. A portion of the transmission line that runs along the western boundary of energy facility footprint is within the public right-of-way on the east side of Bombing Range Road. Additionally, portions of the transmission line that connect solar array areas in the southern portion of the site cross Doherty Road and the Lexington-Echo Highway.~~

~~Project Switchyards and~~ Interconnection Facilities

The facility interconnects with the existing Umatilla Electric Cooperative 230kV Blue Ridge Line at the northwest corner of the facility where the shared switchyard is located (see below). ~~Two switchyards are approved to be located within a separately fenced site either within or adjacent to the energy facility footprint, each~~

~~approximately 3 acres. The interconnection switchyards do not contain transformers and are constructed on foundations with surrounding gravel areas.~~

Operations and Maintenance Buildings

The facility includes one~~up to four~~ operations and maintenance (O&M) building~~s~~, ~~each~~ including a utility room, storage for maintenance supplies and equipment, and a SCADA control room. The building~~s each~~ has~~ve~~ an on-site well and septic system. Power is supplied by a local service provider using overhead and/or underground lines. The~~Each~~ O&M building site also has a graveled parking and storage area~~s~~. The O&M building may be shared with all projects, see below.

Small quantities of chemical materials, including cleaners, insecticides or herbicides, paint, lubricants, degreasers, and solvents, may be stored at the O&M building~~s~~ during construction and operation of the facility. No extremely hazardous materials would be stored on site; other chemicals will be handled in accordance with label instructions as well as state and federal standards.

The facility includes an aboveground fuel storage tank with capacity to store up to 500 gallons of diesel fuel or gasoline at the~~each~~ O&M building site.

The O&M building~~s~~ is~~are~~ equipped with basic firefighting equipment for use on-site during maintenance activities, such as shovels, beaters, portable water for hand sprayers, fire extinguishers, and other equipment.

Replacement Solar Panel Storage

To store spare solar panels and associated equipment, the facility is approved to store materials either at the O&M building site~~s~~ or within approximately 50 locked Conex storage containers distributed throughout the site (to be shared with all projects, see below). The containers may be placed directly on the ground or on gravel pads. The containers would store up to the approximately 204,720 replacement panels needed over the life of the facility.

Access and Service Roads

The facility includes up to 7.4 ~~55~~ miles of new roads (graded and graveled to meet load requirements for all equipment) to provide access to facility components; some roads will be shared with all projects, see below. Corridors between module racking are at least 10 feet wide and racking are no closer than 15 feet from perimeter fencing. Some new road construction is required to access site features. Roads will be 10 to 20 feet in width, with some exceptions, including access to the substation~~s~~ and main travel corridors where two-way traffic is required. In these cases, roads will be 20 feet wide. A 5-foot maintained vegetative surface or noncombustible base, approved by the fire code official, will be maintained along the fenced perimeter of the site boundary. Use of the roads may continue

after construction, or new roads may be removed and the land reclaimed to pre-construction conditions.

Security Fencing and Gates

The facility includes approximately 2.2 ~~58~~ miles of security fence to enclose each solar array area, and substation~~, and switchyard site~~. The perimeter fencing has lockable vehicle and pedestrian access gates to provide access to the site.

Temporary Construction Areas

The facility includes up to 3~~54~~ temporary construction areas within the energy facility footprint to support construction, store supplies and equipment, and facilitate the delivery and assembly of materials and equipment. Each area consists of a 5-acre site that would be cleared and graveled prior to construction.

Up to five above-ground diesel tanks and one temporary above-ground gasoline tank may be stored in the temporary construction areas (to be shared with all projects, see below). The tanks each hold up to 1,000 gallons of fuel. Most fuel containers have self-contained secondary containment (e.g., double-walled containers) that provide capacity for the entire container plus precipitation, but in some cases may be placed in a constructed secondary containment area that is impervious and is diked or otherwise contained to provide the required fuel and precipitation capacity.

Shared Related or Supporting Facilities

The certificate holder is authorized to share related or supporting facilities between the Sunstone Solar Projects 1-6, including the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary constructions areas (including fuel tanks). These related or supporting facilities are split accordingly between the Sunstone Solar Projects 1-6, as demonstrated in their associated site certificates. Similarly, compliance with site certificate conditions and EFSC standards which apply to these shared related or supporting facilities are also split accordingly between Sunstone Solar Projects’ 1-6 site certificates and certificate holders. In accordance with Condition GEN-GS-07 if either certificate holder substantially modifies a shared related or supporting facility or ceases facility operation, the applicable/relevant certificate holder is obligated to submit an amendment determination request or request for amendment to the Department to determine the appropriate process for evaluating the change and ensuring full regulatory coverage under each site certificate, or remaining site certificate if either is terminated, in the future. Additionally, each certificate holder is obligated to demonstrate to the Department that a “Common Facilities Agreement” or similarly legally binding agreement has been fully executed between certificate holders to ensure approval and agreement of access to the shared resources has been obtained prior to operation of shared facilities.

4.0 Facility Development

4.1 Construction

The initial applicant proposed to construct the originally permitted~~proposed~~ facility in six phases, with each phase including approximately 200 MWs of generating capacity, one of which is the subject of this Site Certificate.

Portions of the site, including the substation~~sites~~, inverter and battery energy storage system sites, and access roads will be cleared and graded, prior to construction of the applicable facility components. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems in the energy facility footprint are left intact during construction to the maximum extent practicable to minimize soil and erosion impacts, and that grading in solar arrays is limited to those areas where the slope and gradient are outside of panel and racking tolerances. Typical grading tolerances within the array are 10% maximum on North slopes and 15% maximum in other directions. Following construction, operational requirements include long-term site stabilization and revegetation of disturbed areas.

Adherence to the requirements of a Fugitive Dust Control Plan is required under Condition PRE-SP-02. Measures implemented under this plan include maintaining existing vegetative root systems, applying dust suppressants, and restricting traffic speeds on-site. Typically, water is

applied as a dust suppressant on access roads, but under drought conditions, alternative dust suppressants including synthetic polymer emulsions, chemical suppressants, organic glues, and wood fiber materials may be applied at the site by qualified vendors.

Construction of the originally permitted facility for all six projects will generate 910 commuting trips and 250 truck trips per day over approximately 1,224 construction workdays. At the peak of construction, it is estimated a maximum of approximately 1,266 commuting trips per day and 250 truck trips per day. The primary route to the site would be Bombing Range Road via Interstate Highway 84 (I-84) at the I-84/Irrigon Junction. Alternate routes would be via OR-207 via I-84 south of Hermiston.

4.2 Operations and Maintenance

Operation and maintenance activities include routine inspections, replacement of solar modules and battery components, panel washing, and vegetation management. Up to 10 permanent employees would operate and maintain the facility (to be shared by all six projects), with occasional delivery truck accessing the site during operations depending on the type of maintenance activity.

Individual batteries associated with the BESS will be inspected according to the manufacturer's recommendations and will need to be replaced approximately every 20 years, and every battery will be replaced during the life of the facility. Each type of electrical facility component would have routine inspections as designated in the operational Wildfire Mitigation Plan. The solar panels may require periodic washing during operations, and other incidental water use for sanitation and equipment washing.

Vegetation will be cleared and maintained along access roads to provide a vegetation clearance area for fire safety. This includes mowing to a height of no more than 12 inches. Use of the roads may continue after construction, or new roads may be removed, and the land reclaimed to pre-construction conditions.

An aboveground 500-gallon fuel storage tank sized may be installed at each O&M building. Secondary containment and refueling procedures for on-site fuel storage during operations will continue to follow the SPCC Plan and requirements for secondary containment. No extremely hazardous materials are expected to be produced, used, stored, transported, or disposed of at the facility during operation.

4.3 Retirement

The estimated useful life of the proposed facility is 40 years. Operational jobs would be eliminated after the facility ceased operating; however, some short-term contract jobs to monitor restored areas may be added to facilitate retirement activities. Decommissioning requires similar workforce numbers as required for the construction of the originally permitted facility/six projects in total and is estimated to require a similar duration of up to 47 months.

Final retirement activities will be designated in a retirement plan but would begin with disconnecting all electrical equipment disassembling equipment and components such and the battery storage units, solar panels and transformers. Larger containers and equipment would be removed, trucked off-site and recycled and disposed of. Solar panels would be disconnected, and piles would be removed including the excavation of any concrete foundations. Gravel and foundations from the inverters and transformers, O&M building, substation~~s~~, and battery unit~~s~~ would be removed by trenching and excavation. The facility site would then be restored through grading, filling, and revegetation with plants or seed mix consistent with applicable plans and conditions discussed in this order or landowner interests.

5.0 Site Certificate Conditions

The conditions of this Site Certificate are organized and coded to indicate the phase of implementation, the standard the condition is required to satisfy, and an identification number (1, 2, 3, etc.).[3] The table below presents a "key" for phase of implementation:

Key	Type of Conditions/Phase of Implementation
GEN	General Conditions: Design, Construction and Operation
PRE	Pre-Construction Conditions
CON	Construction Conditions
PRO	Pre-Operational Conditions
OPR	Operational Conditions
RET	Retirement Conditions

To align with the phased construction approach, preconditions requiring applicant actions prior to construction allow for phased compliance. These apply specifically to the area in which the phased activities would occur, rather than the entirety of the site.

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[3] The identification number is not representative of an order that conditions must be implemented; it is intended only to represent a numerical value for identifying the condition.

5.1 General (GEN) Conditions: Design, Construction and Operations

Condition Number	General (GEN) Conditions
STANDARD: GENERAL STANDARD OF REVIEW (GS) [OAR 345-022-0000]	
GEN-GS-01	The certificate holder must design, construct, operate and retire the facility: a. Substantially as described in the site certificate; b. In compliance with the requirements of ORS Chapter 469, applicable Council rules, and applicable state and local laws, rules and ordinances in effect at the time the site certificate was issued; and c. In compliance with all applicable permit requirements of other state agencies. [Mandatory Condition OAR 345-025-0006(10); General Standard Condition 1; Final Order on ASC]
GEN-GS-02	The certificate holder must begin and complete construction of the facility ~~or facility phase~~ by the following dates: a. Construction of the facility ~~or first facility phase~~ must begin on or before November 18, 2028~~7~~. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site. ~~b. Construction of the final facility phase must begin on or before November 18, 2028. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site.~~ c. All facility construction must be completed on or before November 18, 2030~~within 2 years after the date construction of the final facility phase (under (b)) begins~~. Within 7 days after completing construction, the certificate holder shall provide the Department written verification that it has met the deadline. [General Standard Condition 2; Final Order on ASC]
GEN-GS-03	If the certificate holder becomes aware of a significant environmental change or impact attributable to the facility, the certificate holder must, as soon as possible, submit a written report to the Department describing the impact on the facility and any affected site certificate conditions. [Mandatory Condition OAR 345-025-0006(6); General Standard Condition 3; Final Order on ASC]
GEN-GS-04	The certificate holder must prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder. [Mandatory Condition OAR 345-025-0006(7); General Standard Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-GS-05	Upon completion of construction, the certificate holder must restore vegetation to the extent practicable and must landscape all areas disturbed by construction in a manner compatible with the surroundings and proposed use. Upon completion of construction, the certificate holder must remove all temporary structures not required for facility operation and dispose of all timber, brush, refuse and flammable or combustible material resulting from clearing of land and construction of the facility. [Mandatory Condition OAR 345-025-0006(11); General Standard Condition 6; Final Order on ASC]
~~GEN-GS-06~~	~~The certificate holder is authorized to construct the 230 kV transmission lines anywhere within the approved transmission line corridors, subject to the conditions in the site certificate. The approved transmission line corridor includes:~~ ~~a. Southern transmission line: Approximately 6.3 miles, extending between the facility switchyard to four collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~b. Northern transmission line: Approximately 3.2 miles, extending between the facility switchyard to two collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~[Site Specific Condition OAR 345-025-0010(5); General Standard Condition 7; Final Order on ASC]~~
GEN-GS-07	The certificate holder may operationally share the following related or supporting facilities between Sunstone Solar Projects 1-6: the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary construction areas, subject to the following: a. Within 30 days of use by certificate holders of the shared facilities, the certificate holder must provide evidence to the Department that the certificate holders of the shared facilities have an executed agreement for shared use of any constructed shared facilities. The Shared Use Agreements must allow operation and maintenance personnel and contractors access to the shared facilities of Sunstone Solar Projects 1-6.
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
GEN-OE-01	Before any transfer of ownership of the facility or ownership of the site certificate holder, the certificate holder must inform the Department of the proposed new owners. The requirements of OAR 345-027-0400 apply to any transfer of ownership that requires a transfer of the site certificate. [Organizational Expertise Condition 1; Final Order on ASC]
GEN-OE-02	Any matter of non-compliance under the site certificate is the responsibility of the certificate holder. Any notice of violation issued under the site certificate will be issued to the certificate holder. Any civil penalties under the site certificate will be levied on the certificate holder. [Organizational Expertise Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-OE-03	The certificate holder must notify the Department within 72 hours of any occurrence of the following: a. There is an attempt by anyone to interfere with the facility's safe operation. b. There is a significant nature event such as a fire, earthquake, flood, tsunami or tornado, or human-caused event such as a fire or explosion. c. There is any fatal injury at the facility. [Organizational Expertise Condition 5; Final Order on ASC]
GEN-OE-04	The certificate holder shall, as soon as reasonably possible: a. Report incidents or circumstances that may violate the terms or conditions of the site certificate, terms or conditions of any order of the Council, or the terms or conditions of any order issued under OAR 345-027-0230, to the Department. In the report to the Department, the certificate holder shall provide all pertinent facts including an estimate of how long the conditions or circumstances existed, how long they are expected to continue before they can be corrected, and whether the conditions or circumstances were discovered as a result of a regularly scheduled compliance audit; b. Initiate and complete appropriate action to correct the conditions or circumstances and to minimize the possibility of recurrence; c. Submit a written report within 30 days of discovery to the Department. The report must refer to the language in (d) of the condition and contain: i. A discussion of the cause of the reported conditions or circumstances; ii. The date of discovery of the conditions or circumstances by the responsible party; iii. A description of immediate actions taken to correct the reported conditions or circumstances; iv. A description of actions taken or planned to minimize the possibility of recurrence; and v. For conditions or circumstances that may violate the terms or conditions of a site certificate, an assessment of the impact on the resources considered under the standards of OAR Chapter 345 Divisions 22 and 24 as a result of the reported conditions or circumstances. d. Upon receipt of the written report in sub(c) of this condition, the Department may review the facility record for incidents or circumstances reported or reportable under sub(a) related to public health and safety, the environment, or other resources protected under Council standards. If these incidences are determined by the Department to impact the adequacy of the facility decommissioning cost, the Department or Council may adjust the contingencies identified in Final Order on ASC Table 4 and shall request and receive an updated bond or letter of credit from certificate holder in the adjusted amount. [Organizational Expertise Condition 6; Final Order on ASC]
STANDARD: Structural Standard (SS) [OAR 345-022-0020]	

Condition Number	General (GEN) Conditions
GEN-SS-01	The certificate holder must design, engineer and construct the facility to avoid dangers to human safety and the environment presented by seismic hazards affecting the site that are expected to result from all maximum probable seismic events. “Seismic hazards” include ground shaking, ground failure, landslide, liquefaction triggering and consequences (including flow failure, settlement buoyancy, and lateral spreading), cyclic softening of clays and silts, fault rupture, directivity effects and soil-structure interaction. [Mandatory Condition OAR 345-025-0006(12); Structural Standard Condition 1; Final Order on ASC]
GEN-SS-02	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if site investigations or trenching reveal that conditions in the foundation rocks differ significantly from those described in the application for a site certificate. After the Department receives the notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(13); Structural Standard Condition 2; Final Order on ASC]
GEN-SS-03	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if shear zones, artesian aquifers, deformations or clastic dikes are found at or in the vicinity of the site. After the Department receives notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(14); Structural Standard Condition 3; Final Order on ASC]
GEN-SS-04	The certificate holder shall design, engineer, and construct the facility in accordance with the versions of the International Building Code, Oregon Structural Specialty Code, and local building codes in effect at the time of construction. [Structural Standard Condition 5; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
GEN-LU-01	The certificate holder shall provide evidence to the Department of coordination with the owners of adjacent lands dedicated to agricultural use. Coordination must include information about the facility that could impact agricultural activities. The certificate holder must document any recommendations made by adjacent landowners regarding measures to reduce or avoid any adverse impacts to farm practices on surrounding lands and to avoid any increase in farming costs as well as any responses made to these recommendations. [Land Use Condition 9; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-LU-02	The certificate holder must adhere to the terms of the Memorandum of Agreement for Agricultural Mitigation Fund included in Attachment F of the Final Order on the ASC, or subsequently amended. It is the certificate holder's responsibility to ensure that the Council and Department receive all reports and notifications required by the agreement. [Land Use Condition 12; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
GEN-RF-01	The certificate holder shall prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder.
	[Mandatory Condition OAR 345-025-0006(7); Retirement and Financial Assurance Condition 1; Final Order on ASC]
STANDARD: Siting Standards for Transmission Lines (TL) [OAR 345-024-0090]	
~~GEN-TL-01~~	~~The certificate holder shall:~~ ~~a. Design, construct and operate the transmission lines in accordance with the requirements of the National Electrical Safety Code as approved by the American National Standards Institute; and~~ ~~b. Develop and implement a program that provides reasonable assurance that all fences, gates, cattle guards, trailers, or other objects or structures of a permanent nature that could become inadvertently charged with electricity are grounded or bonded throughout the life of the line.~~ ~~[Siting Standards for Transmission Line Condition 1; Final Order on ASC]~~

5.3 Pre-Construction (PRE) Conditions

Condition Number	Preconstruction (PRE) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
PRE-GS-01	Except as necessary for the initial survey, the certificate holder may not begin construction of the facility or phase, or create a clearing on any part of the site of the facility or phase, as applicable, until the certificate holder has the legal right to engage in construction activities on the relevant parts of the site for the facility or phase. [Mandatory Condition OAR 345-025-0006(5); General Standard Condition 5; Final Order on ASC]
PRE-GS-02	At least 90 days prior to construction of the facility or phase, as applicable (unless otherwise agreed to by the Department), the certificate holder shall submit to the Department a compliance plan documenting and demonstrating actions completed or to be completed to satisfy the requirements of all site certificate terms and conditions and applicable statutes and rules. The plan shall be provided to the Department for review and compliance determination for each requirement. The Department may request additional information or evaluation deemed necessary to demonstrate compliance. [OAR 345-026-0048, General Standard Condition 8; Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRE-OE-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall notify the Department of the identity and qualifications of the major design, engineering and construction contractor(s). The certificate holder shall select contractors that have substantial experience in the design, engineering and construction of similar facilities. The certificate holder shall report to the Department any changes of major contractors. [Organizational Expertise Condition 2; Final Order on ASC]
PRE-OE-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall select a construction contractor with a low rate of historic environmental and safety compliance citations. Certificate holder shall provide the following documentation to the Department: a. Qualifications and contact information of the of the major design, engineering and construction contractor(s) and subcontractors, as applicable. b. Construction contractor compliance history. c. Contract excerpt affirming that contractors are required to comply with the terms and conditions of the site certificate, including selecting design layout and construction materials that minimize impacts to resources protected under Council standards. [Organizational Expertise Condition 7; Final Order on ASC]
PRE-OE-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide to the Department the qualifications and contact information of the certificate holder’s construction manager.

Condition Number	Preconstruction (PRE) Conditions
	[Organizational Expertise Condition 8; Final Order on ASC]
PRE-OE-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Provide the Department a list of federal, state and local permits, including any third-party permits related to facility siting; and a schedule for obtaining identified permits. b. Once obtained, provide copies of all permits, including third-party permits, required for facility siting to the Department. [Organizational Expertise Condition 12; Final Order on ASC]
STANDARD: Structural (SS) [OAR 345-022-0020]	
PRE-SS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a site-specific geotechnical investigation report, consistent with the Oregon State Board of Geologist Examiners Guideline for Preparing Engineering Geologic Reports, or newer guidelines if available to the Department, for review in consultation with its third-party consultant. [Structural Standard Condition 4; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRE-SP-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide a Vegetation and Grading Plan that demonstrates contractors are required to adhere to the following: a. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems shall be left intact to the maximum extent practicable. b. Grading within solar arrays shall be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically 10% maximum on North slopes and 15% maximum in other directions). [Soil Protection Condition 1; Final Order on ASC]
PRE-SP-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Obtain a NPDES 1200-C Permit from DEQ. A copy of the approved permit and attached Erosion and Sediment Control Plan (ESCP) must be submitted to the Department. b. Finalize the Fugitive Dust Control Plan, as provided in the Final Order on ASC Attachment D. Finalization includes verification of names and contact information of individuals responsible for implementation, measures to be implemented and forms to be used for monitoring and reporting. [Soil Protection Condition 3; Final Order on ASC]
PRE-SP-03	Prior to construction of the facility or phase, as applicable, the certificate holder must submit to the Department a Construction Spill Prevention Countermeasures and Control (SPCC) Plan. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-01	Prior to construction of the facility or phase, as applicable, the certificate holder must provide to the Department a copy of the approved Conditional Use Permit and applicable Zoning Permit(s). [Land Use Condition 1; Final Order on ASC]
~~PRE-LU-02~~	~~Prior to construction of the 230 kV transmission lines, the certificate holder shall demonstrate to the Department that the transmission lines will be sited within the exiting road rights-of-way, unless Morrow County Public Works Department and Oregon Department of Transportation, as applicable, confirm that use of the existing road rights-of-way is not feasible.~~ ~~[Land Use Condition 2; Final Order on ASC]~~
PRE-LU-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the draft Noxious Weed Control Plan, as provided in the Final Order on ASC Attachment E, and submit to the Department for review and approval in consultation with the Morrow County Weed Department. [Land Use Condition 3; Final Order on ASC]
PRE-LU-04	Prior to construction of the facility or phase, as applicable, the certificate holder must submit an executed document prohibiting the certificate holder, and the certificate holder's successors in interest, from pursuing a claim for relief or cause of action alleging injury from farming or forest practices as defined in ORS 30.930(2) and (4), and provide evidence that the document has been recorded in the deed records for Morrow County. [Land Use Condition 6; Final Order on ASC]
PRE-LU-05	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the final design adheres to the following setbacks: a. All facility structures and above-ground components except the perimeter fenceline must be sited: 1. At least 20 feet from a property line fronting the right-of-way of a local minor collector or marginal access street, including but not limited to Sand Hollow Road, Grieb Lane, Alpine Lane, Doherty Road, or Melville Road. 2. At least 30 feet from a property line fronting the right-of-way, of a major collector, including but not limited to, Bombing Range Road. 3. At least 80 feet from a property line fronting the right-of-way for an arterial road, including but not limited to State Highway 207. b. All facility structures, and all on-site septic systems or other sewage disposal systems must be set back at least 100 feet from delineated waterways. [Land Use Condition 7; Final Order on ASC]
PRE-LU-06	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a final site plan that includes all information required by MCZO 4.165.E to the County and the Department. The Department may defer review and approval to the County. [Land Use Condition 8; Final Order on ASC]

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-07	Prior to construction of the facility or phase, as applicable, the certificate holder must complete the preconstruction requirements identified in the Memorandum of Agreement for Agricultural Mitigation Fund, as provided in the Final Order on ASC Attachment F, or subsequently amended. [Land Use Condition 11; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
PRE-RF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit to the State of Oregon, through the Council, a bond or letter of credit naming the State of Oregon, acting by and through the Council, as beneficiary or payee. The approved bond or letter of credit amount of $23,446,360.38~~117,945,000~~ (Q4~~1~~ 2025~~3~~ dollars) may be adjusted based on the design configuration of the facility, or phase of the facility, as provided in Sub(a) and adjusted to the year and quarter of issuance as provided under Sub(b). a. The bond or letter of credit amount may be adjusted based on actual design/number of components of the facility or phase, as applicable, and shall use the same unit costs and contingencies presented in the Final Order on the ASC Table 8. b. Adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. c. The bond or letter of credit must be issued by a financial institution that is included on the Council's pre-approved financial institution list. The certificate holder may request to have a financial institution added to the list at any time. d. The bond or letter of credit must be prepared using the most recent Council-approved template. [Retirement and Financial Assurance Condition 4; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
PRE-FW-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Revegetation and Reclamation Plan, based on Attachment G of the Final Order on the ASC, and submit to the Department for review and approval. [Fish and Wildlife Habitat Condition 1]
PRE-FW-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit the draft legal agreement for review and approval by the Department, in consultation with ODFW. The legal agreement shall ensure that payment provided for long-term management and enhancement of the mitigation area is adequate to cover the permanent habitat loss from the facility.

Condition Number	Preconstruction (PRE) Conditions
	[Fish and Wildlife Condition 4, Final Order on ASC]
PRE-FW-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Habitat Mitigation Plan, as provided in Attachment H of the Final Order on ASC, based on the impacts associated with the final facility design and the legal agreement, as approved by the Department. [Fish and Wildlife Condition 5, Final Order on ASC]
PRE-FW-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide evidence to the Department that the design measures included in the Construction Wildlife Monitoring Plan (Final Order on ASC Attachment I) have been included in the final facility design and construction contractor contracts, as applicable. [Fish and Wildlife Condition 7; Final Order on ASC]
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
PRE-TE-01	If construction commences after April 2025, certificate holder shall, prior to construction of the facility or phase, as applicable, conduct protocol-level Washington ground squirrel (WAGS) surveys within areas of planned facility construction that are within suitable WAGS habitat. The certificate holder shall: a. Submit a protocol-level survey plan for surveys to be conducted within suitable WAGS habitat, for review and approval by the Department in consultation with ODFW. At a minimum, the survey plan shall specify the survey area (all areas of suitable habitat within 1,000 feet of ground disturbing activities except where there is a habitat barrier (e.g., a paved road) or access restrictions); and survey timing (February 15 to May 31, unless otherwise approved by ODFW). b. Complete protocol-level WAGS surveys based on the protocol approved per (a). c. Submit survey reports to the Department and ODFW. The certificate holder shall not begin construction within 1,000 feet of Category 1 or Category 2 WAGS habitat until the identified boundaries of Category 1 WAGS habitat have been approved by the Department, in consultation with ODFW. Category 1 habitat includes a 785-foot buffer from an identified active burrow, and the area within the perimeter of multiple active burrows. Category 2 WAGS habitat consists of a 4,136-foot buffer from the exterior boundary of all Category 1 WAGS habitat. The survey results are valid for 3-years. d. Develop maps and worker training materials to inform of sensitive Category 1 and Category 2 habitat. Submit to the Department final facility design maps demonstrating that Category 1 habitat, including 785-buffer from any colonies identified per (b), is avoided. e. Install flagging or other demarcation, as appropriate, to inform workers of sensitive WGS habitat and of avoidance requirement. [Threatened and Endangered Species Condition 1; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	

Condition Number	Preconstruction (PRE) Conditions
PRE-HC-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall update the contact information provided in the Final Order on ASC Attachment K, Inadvertent Discovery Plan. [Historic, Cultural and Archeological Condition 1; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
PRE-PS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall execute a final Road Use Agreement, based on Final Order on ASC Attachment N, and provide a copy to the Department. [Public Services Condition 1, Final Order on ASC]
PRE-PS-02	At least 180-days prior to construction of any phase, the certificate holder shall provide to the Department and Morrow County a temporary housing plan for the construction workforce. The plan shall provide for coordination with contractors and local officials on housing options and strategies to minimize impacts to local housing supply based on an ongoing evaluation of patterns of uses and potential shortages or changes in housing demand. [Public Services Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRE-WF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Construction Wildfire Mitigation Plan, as provided in Attachment L to the Final Order on ASC. The final Construction Wildfire Mitigation Plan shall be submitted to the Department for review and approval. [Wildfire Prevention and Risk Mitigation Condition 1; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRE-WM-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall require contractors to develop and submit to the Department for review and approval, Construction Waste Management Plan(s) that, at a minimum, include the following: a. All sources and quantities of construction waste and wastewater, including damaged or dysfunctional energy facility components, and where feasible, estimated quantities that can be recycled. b. Process for disposal and recycling, including use of licensed haulers and disposal/recycling facilities; names and locations of licensed recycling and disposal facilities; collection, hauling and tracking requirements. c. Process for requesting a permit exemption from DEQ pursuant to OAR 340-093-0080 to ensure that concrete washout materials reused in foundation backfill are substantially the same as clean fill. d. Process for training workers and tracking compliance with the requirements of the plan. [Waste Minimization Condition 1; Final Order on ASC]
STANDARD: Noise Control Regulations (NC) [OAR 340-035-0035]	

Condition Number	Preconstruction (PRE) Conditions
PRE-NC-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the operational noise levels comply with OAR 345-035-0035(1)(b), based on an updated acoustic modeling analysis using final design/layout and equipment specifications. [Noise Control Condition 1; Final Order on ASC]
STANDARD: Other – Removal-Fill (WL)	
PRE-WL-01	Prior to construction of the facility, facility component or phase, as applicable, the certificate holder must provide documentation of a valid jurisdictional determination from the Oregon Department of State Lands demonstrating that no waterways subject to the State Removal-Fill law under ORS 196.795 through 196.990 are present within areas to be disturbed during construction or operation. [Removal-Fill Condition 1, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
PRE-WR-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Identify all water-related needs and estimate daily and annual water demand for each construction phase, as applicable. b. Provide, to the Department, a contract or purchase agreement demonstrating that adequate water supply to meet construction demand has been secured from sources with valid water rights. [Water Rights Condition 1, Final Order on ASC]

5.4 Construction (CON) Conditions

Condition Number	Construction (CON) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
CON-OE-01	The certificate holder shall contractually require all contractors and subcontractors to comply with all applicable laws and regulations and with the terms and conditions of the site certificate. The contractual obligation shall be required of each contractor and subcontractor prior to that firm working on the facility. Such contractual provisions shall not operate to relieve the certificate holder of responsibility under the site certificate. [Organizational Expertise Condition 3; Final Order on ASC]
CON-OE-02	During construction, the certificate holder shall: a. Maintain an onsite construction manager. b. Require that the construction manager implement and monitor all applicable construction related site certificate conditions. c. Within six months after beginning construction, and every six months thereafter during construction of the energy facility and related or supporting facilities, the certificate holder shall submit a semiannual construction progress report to the Department. In each construction progress report, the certificate holder shall describe any significant changes to major milestones for construction. The certificate holder shall report on the progress of construction and shall address the following: i. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. ii. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. iii. Compliance Report: A report describing the certificate holder's compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate. iv. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0050. [Organizational Expertise Condition 9; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	

Condition Number	Construction (CON) Conditions
CON-SP-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Vegetation and Grading Plan. [Soil Protection Condition 2; Final Order on ASC]
CON-SP-02	During construction of the facility or phase, as applicable, the certificate holder shall: a. Conduct all work in compliance with the NPDES 1200-C Permit and Erosion and Sediment Control Plan (ESCP) or revised ESCP if applicable. The ESCP shall be revised if determined necessary by the certificate holder, certificate holder's contractor(s) or the Department. Any Department-required ESCP revisions shall be implemented within 14-days, unless otherwise agreed to by the Department based on a good faith effort to address erosion issues. b. Conduct all work in compliance with the Fugitive Dust Control Plan. The Fugitive Dust Control Plan may be amended, as needed, to ensure that control measures are effective at the site. [Soil Protection Condition 4; Final Order on ASC]
CON-SP-03	During construction, the certificate holder shall require that all onsite contractors and personnel adhere to the requirements of the SPCC Plan. Any SPCC revisions and updates shall be reported to the Department. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
CON-LU-01	During construction, the certificate holder shall implement and adhere to the Noxious Weed Control Plan required under Condition PRE-LU-02. [Land Use Condition 4, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
CON-RF-01	During construction, the certificate holder shall: a. Describe the status of the bond or letter of credit in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. b. If construction extends for more than 12 months, the certificate holder shall adjust the amount of the bond or letter of credit on an annual basis thereafter as described in under Condition PRE-RF-01. c. The Department and Council reserve the right to adjust the contingencies, as necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 5; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
CON-FW-01	During construction, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan, as applicable. [Fish and Wildlife Habitat Condition 2, Final Order on ASC]
CON-FW-02	During construction, the certificate holder shall adhere to the requirements of the Construction Wildlife Monitoring Plan (Attachment I of the Final Order on the ASC). Monitoring records shall be maintained throughout construction and included in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 8; Final Order on ASC]

Condition Number	Construction (CON) Conditions
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
CON-TE-01	Prior to and during construction of the facility or phase, as applicable, any incidentally identified occurrence(s) of Lawrence's milkvetch shall be avoided using a 100-foot buffer via mapping and flagging. [Threatened and Endangered Species Condition 2; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
CON-HC-01	During construction, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan, as submitted to the Department under PRE-HC-01. [Historic, Cultural and Archeological Condition 2; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
CON-PS-01	During construction, the certificate holder shall adhere to the terms and conditions of the Road Use Agreement executed under PRE-PS-01. [Public Services Condition 2; Final Order on ASC]
CON-PS-02	During construction, the certificate holder shall report to the Department the outcomes of the work completed under the temporary housing plan required under PRE-PS-02. The report shall be included in the construction progress report required under CON-OE-02, and shall include, at a minimum: a. Outcome of coordination with construction contractors to identify housing options for incoming workers, including aggregate data on the location (i.e. city) and type of housing used by workers. b. Documentation of coordination with local officials such as the Morrow County Planning Department, nearby cities and towns such as Lexington and Ione, the Lexington Community Development Group, the Ione Community Agri-Business Organization, the Boardman Community Development Association, the Willow Creek Valley Economic Development Group, and other housing providers to identify housing options and strategies to minimize that impacts to local housing supply. [Public Services Condition 4; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
CON-WF-01	During construction of the facility of phase, as applicable, the certificate holder shall implement and require all onsite contractors and employees to adhere to the Construction Wildfire Mitigation Plan required under Condition PRE-WF-01. Updates to the Wildfire Mitigation Plan may be required if determined necessary by the certificate holder, certificate holder's contractor(s), or the Department to address wildfire hazard to public health and safety. Any Department required updates shall be implemented within 14 days, unless otherwise agreed to by the Department based on a good faith effort to address wildfire hazard. [Wildfire Prevention and Risk Mitigation Condition 2; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	

Condition Number	Construction (CON) Conditions
CON-WM-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Construction Waste Management Plan(s) and maintain records of employee training and tracking compliance onsite and available upon Department request. [Waste Minimization Condition 2; Final Order on ASC]
CON-WM-02	During construction, on-site concrete washwater disposal is prohibited unless DEQ approval of a permit exemption for materials substantially similar to clean fill is obtained. If DEQ approval of a permit exemption is obtained, concrete washwater must be disposed of onsite via infiltration and evaporation in accordance with the DEQ-issued NPDES 1200-C permit required under Condition CON-SP-02. [Waste Minimization Condition 3; Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
CON-WR-01	During construction: a. All water used for construction activities shall be appropriated and used in accordance with the applicable provisions of ORS chapter 537 and OAR chapter 690. b. The certificate holder shall report the source and amount of water used during each month of construction under Condition CON-OE-02. The certificate holder shall maintain records adequate to substantiate reports (e.g., written logs and photographs of well meter readings, copies of invoices from water sources) and make such records available to the Department upon request. c. If a water right, limited water use license, or water rights transfer is needed and would not be obtained by a third-party, the certificate holder shall submit and obtain approval of the applicable water permit through the site certificate amendment process. [Water Rights Condition 2; Final Order on ASC]

5.5 Pre-Operational (PRO) Conditions

Condition Number	Pre-Operational (PRO) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRO-OE-01	Prior to operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 10; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRO-SP-01	Following the termination of the 1200-C, the certificate holder shall update the requirements of the Revegetation and Reclamation Plan, specific to the areas within the fenceline not occupied by facility infrastructure. Certificate holder shall provide evidence to the Department that the permit was terminated by DEQ. [Soil Protection Condition 5; Final Order on ASC]
PRO-SP-02	Prior to operation, the certificate holder shall submit to the Department an Operational Spill Prevention Control and Countermeasures (SPCC) Plan. [Soil Protection Condition 8; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRO-WF-01	Prior to operation, the certificate holder shall finalize the operational Wildfire Mitigation Plan (WMP) included as Attachment M to the Final Order on ASC. [Wildfire Prevention and Risk Mitigation Condition 3; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRO-WM-01	Prior to operation, the certificate holder shall develop an Operational Recycling Plan or protocol requiring that damaged or nonfunctional panels and lithium-ion batteries be recycled to the extent practicable. The certificate holder shall report in its annual report to the Department the quantities of panels and lithium-ion batteries recycled, reused or disposed of in a landfill. Requirements for lithium-ion battery recycling do not apply if the BESS is not constructed. [Waste Minimization Condition 4; Final Order on ASC]
STANDARD: Other - Water Rights (WR)	
PRO-WR-01	Prior to operation, the certificate holder shall provide, to the Department, a copy of the map, well log and all other information it provided to OWRD pursuant to ORS 537.545 and ORS 537.765 to qualify for an exempt ground water use for any onsite exempt wells. [Water Rights Condition 3; Final Order on ASC]

5.6 Operational (OPR) Conditions

Condition Number	Operational (OPR) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
OPR-GS-01	The certificate holder must submit a legal description of the site to the Department within 90 days after beginning operation of the facility. The legal description must include a description of metes and bounds or a description of the site by reference to a map and geographic data that clearly and specifically identify the outer boundaries that contain all parts of the facility. [Mandatory Condition OAR 345-025-0006(2); General Standard Condition 9]
OPR-GS-02	After January 1 but no later than April 30 of each year after beginning operation of the facility, the certificate holder shall submit an annual report to the Department. The Council Secretary and the certificate holder may, by mutual agreement, change the reporting date. a. The annual report must include the following information for the calendar year preceding the date of the report: 1. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. 2. Reliability and Efficiency of Power Production: For electric power plants, the plant availability and capacity factors for the reporting year. The certificate holder shall describe any equipment failures or plant breakdowns that had a significant impact on those factors and shall describe any actions taken to prevent the recurrence of such problems. 3. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. 4. Monitoring Report: A list and description of all significant monitoring and mitigation activities performed during the previous year in accordance with site certificate terms and conditions, a summary of the results of those activities and a discussion of any significant changes to any monitoring or mitigation program, including the reason for any such changes. 5. Compliance Report: A report describing the certificate holder’s compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate.

Condition Number	Operational (OPR) Conditions
	6. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0350. b. To the extent that information required by this rule is contained in reports the certificate holder submits to other state, federal or local agencies, the certificate holder may submit excerpts from such other reports to satisfy this rule. The Council reserves the right to request full copies of such excerpted reports. [Mandatory Condition 345-026-0080(1); General Standard Condition 10, Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
OPR-OE-01	During operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 11; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
OPR-SP-01	During operation, the certificate holder shall adhere to the requirements of the Operational SPCC Plan. Any SPCC updates shall be described and included in the Annual Report to the Department. Certificate holder shall report spill and cleanup activities to the Department within 72 hours and shall make inspection records available to the Department upon request. [Soil Protection Condition 9; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
OPR-LU-01	Following the fifth year of monitoring under the Noxious Weed Control Plan required under PRE-LU-03, the certificate holder shall submit a Long-term Noxious Weed Monitoring Plan to the Department, for review and approval. The certificate holder shall implement the plan for the remainder of the facility's operating life. [Land Use Condition 5, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
OPR-RF-01	During operation, the certificate holder shall: a. Annually adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. b. Any changes to the template made by the Council must be incorporated into the bond or letter or letter of credit whenever the amount is adjusted under Sub(a). c. The Department and Council reserve the right to adjust the contingencies, as

Condition Number	Operational (OPR) Conditions
	necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 6; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
OPR-FW-01	During operation, as applicable, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan. [Fish and Wildlife Habitat Condition 3, Final Order on ASC]
OPR-FW-02	During operation, the certificate holder shall provide reports from The Nature Conservancy on the status of long-term management and enhancement of the habitat mitigation area, consistent with the Habitat Mitigation Plan. [Fish and Wildlife Condition 6, Final Order on ASC]
OPR-FW-03	During operation, the certificate holder shall adhere to the requirements of the Operational Wildlife Monitoring Plan (Attachment J of the Final Order on the ASC). Monitoring records shall be maintained throughout operation and included in the annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 9; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
OPR-HC-01	During operations, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan (IDP), as provided for Condition PRE-HC-01. The IDP shall be reviewed and updated annually for current contact information. [Historic, Cultural and Archeological Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
OPR-WF-01	During operation, the certificate holder shall: a. Implement the Operational Wildfire Mitigation Plan finalized under Condition PRO-WF-01. b. Every 5 years after the first operational year, review and update the evaluation of wildfire risk under OAR 345-022-0115(1)(b) and submit the results in the annual report required under Condition CON-OE-02 for that year. c. Submit an updated Operational Wildfire Mitigation Plan to the Department if substantive changes are made to the plan because of the review under sub (b) of this condition, or at any other time substantiative revisions are made. [Wildfire Prevention and Risk Mitigation Condition 4; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
OPR-WM-01	During operation, the certificate holder shall adhere to the requirements of the Operational Recycling Plan or protocol developed under Condition PRO-WM-01. [Waste Minimization Condition 5; Final Order on ASC]
OPR-WM-02	During operation, the certificate holder shall: a. Prohibit use of chemicals, soaps, detergents and heated water unless Chemical Safety Data Sheets for low volatile organic compound/biodegradable cleaning chemicals and solvents are submitted to the Department for review and approval prior to use.

Condition Number	Operational (OPR) Conditions
	b. Ensure that washing is conducted in a manner that does not remove paint or other finishes. c. Discharge wash water through evaporation and infiltration only. [Waste Minimization Condition 6, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
OPR-WR-01	During operation, the certificate holder shall verify that any onsite exempt wells do not use more than 5,000 gallons of ground water a day, collectively, and shall monitor the volume of groundwater used on a daily basis, maintain a record of such use and make the monitoring records available to the Department upon request. [Water Rights Condition 4; Final Order on ASC]

5.7 Retirement (RET) Conditions

Condition Number	Retirement (RET) Conditions
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
RET-RF-01	The certificate holder must retire the facility if the certificate holder permanently ceases construction or operation of the facility. The certificate holder must retire the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410. The certificate holder must pay the actual cost to restore the site to a useful, non-hazardous condition at the time of retirement, notwithstanding the Council's approval in the site certificate of an estimated amount required to restore the site. [Mandatory Condition OAR 345-025-0006(9); Retirement and Financial Assurance Condition 2; Final Order on ASC]
RET-RF-02	If the Council finds that the certificate holder has permanently ceased construction or operation of the facility without retiring the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410, the Council must notify the certificate holder and request that the certificate holder submit a proposed final retirement plan to the Department within a reasonable time not to exceed 90 days. If the certificate holder does not submit a proposed final retirement plan by the specified date, the Council may direct the Department to prepare a proposed final retirement plan for the Council's approval. Upon the Council's approval of the final retirement plan, the Council may draw on the bond or letter of credit described in Condition PRE-RT-01 to restore the site to a useful, non-hazardous condition according to the final retirement plan, in addition to any penalties the Council may impose under OAR chapter 345, division 29. If the amount of the bond or letter of credit is insufficient to pay the actual cost of retirement, the certificate holder must pay any additional cost necessary to restore the site to a useful, non-hazardous condition. After completion of site restoration, the Council must issue an order to terminate the site certificate if the Council finds that the facility has been retired according to the approved final retirement plan. [Mandatory Condition OAR 345-025-0006(16); Retirement and Financial Assurance Condition 3; Final Order on ASC]

6.0 Successors and Assigns

To transfer this site certificate or any portion thereof or to assign or dispose of it in any other manner, directly or indirectly, the certificate holder shall comply with OAR 345-027-0400.

7.0 Severability and Construction

If any provision of this agreement and certificate is declared by a court to be illegal or in conflict with any law, the validity of the remaining terms and conditions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the agreement and certificate did not contain the particular provision held to be invalid.

8.0 Execution

This site certificate may be executed in counterparts and will become effective upon signature by the Chair of the Energy Facility Siting Council and the authorized representative of the certificate holder.

IN WITNESS THEREOF, this site certificate has been executed by the State of Oregon, acting by and through the Energy Facility Siting Council and Sunstone Solar, LLC (certificate holder).

ENERGY FACILITY SITING COUNCIL
Kent Howe
By: Kent Howe (Nov 19, 2024 16:21 PST)
Kent Howe, Chair
Date: 19-Nov-2024

SUNSTONE SOLAR, LLC
Jon Saxon
By: Jon Saxon (Nov 19, 2024 16:26 EST)
Jon Saxon, Authorized Representative
Date: 19-Nov-2024

Sunstone Solar Project 3

ENERGY FACILITY SITING COUNCIL
OF THE STATE OF OREGON

SITE CERTIFICATE FOR THE
SUNSTONE SOLAR PROJECT

3

ISSUE DATE
NOVEMBER 18, 2024

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Table of Contents

1.0 Introduction and Site Certification

This site certificate is a binding agreement between the State of Oregon (State), acting through the Energy Facility Siting Council (EFSC or Council), and Sunstone Solar 3, LLC (certificate holder), owned by Pine Gate Renewables, LLC (parent company). Both the State and certificate holder must abide by local ordinances, state law, and the rules of the Council in effect on the date this site certificate is executed. However, upon a clear showing of a significant threat to public health, safety, or the environment that requires application of later-adopted laws or rules, the Council may require compliance with such later-adopted laws or rules (ORS 469.401(2)).

This site certificate binds the State and all counties, cities and political subdivisions in Oregon as to the approval of the site and the construction, operation, and retirement of the facility as to matters that are addressed in and governed by this site certificate (ORS 469.401(3)). Each affected state agency, county, city, and political subdivision in Oregon with authority to issue a permit, license, or other approval addressed in or governed by this site certificate, shall upon submission of the proper application and payment of the proper fees, but without hearings or other proceedings, issue such permit, license or other approval subject only to conditions set forth in this site certificate. In addition, each state agency or local government agency that issues a permit, license or other approval for this facility shall continue to exercise enforcement authority over such permit, license or other approval (ORS 469.401(3)). For those permits, licenses, or other approvals addressed in and governed by this site certificate, the certificate holder shall comply with applicable state and federal laws adopted in the future to the extent that such compliance is required under the respective state agency statutes and rules (ORS 469.401(2)).

This site certificate does not address, and is not binding with respect to, matters that are not included in and governed by this site certificate, and such matters include, but are not limited to: employee health and safety; building code compliance; wage and hour or other labor regulations; local government fees and charges; other design or operational issues that do not relate to siting the facility (ORS 469.401(4)); and permits issued under statutes and rules for which the decision on compliance has been delegated by the federal government to a state agency other than the Council (ORS 469.503(3)).

The obligation of the certificate holder to report information to the Department or the Council under the conditions listed in this site certificate is subject to the provisions of ORS 192.502 *et seq.* and ORS 469.560. To the extent permitted by law, the Department and the Council will not publicly disclose information that may be exempt from public disclosure if the certificate holder has clearly labeled such information and stated the basis for the exemption at the time of submitting the information to the Department or the Council. If the Council or the Department receives a request for the disclosure of the information, the Council or the Department, as appropriate, will make a reasonable attempt to notify the

certificate holder and will refer the matter to the Attorney General for a determination of whether the exemption is applicable, pursuant to ORS 192.450.

Council shall have continuing authority over the site and may inspect, or direct the Oregon Department of Energy (Department) to inspect, or request another state agency or local government to inspect, the site at any time in order to ensure that the facility is being operated consistently with the terms and conditions of this site certificate (ORS 469.430).

The duration of this site certificate shall be the life of the facility, subject to termination pursuant to OAR 345-027-0110 or the rules in effect on the date that termination is sought, or revocation under ORS 469.440 and OAR 345-029-0100 or the statutes and rules in effect on the date that revocation is ordered. The Council shall not change the conditions of this site certificate except as provided for in OAR Chapter 345, Division 27.

In interpreting this site certificate, any ambiguity will be clarified by reference to the following, in order, incorporated herein by this reference: 1) *Final Order on the Application for Site Certificate for the Sunstone Solar Project* issued on November 18, 2024 (hereafter, *Final Order on the ASC*); 2) the record of the proceedings that led to the Final Order on the ASC.

The definitions in ORS 469.300 and OAR 345-001-0010 apply to the terms used in this site certificate, except where otherwise stated, or where the context clearly indicates otherwise.

2.0 Facility Location and Site Boundary

The facility is located within an approximately 1,165.1 ~~10,960~~-acre (1.8 ~~17~~ sq. mile) site in Morrow County. The site is located on both sides of State Route 207 and is approximately 15 miles northeast of the Town of Lexington and approximately 4.5 miles west of Butter Creek Junction. The site is approximately 3 miles west of the Umatilla County line at its closest point. Table 1 below provides the Township, Range, and Sections occupied wholly, or in part, by the site. Up to 1,138.1 acres~~9,442~~ of land within the site boundary would be occupied by facility components. The regional location of the facility site boundary~~, transmission line corridor,~~ and ~~approximately 1,518 acres~~ areas within the site boundary ~~are~~ excluded from development, as applicable, are~~as~~ shown on Attachment 1~~ASC Exhibit C, Figures C- 2, and C-2.1 to C-2.3, attached~~ to this site certificate ~~as Attachment 1~~.

Table 1: Township, Range, and Section for Areas Occupied by the Site Boundary

Township	Range	Sections
1N	26E	~~1, 2, 3,~~ 4, 5~~, 8, 9, 10, 11, 12, 14, 15~~
2N	26E	~~27, 28, 29, 30, 31,~~ 32, 33, 34~~, 35, 36~~
Reference: SSPAPPDoc25-03 ASC Exhibit C Project Location, Table C-1. 2024-05-15.		

3.0 Facility Description

The energy facility is approved to include the components presented in Table 2 below. Additional details regarding specific components, and discussion of alternative designs or technologies under consideration are provided in the sections that follow.

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Site Boundary		
Site Boundary	1,165.1 ~~10,960~~	acres
Maximum Footprint	1,138.1 ~~9,442~~	acres
Permanent Impacts[1]	1,138.1 ~~9,442~~	acres
Solar Components		
PV Solar Modules		
Approx. total number	656,256~~3,937,536~~	modules
Max Height at full-tilt	15	feet
Posts		
Approx. total number (assumes concrete foundation)	89,176~~535,056~~	posts
Cabling		
Combiner Boxes	10,254~~61,524~~	each
Inverter Step Up (ISU) Transformer Units		
Approx. total number	54 ~~319~~	each
Noise level	89	dBA
Transformer oil-containing capacity	800	gallons
Related or Supporting Facility Components		
34.5 kV Collection System		
Collector line length, belowground	7.7 ~~82~~	miles
Collector line length, overhead (OH)	0.7 ~~4.3~~	miles
Wood Monopoles (max estimate for OH)	26 ~~151~~	each
Collector Substations		
Substations w SCADA; GSU transformers ~~per~~ each	1~~6~~; 1	each
Site size	1.6	acres
Transformer oil-containing capacity	16,000	gallons~~/each~~
Transformer noise level	100	dBA
Max height of structures	45	feet
~~Switchyards~~		

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[1] The energy facility would occupy approximately 1,138.1 ~~9,442~~ acres ~~within up to 20 separately fenced areas~~. Most related or supporting facilities will be located within the energy facility's footprint; however, portions of the overhead 34.5 kV collector and 230-kV transmission lines running between solar array areas would result in additional temporary and permanent disturbance areas.

Table 2: Facility Component Summary

~~Component and Design Standard~~	~~No.~~	~~Unit~~
~~Stations; Transformers per each~~	~~2; 0~~	~~each~~
~~Site size (northern and/or within solar fence line); with foundations and graveled areas~~	~~3~~	~~acres~~
~~230 kV Transmission Line~~		
~~Length (total; northern line; southern line)~~	~~9.5; 3.2; 6.3~~	~~miles~~
~~Structures: Type (Wood or Galvanized Steel); quantity~~	~~H-frame; 50~~	~~each~~
~~Height of structures~~	~~70-180~~	~~feet~~
Battery Energy Storage System (Lithium-ion/Zinc)		
Zinc		
Approx. total battery containers on foundations with fans/heating systems; SCADA	2,491~~14,946~~	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	9.5 x 8 x 20	H x W x L; feet
Noise level (broadband)	66	dBA
Lithium-ion		
Approx. total battery containers on foundations with HVAC and fire suppression systems; SCADA	~~1~~2,000	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	11.25 x 8.1 x 5.2	H x W x L; feet
Noise level (broadband)	66	dBA
O&M Building		
Quantity	1~~4~~	each
Site size	2.8	acres
Height	20	feet
Appurtenances	On-site well, septic system, SCADA System	
Storage for Replacement Solar Panels		
Containers	8-9~~50~~	each
Approx. container dimensions	8.5 x 8 x 40	H x W x L; feet
Location	Dispersed within fence line if not next to O&M, gravel base	
Facility Roads		
Length	7.3 ~~55~~	miles
Width	10- 20	feet
Perimeter Fence		
Length	2 ~~58~~	miles
Height	7-8	feet

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Access/gates	8-9~~52~~	each
Temporary Construction Areas		
Quantity	2~~5~~4	each
Site size	5	acres
Description	Gravel base; diesel/gas storage; within fence line	

Energy Facility

The facility includes a solar photovoltaic power generation facility with up to ~~1,~~200 MW of electric generation capacity. ~~The energy facility consists of up to 20 separately fenced solar arrays organized into six 200 MW blocks.~~

Photovoltaic Modules

Solar photovoltaic modules, or solar panels, convert sunlight into DC electric power. The typical module contains crystalline silicon photovoltaic cells arranged within glass panels equipped with an anti-reflective coating, a metal frame, and wire connectors.

Racking System

The photovoltaic modules are connected in series into strings and then mounted on a racking system. Each rack would contain 2 strings of 32 modules mounted on a single-axis tracking system. Multiple racks are organized into rows between 200 and 400 feet in length depending on topography. Rows would be spaced at least 10 feet apart and at least 15 feet from perimeter fencing to provide vehicle access.

Posts

Each row of tracker mounted modules is supported by multiple hollow, screw pile, or pile-type steel posts. Posts are typically installed to a depth of 6-8 feet below surface and extend 5 feet above grade. Posts at the end of rows may be installed at greater depths to withstand wind uplift. Posts may be installed directly in the ground or concrete backfill may be required in some soil conditions.

DC Cabling System

Combiner boxes or a Big Lead Assembly (BLA) harness system is used to aggregate the DC output of the photovoltaic modules for transmission to an inverter by low-voltage DC cables. Using the combiner boxes, strings of modules are connected to a pad-mounted combiner box installed at each row, which in turn, are connected to the inverters by low voltage DC cables

that are either mounted to the tracking system, installed in trays, or buried underground. Using the BLA system, strings are connected directly to a rack-mounted cabling system.

Inverters and Inverter Step Up (ISU) Transformers

Inverters convert the DC output of the photovoltaic modules to AC power that can be transmitted to the electric grid. A typical inverter in utility scale solar facilities converts the 900 to 1,500 volt DC module output to 660 volt AC output. After conversion, the output is sent to an inverter step-up (ISU) transformer to increase the voltage to 34.5 kV power for transmission to the collector substation via the electrical collector system. Inverters and ISU transformers are collocated on concrete slabs near each module block.

Related or Supporting Facilities

Related or supporting facilities include a battery energy storage system, ~~an interconnection substation,~~ one~~up to six~~ collector substation~~s~~, one~~up to four~~ operations and maintenance building, and other structures.

Battery Energy Storage System

The battery energy storage system (BESS) is designed to provide up to 1~~7~~.2 gigawatt-hours GWh) of storage capacity. The BESS may use either Lithium-Ion (Li-ion) or Zinc-based battery technology. Under either technology, batteries are contained in pre-constructed modular containers, or "segments," placed on concrete slab foundations.
The battery storage system includes, but is not limited to, the following elements:

- Batteries and containers, inverters, isolation transformers, and switchboards;
- Balance of plant equipment, which may include medium-voltage and low-voltage electrical systems, fire suppression and HVAC systems (for Li- ion technology, if selected), building auxiliary electrical systems, and network/SCADA systems;
- Cooling system, which may include a separate chiller plant located outside the battery racks with chillers, pumps, and heat exchangers (Li-ion only, if selected); zinc batteries will have fans and a heating unit for climate control; and
- High-voltage (HV) equipment, including a step-up transformer, circuit breaker, current transformers and voltage transformers, a packaged control building for the breaker and transformer equipment, towers, structures, and cabling.

The batteries and associated equipment may be oversized or periodically augmented in accordance with the manufacturer's recommendations to ensure a minimum of 1~~7~~,200 MWh of energy storage capability over the life of the BESS, taking into account natural degradation of the batteries over time.

Li-ion batteries are currently the most common battery type used in utility-scale battery energy storage systems. If a Li-ion battery technology is used at the facility, it would use Li-ion phosphate batteries, which are more thermally stable than Li-ion cathode batteries.
Each module contains approximately 10 hermetically sealed battery cells filled with a gel or liquid electrolyte. The module containers serve as secondary containment for the cells. Each container holds approximately 840 cells with a combined capacity of approximately 740 kilowatt-hour AC, and approximately ~~1~~2,000 containers would be required to meet the capacity needs of the facility.

The electrolyte used in Li-ion batteries is flammable and susceptible to overheating and vaporization, so Li-ion Battery Systems typically require cooling, ventilation, and fire suppression systems included in each container. If Li-ion battery technology is used at the site, it would implement the following design features and fire prevention and control methods to minimize fire and safety risks:

- Batteries would be stored in completely contained, leak-proof modules.
- Ample working space would be provided around the BESS for maintenance and safety purposes.
- An off-site, 24-hour monitoring system with shutdown capabilities would be implemented.
- Batteries would be transported in accordance with Department of Transportation Pipeline and Hazardous Material Administration regulations under 49 CFR 173.185
- Battery systems would be designed in accordance with applicable Underwriters Laboratories, National Electric Code, and National Fire Protection Association Standards, including but not limited to, UL 1642, 1741, 1973, and 9540A, and NFPA 855.
- An advanced and proven battery management system would be employed;
- Battery Containers would be equipped with:
    - Heating, ventilation, and air conditioning (HVAC) systems to maintain optimal battery temperatures;
    - Fire control panels with 24-hour battery backup;
    - Fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems;
    - Doors equipped with a contact that will shut down the battery container if opened;
    - Fire extinguishing and thermal insulation sheets between each individual battery cell;
    - Locks and fencing to prevent entry of unauthorized personnel;
    - Remote power disconnect switches with clear and visible signs identifying their location.[2]

Li-ion battery modules under consideration for this facility have an expected useful life of 20 years and it is expected that every module at the facility would need to be replaced at least once during the life of the facility. Used Li-ion batteries are generally considered to be

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[2] SSPAPPDoc25-02 ASC Exhibit B Project Description 2024-05-15, Section 2.7.1.

hazardous waste by the EPA and must be transported and disposed of according to the most current guidelines at end of life.

A typical zinc-based BESS container includes 144 zinc-hybrid cathode powered batteries with a combined 700 kWh capacity. Zinc batteries are estimated to have a lifespan of at least 20 years. Zinc battery systems can operate across a higher range of temperatures and only require cooling fans rather than a full HVAC system. Zinc batteries have a lower fire-risk than lithium-ion batteries and do not require fire suppression systems to be included in the container design.

The BESS may be designed either as a DC-coupled system, with containers distributed throughout the energy facility site near inverter/transformer station sites, or as an AC-coupled system with containers concentrated in a single area near the ~~switchyards~~ substation. In either case, the containers and other BESS equipment are located within the fenced solar array areas and may have their own additional fencing.

34.5 kV Electrical Collection System

The facility includes up to 7.7~~86~~ miles of 34.5 kV electrical collector lines that connects energy facility components to the collector substation~~s~~ described below. The majority of the collector lines are buried underground; however, overhead lines are installed at long “home run” stretches, stream or canyon crossings, and other areas where burial is infeasible. The collector lines are generally located within the energy facility footprint except at road crossings and crossings between fenced solar array areas.

Communication and SCADA System

The facility includes a system of fiber optic and copper communication lines that connect the solar arrays, BESS, and substation~~s~~ to Supervisory Control and Data Acquisition (SCADA) system control rooms within the~~each~~ collector substation (to be shared with all projects, see below). The communication lines are collocated with the 34.5 kV electrical collection system described above. The SCADA system monitors meteorological conditions, critical operating parameters, and power output, for each solar string, battery energy storage system, and substation. The SCADA system is monitored by a remote operations center. Smoke and fire detectors placed around the site also connect to the SCADA system and will contact local emergency responders in the event of a fire at the site.

Collector Substations

The facility includes up to one~~six~~ collector substation~~s~~ at the site. The~~Each~~ substation includes a generator-step up (GSU) transformer and control building, and may also include circuit-breakers and fuses, transmission line termination structures, power transformers, bus bars and insulators, disconnect switches, relaying, battery and charger, surge arresters, AC and DC

supplies, control systems, metering equipment, grounding, a lightning protection system and associated control wiring.

The GSU transformer~~s~~ increases the 34.5-kV ISU transformer output to 230-kV power. The GSU transformer~~s~~ is~~are~~ ground-mounted units constructed on concrete pads. The~~Each of the six~~ GSU transformer is~~s are~~ filled with up to 16,000 gallons of non-toxic oil such as mineral or seed oil.

The~~Each~~ GSU transformer is equipped with a secondary spill containment catchment system designed to minimize the possibility of accidental leakage. The concrete catchment system is sized to contain approximately 1.25 times the amount of oil inside the transformer.

All substation structures and components are surrounded by a graveled area and enclosed by an 8-foot-tall chain-link fence with three strands of barbed wire one foot above the top. Access to substation sites is limited with a locked gate.

~~230-kV Transmission Line~~

~~The facility includes up to two 230-kV overhead transmission lines that connect the collector substations to the two primary interconnection switchyards located at the point of interconnection. The transmission lines are supported by steel or wood monopole or H-Frame structures, spaced approximately 1,000 feet between structures, and ve a combined length of approximately 9.5 miles. The northern line connects two collector substations along the south side of Alpine Lane to the switchyard and extends approximately 3.2 miles. The southern line connects four collector substations across the southern portion of the site and extend approximately 6.3 miles. The two lines run in parallel for approximately 1-mile between Bombing Range Road and the switchyards.~~

~~The transmission lines are located within the fenced solar array areas except where the lines span roads or corridors between areas and between the switchyards and the point of interconnection. All transmission line components are sited within the facility lease boundary.~~

~~No new or expanded right-of-way will be required, but some portions of the transmission lines are located within existing public rights-of-way. A portion of the transmission line that runs along the western boundary of energy facility footprint is within the public right-of-way on the east side of Bombing Range Road. Additionally, portions of the transmission line that connect solar array areas in the southern portion of the site cross Doherty Road and the Lexington-Echo Highway.~~

~~Project Switchyards and~~ Interconnection Facilities

The facility interconnects with the existing Umatilla Electric Cooperative 230kV Blue Ridge Line at the northwest corner of the facility where the shared switchyard is located (see below). ~~Two switchyards are approved to be located within a separately fenced site either within or adjacent to the energy facility footprint, each~~

~~approximately 3 acres. The interconnection switchyards do not contain transformers and are constructed on foundations with surrounding gravel areas.~~

Operations and Maintenance Buildings

The facility includes one~~up to four~~ operations and maintenance (O&M) building~~s~~, ~~each~~ including a utility room, storage for maintenance supplies and equipment, and a SCADA control room. The building~~s each~~ has~~ve~~ an on-site well and septic system. Power is supplied by a local service provider using overhead and/or underground lines. The~~Each~~ O&M building site also has a graveled parking and storage area~~s~~. The O&M building may be shared with all projects, see below.

Small quantities of chemical materials, including cleaners, insecticides or herbicides, paint, lubricants, degreasers, and solvents, may be stored at the O&M building~~s~~ during construction and operation of the facility. No extremely hazardous materials would be stored on site; other chemicals will be handled in accordance with label instructions as well as state and federal standards.

The facility includes an aboveground fuel storage tank with capacity to store up to 500 gallons of diesel fuel or gasoline at the~~each~~ O&M building site.

The O&M building~~s~~ is~~are~~ equipped with basic firefighting equipment for use on-site during maintenance activities, such as shovels, beaters, portable water for hand sprayers, fire extinguishers, and other equipment.

Replacement Solar Panel Storage

To store spare solar panels and associated equipment, the facility is approved to store materials either at the O&M building site~~s~~ or within approximately 50 locked Conex storage containers distributed throughout the site (to be shared with all projects, see below). The containers may be placed directly on the ground or on gravel pads. The containers would store up to the approximately 204,720 replacement panels needed over the life of the facility.

Access and Service Roads

The facility includes up to 7.3~~ 55~~ miles of new roads (graded and graveled to meet load requirements for all equipment) to provide access to facility components; some roads will be shared with all projects, see below. Corridors between module racking are at least 10 feet wide and racking are no closer than 15 feet from perimeter fencing. Some new road construction is required to access site features. Roads will be 10 to 20 feet in width, with some exceptions, including access to the substation~~s~~ and main travel corridors where two-way traffic is required. In these cases, roads will be 20 feet wide. A 5-foot maintained vegetative surface or noncombustible base, approved by the fire code official, will be maintained along the fenced perimeter of the site boundary. Use of the roads may continue

after construction, or new roads may be removed and the land reclaimed to pre-construction conditions.

Security Fencing and Gates

The facility includes approximately 2~~58~~ miles of security fence to enclose each solar array area, and substation~~, and switchyard site~~. The perimeter fencing has lockable vehicle and pedestrian access gates to provide access to the site.

Temporary Construction Areas

The facility includes up to 2~~54~~ temporary construction areas within the energy facility footprint to support construction, store supplies and equipment, and facilitate the delivery and assembly of materials and equipment. Each area consists of a 5-acre site that would be cleared and graveled prior to construction.

Up to five above-ground diesel tanks and one temporary above-ground gasoline tank may be stored in the temporary construction areas (to be shared with all projects, see below). The tanks each hold up to 1,000 gallons of fuel. Most fuel containers have self-contained secondary containment (e.g., double-walled containers) that provide capacity for the entire container plus precipitation, but in some cases may be placed in a constructed secondary containment area that is impervious and is diked or otherwise contained to provide the required fuel and precipitation capacity.

Shared Related or Supporting Facilities

The certificate holder is authorized to share related or supporting facilities between the Sunstone Solar Projects 1-6, including the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary constructions areas (including fuel tanks). These related or supporting facilities are split accordingly between the Sunstone Solar Projects 1-6, as demonstrated in their associated site certificates. Similarly, compliance with site certificate conditions and EFSC standards which apply to these shared related or supporting facilities are also split accordingly between Sunstone Solar Projects' 1-6 site certificates and certificate holders. In accordance with Condition GEN-GS-07 if either certificate holder substantially modifies a shared related or supporting facility or ceases facility operation, the applicable/relevant certificate holder is obligated to submit an amendment determination request or request for amendment to the Department to determine the appropriate process for evaluating the change and ensuring full regulatory coverage under each site certificate, or remaining site certificate if either is terminated, in the future. Additionally, each certificate holder is obligated to demonstrate to the Department that a "Common Facilities Agreement" or similarly legally binding agreement has been fully executed between certificate holders to ensure approval and agreement of access to the shared resources has been obtained prior to operation of shared facilities.

4.0 Facility Development

4.1 Construction

The initial applicant proposed to construct the originally permitted~~proposed~~ facility in six phases, with each phase including approximately 200 MWs of generating capacity, one of which is the subject of this Site Certificate.

Portions of the site, including the substation~~sites~~, inverter and battery energy storage system sites, and access roads will be cleared and graded, prior to construction of the applicable facility components. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems in the energy facility footprint are left intact during construction to the maximum extent practicable to minimize soil and erosion impacts, and that grading in solar arrays is limited to those areas where the slope and gradient are outside of panel and racking tolerances. Typical grading tolerances within the array are 10% maximum on North slopes and 15% maximum in other directions. Following construction, operational requirements include long-term site stabilization and revegetation of disturbed areas.

Adherence to the requirements of a Fugitive Dust Control Plan is required under Condition PRE-SP-02. Measures implemented under this plan include maintaining existing vegetative root systems, applying dust suppressants, and restricting traffic speeds on-site. Typically, water is

applied as a dust suppressant on access roads, but under drought conditions, alternative dust suppressants including synthetic polymer emulsions, chemical suppressants, organic glues, and wood fiber materials may be applied at the site by qualified vendors.

Construction of the originally permitted facility for all six projects will generate 910 commuting trips and 250 truck trips per day over approximately 1,224 construction workdays. At the peak of construction, it is estimated a maximum of approximately 1,266 commuting trips per day and 250 truck trips per day. The primary route to the site would be Bombing Range Road via Interstate Highway 84 (I-84) at the I-84/Irrigon Junction. Alternate routes would be via OR-207 via I-84 south of Hermiston.

4.2 Operations and Maintenance

Operation and maintenance activities include routine inspections, replacement of solar modules and battery components, panel washing, and vegetation management. Up to 10 permanent employees would operate and maintain the facility (to be shared by all six projects), with occasional delivery truck accessing the site during operations depending on the type of maintenance activity.

Individual batteries associated with the BESS will be inspected according to the manufacturer's recommendations and will need to be replaced approximately every 20 years, and every battery will be replaced during the life of the facility. Each type of electrical facility component would have routine inspections as designated in the operational Wildfire Mitigation Plan. The solar panels may require periodic washing during operations, and other incidental water use for sanitation and equipment washing.

Vegetation will be cleared and maintained along access roads to provide a vegetation clearance area for fire safety. This includes mowing to a height of no more than 12 inches. Use of the roads may continue after construction, or new roads may be removed, and the land reclaimed to pre-construction conditions.

An aboveground 500-gallon fuel storage tank sized may be installed at each O&M building. Secondary containment and refueling procedures for on-site fuel storage during operations will continue to follow the SPCC Plan and requirements for secondary containment. No extremely hazardous materials are expected to be produced, used, stored, transported, or disposed of at the facility during operation.

4.3 Retirement

The estimated useful life of the proposed facility is 40 years. Operational jobs would be eliminated after the facility ceased operating; however, some short-term contract jobs to monitor restored areas may be added to facilitate retirement activities. Decommissioning requires similar workforce numbers as required for the construction of the originally permitted facility/six projects in total and is estimated to require a similar duration of up to 47 months.

Final retirement activities will be designated in a retirement plan but would begin with disconnecting all electrical equipment disassembling equipment and components such and the battery storage units, solar panels and transformers. Larger containers and equipment would be removed, trucked off-site and recycled and disposed of. Solar panels would be disconnected, and piles would be removed including the excavation of any concrete foundations. Gravel and foundations from the inverters and transformers, O&M building, substation~~s~~, and battery unit~~s~~ would be removed by trenching and excavation. The facility site would then be restored through grading, filling, and revegetation with plants or seed mix consistent with applicable plans and conditions discussed in this order or landowner interests.

5.0 Site Certificate Conditions

The conditions of this Site Certificate are organized and coded to indicate the phase of implementation, the standard the condition is required to satisfy, and an identification number (1, 2, 3, etc.).[3] The table below presents a "key" for phase of implementation:

Key	Type of Conditions/Phase of Implementation
GEN	General Conditions: Design, Construction and Operation
PRE	Pre-Construction Conditions
CON	Construction Conditions
PRO	Pre-Operational Conditions
OPR	Operational Conditions
RET	Retirement Conditions

To align with the phased construction approach, preconditions requiring applicant actions prior to construction allow for phased compliance. These apply specifically to the area in which the phased activities would occur, rather than the entirety of the site.

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[3] The identification number is not representative of an order that conditions must be implemented; it is intended only to represent a numerical value for identifying the condition.

5.1 General (GEN) Conditions: Design, Construction and Operations

Condition Number	General (GEN) Conditions
STANDARD: GENERAL STANDARD OF REVIEW (GS) [OAR 345-022-0000]	
GEN-GS-01	The certificate holder must design, construct, operate and retire the facility: a. Substantially as described in the site certificate; b. In compliance with the requirements of ORS Chapter 469, applicable Council rules, and applicable state and local laws, rules and ordinances in effect at the time the site certificate was issued; and c. In compliance with all applicable permit requirements of other state agencies. [Mandatory Condition OAR 345-025-0006(10); General Standard Condition 1; Final Order on ASC]
GEN-GS-02	The certificate holder must begin and complete construction of the facility ~~or facility phase~~ by the following dates: a. Construction of the facility or first facility phase must begin on or before November 18, 2028~~7~~. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site. ~~b. Construction of the final facility phase must begin on or before November 18, 2028. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site.~~ c. All facility construction must be completed on or before November 18, 2030~~within 2 years after the date construction of the final facility phase (under (b)) begins~~. Within 7 days after completing construction, the certificate holder shall provide the Department written verification that it has met the deadline. [General Standard Condition 2; Final Order on ASC]
GEN-GS-03	If the certificate holder becomes aware of a significant environmental change or impact attributable to the facility, the certificate holder must, as soon as possible, submit a written report to the Department describing the impact on the facility and any affected site certificate conditions. [Mandatory Condition OAR 345-025-0006(6); General Standard Condition 3; Final Order on ASC]
GEN-GS-04	The certificate holder must prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder. [Mandatory Condition OAR 345-025-0006(7); General Standard Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-GS-05	Upon completion of construction, the certificate holder must restore vegetation to the extent practicable and must landscape all areas disturbed by construction in a manner compatible with the surroundings and proposed use. Upon completion of construction, the certificate holder must remove all temporary structures not required for facility operation and dispose of all timber, brush, refuse and flammable or combustible material resulting from clearing of land and construction of the facility. [Mandatory Condition OAR 345-025-0006(11); General Standard Condition 6; Final Order on ASC]
~~GEN-GS-06~~	~~The certificate holder is authorized to construct the 230 kV transmission lines anywhere within the approved transmission line corridors, subject to the conditions in the site certificate. The approved transmission line corridor includes:~~ ~~a. Southern transmission line: Approximately 6.3 miles, extending between the facility switchyard to four collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~b. Northern transmission line: Approximately 3.2 miles, extending between the facility switchyard to two collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~[Site Specific Condition OAR 345-025-0010(5); General Standard Condition 7; Final Order on ASC]~~
GEN-GS-07	The certificate holder may operationally share the following related or supporting facilities between Sunstone Solar Projects 1-6: the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary construction areas, subject to the following: a. Within 30 days of use by certificate holders of the shared facilities, the certificate holder must provide evidence to the Department that the certificate holders of the shared facilities have an executed agreement for shared use of any constructed shared facilities. The Shared Use Agreements must allow operation and maintenance personnel and contractors access to the shared facilities of Sunstone Solar Projects 1-6.
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
GEN-OE-01	Before any transfer of ownership of the facility or ownership of the site certificate holder, the certificate holder must inform the Department of the proposed new owners. The requirements of OAR 345-027-0400 apply to any transfer of ownership that requires a transfer of the site certificate. [Organizational Expertise Condition 1; Final Order on ASC]
GEN-OE-02	Any matter of non-compliance under the site certificate is the responsibility of the certificate holder. Any notice of violation issued under the site certificate will be issued to the certificate holder. Any civil penalties under the site certificate will be levied on the certificate holder. [Organizational Expertise Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-OE-03	The certificate holder must notify the Department within 72 hours of any occurrence of the following: a. There is an attempt by anyone to interfere with the facility's safe operation. b. There is a significant nature event such as a fire, earthquake, flood, tsunami or tornado, or human-caused event such as a fire or explosion. c. There is any fatal injury at the facility. [Organizational Expertise Condition 5; Final Order on ASC]
GEN-OE-04	The certificate holder shall, as soon as reasonably possible: a. Report incidents or circumstances that may violate the terms or conditions of the site certificate, terms or conditions of any order of the Council, or the terms or conditions of any order issued under OAR 345-027-0230, to the Department. In the report to the Department, the certificate holder shall provide all pertinent facts including an estimate of how long the conditions or circumstances existed, how long they are expected to continue before they can be corrected, and whether the conditions or circumstances were discovered as a result of a regularly scheduled compliance audit; b. Initiate and complete appropriate action to correct the conditions or circumstances and to minimize the possibility of recurrence; c. Submit a written report within 30 days of discovery to the Department. The report must refer to the language in (d) of the condition and contain: i. A discussion of the cause of the reported conditions or circumstances; ii. The date of discovery of the conditions or circumstances by the responsible party; iii. A description of immediate actions taken to correct the reported conditions or circumstances; iv. A description of actions taken or planned to minimize the possibility of recurrence; and v. For conditions or circumstances that may violate the terms or conditions of a site certificate, an assessment of the impact on the resources considered under the standards of OAR Chapter 345 Divisions 22 and 24 as a result of the reported conditions or circumstances. d. Upon receipt of the written report in sub(c) of this condition, the Department may review the facility record for incidents or circumstances reported or reportable under sub(a) related to public health and safety, the environment, or other resources protected under Council standards. If these incidences are determined by the Department to impact the adequacy of the facility decommissioning cost, the Department or Council may adjust the contingencies identified in Final Order on ASC Table 4 and shall request and receive an updated bond or letter of credit from certificate holder in the adjusted amount. [Organizational Expertise Condition 6; Final Order on ASC]
STANDARD: Structural Standard (SS) [OAR 345-022-0020]	

Condition Number	General (GEN) Conditions
GEN-SS-01	The certificate holder must design, engineer and construct the facility to avoid dangers to human safety and the environment presented by seismic hazards affecting the site that are expected to result from all maximum probable seismic events. "Seismic hazards" include ground shaking, ground failure, landslide, liquefaction triggering and consequences (including flow failure, settlement buoyancy, and lateral spreading), cyclic softening of clays and silts, fault rupture, directivity effects and soil-structure interaction. [Mandatory Condition OAR 345-025-0006(12); Structural Standard Condition 1; Final Order on ASC]
GEN-SS-02	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if site investigations or trenching reveal that conditions in the foundation rocks differ significantly from those described in the application for a site certificate. After the Department receives the notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(13); Structural Standard Condition 2; Final Order on ASC]
GEN-SS-03	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if shear zones, artesian aquifers, deformations or clastic dikes are found at or in the vicinity of the site. After the Department receives notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(14); Structural Standard Condition 3; Final Order on ASC]
GEN-SS-04	The certificate holder shall design, engineer, and construct the facility in accordance with the versions of the International Building Code, Oregon Structural Specialty Code, and local building codes in effect at the time of construction. [Structural Standard Condition 5; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
GEN-LU-01	The certificate holder shall provide evidence to the Department of coordination with the owners of adjacent lands dedicated to agricultural use. Coordination must include information about the facility that could impact agricultural activities. The certificate holder must document any recommendations made by adjacent landowners regarding measures to reduce or avoid any adverse impacts to farm practices on surrounding lands and to avoid any increase in farming costs as well as any responses made to these recommendations. [Land Use Condition 9; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-LU-02	The certificate holder must adhere to the terms of the Memorandum of Agreement for Agricultural Mitigation Fund included in Attachment F of the Final Order on the ASC, or subsequently amended. It is the certificate holder's responsibility to ensure that the Council and Department receive all reports and notifications required by the agreement. [Land Use Condition 12; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
GEN-RF-01	The certificate holder shall prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder.
	[Mandatory Condition OAR 345-025-0006(7); Retirement and Financial Assurance Condition 1; Final Order on ASC]
STANDARD: Siting Standards for Transmission Lines (TL) [OAR 345-024-0090]	
~~GEN-TL-01~~	~~The certificate holder shall:~~ ~~a. Design, construct and operate the transmission lines in accordance with the requirements of the National Electrical Safety Code as approved by the American National Standards Institute; and~~ ~~b. Develop and implement a program that provides reasonable assurance that all fences, gates, cattle guards, trailers, or other objects or structures of a permanent nature that could become inadvertently charged with electricity are grounded or bonded throughout the life of the line.~~ ~~[Siting Standards for Transmission Line Condition 1; Final Order on ASC]~~

5.3 Pre-Construction (PRE) Conditions

Condition Number	Preconstruction (PRE) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
PRE-GS-01	Except as necessary for the initial survey, the certificate holder may not begin construction of the facility or phase, or create a clearing on any part of the site of the facility or phase, as applicable, until the certificate holder has the legal right to engage in construction activities on the relevant parts of the site for the facility or phase. [Mandatory Condition OAR 345-025-0006(5); General Standard Condition 5; Final Order on ASC]
PRE-GS-02	At least 90 days prior to construction of the facility or phase, as applicable (unless otherwise agreed to by the Department), the certificate holder shall submit to the Department a compliance plan documenting and demonstrating actions completed or to be completed to satisfy the requirements of all site certificate terms and conditions and applicable statutes and rules. The plan shall be provided to the Department for review and compliance determination for each requirement. The Department may request additional information or evaluation deemed necessary to demonstrate compliance. [OAR 345-026-0048, General Standard Condition 8; Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRE-OE-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall notify the Department of the identity and qualifications of the major design, engineering and construction contractor(s). The certificate holder shall select contractors that have substantial experience in the design, engineering and construction of similar facilities. The certificate holder shall report to the Department any changes of major contractors. [Organizational Expertise Condition 2; Final Order on ASC]
PRE-OE-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall select a construction contractor with a low rate of historic environmental and safety compliance citations. Certificate holder shall provide the following documentation to the Department: a. Qualifications and contact information of the of the major design, engineering and construction contractor(s) and subcontractors, as applicable. b. Construction contractor compliance history. c. Contract excerpt affirming that contractors are required to comply with the terms and conditions of the site certificate, including selecting design layout and construction materials that minimize impacts to resources protected under Council standards. [Organizational Expertise Condition 7; Final Order on ASC]
PRE-OE-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide to the Department the qualifications and contact information of the certificate holder's construction manager.

Condition Number	Preconstruction (PRE) Conditions
	[Organizational Expertise Condition 8; Final Order on ASC]
PRE-OE-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Provide the Department a list of federal, state and local permits, including any third-party permits related to facility siting; and a schedule for obtaining identified permits. b. Once obtained, provide copies of all permits, including third-party permits, required for facility siting to the Department. [Organizational Expertise Condition 12; Final Order on ASC]
STANDARD: Structural (SS) [OAR 345-022-0020]	
PRE-SS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a site-specific geotechnical investigation report, consistent with the Oregon State Board of Geologist Examiners Guideline for Preparing Engineering Geologic Reports, or newer guidelines if available to the Department, for review in consultation with its third-party consultant. [Structural Standard Condition 4; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRE-SP-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide a Vegetation and Grading Plan that demonstrates contractors are required to adhere to the following: a. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems shall be left intact to the maximum extent practicable. b. Grading within solar arrays shall be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically 10% maximum on North slopes and 15% maximum in other directions). [Soil Protection Condition 1; Final Order on ASC]
PRE-SP-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Obtain a NPDES 1200-C Permit from DEQ. A copy of the approved permit and attached Erosion and Sediment Control Plan (ESCP) must be submitted to the Department. b. Finalize the Fugitive Dust Control Plan, as provided in the Final Order on ASC Attachment D. Finalization includes verification of names and contact information of individuals responsible for implementation, measures to be implemented and forms to be used for monitoring and reporting. [Soil Protection Condition 3; Final Order on ASC]
PRE-SP-03	Prior to construction of the facility or phase, as applicable, the certificate holder must submit to the Department a Construction Spill Prevention Countermeasures and Control (SPCC) Plan. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-01	Prior to construction of the facility or phase, as applicable, the certificate holder must provide to the Department a copy of the approved Conditional Use Permit and applicable Zoning Permit(s). [Land Use Condition 1; Final Order on ASC]
~~PRE-LU-02~~	~~Prior to construction of the 230 kV transmission lines, the certificate holder shall demonstrate to the Department that the transmission lines will be sited within the exiting road rights-of-way, unless Morrow County Public Works Department and Oregon Department of Transportation, as applicable, confirm that use of the existing road rights-of-way is not feasible.~~ ~~[Land Use Condition 2; Final Order on ASC]~~
PRE-LU-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the draft Noxious Weed Control Plan, as provided in the Final Order on ASC Attachment E, and submit to the Department for review and approval in consultation with the Morrow County Weed Department. [Land Use Condition 3; Final Order on ASC]
PRE-LU-04	Prior to construction of the facility or phase, as applicable, the certificate holder must submit an executed document prohibiting the certificate holder, and the certificate holder's successors in interest, from pursuing a claim for relief or cause of action alleging injury from farming or forest practices as defined in ORS 30.930(2) and (4), and provide evidence that the document has been recorded in the deed records for Morrow County. [Land Use Condition 6; Final Order on ASC]
PRE-LU-05	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the final design adheres to the following setbacks: a. All facility structures and above-ground components except the perimeter fenceline must be sited: 1. At least 20 feet from a property line fronting the right-of-way of a local minor collector or marginal access street, including but not limited to Sand Hollow Road, Grieb Lane, Alpine Lane, Doherty Road, or Melville Road. 2. At least 30 feet from a property line fronting the right-of-way, of a major collector, including but not limited to, Bombing Range Road. 3. At least 80 feet from a property line fronting the right-of-way for an arterial road, including but not limited to State Highway 207. b. All facility structures, and all on-site septic systems or other sewage disposal systems must be set back at least 100 feet from delineated waterways. [Land Use Condition 7; Final Order on ASC]
PRE-LU-06	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a final site plan that includes all information required by MCZO 4.165.E to the County and the Department. The Department may defer review and approval to the County. [Land Use Condition 8; Final Order on ASC]

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-07	Prior to construction of the facility or phase, as applicable, the certificate holder must complete the preconstruction requirements identified in the Memorandum of Agreement for Agricultural Mitigation Fund, as provided in the Final Order on ASC Attachment F, or subsequently amended. [Land Use Condition 11; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
PRE-RF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit to the State of Oregon, through the Council, a bond or letter of credit naming the State of Oregon, acting by and through the Council, as beneficiary or payee. The approved bond or letter of credit amount of $23,391,436.10~~117,945,000~~ (Q4~~1~~ 2025~~3~~ dollars) may be adjusted based on the design configuration of the facility, or phase of the facility, as provided in Sub(a) and adjusted to the year and quarter of issuance as provided under Sub(b). a. The bond or letter of credit amount may be adjusted based on actual design/number of components of the facility or phase, as applicable, and shall use the same unit costs and contingencies presented in the Final Order on the ASC Table 8. b. Adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. c. The bond or letter of credit must be issued by a financial institution that is included on the Council's pre-approved financial institution list. The certificate holder may request to have a financial institution added to the list at any time. d. The bond or letter of credit must be prepared using the most recent Council-approved template. [Retirement and Financial Assurance Condition 4; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
PRE-FW-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Revegetation and Reclamation Plan, based on Attachment G of the Final Order on the ASC, and submit to the Department for review and approval. [Fish and Wildlife Habitat Condition 1]
PRE-FW-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit the draft legal agreement for review and approval by the Department, in consultation with ODFW. The legal agreement shall ensure that payment provided for long-term management and enhancement of the mitigation area is adequate to cover the permanent habitat loss from the facility.

Condition Number	Preconstruction (PRE) Conditions
	[Fish and Wildlife Condition 4, Final Order on ASC]
PRE-FW-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Habitat Mitigation Plan, as provided in Attachment H of the Final Order on ASC, based on the impacts associated with the final facility design and the legal agreement, as approved by the Department. [Fish and Wildlife Condition 5, Final Order on ASC]
PRE-FW-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide evidence to the Department that the design measures included in the Construction Wildlife Monitoring Plan (Final Order on ASC Attachment I) have been included in the final facility design and construction contractor contracts, as applicable. [Fish and Wildlife Condition 7; Final Order on ASC]
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
PRE-TE-01	If construction commences after April 2025, certificate holder shall, prior to construction of the facility or phase, as applicable, conduct protocol-level Washington ground squirrel (WAGS) surveys within areas of planned facility construction that are within suitable WAGS habitat. The certificate holder shall: a. Submit a protocol-level survey plan for surveys to be conducted within suitable WAGS habitat, for review and approval by the Department in consultation with ODFW. At a minimum, the survey plan shall specify the survey area (all areas of suitable habitat within 1,000 feet of ground disturbing activities except where there is a habitat barrier (e.g., a paved road) or access restrictions); and survey timing (February 15 to May 31, unless otherwise approved by ODFW). b. Complete protocol-level WAGS surveys based on the protocol approved per (a). c. Submit survey reports to the Department and ODFW. The certificate holder shall not begin construction within 1,000 feet of Category 1 or Category 2 WAGS habitat until the identified boundaries of Category 1 WAGS habitat have been approved by the Department, in consultation with ODFW. Category 1 habitat includes a 785-foot buffer from an identified active burrow, and the area within the perimeter of multiple active burrows. Category 2 WAGS habitat consists of a 4,136-foot buffer from the exterior boundary of all Category 1 WAGS habitat. The survey results are valid for 3-years. d. Develop maps and worker training materials to inform of sensitive Category 1 and Category 2 habitat. Submit to the Department final facility design maps demonstrating that Category 1 habitat, including 785-buffer from any colonies identified per (b), is avoided. e. Install flagging or other demarcation, as appropriate, to inform workers of sensitive WGS habitat and of avoidance requirement. [Threatened and Endangered Species Condition 1; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	

Condition Number	Preconstruction (PRE) Conditions
PRE-HC-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall update the contact information provided in the Final Order on ASC Attachment K, Inadvertent Discovery Plan. [Historic, Cultural and Archeological Condition 1; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
PRE-PS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall execute a final Road Use Agreement, based on Final Order on ASC Attachment N, and provide a copy to the Department. [Public Services Condition 1, Final Order on ASC]
PRE-PS-02	At least 180-days prior to construction of any phase, the certificate holder shall provide to the Department and Morrow County a temporary housing plan for the construction workforce. The plan shall provide for coordination with contractors and local officials on housing options and strategies to minimize impacts to local housing supply based on an ongoing evaluation of patterns of uses and potential shortages or changes in housing demand. [Public Services Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRE-WF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Construction Wildfire Mitigation Plan, as provided in Attachment L to the Final Order on ASC. The final Construction Wildfire Mitigation Plan shall be submitted to the Department for review and approval. [Wildfire Prevention and Risk Mitigation Condition 1; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRE-WM-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall require contractors to develop and submit to the Department for review and approval, Construction Waste Management Plan(s) that, at a minimum, include the following: a. All sources and quantities of construction waste and wastewater, including damaged or dysfunctional energy facility components, and where feasible, estimated quantities that can be recycled. b. Process for disposal and recycling, including use of licensed haulers and disposal/recycling facilities; names and locations of licensed recycling and disposal facilities; collection, hauling and tracking requirements. c. Process for requesting a permit exemption from DEQ pursuant to OAR 340-093-0080 to ensure that concrete washout materials reused in foundation backfill are substantially the same as clean fill. d. Process for training workers and tracking compliance with the requirements of the plan. [Waste Minimization Condition 1; Final Order on ASC]
STANDARD: Noise Control Regulations (NC) [OAR 340-035-0035]	

Condition Number	Preconstruction (PRE) Conditions
PRE-NC-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the operational noise levels comply with OAR 345-035-0035(1)(b), based on an updated acoustic modeling analysis using final design/layout and equipment specifications. [Noise Control Condition 1; Final Order on ASC]
STANDARD: Other – Removal-Fill (WL)	
PRE-WL-01	Prior to construction of the facility, facility component or phase, as applicable, the certificate holder must provide documentation of a valid jurisdictional determination from the Oregon Department of State Lands demonstrating that no waterways subject to the State Removal-Fill law under ORS 196.795 through 196.990 are present within areas to be disturbed during construction or operation. [Removal-Fill Condition 1, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
PRE-WR-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Identify all water-related needs and estimate daily and annual water demand for each construction phase, as applicable. b. Provide, to the Department, a contract or purchase agreement demonstrating that adequate water supply to meet construction demand has been secured from sources with valid water rights. [Water Rights Condition 1, Final Order on ASC]

5.4 Construction (CON) Conditions

Condition Number	Construction (CON) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
CON-OE-01	The certificate holder shall contractually require all contractors and subcontractors to comply with all applicable laws and regulations and with the terms and conditions of the site certificate. The contractual obligation shall be required of each contractor and subcontractor prior to that firm working on the facility. Such contractual provisions shall not operate to relieve the certificate holder of responsibility under the site certificate. [Organizational Expertise Condition 3; Final Order on ASC]
CON-OE-02	During construction, the certificate holder shall: a. Maintain an onsite construction manager. b. Require that the construction manager implement and monitor all applicable construction related site certificate conditions. c. Within six months after beginning construction, and every six months thereafter during construction of the energy facility and related or supporting facilities, the certificate holder shall submit a semiannual construction progress report to the Department. In each construction progress report, the certificate holder shall describe any significant changes to major milestones for construction. The certificate holder shall report on the progress of construction and shall address the following: i. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. ii. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. iii. Compliance Report: A report describing the certificate holder’s compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate. iv. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0050. [Organizational Expertise Condition 9; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	

Condition Number	Construction (CON) Conditions
CON-SP-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Vegetation and Grading Plan. [Soil Protection Condition 2; Final Order on ASC]
CON-SP-02	During construction of the facility or phase, as applicable, the certificate holder shall: a. Conduct all work in compliance with the NPDES 1200-C Permit and Erosion and Sediment Control Plan (ESCP) or revised ESCP if applicable. The ESCP shall be revised if determined necessary by the certificate holder, certificate holder’s contractor(s) or the Department. Any Department-required ESCP revisions shall be implemented within 14-days, unless otherwise agreed to by the Department based on a good faith effort to address erosion issues. b. Conduct all work in compliance with the Fugitive Dust Control Plan. The Fugitive Dust Control Plan may be amended, as needed, to ensure that control measures are effective at the site. [Soil Protection Condition 4; Final Order on ASC]
CON-SP-03	During construction, the certificate holder shall require that all onsite contractors and personnel adhere to the requirements of the SPCC Plan. Any SPCC revisions and updates shall be reported to the Department. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
CON-LU-01	During construction, the certificate holder shall implement and adhere to the Noxious Weed Control Plan required under Condition PRE-LU-02. [Land Use Condition 4, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
CON-RF-01	During construction, the certificate holder shall: a. Describe the status of the bond or letter of credit in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. b. If construction extends for more than 12 months, the certificate holder shall adjust the amount of the bond or letter of credit on an annual basis thereafter as described in under Condition PRE-RF-01. c. The Department and Council reserve the right to adjust the contingencies, as necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 5; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
CON-FW-01	During construction, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan, as applicable. [Fish and Wildlife Habitat Condition 2, Final Order on ASC]
CON-FW-02	During construction, the certificate holder shall adhere to the requirements of the Construction Wildlife Monitoring Plan (Attachment I of the Final Order on the ASC). Monitoring records shall be maintained throughout construction and included in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 8; Final Order on ASC]

Condition Number	Construction (CON) Conditions
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
CON-TE-01	Prior to and during construction of the facility or phase, as applicable, any incidentally identified occurrence(s) of Lawrence's milkvetch shall be avoided using a 100-foot buffer via mapping and flagging. [Threatened and Endangered Species Condition 2; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
CON-HC-01	During construction, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan, as submitted to the Department under PRE-HC-01. [Historic, Cultural and Archeological Condition 2; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
CON-PS-01	During construction, the certificate holder shall adhere to the terms and conditions of the Road Use Agreement executed under PRE-PS-01. [Public Services Condition 2; Final Order on ASC]
CON-PS-02	During construction, the certificate holder shall report to the Department the outcomes of the work completed under the temporary housing plan required under PRE-PS-02. The report shall be included in the construction progress report required under CON-OE-02, and shall include, at a minimum: a. Outcome of coordination with construction contractors to identify housing options for incoming workers, including aggregate data on the location (i.e. city) and type of housing used by workers. b. Documentation of coordination with local officials such as the Morrow County Planning Department, nearby cities and towns such as Lexington and Ione, the Lexington Community Development Group, the Ione Community Agri-Business Organization, the Boardman Community Development Association, the Willow Creek Valley Economic Development Group, and other housing providers to identify housing options and strategies to minimize that impacts to local housing supply. [Public Services Condition 4; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
CON-WF-01	During construction of the facility of phase, as applicable, the certificate holder shall implement and require all onsite contractors and employees to adhere to the Construction Wildfire Mitigation Plan required under Condition PRE-WF-01. Updates to the Wildfire Mitigation Plan may be required if determined necessary by the certificate holder, certificate holder's contractor(s), or the Department to address wildfire hazard to public health and safety. Any Department required updates shall be implemented within 14 days, unless otherwise agreed to by the Department based on a good faith effort to address wildfire hazard. [Wildfire Prevention and Risk Mitigation Condition 2; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	

Condition Number	Construction (CON) Conditions
CON-WM-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Construction Waste Management Plan(s) and maintain records of employee training and tracking compliance onsite and available upon Department request. [Waste Minimization Condition 2; Final Order on ASC]
CON-WM-02	During construction, on-site concrete washwater disposal is prohibited unless DEQ approval of a permit exemption for materials substantially similar to clean fill is obtained. If DEQ approval of a permit exemption is obtained, concrete washwater must be disposed of onsite via infiltration and evaporation in accordance with the DEQ-issued NPDES 1200-C permit required under Condition CON-SP-02. [Waste Minimization Condition 3; Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
CON-WR-01	During construction: a. All water used for construction activities shall be appropriated and used in accordance with the applicable provisions of ORS chapter 537 and OAR chapter 690. b. The certificate holder shall report the source and amount of water used during each month of construction under Condition CON-OE-02. The certificate holder shall maintain records adequate to substantiate reports (e.g., written logs and photographs of well meter readings, copies of invoices from water sources) and make such records available to the Department upon request. c. If a water right, limited water use license, or water rights transfer is needed and would not be obtained by a third-party, the certificate holder shall submit and obtain approval of the applicable water permit through the site certificate amendment process. [Water Rights Condition 2; Final Order on ASC]

5.5 Pre-Operational (PRO) Conditions

Condition Number	Pre-Operational (PRO) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRO-OE-01	Prior to operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 10; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRO-SP-01	Following the termination of the 1200-C, the certificate holder shall update the requirements of the Revegetation and Reclamation Plan, specific to the areas within the fenceline not occupied by facility infrastructure. Certificate holder shall provide evidence to the Department that the permit was terminated by DEQ. [Soil Protection Condition 5; Final Order on ASC]
PRO-SP-02	Prior to operation, the certificate holder shall submit to the Department an Operational Spill Prevention Control and Countermeasures (SPCC) Plan. [Soil Protection Condition 8; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRO-WF-01	Prior to operation, the certificate holder shall finalize the operational Wildfire Mitigation Plan (WMP) included as Attachment M to the Final Order on ASC. [Wildfire Prevention and Risk Mitigation Condition 3; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRO-WM-01	Prior to operation, the certificate holder shall develop an Operational Recycling Plan or protocol requiring that damaged or nonfunctional panels and lithium-ion batteries be recycled to the extent practicable. The certificate holder shall report in its annual report to the Department the quantities of panels and lithium-ion batteries recycled, reused or disposed of in a landfill. Requirements for lithium-ion battery recycling do not apply if the BESS is not constructed. [Waste Minimization Condition 4; Final Order on ASC]
STANDARD: Other - Water Rights (WR)	
PRO-WR-01	Prior to operation, the certificate holder shall provide, to the Department, a copy of the map, well log and all other information it provided to OWRD pursuant to ORS 537.545 and ORS 537.765 to qualify for an exempt ground water use for any onsite exempt wells. [Water Rights Condition 3; Final Order on ASC]

5.6 Operational (OPR) Conditions

Condition Number	Operational (OPR) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
OPR-GS-01	The certificate holder must submit a legal description of the site to the Department within 90 days after beginning operation of the facility. The legal description must include a description of metes and bounds or a description of the site by reference to a map and geographic data that clearly and specifically identify the outer boundaries that contain all parts of the facility. [Mandatory Condition OAR 345-025-0006(2); General Standard Condition 9]
OPR-GS-02	After January 1 but no later than April 30 of each year after beginning operation of the facility, the certificate holder shall submit an annual report to the Department. The Council Secretary and the certificate holder may, by mutual agreement, change the reporting date. a. The annual report must include the following information for the calendar year preceding the date of the report: 1. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. 2. Reliability and Efficiency of Power Production: For electric power plants, the plant availability and capacity factors for the reporting year. The certificate holder shall describe any equipment failures or plant breakdowns that had a significant impact on those factors and shall describe any actions taken to prevent the recurrence of such problems. 3. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. 4. Monitoring Report: A list and description of all significant monitoring and mitigation activities performed during the previous year in accordance with site certificate terms and conditions, a summary of the results of those activities and a discussion of any significant changes to any monitoring or mitigation program, including the reason for any such changes. 5. Compliance Report: A report describing the certificate holder’s compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate.

Condition Number	Operational (OPR) Conditions
	6. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0350. b. To the extent that information required by this rule is contained in reports the certificate holder submits to other state, federal or local agencies, the certificate holder may submit excerpts from such other reports to satisfy this rule. The Council reserves the right to request full copies of such excerpted reports. [Mandatory Condition 345-026-0080(1); General Standard Condition 10, Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
OPR-OE-01	During operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 11; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
OPR-SP-01	During operation, the certificate holder shall adhere to the requirements of the Operational SPCC Plan. Any SPCC updates shall be described and included in the Annual Report to the Department. Certificate holder shall report spill and cleanup activities to the Department within 72 hours and shall make inspection records available to the Department upon request. [Soil Protection Condition 9; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
OPR-LU-01	Following the fifth year of monitoring under the Noxious Weed Control Plan required under PRE-LU-03, the certificate holder shall submit a Long-term Noxious Weed Monitoring Plan to the Department, for review and approval. The certificate holder shall implement the plan for the remainder of the facility's operating life. [Land Use Condition 5, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
OPR-RF-01	During operation, the certificate holder shall: a. Annually adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. b. Any changes to the template made by the Council must be incorporated into the bond or letter or letter of credit whenever the amount is adjusted under Sub(a). c. The Department and Council reserve the right to adjust the contingencies, as

Condition Number	Operational (OPR) Conditions
	necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 6; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
OPR-FW-01	During operation, as applicable, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan. [Fish and Wildlife Habitat Condition 3, Final Order on ASC]
OPR-FW-02	During operation, the certificate holder shall provide reports from The Nature Conservancy on the status of long-term management and enhancement of the habitat mitigation area, consistent with the Habitat Mitigation Plan. [Fish and Wildlife Condition 6, Final Order on ASC]
OPR-FW-03	During operation, the certificate holder shall adhere to the requirements of the Operational Wildlife Monitoring Plan (Attachment J of the Final Order on the ASC). Monitoring records shall be maintained throughout operation and included in the annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 9; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
OPR-HC-01	During operations, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan (IDP), as provided for Condition PRE-HC-01. The IDP shall be reviewed and updated annually for current contact information. [Historic, Cultural and Archeological Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
OPR-WF-01	During operation, the certificate holder shall: a. Implement the Operational Wildfire Mitigation Plan finalized under Condition PRO-WF-01. b. Every 5 years after the first operational year, review and update the evaluation of wildfire risk under OAR 345-022-0115(1)(b) and submit the results in the annual report required under Condition CON-OE-02 for that year. c. Submit an updated Operational Wildfire Mitigation Plan to the Department if substantive changes are made to the plan because of the review under sub (b) of this condition, or at any other time substantiative revisions are made. [Wildfire Prevention and Risk Mitigation Condition 4; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
OPR-WM-01	During operation, the certificate holder shall adhere to the requirements of the Operational Recycling Plan or protocol developed under Condition PRO-WM-01. [Waste Minimization Condition 5; Final Order on ASC]
OPR-WM-02	During operation, the certificate holder shall: a. Prohibit use of chemicals, soaps, detergents and heated water unless Chemical Safety Data Sheets for low volatile organic compound/biodegradable cleaning chemicals and solvents are submitted to the Department for review and approval prior to use.

Condition Number	Operational (OPR) Conditions
	b. Ensure that washing is conducted in a manner that does not remove paint or other finishes. c. Discharge wash water through evaporation and infiltration only. [Waste Minimization Condition 6, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
OPR-WR-01	During operation, the certificate holder shall verify that any onsite exempt wells do not use more than 5,000 gallons of ground water a day, collectively, and shall monitor the volume of groundwater used on a daily basis, maintain a record of such use and make the monitoring records available to the Department upon request. [Water Rights Condition 4; Final Order on ASC]

5.7 Retirement (RET) Conditions

Condition Number	Retirement (RET) Conditions
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
RET-RF-01	The certificate holder must retire the facility if the certificate holder permanently ceases construction or operation of the facility. The certificate holder must retire the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410. The certificate holder must pay the actual cost to restore the site to a useful, non-hazardous condition at the time of retirement, notwithstanding the Council's approval in the site certificate of an estimated amount required to restore the site. [Mandatory Condition OAR 345-025-0006(9); Retirement and Financial Assurance Condition 2; Final Order on ASC]
RET-RF-02	If the Council finds that the certificate holder has permanently ceased construction or operation of the facility without retiring the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410, the Council must notify the certificate holder and request that the certificate holder submit a proposed final retirement plan to the Department within a reasonable time not to exceed 90 days. If the certificate holder does not submit a proposed final retirement plan by the specified date, the Council may direct the Department to prepare a proposed final retirement plan for the Council's approval. Upon the Council's approval of the final retirement plan, the Council may draw on the bond or letter of credit described in Condition PRE-RT-01 to restore the site to a useful, non-hazardous condition according to the final retirement plan, in addition to any penalties the Council may impose under OAR chapter 345, division 29. If the amount of the bond or letter of credit is insufficient to pay the actual cost of retirement, the certificate holder must pay any additional cost necessary to restore the site to a useful, non-hazardous condition. After completion of site restoration, the Council must issue an order to terminate the site certificate if the Council finds that the facility has been retired according to the approved final retirement plan. [Mandatory Condition OAR 345-025-0006(16); Retirement and Financial Assurance Condition 3; Final Order on ASC]

6.0 Successors and Assigns

To transfer this site certificate or any portion thereof or to assign or dispose of it in any other manner, directly or indirectly, the certificate holder shall comply with OAR 345-027-0400.

7.0 Severability and Construction

If any provision of this agreement and certificate is declared by a court to be illegal or in conflict with any law, the validity of the remaining terms and conditions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the agreement and certificate did not contain the particular provision held to be invalid.

8.0 Execution

This site certificate may be executed in counterparts and will become effective upon signature by the Chair of the Energy Facility Siting Council and the authorized representative of the certificate holder.

IN WITNESS THEREOF, this site certificate has been executed by the State of Oregon, acting by and through the Energy Facility Siting Council and Sunstone Solar, LLC (certificate holder).

ENERGY FACILITY SITING COUNCIL
Kent Howe
By: Kent Howe (Nov 19, 2024 16:21 PST)
Kent Howe, Chair
Date: 19-Nov-2024

SUNSTONE SOLAR, LLC
Jon Saxon
By: Jon Saxon (Nov 19, 2024 16:26 EST)
Jon Saxon, Authorized Representative
Date: 19-Nov-2024

Sunstone Solar Project 4

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ENERGY FACILITY SITING COUNCIL
OF THE STATE OF OREGON

SITE CERTIFICATE FOR THE
SUNSTONE SOLAR PROJECT
4

ISSUE DATE
NOVEMBER 18, 2024

Table of Contents

1.0 Introduction and Site Certification

This site certificate is a binding agreement between the State of Oregon (State), acting through the Energy Facility Siting Council (EFSC or Council), and Sunstone Solar 4, LLC (certificate holder), owned by Pine Gate Renewables, LLC (parent company). Both the State and certificate holder must abide by local ordinances, state law, and the rules of the Council in effect on the date this site certificate is executed. However, upon a clear showing of a significant threat to public health, safety, or the environment that requires application of later-adopted laws or rules, the Council may require compliance with such later-adopted laws or rules (ORS 469.401(2)).

This site certificate binds the State and all counties, cities and political subdivisions in Oregon as to the approval of the site and the construction, operation, and retirement of the facility as to matters that are addressed in and governed by this site certificate (ORS 469.401(3)). Each affected state agency, county, city, and political subdivision in Oregon with authority to issue a permit, license, or other approval addressed in or governed by this site certificate, shall upon submission of the proper application and payment of the proper fees, but without hearings or other proceedings, issue such permit, license or other approval subject only to conditions set forth in this site certificate. In addition, each state agency or local government agency that issues a permit, license or other approval for this facility shall continue to exercise enforcement authority over such permit, license or other approval (ORS 469.401(3)). For those permits, licenses, or other approvals addressed in and governed by this site certificate, the certificate holder shall comply with applicable state and federal laws adopted in the future to the extent that such compliance is required under the respective state agency statutes and rules (ORS 469.401(2)).

This site certificate does not address, and is not binding with respect to, matters that are not included in and governed by this site certificate, and such matters include, but are not limited to: employee health and safety; building code compliance; wage and hour or other labor regulations; local government fees and charges; other design or operational issues that do not relate to siting the facility (ORS 469.401(4)); and permits issued under statutes and rules for which the decision on compliance has been delegated by the federal government to a state agency other than the Council (ORS 469.503(3)).

The obligation of the certificate holder to report information to the Department or the Council under the conditions listed in this site certificate is subject to the provisions of ORS 192.502 *et seq.* and ORS 469.560. To the extent permitted by law, the Department and the Council will not publicly disclose information that may be exempt from public disclosure if the certificate holder has clearly labeled such information and stated the basis for the exemption at the time of submitting the information to the Department or the Council. If the Council or the Department receives a request for the disclosure of the information, the Council or the Department, as appropriate, will make a reasonable attempt to notify the

certificate holder and will refer the matter to the Attorney General for a determination of whether the exemption is applicable, pursuant to ORS 192.450.

Council shall have continuing authority over the site and may inspect, or direct the Oregon Department of Energy (Department) to inspect, or request another state agency or local government to inspect, the site at any time in order to ensure that the facility is being operated consistently with the terms and conditions of this site certificate (ORS 469.430).

The duration of this site certificate shall be the life of the facility, subject to termination pursuant to OAR 345-027-0110 or the rules in effect on the date that termination is sought, or revocation under ORS 469.440 and OAR 345-029-0100 or the statutes and rules in effect on the date that revocation is ordered. The Council shall not change the conditions of this site certificate except as provided for in OAR Chapter 345, Division 27.

In interpreting this site certificate, any ambiguity will be clarified by reference to the following, in order, incorporated herein by this reference: 1) *Final Order on the Application for Site Certificate for the Sunstone Solar Project* issued on November 18, 2024 (hereafter, *Final Order on the ASC*); 2) the record of the proceedings that led to the Final Order on the ASC.

The definitions in ORS 469.300 and OAR 345-001-0010 apply to the terms used in this site certificate, except where otherwise stated, or where the context clearly indicates otherwise.

2.0 Facility Location and Site Boundary

The facility is located within an approximately 1,273.2 ~~10,960~~-acre (2.0 ~~17~~ sq. mile) site in Morrow County. The site is located on both sides of State Route 207 and is approximately 15 miles northeast of the Town of Lexington and approximately 4.5 miles west of Butter Creek Junction. The site is approximately 3 miles west of the Umatilla County line at its closest point. Table 1 below provides the Township, Range, and Sections occupied wholly, or in part, by the site. Up to 1,267.3 acres~~9,442~~ of land within the site boundary would be occupied by facility components. The regional location of the facility site boundary~~, transmission line corridor,~~ and ~~approximately 1,518 acres~~ areas within the site boundary ~~are~~ excluded from development, as applicable, are~~as~~ shown on Attachment 1~~ASC Exhibit C, Figures C- 2, and C-2.1 to C-2.3, attached~~ to this site certificate ~~as Attachment 1~~.

Table 1: Township, Range, and Section for Areas Occupied by the Site Boundary

Township	Range	Sections
~~1N~~	~~26E~~	~~1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 14, 15~~
2N	26E	27, 28~~, 29, 30, 31, 32,~~ 33, 34~~, 35, 36~~
Reference: SSPAPPDoc25-03 ASC Exhibit C Project Location, Table C-1. 2024-05-15.		

3.0 Facility Description

The energy facility is approved to include the components presented in Table 2 below. Additional details regarding specific components, and discussion of alternative designs or technologies under consideration are provided in the sections that follow.

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Site Boundary		
Site Boundary	1,273.2 ~~10,960~~	acres
Maximum Footprint	1,267.3 ~~9,442~~	acres
Permanent Impacts[1]	1,267.3 ~~9,442~~	acres
Solar Components		
PV Solar Modules		
Approx. total number	656,256~~3,937,536~~	modules
Max Height at full-tilt	15	feet
Posts		
Approx. total number (assumes concrete foundation)	89,176~~535,056~~	posts
Cabling		
Combiner Boxes	10,254~~61,524~~	each
Inverter Step Up (ISU) Transformer Units		
Approx. total number	54 ~~319~~	each
Noise level	89	dBA
Transformer oil-containing capacity	800	gallons
Related or Supporting Facility Components		
34.5 kV Collection System		
Collector line length, belowground	12.4 ~~82~~	miles
Collector line length, overhead (OH)	0.7 ~~4.3~~	miles
Wood Monopoles (max estimate for OH)	26 ~~151~~	each
Collector Substations		
Substations w SCADA; GSU transformers ~~per~~ each	1~~6~~; 1	each
Site size	1.6	acres
Transformer oil-containing capacity	16,000	gallons~~/each~~
Transformer noise level	100	dBA
Max height of structures	45	feet
~~Switchyards~~		

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[1] The energy facility would occupy approximately 1,267.3 ~~9,442~~ acres ~~within up to 20 separately fenced areas~~. Most related or supporting facilities will be located within the energy facility's footprint; however, portions of the overhead 34.5 kV collector and 230-kV transmission lines running between solar array areas would result in additional temporary and permanent disturbance areas.

Table 2: Facility Component Summary

~~Component and Design Standard~~	~~No.~~	~~Unit~~
~~Stations; Transformers per each~~	~~2; 0~~	~~each~~
~~Site size (northern and/or within solar fence line); with foundations and graveled areas~~	~~3~~	~~acres~~
~~230 kV Transmission Line~~		
~~Length (total; northern line; southern line)~~	~~9.5; 3.2; 6.3~~	~~miles~~
~~Structures: Type (Wood or Galvanized Steel); quantity~~	~~H-frame; 50~~	~~each~~
~~Height of structures~~	~~70-180~~	~~feet~~
Battery Energy Storage System (Lithium-ion/Zinc)		
Zinc		
Approx. total battery containers on foundations with fans/heating systems; SCADA	2,491~~14,946~~	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	9.5 x 8 x 20	H x W x L; feet
Noise level (broadband)	66	dBA
Lithium-ion		
Approx. total battery containers on foundations with HVAC and fire suppression systems; SCADA	~~1~~2,000	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	11.25 x 8.1 x 5.2	H x W x L; feet
Noise level (broadband)	66	dBA
~~O&M Building~~		
~~Quantity~~	~~1~~	~~each~~
~~Site size~~	~~2.8~~	~~acres~~
~~Height~~	~~20~~	~~feet~~
~~Appurtenances~~	~~On-site well, septic system, SCADA System~~	
Storage for Replacement Solar Panels		
Containers	8-9~~50~~	each
Approx. container dimensions	8.5 x 8 x 40	H x W x L; feet
Location	Dispersed within fence line ~~if not next to O&M~~, gravel base	
Facility Roads		
Length	7.9 ~~55~~	miles
Width	10- 20	feet
Perimeter Fence		
Length	2.7 ~~58~~	miles
Height	7-8	feet

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Access/gates	8-9~~52~~	each
Temporary Construction Areas		
Quantity	4~~54~~	each
Site size	5	acres
Description	Gravel base; diesel/gas storage; within fence line	

Energy Facility

The facility includes a solar photovoltaic power generation facility with up to ~~1,~~200 MW of electric generation capacity. ~~The energy facility consists of up to 20 separately fenced solar arrays organized into six 200 MW blocks.~~

Photovoltaic Modules

Solar photovoltaic modules, or solar panels, convert sunlight into DC electric power. The typical module contains crystalline silicon photovoltaic cells arranged within glass panels equipped with an anti-reflective coating, a metal frame, and wire connectors.

Racking System

The photovoltaic modules are connected in series into strings and then mounted on a racking system. Each rack would contain 2 strings of 32 modules mounted on a single-axis tracking system. Multiple racks are organized into rows between 200 and 400 feet in length depending on topography. Rows would be spaced at least 10 feet apart and at least 15 feet from perimeter fencing to provide vehicle access.

Posts

Each row of tracker mounted modules is supported by multiple hollow, screw pile, or pile-type steel posts. Posts are typically installed to a depth of 6-8 feet below surface and extend 5 feet above grade. Posts at the end of rows may be installed at greater depths to withstand wind uplift. Posts may be installed directly in the ground or concrete backfill may be required in some soil conditions.

DC Cabling System

Combiner boxes or a Big Lead Assembly (BLA) harness system is used to aggregate the DC output of the photovoltaic modules for transmission to an inverter by low-voltage DC cables. Using the combiner boxes, strings of modules are connected to a pad-mounted combiner box installed at each row, which in turn, are connected to the inverters by low voltage DC cables

that are either mounted to the tracking system, installed in trays, or buried underground. Using the BLA system, strings are connected directly to a rack-mounted cabling system.

Inverters and Inverter Step Up (ISU) Transformers

Inverters convert the DC output of the photovoltaic modules to AC power that can be transmitted to the electric grid. A typical inverter in utility scale solar facilities converts the 900 to 1,500 volt DC module output to 660 volt AC output. After conversion, the output is sent to an inverter step-up (ISU) transformer to increase the voltage to 34.5 kV power for transmission to the collector substation via the electrical collector system. Inverters and ISU transformers are collocated on concrete slabs near each module block.

Related or Supporting Facilities

Related or supporting facilities include a battery energy storage system, ~~an interconnection substation,~~ one~~up to six~~ collector substation~~s~~, ~~up to four operations and maintenance buildings,~~ and other structures.

Battery Energy Storage System

The battery energy storage system (BESS) is designed to provide up to 1~~7~~.2 gigawatt-hours (GWh) of storage capacity. The BESS may use either Lithium-Ion (Li-ion) or Zinc-based battery technology. Under either technology, batteries are contained in pre-constructed modular containers, or "segments," placed on concrete slab foundations.
The battery storage system includes, but is not limited to, the following elements:

- Batteries and containers, inverters, isolation transformers, and switchboards;
- Balance of plant equipment, which may include medium-voltage and low-voltage electrical systems, fire suppression and HVAC systems (for Li- ion technology, if selected), building auxiliary electrical systems, and network/SCADA systems;
- Cooling system, which may include a separate chiller plant located outside the battery racks with chillers, pumps, and heat exchangers (Li-ion only, if selected); zinc batteries will have fans and a heating unit for climate control; and
- High-voltage (HV) equipment, including a step-up transformer, circuit breaker, current transformers and voltage transformers, a packaged control building for the breaker and transformer equipment, towers, structures, and cabling.

The batteries and associated equipment may be oversized or periodically augmented in accordance with the manufacturer's recommendations to ensure a minimum of 1~~7~~,200 MWh of energy storage capability over the life of the BESS, taking into account natural degradation of the batteries over time.

Li-ion batteries are currently the most common battery type used in utility-scale battery energy storage systems. If a Li-ion battery technology is used at the facility, it would use Li-ion phosphate batteries, which are more thermally stable than Li-ion cathode batteries.
Each module contains approximately 10 hermetically sealed battery cells filled with a gel or liquid electrolyte. The module containers serve as secondary containment for the cells. Each container holds approximately 840 cells with a combined capacity of approximately 740 kilowatt-hour AC, and approximately ~~1~~2,000 containers would be required to meet the capacity needs of the facility.

The electrolyte used in Li-ion batteries is flammable and susceptible to overheating and vaporization, so Li-ion Battery Systems typically require cooling, ventilation, and fire suppression systems included in each container. If Li-ion battery technology is used at the site, it would implement the following design features and fire prevention and control methods to minimize fire and safety risks:

- Batteries would be stored in completely contained, leak-proof modules.
- Ample working space would be provided around the BESS for maintenance and safety purposes.
- An off-site, 24-hour monitoring system with shutdown capabilities would be implemented.
- Batteries would be transported in accordance with Department of Transportation Pipeline and Hazardous Material Administration regulations under 49 CFR 173.185
- Battery systems would be designed in accordance with applicable Underwriters Laboratories, National Electric Code, and National Fire Protection Association Standards, including but not limited to, UL 1642, 1741, 1973, and 9540A, and NFPA 855.
- An advanced and proven battery management system would be employed;
- Battery Containers would be equipped with:
  - Heating, ventilation, and air conditioning (HVAC) systems to maintain optimal battery temperatures;
  - Fire control panels with 24-hour battery backup;
  - Fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems;
  - Doors equipped with a contact that will shut down the battery container if opened;
  - Fire extinguishing and thermal insulation sheets between each individual battery cell;
  - Locks and fencing to prevent entry of unauthorized personnel;
  - Remote power disconnect switches with clear and visible signs identifying their location.[2]

Li-ion battery modules under consideration for this facility have an expected useful life of 20 years and it is expected that every module at the facility would need to be replaced at least once during the life of the facility. Used Li-ion batteries are generally considered to be

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[2] SSPAPPDoc25-02 ASC Exhibit B Project Description 2024-05-15, Section 2.7.1.

hazardous waste by the EPA and must be transported and disposed of according to the most current guidelines at end of life.

A typical zinc-based BESS container includes 144 zinc-hybrid cathode powered batteries with a combined 700 kWh capacity. Zinc batteries are estimated to have a lifespan of at least 20 years. Zinc battery systems can operate across a higher range of temperatures and only require cooling fans rather than a full HVAC system. Zinc batteries have a lower fire-risk than lithium-ion batteries and do not require fire suppression systems to be included in the container design.

The BESS may be designed either as a DC-coupled system, with containers distributed throughout the energy facility site near inverter/transformer station sites, or as an AC-coupled system with containers concentrated in a single area near the ~~switchyards~~ substation. In either case, the containers and other BESS equipment are located within the fenced solar array areas and may have their own additional fencing.

34.5 kV Electrical Collection System

The facility includes up to 12.4~~86~~ miles of 34.5 kV electrical collector lines that connects energy facility components to the collector substation~~s~~ described below. The majority of the collector lines are buried underground; however, overhead lines are installed at long “home run” stretches, stream or canyon crossings, and other areas where burial is infeasible. The collector lines are generally located within the energy facility footprint except at road crossings and crossings between fenced solar array areas.

Communication and SCADA System

The facility includes a system of fiber optic and copper communication lines that connect the solar arrays, BESS, and substation~~s~~ to Supervisory Control and Data Acquisition (SCADA) system control rooms within the~~each~~ collector substation (to be shared with all projects, see below). The communication lines are collocated with the 34.5 kV electrical collection system described above. The SCADA system monitors meteorological conditions, critical operating parameters, and power output, for each solar string, battery energy storage system, and substation. The SCADA system is monitored by a remote operations center. Smoke and fire detectors placed around the site also connect to the SCADA system and will contact local emergency responders in the event of a fire at the site.

Collector Substations

The facility includes up to one~~six~~ collector substation~~s~~ at the site. The~~Each~~ substation includes a generator-step up (GSU) transformer and control building, and may also include circuit-breakers and fuses, transmission line termination structures, power transformers, bus bars and insulators, disconnect switches, relaying, battery and charger, surge arresters, AC and DC

supplies, control systems, metering equipment, grounding, a lightning protection system and associated control wiring.

The GSU transformer~~s~~ increases the 34.5-kV ISU transformer output to 230-kV power. The GSU transformer~~s~~ is~~are~~ ground-mounted units constructed on concrete pads. The~~Each of the six~~ GSU transformer is~~s are~~ filled with up to 16,000 gallons of non-toxic oil such as mineral or seed oil.

The~~Each~~ GSU transformer is equipped with a secondary spill containment catchment system designed to minimize the possibility of accidental leakage. The concrete catchment system is sized to contain approximately 1.25 times the amount of oil inside the transformer.

All substation structures and components are surrounded by a graveled area and enclosed by an 8-foot-tall chain-link fence with three strands of barbed wire one foot above the top. Access to substation sites is limited with a locked gate.

~~230-kV Transmission Line~~

~~The facility includes up to two 230-kV overhead transmission lines that connect the collector substations to the two primary interconnection switchyards located at the point of interconnection. The transmission lines are supported by steel or wood monopole or H-Frame structures, spaced approximately 1,000 feet between structures, and ve a combined length of approximately 9.5 miles. The northern line connects two collector substations along the south side of Alpine Lane to the switchyard and extends approximately 3.2 miles. The southern line connects four collector substations across the southern portion of the site and extend approximately 6.3 miles. The two lines run in parallel for approximately 1-mile between Bombing Range Road and the switchyards.~~

~~The transmission lines are located within the fenced solar array areas except where the lines span roads or corridors between areas and between the switchyards and the point of interconnection. All transmission line components are sited within the facility lease boundary.~~

~~No new or expanded right-of-way will be required, but some portions of the transmission lines are located within existing public rights-of-way. A portion of the transmission line that runs along the western boundary of energy facility footprint is within the public right-of-way on the east side of Bombing Range Road. Additionally, portions of the transmission line that connect solar array areas in the southern portion of the site cross Doherty Road and the Lexington-Echo Highway.~~

~~Project Switchyards and~~ Interconnection Facilities

The facility interconnects with the existing Umatilla Electric Cooperative 230kV Blue Ridge Line at the northwest corner of the facility where the shared switchyard is located (see below). ~~Two switchyards are approved to be located within a separately fenced site either within or adjacent to the energy facility footprint, each~~

~~approximately 3 acres. The interconnection switchyards do not contain transformers and are constructed on foundations with surrounding gravel areas.~~

~~Operations and Maintenance Buildings~~

~~The facility includes up to four operations and maintenance (O&M) buildings, each including a utility room, storage for maintenance supplies and equipment, and a SCADA control room. The buildings each have an on-site well and septic system. Power is supplied by a local service provider using overhead and/or underground lines. Each O&M building site also has graveled parking and storage areas.~~

~~Small quantities of chemical materials, including cleaners, insecticides or herbicides, paint, lubricants, degreasers, and solvents, may be stored at the O&M buildings during construction and operation of the facility. No extremely hazardous materials would be stored on site; other chemicals will be handled in accordance with label instructions as well as state and federal standards.~~

~~The facility includes an aboveground fuel storage tank with capacity to store up to 500 gallons of diesel fuel or gasoline at each O&M building site.~~

~~The O&M buildings are equipped with basic firefighting equipment for use on-site during maintenance activities, such as shovels, beaters, portable water for hand sprayers, fire extinguishers, and other equipment.~~

Replacement Solar Panel Storage

To store spare solar panels and associated equipment, the facility is approved to store materials either at the O&M building sites (to be shared with all projects, but not related/supporting infrastructure for this phase, see below) or within approximately 50 locked Conex storage containers distributed throughout the site (to be shared with all projects, see below). The containers may be placed directly on the ground or on gravel pads. The containers would store up to the approximately 204,720 replacement panels needed over the life of the facility.

Access and Service Roads

The facility includes up to 7.9 ~~55~~ miles of new roads (graded and graveled to meet load requirements for all equipment) to provide access to facility components; some roads will be shared with all projects, see below. Corridors between module racking are at least 10 feet wide and racking are no closer than 15 feet from perimeter fencing. Some new road construction is required to access site features. Roads will be 10 to 20 feet in width, with some exceptions, including access to the substation~~s~~ and main travel corridors where two-way traffic is required. In these cases, roads will be 20 feet wide. A 5-foot maintained vegetative surface or noncombustible base, approved by the fire code official, will be maintained along the fenced perimeter of the site boundary. Use of the roads may continue

after construction, or new roads may be removed and the land reclaimed to pre-construction conditions.

Security Fencing and Gates

The facility includes approximately 2.7 ~~58~~ miles of security fence to enclose each solar array area, and substation~~, and switchyard site~~. The perimeter fencing has lockable vehicle and pedestrian access gates to provide access to the site.

Temporary Construction Areas

The facility includes up to 4~~54~~ temporary construction areas within the energy facility footprint to support construction, store supplies and equipment, and facilitate the delivery and assembly of materials and equipment. Each area consists of a 5-acre site that would be cleared and graveled prior to construction.

Up to five above-ground diesel tanks and one temporary above-ground gasoline tank may be stored in the temporary construction areas (to be shared with all projects, see below). The tanks each hold up to 1,000 gallons of fuel. Most fuel containers have self-contained secondary containment (e.g., double-walled containers) that provide capacity for the entire container plus precipitation, but in some cases may be placed in a constructed secondary containment area that is impervious and is diked or otherwise contained to provide the required fuel and precipitation capacity.

Shared Related or Supporting Facilities

The certificate holder is authorized to share related or supporting facilities between the Sunstone Solar Projects 1-6, including the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary constructions areas (including fuel tanks). These related or supporting facilities are split accordingly between the Sunstone Solar Projects 1-6, as demonstrated in their associated site certificates. Similarly, compliance with site certificate conditions and EFSC standards which apply to these shared related or supporting facilities are also split accordingly between Sunstone Solar Projects' 1-6 site certificates and certificate holders. In accordance with Condition GEN-GS-07 if either certificate holder substantially modifies a shared related or supporting facility or ceases facility operation, the applicable/relevant certificate holder is obligated to submit an amendment determination request or request for amendment to the Department to determine the appropriate process for evaluating the change and ensuring full regulatory coverage under each site certificate, or remaining site certificate if either is terminated, in the future. Additionally, each certificate holder is obligated to demonstrate to the Department that a "Common Facilities Agreement" or similarly legally binding agreement has been fully executed between certificate holders to ensure approval and agreement of access to the shared resources has been obtained prior to operation of shared facilities.

4.0 Facility Development

4.1 Construction

The initial applicant proposed to construct the originally permitted~~proposed~~ facility in six phases, with each phase including approximately 200 MWs of generating capacity, one of which is the subject of this Site Certificate.

Portions of the site, including the substation~~sites~~, inverter and battery energy storage system sites, and access roads will be cleared and graded, prior to construction of the applicable facility components. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems in the energy facility footprint are left intact during construction to the maximum extent practicable to minimize soil and erosion impacts, and that grading in solar arrays is limited to those areas where the slope and gradient are outside of panel and racking tolerances. Typical grading tolerances within the array are 10% maximum on North slopes and 15% maximum in other directions. Following construction, operational requirements include long-term site stabilization and revegetation of disturbed areas.

Adherence to the requirements of a Fugitive Dust Control Plan is required under Condition PRE-SP-02. Measures implemented under this plan include maintaining existing vegetative root systems, applying dust suppressants, and restricting traffic speeds on-site. Typically, water is

applied as a dust suppressant on access roads, but under drought conditions, alternative dust suppressants including synthetic polymer emulsions, chemical suppressants, organic glues, and wood fiber materials may be applied at the site by qualified vendors.

Construction of the originally permitted facility for all six projects will generate 910 commuting trips and 250 truck trips per day over approximately 1,224 construction workdays. At the peak of construction, it is estimated a maximum of approximately 1,266 commuting trips per day and 250 truck trips per day. The primary route to the site would be Bombing Range Road via Interstate Highway 84 (I-84) at the I-84/Irrigon Junction. Alternate routes would be via OR-207 via I-84 south of Hermiston.

4.2 Operations and Maintenance

Operation and maintenance activities include routine inspections, replacement of solar modules and battery components, panel washing, and vegetation management. Up to 10 permanent employees would operate and maintain the facility (staff to be shared by all six projects), with occasional delivery truck accessing the site during operations depending on the type of maintenance activity.

Individual batteries associated with the BESS will be inspected according to the manufacturer's recommendations and will need to be replaced approximately every 20 years, and every battery will be replaced during the life of the facility. Each type of electrical facility component would have routine inspections as designated in the operational Wildfire Mitigation Plan. The solar panels may require periodic washing during operations, and other incidental water use for sanitation and equipment washing.

Vegetation will be cleared and maintained along access roads to provide a vegetation clearance area for fire safety. This includes mowing to a height of no more than 12 inches. Use of the roads may continue after construction, or new roads may be removed, and the land reclaimed to pre-construction conditions.

An aboveground 500-gallon fuel storage tank sized may be installed at each O&M building (to be shared with all projects, but not related/supporting infrastructure for this phase). Secondary containment and refueling procedures for on-site fuel storage during operations will continue to follow the SPCC Plan and requirements for secondary containment. No extremely hazardous materials are expected to be produced, used, stored, transported, or disposed of at the facility during operation.

4.3 Retirement

The estimated useful life of the proposed facility is 40 years. Operational jobs would be eliminated after the facility ceased operating; however, some short-term contract jobs to monitor restored areas may be added to facilitate retirement activities. Decommissioning requires similar workforce numbers as required for the construction of the originally permitted facility/six projects in total and is estimated to require a similar duration of up to 47 months.

Final retirement activities will be designated in a retirement plan but would begin with disconnecting all electrical equipment disassembling equipment and components such and the battery storage units, solar panels and transformers. Larger containers and equipment would be removed, trucked off-site and recycled and disposed of. Solar panels would be disconnected, and piles would be removed including the excavation of any concrete foundations. Gravel and foundations from the inverters and transformers, O&M buildings (to be shared with all projects, but not related/supporting infrastructure for this phase), substation~~s~~, and battery unit~~s~~ would be removed by trenching and excavation. The facility site would then be restored through grading, filling, and revegetation with plants or seed mix consistent with applicable plans and conditions discussed in this order or landowner interests.

5.0 Site Certificate Conditions

The conditions of this Site Certificate are organized and coded to indicate the phase of implementation, the standard the condition is required to satisfy, and an identification number (1, 2, 3, etc.).[3] The table below presents a "key" for phase of implementation:

Key	Type of Conditions/Phase of Implementation
GEN	General Conditions: Design, Construction and Operation
PRE	Pre-Construction Conditions
CON	Construction Conditions
PRO	Pre-Operational Conditions
OPR	Operational Conditions
RET	Retirement Conditions

To align with the phased construction approach, preconditions requiring applicant actions prior to construction allow for phased compliance. These apply specifically to the area in which the phased activities would occur, rather than the entirety of the site.

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[3] The identification number is not representative of an order that conditions must be implemented; it is intended only to represent a numerical value for identifying the condition.

5.1 General (GEN) Conditions: Design, Construction and Operations

Condition Number	General (GEN) Conditions
STANDARD: GENERAL STANDARD OF REVIEW (GS) [OAR 345-022-0000]	
GEN-GS-01	The certificate holder must design, construct, operate and retire the facility: a. Substantially as described in the site certificate; b. In compliance with the requirements of ORS Chapter 469, applicable Council rules, and applicable state and local laws, rules and ordinances in effect at the time the site certificate was issued; and c. In compliance with all applicable permit requirements of other state agencies. [Mandatory Condition OAR 345-025-0006(10); General Standard Condition 1; Final Order on ASC]
GEN-GS-02	The certificate holder must begin and complete construction of the facility ~~or facility phase~~ by the following dates: a. Construction of the facility or first facility phase must begin on or before November 18, 2028~~7~~. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site. ~~b. Construction of the final facility phase must begin on or before November 18, 2028. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site.~~ c. All facility construction must be completed on or before November 18, 2030~~within 2 years after the date construction of the final facility phase (under (b)) begins~~. Within 7 days after completing construction, the certificate holder shall provide the Department written verification that it has met the deadline. [General Standard Condition 2; Final Order on ASC]
GEN-GS-03	If the certificate holder becomes aware of a significant environmental change or impact attributable to the facility, the certificate holder must, as soon as possible, submit a written report to the Department describing the impact on the facility and any affected site certificate conditions. [Mandatory Condition OAR 345-025-0006(6); General Standard Condition 3; Final Order on ASC]
GEN-GS-04	The certificate holder must prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder. [Mandatory Condition OAR 345-025-0006(7); General Standard Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-GS-05	Upon completion of construction, the certificate holder must restore vegetation to the extent practicable and must landscape all areas disturbed by construction in a manner compatible with the surroundings and proposed use. Upon completion of construction, the certificate holder must remove all temporary structures not required for facility operation and dispose of all timber, brush, refuse and flammable or combustible material resulting from clearing of land and construction of the facility. [Mandatory Condition OAR 345-025-0006(11); General Standard Condition 6; Final Order on ASC]
~~GEN-GS-06~~	~~The certificate holder is authorized to construct the 230 kV transmission lines anywhere within the approved transmission line corridors, subject to the conditions in the site certificate. The approved transmission line corridor includes:~~ ~~a. Southern transmission line: Approximately 6.3 miles, extending between the facility switchyard to four collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~b. Northern transmission line: Approximately 3.2 miles, extending between the facility switchyard to two collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~[Site Specific Condition OAR 345-025-0010(5); General Standard Condition 7; Final Order on ASC]~~
GEN-GS-07	The certificate holder may operationally share the following related or supporting facilities between Sunstone Solar Projects 1-6: the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary construction areas, subject to the following: a. Within 30 days of use by certificate holders of the shared facilities, the certificate holder must provide evidence to the Department that the certificate holders of the shared facilities have an executed agreement for shared use of any constructed shared facilities. The Shared Use Agreements must allow operation and maintenance personnel and contractors access to the shared facilities of Sunstone Solar Projects 1-6.
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
GEN-OE-01	Before any transfer of ownership of the facility or ownership of the site certificate holder, the certificate holder must inform the Department of the proposed new owners. The requirements of OAR 345-027-0400 apply to any transfer of ownership that requires a transfer of the site certificate. [Organizational Expertise Condition 1; Final Order on ASC]
GEN-OE-02	Any matter of non-compliance under the site certificate is the responsibility of the certificate holder. Any notice of violation issued under the site certificate will be issued to the certificate holder. Any civil penalties under the site certificate will be levied on the certificate holder. [Organizational Expertise Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-OE-03	The certificate holder must notify the Department within 72 hours of any occurrence of the following: a. There is an attempt by anyone to interfere with the facility’s safe operation. b. There is a significant nature event such as a fire, earthquake, flood, tsunami or tornado, or human-caused event such as a fire or explosion. c. There is any fatal injury at the facility. [Organizational Expertise Condition 5; Final Order on ASC]
GEN-OE-04	The certificate holder shall, as soon as reasonably possible: a. Report incidents or circumstances that may violate the terms or conditions of the site certificate, terms or conditions of any order of the Council, or the terms or conditions of any order issued under OAR 345-027-0230, to the Department. In the report to the Department, the certificate holder shall provide all pertinent facts including an estimate of how long the conditions or circumstances existed, how long they are expected to continue before they can be corrected, and whether the conditions or circumstances were discovered as a result of a regularly scheduled compliance audit; b. Initiate and complete appropriate action to correct the conditions or circumstances and to minimize the possibility of recurrence; c. Submit a written report within 30 days of discovery to the Department. The report must refer to the language in (d) of the condition and contain: i. A discussion of the cause of the reported conditions or circumstances; ii. The date of discovery of the conditions or circumstances by the responsible party; iii. A description of immediate actions taken to correct the reported conditions or circumstances; iv. A description of actions taken or planned to minimize the possibility of recurrence; and v. For conditions or circumstances that may violate the terms or conditions of a site certificate, an assessment of the impact on the resources considered under the standards of OAR Chapter 345 Divisions 22 and 24 as a result of the reported conditions or circumstances. d. Upon receipt of the written report in sub(c) of this condition, the Department may review the facility record for incidents or circumstances reported or reportable under sub(a) related to public health and safety, the environment, or other resources protected under Council standards. If these incidences are determined by the Department to impact the adequacy of the facility decommissioning cost, the Department or Council may adjust the contingencies identified in Final Order on ASC Table 4 and shall request and receive an updated bond or letter of credit from certificate holder in the adjusted amount. [Organizational Expertise Condition 6; Final Order on ASC]
STANDARD: Structural Standard (SS) [OAR 345-022-0020]	

Condition Number	General (GEN) Conditions
GEN-SS-01	The certificate holder must design, engineer and construct the facility to avoid dangers to human safety and the environment presented by seismic hazards affecting the site that are expected to result from all maximum probable seismic events. “Seismic hazards” include ground shaking, ground failure, landslide, liquefaction triggering and consequences (including flow failure, settlement buoyancy, and lateral spreading), cyclic softening of clays and silts, fault rupture, directivity effects and soil-structure interaction. [Mandatory Condition OAR 345-025-0006(12); Structural Standard Condition 1; Final Order on ASC]
GEN-SS-02	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if site investigations or trenching reveal that conditions in the foundation rocks differ significantly from those described in the application for a site certificate. After the Department receives the notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(13); Structural Standard Condition 2; Final Order on ASC]
GEN-SS-03	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if shear zones, artesian aquifers, deformations or clastic dikes are found at or in the vicinity of the site. After the Department receives notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(14); Structural Standard Condition 3; Final Order on ASC]
GEN-SS-04	The certificate holder shall design, engineer, and construct the facility in accordance with the versions of the International Building Code, Oregon Structural Specialty Code, and local building codes in effect at the time of construction. [Structural Standard Condition 5; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
GEN-LU-01	The certificate holder shall provide evidence to the Department of coordination with the owners of adjacent lands dedicated to agricultural use. Coordination must include information about the facility that could impact agricultural activities. The certificate holder must document any recommendations made by adjacent landowners regarding measures to reduce or avoid any adverse impacts to farm practices on surrounding lands and to avoid any increase in farming costs as well as any responses made to these recommendations. [Land Use Condition 9; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-LU-02	The certificate holder must adhere to the terms of the Memorandum of Agreement for Agricultural Mitigation Fund included in Attachment F of the Final Order on the ASC, or subsequently amended. It is the certificate holder's responsibility to ensure that the Council and Department receive all reports and notifications required by the agreement. [Land Use Condition 12; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
GEN-RF-01	The certificate holder shall prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder.
	[Mandatory Condition OAR 345-025-0006(7); Retirement and Financial Assurance Condition 1; Final Order on ASC]
STANDARD: Siting Standards for Transmission Lines (TL) [OAR 345-024-0090]	
~~GEN-TL-01~~	~~The certificate holder shall:~~ ~~a. Design, construct and operate the transmission lines in accordance with the requirements of the National Electrical Safety Code as approved by the American National Standards Institute; and~~ ~~b. Develop and implement a program that provides reasonable assurance that all fences, gates, cattle guards, trailers, or other objects or structures of a permanent nature that could become inadvertently charged with electricity are grounded or bonded throughout the life of the line.~~ ~~[Siting Standards for Transmission Line Condition 1; Final Order on ASC]~~

5.3 Pre-Construction (PRE) Conditions

Condition Number	Preconstruction (PRE) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
PRE-GS-01	Except as necessary for the initial survey, the certificate holder may not begin construction of the facility or phase, or create a clearing on any part of the site of the facility or phase, as applicable, until the certificate holder has the legal right to engage in construction activities on the relevant parts of the site for the facility or phase. [Mandatory Condition OAR 345-025-0006(5); General Standard Condition 5; Final Order on ASC]
PRE-GS-02	At least 90 days prior to construction of the facility or phase, as applicable (unless otherwise agreed to by the Department), the certificate holder shall submit to the Department a compliance plan documenting and demonstrating actions completed or to be completed to satisfy the requirements of all site certificate terms and conditions and applicable statutes and rules. The plan shall be provided to the Department for review and compliance determination for each requirement. The Department may request additional information or evaluation deemed necessary to demonstrate compliance. [OAR 345-026-0048, General Standard Condition 8; Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRE-OE-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall notify the Department of the identity and qualifications of the major design, engineering and construction contractor(s). The certificate holder shall select contractors that have substantial experience in the design, engineering and construction of similar facilities. The certificate holder shall report to the Department any changes of major contractors. [Organizational Expertise Condition 2; Final Order on ASC]
PRE-OE-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall select a construction contractor with a low rate of historic environmental and safety compliance citations. Certificate holder shall provide the following documentation to the Department: a. Qualifications and contact information of the of the major design, engineering and construction contractor(s) and subcontractors, as applicable. b. Construction contractor compliance history. c. Contract excerpt affirming that contractors are required to comply with the terms and conditions of the site certificate, including selecting design layout and construction materials that minimize impacts to resources protected under Council standards. [Organizational Expertise Condition 7; Final Order on ASC]
PRE-OE-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide to the Department the qualifications and contact information of the certificate holder's construction manager.

Condition Number	Preconstruction (PRE) Conditions
	[Organizational Expertise Condition 8; Final Order on ASC]
PRE-OE-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Provide the Department a list of federal, state and local permits, including any third-party permits related to facility siting; and a schedule for obtaining identified permits. b. Once obtained, provide copies of all permits, including third-party permits, required for facility siting to the Department. [Organizational Expertise Condition 12; Final Order on ASC]
STANDARD: Structural (SS) [OAR 345-022-0020]	
PRE-SS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a site-specific geotechnical investigation report, consistent with the Oregon State Board of Geologist Examiners Guideline for Preparing Engineering Geologic Reports, or newer guidelines if available to the Department, for review in consultation with its third-party consultant. [Structural Standard Condition 4; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRE-SP-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide a Vegetation and Grading Plan that demonstrates contractors are required to adhere to the following: a. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems shall be left intact to the maximum extent practicable. b. Grading within solar arrays shall be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically 10% maximum on North slopes and 15% maximum in other directions). [Soil Protection Condition 1; Final Order on ASC]
PRE-SP-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Obtain a NPDES 1200-C Permit from DEQ. A copy of the approved permit and attached Erosion and Sediment Control Plan (ESCP) must be submitted to the Department. b. Finalize the Fugitive Dust Control Plan, as provided in the Final Order on ASC Attachment D. Finalization includes verification of names and contact information of individuals responsible for implementation, measures to be implemented and forms to be used for monitoring and reporting. [Soil Protection Condition 3; Final Order on ASC]
PRE-SP-03	Prior to construction of the facility or phase, as applicable, the certificate holder must submit to the Department a Construction Spill Prevention Countermeasures and Control (SPCC) Plan. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-01	Prior to construction of the facility or phase, as applicable, the certificate holder must provide to the Department a copy of the approved Conditional Use Permit and applicable Zoning Permit(s). [Land Use Condition 1; Final Order on ASC]
~~PRE-LU-02~~	~~Prior to construction of the 230 kV transmission lines, the certificate holder shall demonstrate to the Department that the transmission lines will be sited within the exiting road rights-of-way, unless Morrow County Public Works Department and Oregon Department of Transportation, as applicable, confirm that use of the existing road rights-of-way is not feasible.~~ ~~[Land Use Condition 2; Final Order on ASC]~~
PRE-LU-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the draft Noxious Weed Control Plan, as provided in the Final Order on ASC Attachment E, and submit to the Department for review and approval in consultation with the Morrow County Weed Department. [Land Use Condition 3; Final Order on ASC]
PRE-LU-04	Prior to construction of the facility or phase, as applicable, the certificate holder must submit an executed document prohibiting the certificate holder, and the certificate holder's successors in interest, from pursuing a claim for relief or cause of action alleging injury from farming or forest practices as defined in ORS 30.930(2) and (4), and provide evidence that the document has been recorded in the deed records for Morrow County. [Land Use Condition 6; Final Order on ASC]
PRE-LU-05	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the final design adheres to the following setbacks: a. All facility structures and above-ground components except the perimeter fenceline must be sited: 1. At least 20 feet from a property line fronting the right-of-way of a local minor collector or marginal access street, including but not limited to Sand Hollow Road, Grieb Lane, Alpine Lane, Doherty Road, or Melville Road. 2. At least 30 feet from a property line fronting the right-of-way, of a major collector, including but not limited to, Bombing Range Road. 3. At least 80 feet from a property line fronting the right-of-way for an arterial road, including but not limited to State Highway 207. b. All facility structures, and all on-site septic systems or other sewage disposal systems must be set back at least 100 feet from delineated waterways. [Land Use Condition 7; Final Order on ASC]
PRE-LU-06	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a final site plan that includes all information required by MCZO 4.165.E to the County and the Department. The Department may defer review and approval to the County. [Land Use Condition 8; Final Order on ASC]

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-07	Prior to construction of the facility or phase, as applicable, the certificate holder must complete the preconstruction requirements identified in the Memorandum of Agreement for Agricultural Mitigation Fund, as provided in the Final Order on ASC Attachment F, or subsequently amended. [Land Use Condition 11; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
PRE-RF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit to the State of Oregon, through the Council, a bond or letter of credit naming the State of Oregon, acting by and through the Council, as beneficiary or payee. The approved bond or letter of credit amount of $23,420,740.28~~117,945,000~~ (Q4~~1~~ 2025~~3~~ dollars) may be adjusted based on the design configuration of the facility, or phase of the facility, as provided in Sub(a) and adjusted to the year and quarter of issuance as provided under Sub(b). a. The bond or letter of credit amount may be adjusted based on actual design/number of components of the facility or phase, as applicable, and shall use the same unit costs and contingencies presented in the Final Order on the ASC Table 8. b. Adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. c. The bond or letter of credit must be issued by a financial institution that is included on the Council's pre-approved financial institution list. The certificate holder may request to have a financial institution added to the list at any time. d. The bond or letter of credit must be prepared using the most recent Council-approved template. [Retirement and Financial Assurance Condition 4; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
PRE-FW-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Revegetation and Reclamation Plan, based on Attachment G of the Final Order on the ASC, and submit to the Department for review and approval. [Fish and Wildlife Habitat Condition 1]
PRE-FW-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit the draft legal agreement for review and approval by the Department, in consultation with ODFW. The legal agreement shall ensure that payment provided for long-term management and enhancement of the mitigation area is adequate to cover the permanent habitat loss from the facility.

Condition Number	Preconstruction (PRE) Conditions
	[Fish and Wildlife Condition 4, Final Order on ASC]
PRE-FW-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Habitat Mitigation Plan, as provided in Attachment H of the Final Order on ASC, based on the impacts associated with the final facility design and the legal agreement, as approved by the Department. [Fish and Wildlife Condition 5, Final Order on ASC]
PRE-FW-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide evidence to the Department that the design measures included in the Construction Wildlife Monitoring Plan (Final Order on ASC Attachment I) have been included in the final facility design and construction contractor contracts, as applicable. [Fish and Wildlife Condition 7; Final Order on ASC]
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
PRE-TE-01	If construction commences after April 2025, certificate holder shall, prior to construction of the facility or phase, as applicable, conduct protocol-level Washington ground squirrel (WAGS) surveys within areas of planned facility construction that are within suitable WAGS habitat. The certificate holder shall: a. Submit a protocol-level survey plan for surveys to be conducted within suitable WAGS habitat, for review and approval by the Department in consultation with ODFW. At a minimum, the survey plan shall specify the survey area (all areas of suitable habitat within 1,000 feet of ground disturbing activities except where there is a habitat barrier (e.g., a paved road) or access restrictions); and survey timing (February 15 to May 31, unless otherwise approved by ODFW). b. Complete protocol-level WAGS surveys based on the protocol approved per (a). c. Submit survey reports to the Department and ODFW. The certificate holder shall not begin construction within 1,000 feet of Category 1 or Category 2 WAGS habitat until the identified boundaries of Category 1 WAGS habitat have been approved by the Department, in consultation with ODFW. Category 1 habitat includes a 785-foot buffer from an identified active burrow, and the area within the perimeter of multiple active burrows. Category 2 WAGS habitat consists of a 4,136-foot buffer from the exterior boundary of all Category 1 WAGS habitat. The survey results are valid for 3-years. d. Develop maps and worker training materials to inform of sensitive Category 1 and Category 2 habitat. Submit to the Department final facility design maps demonstrating that Category 1 habitat, including 785-buffer from any colonies identified per (b), is avoided. e. Install flagging or other demarcation, as appropriate, to inform workers of sensitive WGS habitat and of avoidance requirement. [Threatened and Endangered Species Condition 1; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	

Condition Number	Preconstruction (PRE) Conditions
PRE-HC-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall update the contact information provided in the Final Order on ASC Attachment K, Inadvertent Discovery Plan. [Historic, Cultural and Archeological Condition 1; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
PRE-PS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall execute a final Road Use Agreement, based on Final Order on ASC Attachment N, and provide a copy to the Department. [Public Services Condition 1, Final Order on ASC]
PRE-PS-02	At least 180-days prior to construction of any phase, the certificate holder shall provide to the Department and Morrow County a temporary housing plan for the construction workforce. The plan shall provide for coordination with contractors and local officials on housing options and strategies to minimize impacts to local housing supply based on an ongoing evaluation of patterns of uses and potential shortages or changes in housing demand. [Public Services Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRE-WF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Construction Wildfire Mitigation Plan, as provided in Attachment L to the Final Order on ASC. The final Construction Wildfire Mitigation Plan shall be submitted to the Department for review and approval. [Wildfire Prevention and Risk Mitigation Condition 1; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRE-WM-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall require contractors to develop and submit to the Department for review and approval, Construction Waste Management Plan(s) that, at a minimum, include the following: a. All sources and quantities of construction waste and wastewater, including damaged or dysfunctional energy facility components, and where feasible, estimated quantities that can be recycled. b. Process for disposal and recycling, including use of licensed haulers and disposal/recycling facilities; names and locations of licensed recycling and disposal facilities; collection, hauling and tracking requirements. c. Process for requesting a permit exemption from DEQ pursuant to OAR 340-093-0080 to ensure that concrete washout materials reused in foundation backfill are substantially the same as clean fill. d. Process for training workers and tracking compliance with the requirements of the plan. [Waste Minimization Condition 1; Final Order on ASC]
STANDARD: Noise Control Regulations (NC) [OAR 340-035-0035]	

Condition Number	Preconstruction (PRE) Conditions
PRE-NC-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the operational noise levels comply with OAR 345-035-0035(1)(b), based on an updated acoustic modeling analysis using final design/layout and equipment specifications. [Noise Control Condition 1; Final Order on ASC]
STANDARD: Other – Removal-Fill (WL)	
PRE-WL-01	Prior to construction of the facility, facility component or phase, as applicable, the certificate holder must provide documentation of a valid jurisdictional determination from the Oregon Department of State Lands demonstrating that no waterways subject to the State Removal-Fill law under ORS 196.795 through 196.990 are present within areas to be disturbed during construction or operation. [Removal-Fill Condition 1, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
PRE-WR-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Identify all water-related needs and estimate daily and annual water demand for each construction phase, as applicable. b. Provide, to the Department, a contract or purchase agreement demonstrating that adequate water supply to meet construction demand has been secured from sources with valid water rights. [Water Rights Condition 1, Final Order on ASC]

5.4 Construction (CON) Conditions

Condition Number	Construction (CON) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
CON-OE-01	The certificate holder shall contractually require all contractors and subcontractors to comply with all applicable laws and regulations and with the terms and conditions of the site certificate. The contractual obligation shall be required of each contractor and subcontractor prior to that firm working on the facility. Such contractual provisions shall not operate to relieve the certificate holder of responsibility under the site certificate. [Organizational Expertise Condition 3; Final Order on ASC]
CON-OE-02	During construction, the certificate holder shall: a. Maintain an onsite construction manager. b. Require that the construction manager implement and monitor all applicable construction related site certificate conditions. c. Within six months after beginning construction, and every six months thereafter during construction of the energy facility and related or supporting facilities, the certificate holder shall submit a semiannual construction progress report to the Department. In each construction progress report, the certificate holder shall describe any significant changes to major milestones for construction. The certificate holder shall report on the progress of construction and shall address the following: i. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. ii. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. iii. Compliance Report: A report describing the certificate holder’s compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate. iv. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0050. [Organizational Expertise Condition 9; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	

Condition Number	Construction (CON) Conditions
CON-SP-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Vegetation and Grading Plan. [Soil Protection Condition 2; Final Order on ASC]
CON-SP-02	During construction of the facility or phase, as applicable, the certificate holder shall: a. Conduct all work in compliance with the NPDES 1200-C Permit and Erosion and Sediment Control Plan (ESCP) or revised ESCP if applicable. The ESCP shall be revised if determined necessary by the certificate holder, certificate holder's contractor(s) or the Department. Any Department-required ESCP revisions shall be implemented within 14-days, unless otherwise agreed to by the Department based on a good faith effort to address erosion issues. b. Conduct all work in compliance with the Fugitive Dust Control Plan. The Fugitive Dust Control Plan may be amended, as needed, to ensure that control measures are effective at the site. [Soil Protection Condition 4; Final Order on ASC]
CON-SP-03	During construction, the certificate holder shall require that all onsite contractors and personnel adhere to the requirements of the SPCC Plan. Any SPCC revisions and updates shall be reported to the Department. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
CON-LU-01	During construction, the certificate holder shall implement and adhere to the Noxious Weed Control Plan required under Condition PRE-LU-02. [Land Use Condition 4, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
CON-RF-01	During construction, the certificate holder shall: a. Describe the status of the bond or letter of credit in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. b. If construction extends for more than 12 months, the certificate holder shall adjust the amount of the bond or letter of credit on an annual basis thereafter as described in under Condition PRE-RF-01. c. The Department and Council reserve the right to adjust the contingencies, as necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 5; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
CON-FW-01	During construction, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan, as applicable. [Fish and Wildlife Habitat Condition 2, Final Order on ASC]
CON-FW-02	During construction, the certificate holder shall adhere to the requirements of the Construction Wildlife Monitoring Plan (Attachment I of the Final Order on the ASC). Monitoring records shall be maintained throughout construction and included in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 8; Final Order on ASC]

Condition Number	Construction (CON) Conditions
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
CON-TE-01	Prior to and during construction of the facility or phase, as applicable, any incidentally identified occurrence(s) of Lawrence's milkvetch shall be avoided using a 100-foot buffer via mapping and flagging. [Threatened and Endangered Species Condition 2; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
CON-HC-01	During construction, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan, as submitted to the Department under PRE-HC-01. [Historic, Cultural and Archeological Condition 2; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
CON-PS-01	During construction, the certificate holder shall adhere to the terms and conditions of the Road Use Agreement executed under PRE-PS-01. [Public Services Condition 2; Final Order on ASC]
CON-PS-02	During construction, the certificate holder shall report to the Department the outcomes of the work completed under the temporary housing plan required under PRE-PS-02. The report shall be included in the construction progress report required under CON-OE-02, and shall include, at a minimum: a. Outcome of coordination with construction contractors to identify housing options for incoming workers, including aggregate data on the location (i.e. city) and type of housing used by workers. b. Documentation of coordination with local officials such as the Morrow County Planning Department, nearby cities and towns such as Lexington and Ione, the Lexington Community Development Group, the Ione Community Agri-Business Organization, the Boardman Community Development Association, the Willow Creek Valley Economic Development Group, and other housing providers to identify housing options and strategies to minimize that impacts to local housing supply. [Public Services Condition 4; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
CON-WF-01	During construction of the facility of phase, as applicable, the certificate holder shall implement and require all onsite contractors and employees to adhere to the Construction Wildfire Mitigation Plan required under Condition PRE-WF-01. Updates to the Wildfire Mitigation Plan may be required if determined necessary by the certificate holder, certificate holder's contractor(s), or the Department to address wildfire hazard to public health and safety. Any Department required updates shall be implemented within 14 days, unless otherwise agreed to by the Department based on a good faith effort to address wildfire hazard. [Wildfire Prevention and Risk Mitigation Condition 2; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	

Condition Number	Construction (CON) Conditions
CON-WM-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Construction Waste Management Plan(s) and maintain records of employee training and tracking compliance onsite and available upon Department request. [Waste Minimization Condition 2; Final Order on ASC]
CON-WM-02	During construction, on-site concrete washwater disposal is prohibited unless DEQ approval of a permit exemption for materials substantially similar to clean fill is obtained. If DEQ approval of a permit exemption is obtained, concrete washwater must be disposed of onsite via infiltration and evaporation in accordance with the DEQ-issued NPDES 1200-C permit required under Condition CON-SP-02. [Waste Minimization Condition 3; Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
CON-WR-01	During construction: a. All water used for construction activities shall be appropriated and used in accordance with the applicable provisions of ORS chapter 537 and OAR chapter 690. b. The certificate holder shall report the source and amount of water used during each month of construction under Condition CON-OE-02. The certificate holder shall maintain records adequate to substantiate reports (e.g., written logs and photographs of well meter readings, copies of invoices from water sources) and make such records available to the Department upon request. c. If a water right, limited water use license, or water rights transfer is needed and would not be obtained by a third-party, the certificate holder shall submit and obtain approval of the applicable water permit through the site certificate amendment process. [Water Rights Condition 2; Final Order on ASC]

5.5 Pre-Operational (PRO) Conditions

Condition Number	Pre-Operational (PRO) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRO-OE-01	Prior to operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 10; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRO-SP-01	Following the termination of the 1200-C, the certificate holder shall update the requirements of the Revegetation and Reclamation Plan, specific to the areas within the fenceline not occupied by facility infrastructure. Certificate holder shall provide evidence to the Department that the permit was terminated by DEQ. [Soil Protection Condition 5; Final Order on ASC]
PRO-SP-02	Prior to operation, the certificate holder shall submit to the Department an Operational Spill Prevention Control and Countermeasures (SPCC) Plan. [Soil Protection Condition 8; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRO-WF-01	Prior to operation, the certificate holder shall finalize the operational Wildfire Mitigation Plan (WMP) included as Attachment M to the Final Order on ASC. [Wildfire Prevention and Risk Mitigation Condition 3; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRO-WM-01	Prior to operation, the certificate holder shall develop an Operational Recycling Plan or protocol requiring that damaged or nonfunctional panels and lithium-ion batteries be recycled to the extent practicable. The certificate holder shall report in its annual report to the Department the quantities of panels and lithium-ion batteries recycled, reused or disposed of in a landfill. Requirements for lithium-ion battery recycling do not apply if the BESS is not constructed. [Waste Minimization Condition 4; Final Order on ASC]
STANDARD: Other - Water Rights (WR)	
PRO-WR-01	Prior to operation, the certificate holder shall provide, to the Department, a copy of the map, well log and all other information it provided to OWRD pursuant to ORS 537.545 and ORS 537.765 to qualify for an exempt ground water use for any onsite exempt wells. [Water Rights Condition 3; Final Order on ASC]

5.6 Operational (OPR) Conditions

Condition Number	Operational (OPR) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
OPR-GS-01	The certificate holder must submit a legal description of the site to the Department within 90 days after beginning operation of the facility. The legal description must include a description of metes and bounds or a description of the site by reference to a map and geographic data that clearly and specifically identify the outer boundaries that contain all parts of the facility. [Mandatory Condition OAR 345-025-0006(2); General Standard Condition 9]
OPR-GS-02	After January 1 but no later than April 30 of each year after beginning operation of the facility, the certificate holder shall submit an annual report to the Department. The Council Secretary and the certificate holder may, by mutual agreement, change the reporting date. a. The annual report must include the following information for the calendar year preceding the date of the report: 1. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. 2. Reliability and Efficiency of Power Production: For electric power plants, the plant availability and capacity factors for the reporting year. The certificate holder shall describe any equipment failures or plant breakdowns that had a significant impact on those factors and shall describe any actions taken to prevent the recurrence of such problems. 3. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. 4. Monitoring Report: A list and description of all significant monitoring and mitigation activities performed during the previous year in accordance with site certificate terms and conditions, a summary of the results of those activities and a discussion of any significant changes to any monitoring or mitigation program, including the reason for any such changes. 5. Compliance Report: A report describing the certificate holder’s compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate.

Condition Number	Operational (OPR) Conditions
	6. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0350. b. To the extent that information required by this rule is contained in reports the certificate holder submits to other state, federal or local agencies, the certificate holder may submit excerpts from such other reports to satisfy this rule. The Council reserves the right to request full copies of such excerpted reports. [Mandatory Condition 345-026-0080(1); General Standard Condition 10, Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
OPR-OE-01	During operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 11; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
OPR-SP-01	During operation, the certificate holder shall adhere to the requirements of the Operational SPCC Plan. Any SPCC updates shall be described and included in the Annual Report to the Department. Certificate holder shall report spill and cleanup activities to the Department within 72 hours and shall make inspection records available to the Department upon request. [Soil Protection Condition 9; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
OPR-LU-01	Following the fifth year of monitoring under the Noxious Weed Control Plan required under PRE-LU-03, the certificate holder shall submit a Long-term Noxious Weed Monitoring Plan to the Department, for review and approval. The certificate holder shall implement the plan for the remainder of the facility's operating life. [Land Use Condition 5, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
OPR-RF-01	During operation, the certificate holder shall: a. Annually adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. b. Any changes to the template made by the Council must be incorporated into the bond or letter or letter of credit whenever the amount is adjusted under Sub(a). c. The Department and Council reserve the right to adjust the contingencies, as

Condition Number	Operational (OPR) Conditions
	necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 6; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
OPR-FW-01	During operation, as applicable, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan. [Fish and Wildlife Habitat Condition 3, Final Order on ASC]
OPR-FW-02	During operation, the certificate holder shall provide reports from The Nature Conservancy on the status of long-term management and enhancement of the habitat mitigation area, consistent with the Habitat Mitigation Plan. [Fish and Wildlife Condition 6, Final Order on ASC]
OPR-FW-03	During operation, the certificate holder shall adhere to the requirements of the Operational Wildlife Monitoring Plan (Attachment J of the Final Order on the ASC). Monitoring records shall be maintained throughout operation and included in the annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 9; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
OPR-HC-01	During operations, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan (IDP), as provided for Condition PRE-HC-01. The IDP shall be reviewed and updated annually for current contact information. [Historic, Cultural and Archeological Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
OPR-WF-01	During operation, the certificate holder shall: a. Implement the Operational Wildfire Mitigation Plan finalized under Condition PRO-WF-01. b. Every 5 years after the first operational year, review and update the evaluation of wildfire risk under OAR 345-022-0115(1)(b) and submit the results in the annual report required under Condition CON-OE-02 for that year. c. Submit an updated Operational Wildfire Mitigation Plan to the Department if substantive changes are made to the plan because of the review under sub (b) of this condition, or at any other time substantiative revisions are made. [Wildfire Prevention and Risk Mitigation Condition 4; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
OPR-WM-01	During operation, the certificate holder shall adhere to the requirements of the Operational Recycling Plan or protocol developed under Condition PRO-WM-01. [Waste Minimization Condition 5; Final Order on ASC]
OPR-WM-02	During operation, the certificate holder shall: a. Prohibit use of chemicals, soaps, detergents and heated water unless Chemical Safety Data Sheets for low volatile organic compound/biodegradable cleaning chemicals and solvents are submitted to the Department for review and approval prior to use.

Condition Number	Operational (OPR) Conditions
	b. Ensure that washing is conducted in a manner that does not remove paint or other finishes. c. Discharge wash water through evaporation and infiltration only. [Waste Minimization Condition 6, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
OPR-WR-01	During operation, the certificate holder shall verify that any onsite exempt wells do not use more than 5,000 gallons of ground water a day, collectively, and shall monitor the volume of groundwater used on a daily basis, maintain a record of such use and make the monitoring records available to the Department upon request. [Water Rights Condition 4; Final Order on ASC]

5.7 Retirement (RET) Conditions

Condition Number	Retirement (RET) Conditions
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
RET-RF-01	The certificate holder must retire the facility if the certificate holder permanently ceases construction or operation of the facility. The certificate holder must retire the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410. The certificate holder must pay the actual cost to restore the site to a useful, non-hazardous condition at the time of retirement, notwithstanding the Council's approval in the site certificate of an estimated amount required to restore the site. [Mandatory Condition OAR 345-025-0006(9); Retirement and Financial Assurance Condition 2; Final Order on ASC]
RET-RF-02	If the Council finds that the certificate holder has permanently ceased construction or operation of the facility without retiring the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410, the Council must notify the certificate holder and request that the certificate holder submit a proposed final retirement plan to the Department within a reasonable time not to exceed 90 days. If the certificate holder does not submit a proposed final retirement plan by the specified date, the Council may direct the Department to prepare a proposed final retirement plan for the Council's approval. Upon the Council's approval of the final retirement plan, the Council may draw on the bond or letter of credit described in Condition PRE-RT-01 to restore the site to a useful, non-hazardous condition according to the final retirement plan, in addition to any penalties the Council may impose under OAR chapter 345, division 29. If the amount of the bond or letter of credit is insufficient to pay the actual cost of retirement, the certificate holder must pay any additional cost necessary to restore the site to a useful, non-hazardous condition. After completion of site restoration, the Council must issue an order to terminate the site certificate if the Council finds that the facility has been retired according to the approved final retirement plan. [Mandatory Condition OAR 345-025-0006(16); Retirement and Financial Assurance Condition 3; Final Order on ASC]

6.0 Successors and Assigns

To transfer this site certificate or any portion thereof or to assign or dispose of it in any other manner, directly or indirectly, the certificate holder shall comply with OAR 345-027-0400.

7.0 Severability and Construction

If any provision of this agreement and certificate is declared by a court to be illegal or in conflict with any law, the validity of the remaining terms and conditions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the agreement and certificate did not contain the particular provision held to be invalid.

8.0 Execution

This site certificate may be executed in counterparts and will become effective upon signature by the Chair of the Energy Facility Siting Council and the authorized representative of the certificate holder.

IN WITNESS THEREOF, this site certificate has been executed by the State of Oregon, acting by and through the Energy Facility Siting Council and Sunstone Solar, LLC (certificate holder).

ENERGY FACILITY SITING COUNCIL

Kent Howe

By: Kent Howe (Nov 19, 2024 16:21 PST)

Kent Howe, Chair

Date: 19-Nov-2024

SUNSTONE SOLAR, LLC

Jon Saxon

By: Jon Saxon (Nov 19, 2024 16:26 EST)

Jon Saxon, Authorized Representative

Date: 19-Nov-2024

Sunstone Solar Project 5

ENERGY FACILITY SITING COUNCIL
OF THE STATE OF OREGON

SITE CERTIFICATE FOR THE
SUNSTONE SOLAR PROJECT

5

ISSUE DATE
NOVEMBER 18, 2024

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Table of Contents

1.0 Introduction and Site Certification

This site certificate is a binding agreement between the State of Oregon (State), acting through the Energy Facility Siting Council (EFSC or Council), and Sunstone Solar 5, LLC (certificate holder), owned by Pine Gate Renewables, LLC (parent company). Both the State and certificate holder must abide by local ordinances, state law, and the rules of the Council in effect on the date this site certificate is executed. However, upon a clear showing of a significant threat to public health, safety, or the environment that requires application of later-adopted laws or rules, the Council may require compliance with such later-adopted laws or rules (ORS 469.401(2)).

This site certificate binds the State and all counties, cities and political subdivisions in Oregon as to the approval of the site and the construction, operation, and retirement of the facility as to matters that are addressed in and governed by this site certificate (ORS 469.401(3)). Each affected state agency, county, city, and political subdivision in Oregon with authority to issue a permit, license, or other approval addressed in or governed by this site certificate, shall upon submission of the proper application and payment of the proper fees, but without hearings or other proceedings, issue such permit, license or other approval subject only to conditions set forth in this site certificate. In addition, each state agency or local government agency that issues a permit, license or other approval for this facility shall continue to exercise enforcement authority over such permit, license or other approval (ORS 469.401(3)). For those permits, licenses, or other approvals addressed in and governed by this site certificate, the certificate holder shall comply with applicable state and federal laws adopted in the future to the extent that such compliance is required under the respective state agency statutes and rules (ORS 469.401(2)).

This site certificate does not address, and is not binding with respect to, matters that are not included in and governed by this site certificate, and such matters include, but are not limited to: employee health and safety; building code compliance; wage and hour or other labor regulations; local government fees and charges; other design or operational issues that do not relate to siting the facility (ORS 469.401(4)); and permits issued under statutes and rules for which the decision on compliance has been delegated by the federal government to a state agency other than the Council (ORS 469.503(3)).

The obligation of the certificate holder to report information to the Department or the Council under the conditions listed in this site certificate is subject to the provisions of ORS 192.502 *et seq.* and ORS 469.560. To the extent permitted by law, the Department and the Council will not publicly disclose information that may be exempt from public disclosure if the certificate holder has clearly labeled such information and stated the basis for the exemption at the time of submitting the information to the Department or the Council. If the Council or the Department receives a request for the disclosure of the information, the Council or the Department, as appropriate, will make a reasonable attempt to notify the

certificate holder and will refer the matter to the Attorney General for a determination of whether the exemption is applicable, pursuant to ORS 192.450.

Council shall have continuing authority over the site and may inspect, or direct the Oregon Department of Energy (Department) to inspect, or request another state agency or local government to inspect, the site at any time in order to ensure that the facility is being operated consistently with the terms and conditions of this site certificate (ORS 469.430).

The duration of this site certificate shall be the life of the facility, subject to termination pursuant to OAR 345-027-0110 or the rules in effect on the date that termination is sought, or revocation under ORS 469.440 and OAR 345-029-0100 or the statutes and rules in effect on the date that revocation is ordered. The Council shall not change the conditions of this site certificate except as provided for in OAR Chapter 345, Division 27.

In interpreting this site certificate, any ambiguity will be clarified by reference to the following, in order, incorporated herein by this reference: 1) *Final Order on the Application for Site Certificate for the Sunstone Solar Project* issued on November 18, 2024 (hereafter, *Final Order on the ASC*); 2) the record of the proceedings that led to the Final Order on the ASC.

The definitions in ORS 469.300 and OAR 345-001-0010 apply to the terms used in this site certificate, except where otherwise stated, or where the context clearly indicates otherwise.

2.0 Facility Location and Site Boundary

The facility is located within an approximately 4,402.3~~10,960~~-acre (6.9 ~~17~~ sq. mile) site in Morrow County. The site is located on both sides of State Route 207 and is approximately 15 miles northeast of the Town of Lexington and approximately 4.5 miles west of Butter Creek Junction. The site is approximately 3 miles west of the Umatilla County line at its closest point. Table 1 below provides the Township, Range, and Sections occupied wholly, or in part, by the site. Up to 3,103 acres~~9,442~~ of land within the site boundary would be occupied by facility components. The regional location of the facility site boundary~~, transmission line corridor,~~ and ~~approximately 1,518 acres~~ areas within the site boundary ~~are~~ excluded from development, as applicable, are~~as~~ shown on Attachment 1~~ASC Exhibit C, Figures C- 2, and C-2.1 to C-2.3, attached~~ to this site certificate ~~as Attachment 1~~.

Table 1: Township, Range, and Section for Areas Occupied by the Site Boundary

Township	Range	Sections
1N	26E	1, 2, 3, 4~~, 5, 8, 9,~~ 10~~, 11,~~ 12, 14, 15
2N	26E	~~27, 28, 29, 30, 31, 32,~~ 33, 34, 35, 36
Reference: SSPAPPDoc25-03 ASC Exhibit C Project Location, Table C-1. 2024-05-15.		

3.0 Facility Description

The energy facility is approved to include the components presented in Table 2 below. Additional details regarding specific components, and discussion of alternative designs or technologies under consideration are provided in the sections that follow.

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Site Boundary		
Site Boundary	4,402.3 ~~10,960~~	acres
Maximum Footprint	3,103 ~~9,442~~	acres
Permanent Impacts[1]	3,103 ~~9,442~~	acres
Solar Components		
PV Solar Modules		
Approx. total number	656,256~~3,937,536~~	modules
Max Height at full-tilt	15	feet
Posts		
Approx. total number (assumes concrete foundation)	89,176~~535,056~~	posts
Cabling		
Combiner Boxes	10,254~~61,524~~	each
Inverter Step Up (ISU) Transformer Units		
Approx. total number	54 ~~319~~	each
Noise level	89	dBA
Transformer oil-containing capacity	800	gallons
Related or Supporting Facility Components		
34.5 kV Collection System		
Collector line length, belowground	22.8 ~~82~~	miles
Collector line length, overhead (OH)	0.7 ~~4.3~~	miles
Wood Monopoles (max estimate for OH)	26 ~~151~~	each
Collector Substations		
Substations w SCADA; GSU transformers ~~per~~ each	1~~6~~; 1	each
Site size	1.6	acres
Transformer oil-containing capacity	16,000	gallons~~/each~~
Transformer noise level	100	dBA
Max height of structures	45	feet
Switchyards		

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[1] The energy facility would occupy approximately 3,103 ~~9,442~~ acres ~~within up to 20 separately fenced areas~~. Most related or supporting facilities will be located within the energy facility's footprint; however, portions of the overhead 34.5 kV collector and 230-kV transmission lines running between solar array areas would result in additional temporary and permanent disturbance areas.

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Stations; Transformers per each	1~~2~~; 0	each
Site size (northern and/or within solar fence line); with foundations and graveled areas	3	acres each
~~230 kV Transmission Line~~		
~~Length (total; northern line; southern line)~~	~~9.5; 3.2; 6.3~~	~~miles~~
~~Structures: Type (Wood or Galvanized Steel); quantity~~	~~H-frame; 50~~	~~each~~
~~Height of structures~~	~~70-180~~	~~feet~~
Battery Energy Storage System (Lithium-ion/Zinc)		
Zinc		
Approx. total battery containers on foundations with fans/heating systems; SCADA	2,491~~14,946~~	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	9.5 x 8 x 20	H x W x L; feet
Noise level (broadband)	66	dBA
Lithium-ion		
Approx. total battery containers on foundations with HVAC and fire suppression systems; SCADA	~~1~~2,000	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	11.25 x 8.1 x 5.2	H x W x L; feet
Noise level (broadband)	66	dBA
O&M Building		
Quantity	1~~4~~	each
Site size	2.8	acres
Height	20	feet
Appurtenances	On-site well, septic system, SCADA System	
Storage for Replacement Solar Panels		
Containers	8-9~~50~~	each
Approx. container dimensions	8.5 x 8 x 40	H x W x L; feet
Location	Dispersed within fence line if not next to O&M, gravel base	
Facility Roads		
Length	17.4 ~~55~~	miles
Width	10- 20	feet
Perimeter Fence		
Length	28.1 ~~58~~	miles
Height	7-8	feet

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Access/gates	8-9~~52~~	each
Temporary Construction Areas		
Quantity	27~~54~~	each
Site size	5	acres
Description	Gravel base; diesel/gas storage; within fence line	

Energy Facility

The facility includes a solar photovoltaic power generation facility with up to ~~1,~~200 MW of electric generation capacity. ~~The energy facility consists of up to 20 separately fenced solar arrays organized into six 200 MW blocks.~~

Photovoltaic Modules

Solar photovoltaic modules, or solar panels, convert sunlight into DC electric power. The typical module contains crystalline silicon photovoltaic cells arranged within glass panels equipped with an anti-reflective coating, a metal frame, and wire connectors.

Racking System

The photovoltaic modules are connected in series into strings and then mounted on a racking system. Each rack would contain 2 strings of 32 modules mounted on a single-axis tracking system. Multiple racks are organized into rows between 200 and 400 feet in length depending on topography. Rows would be spaced at least 10 feet apart and at least 15 feet from perimeter fencing to provide vehicle access.

Posts

Each row of tracker mounted modules is supported by multiple hollow, screw pile, or pile-type steel posts. Posts are typically installed to a depth of 6-8 feet below surface and extend 5 feet above grade. Posts at the end of rows may be installed at greater depths to withstand wind uplift. Posts may be installed directly in the ground or concrete backfill may be required in some soil conditions.

DC Cabling System

Combiner boxes or a Big Lead Assembly (BLA) harness system is used to aggregate the DC output of the photovoltaic modules for transmission to an inverter by low-voltage DC cables. Using the combiner boxes, strings of modules are connected to a pad-mounted combiner box installed at each row, which in turn, are connected to the inverters by low voltage DC cables

that are either mounted to the tracking system, installed in trays, or buried underground. Using the BLA system, strings are connected directly to a rack-mounted cabling system.

Inverters and Inverter Step Up (ISU) Transformers

Inverters convert the DC output of the photovoltaic modules to AC power that can be transmitted to the electric grid. A typical inverter in utility scale solar facilities converts the 900 to 1,500 volt DC module output to 660 volt AC output. After conversion, the output is sent to an inverter step-up (ISU) transformer to increase the voltage to 34.5 kV power for transmission to the collector substation via the electrical collector system. Inverters and ISU transformers are collocated on concrete slabs near each module block.

Related or Supporting Facilities

Related or supporting facilities include a battery energy storage system, ~~an interconnection~~ switchyard~~substation,~~ up to~~ ~~one~~ six~~ collector substation~~s~~, one~~up to four~~ operations and maintenance building, and other structures.

Battery Energy Storage System

The battery energy storage system (BESS) is designed to provide up to 1~~7~~.2 gigawatt-hours (GWh) of storage capacity. The BESS may use either Lithium-Ion (Li-ion) or Zinc-based battery technology. Under either technology, batteries are contained in pre-constructed modular containers, or “segments,” placed on concrete slab foundations.
The battery storage system includes, but is not limited to, the following elements:

- Batteries and containers, inverters, isolation transformers, and switchboards;
- Balance of plant equipment, which may include medium-voltage and low-voltage electrical systems, fire suppression and HVAC systems (for Li- ion technology, if selected), building auxiliary electrical systems, and network/SCADA systems;
- Cooling system, which may include a separate chiller plant located outside the battery racks with chillers, pumps, and heat exchangers (Li-ion only, if selected); zinc batteries will have fans and a heating unit for climate control; and
- High-voltage (HV) equipment, including a step-up transformer, circuit breaker, current transformers and voltage transformers, a packaged control building for the breaker and transformer equipment, towers, structures, and cabling.

The batteries and associated equipment may be oversized or periodically augmented in accordance with the manufacturer’s recommendations to ensure a minimum of 1~~7~~,200 MWh of energy storage capability over the life of the BESS, taking into account natural degradation of the batteries over time.

Li-ion batteries are currently the most common battery type used in utility-scale battery energy storage systems. If a Li-ion battery technology is used at the facility, it would use Li-ion phosphate batteries, which are more thermally stable than Li-ion cathode batteries.
Each module contains approximately 10 hermetically sealed battery cells filled with a gel or liquid electrolyte. The module containers serve as secondary containment for the cells. Each container holds approximately 840 cells with a combined capacity of approximately 740 kilowatt-hour AC, and approximately ~~1~~2,000 containers would be required to meet the capacity needs of the facility.

The electrolyte used in Li-ion batteries is flammable and susceptible to overheating and vaporization, so Li-ion Battery Systems typically require cooling, ventilation, and fire suppression systems included in each container. If Li-ion battery technology is used at the site, it would implement the following design features and fire prevention and control methods to minimize fire and safety risks:

- Batteries would be stored in completely contained, leak-proof modules.
- Ample working space would be provided around the BESS for maintenance and safety purposes.
- An off-site, 24-hour monitoring system with shutdown capabilities would be implemented.
- Batteries would be transported in accordance with Department of Transportation Pipeline and Hazardous Material Administration regulations under 49 CFR 173.185
- Battery systems would be designed in accordance with applicable Underwriters Laboratories, National Electric Code, and National Fire Protection Association Standards, including but not limited to, UL 1642, 1741, 1973, and 9540A, and NFPA 855.
- An advanced and proven battery management system would be employed;
- Battery Containers would be equipped with:
  - Heating, ventilation, and air conditioning (HVAC) systems to maintain optimal battery temperatures;
  - Fire control panels with 24-hour battery backup;
  - Fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems;
  - Doors equipped with a contact that will shut down the battery container if opened;
  - Fire extinguishing and thermal insulation sheets between each individual battery cell;
  - Locks and fencing to prevent entry of unauthorized personnel;
  - Remote power disconnect switches with clear and visible signs identifying their location.[2]

Li-ion battery modules under consideration for this facility have an expected useful life of 20 years and it is expected that every module at the facility would need to be replaced at least once during the life of the facility. Used Li-ion batteries are generally considered to be

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[2] SSPAPPDoc25-02 ASC Exhibit B Project Description 2024-05-15, Section 2.7.1.

hazardous waste by the EPA and must be transported and disposed of according to the most current guidelines at end of life.

A typical zinc-based BESS container includes 144 zinc-hybrid cathode powered batteries with a combined 700 kWh capacity. Zinc batteries are estimated to have a lifespan of at least 20 years. Zinc battery systems can operate across a higher range of temperatures and only require cooling fans rather than a full HVAC system. Zinc batteries have a lower fire-risk than lithium-ion batteries and do not require fire suppression systems to be included in the container design.

The BESS may be designed either as a DC-coupled system, with containers distributed throughout the energy facility site near inverter/transformer station sites, or as an AC-coupled system with containers concentrated in a single area near the switchyard~~s~~ or substation. In either case, the containers and other BESS equipment are located within the fenced solar array areas and may have their own additional fencing.

34.5 kV Electrical Collection System

The facility includes up to 22.8~~86~~ miles of 34.5 kV electrical collector lines that connects energy facility components to the collector substation~~s~~ described below. The majority of the collector lines are buried underground; however, overhead lines are installed at long "home run" stretches, stream or canyon crossings, and other areas where burial is infeasible. The collector lines are generally located within the energy facility footprint except at road crossings and crossings between fenced solar array areas.

Communication and SCADA System

The facility includes a system of fiber optic and copper communication lines that connect the solar arrays, BESS, and substation~~s~~ to Supervisory Control and Data Acquisition (SCADA) system control rooms within the~~each~~ collector substation (to be shared with all projects, see below). The communication lines are collocated with the 34.5 kV electrical collection system described above. The SCADA system monitors meteorological conditions, critical operating parameters, and power output, for each solar string, battery energy storage system, and substation. The SCADA system is monitored by a remote operations center. Smoke and fire detectors placed around the site also connect to the SCADA system and will contact local emergency responders in the event of a fire at the site.

Collector Substations

The facility includes up to one~~six~~ collector substation~~s~~ at the site. The~~Each~~ substation includes a generator-step up (GSU) transformer and control building, and may also include circuit-breakers and fuses, transmission line termination structures, power transformers, bus bars and insulators, disconnect switches, relaying, battery and charger, surge arresters, AC and DC

supplies, control systems, metering equipment, grounding, a lightning protection system and associated control wiring.

The GSU transformer~~s~~ increases the 34.5-kV ISU transformer output to 230-kV power. The GSU transformer~~s~~ is a~~are~~ ground-mounted unit~~s~~ constructed on a concrete pad~~s~~. The single~~Each of the six~~ GSU transformer is~~s are~~ filled with up to 16,000 gallons of non-toxic oil such as mineral or seed oil.

The~~Each~~ GSU transformer is equipped with a secondary spill containment catchment system designed to minimize the possibility of accidental leakage. The concrete catchment system is sized to contain approximately 1.25 times the amount of oil inside the transformer.

All substation structures and components are surrounded by a graveled area and enclosed by an 8-foot-tall chain-link fence with three strands of barbed wire one foot above the top. Access to the substation site~~s~~ is limited with a locked gate.

~~230-kV Transmission Line~~

~~The facility includes up to two 230-kV overhead transmission lines that connect the collector substations to the two primary interconnection switchyards located at the point of interconnection. The transmission lines are supported by steel or wood monopole or H-Frame structures, spaced approximately 1,000 feet between structures, and ve a combined length of approximately 9.5 miles. The northern line connects two collector substations along the south side of Alpine Lane to the switchyard and extends approximately 3.2 miles. The southern line connects four collector substations across the southern portion of the site and extend approximately 6.3 miles. The two lines run in parallel for approximately 1-mile between Bombing Range Road and the switchyards.~~

~~The transmission lines are located within the fenced solar array areas except where the lines span roads or corridors between areas and between the switchyards and the point of interconnection. All transmission line components are sited within the facility lease boundary.~~

~~No new or expanded right-of-way will be required, but some portions of the transmission lines are located within existing public rights-of-way. A portion of the transmission line that runs along the western boundary of energy facility footprint is within the public right-of-way on the east side of Bombing Range Road. Additionally, portions of the transmission line that connect solar array areas in the southern portion of the site cross Doherty Road and the Lexington-Echo Highway.~~

Project Switchyards and Interconnection Facilities

The facility interconnects with the existing Umatilla Electric Cooperative 230kV Blue Ridge Line at the northwest corner of the facility where the shared switchyard is located (see below). One~~Two~~ switchyard is~~s are~~ approved to be located within a separately fenced site either within or adjacent to the energy facility footprint, ~~each~~

approximately 3 acres. The interconnection switchyard~~s~~ does not contain transformers and is~~are~~ constructed on a foundation~~s~~ with a surrounding gravel area~~s~~.

Operations and Maintenance Buildings

The facility includes one~~up to four~~ operations and maintenance (O&M) building~~s~~, ~~each~~ including a utility room, storage for maintenance supplies and equipment, and a SCADA control room. The building~~s each~~ has~~ve~~ an on-site well and septic system. Power is supplied by a local service provider using overhead and/or underground lines. The~~Each~~ O&M building site also has a graveled parking and storage area~~s~~. The O&M building may be shared with all projects, see below.

Small quantities of chemical materials, including cleaners, insecticides or herbicides, paint, lubricants, degreasers, and solvents, may be stored at the O&M building~~s~~ during construction and operation of the facility. No extremely hazardous materials would be stored on site; other chemicals will be handled in accordance with label instructions as well as state and federal standards.

The facility includes an aboveground fuel storage tank with capacity to store up to 500 gallons of diesel fuel or gasoline at the~~each~~ O&M building site.

The O&M building~~s~~ is~~are~~ equipped with basic firefighting equipment for use on-site during maintenance activities, such as shovels, beaters, portable water for hand sprayers, fire extinguishers, and other equipment.

Replacement Solar Panel Storage

To store spare solar panels and associated equipment, the facility is approved to store materials either at the O&M building site~~s~~ or within approximately 50 locked Conex storage containers distributed throughout the site (to be shared with all projects, see below). The containers may be placed directly on the ground or on gravel pads. The containers would store up to the approximately 204,720 replacement panels needed over the life of the facility.

Access and Service Roads

The facility includes up to 17.4~~55~~ miles of new roads (graded and graveled to meet load requirements for all equipment) to provide access to facility components; some roads will be shared with all projects, see below. Corridors between module racking are at least 10 feet wide and racking are no closer than 15 feet from perimeter fencing. Some new road construction is required to access site features. Roads will be 10 to 20 feet in width, with some exceptions, including access to the substation~~s~~ and main travel corridors where two-way traffic is required. In these cases, roads will be 20 feet wide. A 5-foot maintained vegetative surface or noncombustible base, approved by the fire code official, will be maintained along the fenced perimeter of the site boundary. Use of the roads may continue

after construction, or new roads may be removed and the land reclaimed to pre-construction conditions.

Security Fencing and Gates

The facility includes approximately 28.1 ~~58~~ miles of security fence to enclose each solar array area, substation, and switchyard site. The perimeter fencing has lockable vehicle and pedestrian access gates to provide access to the site.

Temporary Construction Areas

The facility includes up to 27~~54~~ temporary construction areas within the energy facility footprint to support construction, store supplies and equipment, and facilitate the delivery and assembly of materials and equipment. Each area consists of a 5-acre site that would be cleared and graveled prior to construction.

Up to five above-ground diesel tanks and one temporary above-ground gasoline tank may be stored in the temporary construction areas (to be shared with all projects, see below). The tanks each hold up to 1,000 gallons of fuel. Most fuel containers have self-contained secondary containment (e.g., double-walled containers) that provide capacity for the entire container plus precipitation, but in some cases may be placed in a constructed secondary containment area that is impervious and is diked or otherwise contained to provide the required fuel and precipitation capacity.

Shared Related or Supporting Facilities

The certificate holder is authorized to share related or supporting facilities between the Sunstone Solar Projects 1-6, including the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary constructions areas (including fuel tanks). These related or supporting facilities are split accordingly between the Sunstone Solar Projects 1-6, as demonstrated in their associated site certificates. Similarly, compliance with site certificate conditions and EFSC standards which apply to these shared related or supporting facilities are also split accordingly between Sunstone Solar Projects' 1-6 site certificates and certificate holders. In accordance with Condition GEN-GS-07 if either certificate holder substantially modifies a shared related or supporting facility or ceases facility operation, the applicable/relevant certificate holder is obligated to submit an amendment determination request or request for amendment to the Department to determine the appropriate process for evaluating the change and ensuring full regulatory coverage under each site certificate, or remaining site certificate if either is terminated, in the future. Additionally, each certificate holder is obligated to demonstrate to the Department that a "Common Facilities Agreement" or similarly legally binding agreement has been fully executed between certificate holders to ensure approval and agreement of access to the shared resources has been obtained prior to operation of shared facilities.

4.0 Facility Development

4.1 Construction

The initial applicant proposed to construct the originally permitted~~proposed~~ facility in six phases, with each phase including approximately 200 MWs of generating capacity, one of which is the subject of this Site Certificate.

Portions of the site, including the substation~~sites~~, inverter and battery energy storage system sites, and access roads will be cleared and graded, prior to construction of the applicable facility components. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems in the energy facility footprint are left intact during construction to the maximum extent practicable to minimize soil and erosion impacts, and that grading in solar arrays is limited to those areas where the slope and gradient are outside of panel and racking tolerances. Typical grading tolerances within the array are 10% maximum on North slopes and 15% maximum in other directions. Following construction, operational requirements include long-term site stabilization and revegetation of disturbed areas.

Adherence to the requirements of a Fugitive Dust Control Plan is required under Condition PRE-SP-02. Measures implemented under this plan include maintaining existing vegetative root systems, applying dust suppressants, and restricting traffic speeds on-site. Typically, water is

applied as a dust suppressant on access roads, but under drought conditions, alternative dust suppressants including synthetic polymer emulsions, chemical suppressants, organic glues, and wood fiber materials may be applied at the site by qualified vendors.

Construction of the originally permitted facility for all six projects will generate 910 commuting trips and 250 truck trips per day over approximately 1,224 construction workdays. At the peak of construction, it is estimated a maximum of approximately 1,266 commuting trips per day and 250 truck trips per day. The primary route to the site would be Bombing Range Road via Interstate Highway 84 (I-84) at the I-84/Irrigon Junction. Alternate routes would be via OR-207 via I-84 south of Hermiston.

4.2 Operations and Maintenance

Operation and maintenance activities include routine inspections, replacement of solar modules and battery components, panel washing, and vegetation management. Up to 10 permanent employees would operate and maintain the facility (to be shared by all six projects), with occasional delivery truck accessing the site during operations depending on the type of maintenance activity.

Individual batteries associated with the BESS will be inspected according to the manufacturer's recommendations and will need to be replaced approximately every 20 years, and every battery will be replaced during the life of the facility. Each type of electrical facility component would have routine inspections as designated in the operational Wildfire Mitigation Plan. The solar panels may require periodic washing during operations, and other incidental water use for sanitation and equipment washing.

Vegetation will be cleared and maintained along access roads to provide a vegetation clearance area for fire safety. This includes mowing to a height of no more than 12 inches. Use of the roads may continue after construction, or new roads may be removed, and the land reclaimed to pre-construction conditions.

An aboveground 500-gallon fuel storage tank sized may be installed at each O&M building. Secondary containment and refueling procedures for on-site fuel storage during operations will continue to follow the SPCC Plan and requirements for secondary containment. No extremely hazardous materials are expected to be produced, used, stored, transported, or disposed of at the facility during operation.

4.3 Retirement

The estimated useful life of the proposed facility is 40 years. Operational jobs would be eliminated after the facility ceased operating; however, some short-term contract jobs to monitor restored areas may be added to facilitate retirement activities. Decommissioning requires similar workforce numbers as required for the construction of the originally permitted facility/six projects in total and is estimated to require a similar duration of up to 47 months.

Final retirement activities will be designated in a retirement plan but would begin with disconnecting all electrical equipment disassembling equipment and components such and the battery storage units, solar panels and transformers. Larger containers and equipment would be removed, trucked off-site and recycled and disposed of. Solar panels would be disconnected, and piles would be removed including the excavation of any concrete foundations. Gravel and foundations from the inverters and transformers, O&M building, substation~~s~~, and battery unit~~s~~ would be removed by trenching and excavation. The facility site would then be restored through grading, filling, and revegetation with plants or seed mix consistent with applicable plans and conditions discussed in this order or landowner interests.

5.0 Site Certificate Conditions

The conditions of this Site Certificate are organized and coded to indicate the phase of implementation, the standard the condition is required to satisfy, and an identification number (1, 2, 3, etc.).[3] The table below presents a "key" for phase of implementation:

Key	Type of Conditions/Phase of Implementation
GEN	General Conditions: Design, Construction and Operation
PRE	Pre-Construction Conditions
CON	Construction Conditions
PRO	Pre-Operational Conditions
OPR	Operational Conditions
RET	Retirement Conditions

To align with the phased construction approach, preconditions requiring applicant actions prior to construction allow for phased compliance. These apply specifically to the area in which the phased activities would occur, rather than the entirety of the site.

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[3] The identification number is not representative of an order that conditions must be implemented; it is intended only to represent a numerical value for identifying the condition.

5.1 General (GEN) Conditions: Design, Construction and Operations

Condition Number	General (GEN) Conditions
STANDARD: GENERAL STANDARD OF REVIEW (GS) [OAR 345-022-0000]	
GEN-GS-01	The certificate holder must design, construct, operate and retire the facility: a. Substantially as described in the site certificate; b. In compliance with the requirements of ORS Chapter 469, applicable Council rules, and applicable state and local laws, rules and ordinances in effect at the time the site certificate was issued; and c. In compliance with all applicable permit requirements of other state agencies. [Mandatory Condition OAR 345-025-0006(10); General Standard Condition 1; Final Order on ASC]
GEN-GS-02	The certificate holder must begin and complete construction of the facility ~~or facility phase~~ by the following dates: a. Construction of the facility ~~or first facility phase~~ must begin on or before November 18, 2028~~7~~. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site. ~~b. Construction of the final facility phase must begin on or before November 18, 2028. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site.~~ c. All facility construction must be completed on or before November 18 2030~~within 2 years after the date construction of the final facility phase (under (b)) begins~~. Within 7 days after completing construction, the certificate holder shall provide the Department written verification that it has met the deadline. [General Standard Condition 2; Final Order on ASC]
GEN-GS-03	If the certificate holder becomes aware of a significant environmental change or impact attributable to the facility, the certificate holder must, as soon as possible, submit a written report to the Department describing the impact on the facility and any affected site certificate conditions. [Mandatory Condition OAR 345-025-0006(6); General Standard Condition 3; Final Order on ASC]
GEN-GS-04	The certificate holder must prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder. [Mandatory Condition OAR 345-025-0006(7); General Standard Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-GS-05	Upon completion of construction, the certificate holder must restore vegetation to the extent practicable and must landscape all areas disturbed by construction in a manner compatible with the surroundings and proposed use. Upon completion of construction, the certificate holder must remove all temporary structures not required for facility operation and dispose of all timber, brush, refuse and flammable or combustible material resulting from clearing of land and construction of the facility. [Mandatory Condition OAR 345-025-0006(11); General Standard Condition 6; Final Order on ASC]
~~GEN-GS-06~~	~~The certificate holder is authorized to construct the 230 kV transmission lines anywhere within the approved transmission line corridors, subject to the conditions in the site certificate. The approved transmission line corridor includes:~~ ~~a. Southern transmission line: Approximately 6.3 miles, extending between the facility switchyard to four collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~b. Northern transmission line: Approximately 3.2 miles, extending between the facility switchyard to two collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~[Site Specific Condition OAR 345-025-0010(5); General Standard Condition 7; Final Order on ASC]~~
GEN-GS-07	The certificate holder may operationally share the following related or supporting facilities between Sunstone Solar Projects 1-6: the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary construction areas, subject to the following: a. Within 30 days of use by certificate holders of the shared facilities, the certificate holder must provide evidence to the Department that the certificate holders of the shared facilities have an executed agreement for shared use of any constructed shared facilities. The Shared Use Agreements must allow operation and maintenance personnel and contractors access to the shared facilities of Sunstone Solar Projects 1-6.
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
GEN-OE-01	Before any transfer of ownership of the facility or ownership of the site certificate holder, the certificate holder must inform the Department of the proposed new owners. The requirements of OAR 345-027-0400 apply to any transfer of ownership that requires a transfer of the site certificate. [Organizational Expertise Condition 1; Final Order on ASC]
GEN-OE-02	Any matter of non-compliance under the site certificate is the responsibility of the certificate holder. Any notice of violation issued under the site certificate will be issued to the certificate holder. Any civil penalties under the site certificate will be levied on the certificate holder. [Organizational Expertise Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-OE-03	The certificate holder must notify the Department within 72 hours of any occurrence of the following: a. There is an attempt by anyone to interfere with the facility's safe operation. b. There is a significant nature event such as a fire, earthquake, flood, tsunami or tornado, or human-caused event such as a fire or explosion. c. There is any fatal injury at the facility. [Organizational Expertise Condition 5; Final Order on ASC]
GEN-OE-04	The certificate holder shall, as soon as reasonably possible: a. Report incidents or circumstances that may violate the terms or conditions of the site certificate, terms or conditions of any order of the Council, or the terms or conditions of any order issued under OAR 345-027-0230, to the Department. In the report to the Department, the certificate holder shall provide all pertinent facts including an estimate of how long the conditions or circumstances existed, how long they are expected to continue before they can be corrected, and whether the conditions or circumstances were discovered as a result of a regularly scheduled compliance audit; b. Initiate and complete appropriate action to correct the conditions or circumstances and to minimize the possibility of recurrence; c. Submit a written report within 30 days of discovery to the Department. The report must refer to the language in (d) of the condition and contain: i. A discussion of the cause of the reported conditions or circumstances; ii. The date of discovery of the conditions or circumstances by the responsible party; iii. A description of immediate actions taken to correct the reported conditions or circumstances; iv. A description of actions taken or planned to minimize the possibility of recurrence; and v. For conditions or circumstances that may violate the terms or conditions of a site certificate, an assessment of the impact on the resources considered under the standards of OAR Chapter 345 Divisions 22 and 24 as a result of the reported conditions or circumstances. d. Upon receipt of the written report in sub(c) of this condition, the Department may review the facility record for incidents or circumstances reported or reportable under sub(a) related to public health and safety, the environment, or other resources protected under Council standards. If these incidences are determined by the Department to impact the adequacy of the facility decommissioning cost, the Department or Council may adjust the contingencies identified in Final Order on ASC Table 4 and shall request and receive an updated bond or letter of credit from certificate holder in the adjusted amount. [Organizational Expertise Condition 6; Final Order on ASC]
STANDARD: Structural Standard (SS) [OAR 345-022-0020]	

Condition Number	General (GEN) Conditions
GEN-SS-01	The certificate holder must design, engineer and construct the facility to avoid dangers to human safety and the environment presented by seismic hazards affecting the site that are expected to result from all maximum probable seismic events. “Seismic hazards” include ground shaking, ground failure, landslide, liquefaction triggering and consequences (including flow failure, settlement buoyancy, and lateral spreading), cyclic softening of clays and silts, fault rupture, directivity effects and soil-structure interaction. [Mandatory Condition OAR 345-025-0006(12); Structural Standard Condition 1; Final Order on ASC]
GEN-SS-02	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if site investigations or trenching reveal that conditions in the foundation rocks differ significantly from those described in the application for a site certificate. After the Department receives the notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(13); Structural Standard Condition 2; Final Order on ASC]
GEN-SS-03	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if shear zones, artesian aquifers, deformations or clastic dikes are found at or in the vicinity of the site. After the Department receives notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(14); Structural Standard Condition 3; Final Order on ASC]
GEN-SS-04	The certificate holder shall design, engineer, and construct the facility in accordance with the versions of the International Building Code, Oregon Structural Specialty Code, and local building codes in effect at the time of construction. [Structural Standard Condition 5; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
GEN-LU-01	The certificate holder shall provide evidence to the Department of coordination with the owners of adjacent lands dedicated to agricultural use. Coordination must include information about the facility that could impact agricultural activities. The certificate holder must document any recommendations made by adjacent landowners regarding measures to reduce or avoid any adverse impacts to farm practices on surrounding lands and to avoid any increase in farming costs as well as any responses made to these recommendations. [Land Use Condition 9; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-LU-02	The certificate holder must adhere to the terms of the Memorandum of Agreement for Agricultural Mitigation Fund included in Attachment F of the Final Order on the ASC, or subsequently amended. It is the certificate holder's responsibility to ensure that the Council and Department receive all reports and notifications required by the agreement. [Land Use Condition 12; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
GEN-RF-01	The certificate holder shall prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder.
	[Mandatory Condition OAR 345-025-0006(7); Retirement and Financial Assurance Condition 1; Final Order on ASC]
STANDARD: Siting Standards for Transmission Lines (TL) [OAR 345-024-0090]	
~~GEN-TL-01~~	~~The certificate holder shall:~~ ~~a. Design, construct and operate the transmission lines in accordance with the requirements of the National Electrical Safety Code as approved by the American National Standards Institute; and~~ ~~b. Develop and implement a program that provides reasonable assurance that all fences, gates, cattle guards, trailers, or other objects or structures of a permanent nature that could become inadvertently charged with electricity are grounded or bonded throughout the life of the line.~~ ~~[Siting Standards for Transmission Line Condition 1; Final Order on ASC]~~

5.3 Pre-Construction (PRE) Conditions

Condition Number	Preconstruction (PRE) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
PRE-GS-01	Except as necessary for the initial survey, the certificate holder may not begin construction of the facility or phase, or create a clearing on any part of the site of the facility or phase, as applicable, until the certificate holder has the legal right to engage in construction activities on the relevant parts of the site for the facility or phase. [Mandatory Condition OAR 345-025-0006(5); General Standard Condition 5; Final Order on ASC]
PRE-GS-02	At least 90 days prior to construction of the facility or phase, as applicable (unless otherwise agreed to by the Department), the certificate holder shall submit to the Department a compliance plan documenting and demonstrating actions completed or to be completed to satisfy the requirements of all site certificate terms and conditions and applicable statutes and rules. The plan shall be provided to the Department for review and compliance determination for each requirement. The Department may request additional information or evaluation deemed necessary to demonstrate compliance. [OAR 345-026-0048, General Standard Condition 8; Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRE-OE-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall notify the Department of the identity and qualifications of the major design, engineering and construction contractor(s). The certificate holder shall select contractors that have substantial experience in the design, engineering and construction of similar facilities. The certificate holder shall report to the Department any changes of major contractors. [Organizational Expertise Condition 2; Final Order on ASC]
PRE-OE-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall select a construction contractor with a low rate of historic environmental and safety compliance citations. Certificate holder shall provide the following documentation to the Department: a. Qualifications and contact information of the of the major design, engineering and construction contractor(s) and subcontractors, as applicable. b. Construction contractor compliance history. c. Contract excerpt affirming that contractors are required to comply with the terms and conditions of the site certificate, including selecting design layout and construction materials that minimize impacts to resources protected under Council standards. [Organizational Expertise Condition 7; Final Order on ASC]
PRE-OE-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide to the Department the qualifications and contact information of the certificate holder's construction manager.

Condition Number	Preconstruction (PRE) Conditions
	[Organizational Expertise Condition 8; Final Order on ASC]
PRE-OE-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Provide the Department a list of federal, state and local permits, including any third-party permits related to facility siting; and a schedule for obtaining identified permits. b. Once obtained, provide copies of all permits, including third-party permits, required for facility siting to the Department. [Organizational Expertise Condition 12; Final Order on ASC]
STANDARD: Structural (SS) [OAR 345-022-0020]	
PRE-SS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a site-specific geotechnical investigation report, consistent with the Oregon State Board of Geologist Examiners Guideline for Preparing Engineering Geologic Reports, or newer guidelines if available to the Department, for review in consultation with its third-party consultant. [Structural Standard Condition 4; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRE-SP-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide a Vegetation and Grading Plan that demonstrates contractors are required to adhere to the following: a. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems shall be left intact to the maximum extent practicable. b. Grading within solar arrays shall be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically 10% maximum on North slopes and 15% maximum in other directions). [Soil Protection Condition 1; Final Order on ASC]
PRE-SP-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Obtain a NPDES 1200-C Permit from DEQ. A copy of the approved permit and attached Erosion and Sediment Control Plan (ESCP) must be submitted to the Department. b. Finalize the Fugitive Dust Control Plan, as provided in the Final Order on ASC Attachment D. Finalization includes verification of names and contact information of individuals responsible for implementation, measures to be implemented and forms to be used for monitoring and reporting. [Soil Protection Condition 3; Final Order on ASC]
PRE-SP-03	Prior to construction of the facility or phase, as applicable, the certificate holder must submit to the Department a Construction Spill Prevention Countermeasures and Control (SPCC) Plan. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-01	Prior to construction of the facility or phase, as applicable, the certificate holder must provide to the Department a copy of the approved Conditional Use Permit and applicable Zoning Permit(s). [Land Use Condition 1; Final Order on ASC]
~~PRE-LU-02~~	~~Prior to construction of the 230 kV transmission lines, the certificate holder shall demonstrate to the Department that the transmission lines will be sited within the exiting road rights-of-way, unless Morrow County Public Works Department and Oregon Department of Transportation, as applicable, confirm that use of the existing road rights-of-way is not feasible.~~ ~~[Land Use Condition 2; Final Order on ASC]~~
PRE-LU-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the draft Noxious Weed Control Plan, as provided in the Final Order on ASC Attachment E, and submit to the Department for review and approval in consultation with the Morrow County Weed Department. [Land Use Condition 3; Final Order on ASC]
PRE-LU-04	Prior to construction of the facility or phase, as applicable, the certificate holder must submit an executed document prohibiting the certificate holder, and the certificate holder's successors in interest, from pursuing a claim for relief or cause of action alleging injury from farming or forest practices as defined in ORS 30.930(2) and (4), and provide evidence that the document has been recorded in the deed records for Morrow County. [Land Use Condition 6; Final Order on ASC]
PRE-LU-05	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the final design adheres to the following setbacks: a. All facility structures and above-ground components except the perimeter fenceline must be sited: 1. At least 20 feet from a property line fronting the right-of-way of a local minor collector or marginal access street, including but not limited to Sand Hollow Road, Grieb Lane, Alpine Lane, Doherty Road, or Melville Road. 2. At least 30 feet from a property line fronting the right-of-way, of a major collector, including but not limited to, Bombing Range Road. 3. At least 80 feet from a property line fronting the right-of-way for an arterial road, including but not limited to State Highway 207. b. All facility structures, and all on-site septic systems or other sewage disposal systems must be set back at least 100 feet from delineated waterways. [Land Use Condition 7; Final Order on ASC]
PRE-LU-06	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a final site plan that includes all information required by MCZO 4.165.E to the County and the Department. The Department may defer review and approval to the County. [Land Use Condition 8; Final Order on ASC]

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-07	Prior to construction of the facility or phase, as applicable, the certificate holder must complete the preconstruction requirements identified in the Memorandum of Agreement for Agricultural Mitigation Fund, as provided in the Final Order on ASC Attachment F, or subsequently amended. [Land Use Condition 11; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
PRE-RF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit to the State of Oregon, through the Council, a bond or letter of credit naming the State of Oregon, acting by and through the Council, as beneficiary or payee. The approved bond or letter of credit amount of $24,974,952.51~~117,945,000~~ (Q4~~1~~ 2025~~3~~ dollars) may be adjusted based on the design configuration of the facility, or phase of the facility, as provided in Sub(a) and adjusted to the year and quarter of issuance as provided under Sub(b). a. The bond or letter of credit amount may be adjusted based on actual design/number of components of the facility or phase, as applicable, and shall use the same unit costs and contingencies presented in the Final Order on the ASC Table 8. b. Adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. c. The bond or letter of credit must be issued by a financial institution that is included on the Council's pre-approved financial institution list. The certificate holder may request to have a financial institution added to the list at any time. d. The bond or letter of credit must be prepared using the most recent Council-approved template. [Retirement and Financial Assurance Condition 4; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
PRE-FW-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Revegetation and Reclamation Plan, based on Attachment G of the Final Order on the ASC, and submit to the Department for review and approval. [Fish and Wildlife Habitat Condition 1]
PRE-FW-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit the draft legal agreement for review and approval by the Department, in consultation with ODFW. The legal agreement shall ensure that payment provided for long-term management and enhancement of the mitigation area is adequate to cover the permanent habitat loss from the facility.

Condition Number	Preconstruction (PRE) Conditions
	[Fish and Wildlife Condition 4, Final Order on ASC]
PRE-FW-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Habitat Mitigation Plan, as provided in Attachment H of the Final Order on ASC, based on the impacts associated with the final facility design and the legal agreement, as approved by the Department. [Fish and Wildlife Condition 5, Final Order on ASC]
PRE-FW-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide evidence to the Department that the design measures included in the Construction Wildlife Monitoring Plan (Final Order on ASC Attachment I) have been included in the final facility design and construction contractor contracts, as applicable. [Fish and Wildlife Condition 7; Final Order on ASC]
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
PRE-TE-01	If construction commences after April 2025, certificate holder shall, prior to construction of the facility or phase, as applicable, conduct protocol-level Washington ground squirrel (WAGS) surveys within areas of planned facility construction that are within suitable WAGS habitat. The certificate holder shall: a. Submit a protocol-level survey plan for surveys to be conducted within suitable WAGS habitat, for review and approval by the Department in consultation with ODFW. At a minimum, the survey plan shall specify the survey area (all areas of suitable habitat within 1,000 feet of ground disturbing activities except where there is a habitat barrier (e.g., a paved road) or access restrictions); and survey timing (February 15 to May 31, unless otherwise approved by ODFW). b. Complete protocol-level WAGS surveys based on the protocol approved per (a). c. Submit survey reports to the Department and ODFW. The certificate holder shall not begin construction within 1,000 feet of Category 1 or Category 2 WAGS habitat until the identified boundaries of Category 1 WAGS habitat have been approved by the Department, in consultation with ODFW. Category 1 habitat includes a 785-foot buffer from an identified active burrow, and the area within the perimeter of multiple active burrows. Category 2 WAGS habitat consists of a 4,136-foot buffer from the exterior boundary of all Category 1 WAGS habitat. The survey results are valid for 3-years. d. Develop maps and worker training materials to inform of sensitive Category 1 and Category 2 habitat. Submit to the Department final facility design maps demonstrating that Category 1 habitat, including 785-buffer from any colonies identified per (b), is avoided. e. Install flagging or other demarcation, as appropriate, to inform workers of sensitive WGS habitat and of avoidance requirement. [Threatened and Endangered Species Condition 1; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	

Condition Number	Preconstruction (PRE) Conditions
PRE-HC-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall update the contact information provided in the Final Order on ASC Attachment K, Inadvertent Discovery Plan. [Historic, Cultural and Archeological Condition 1; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
PRE-PS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall execute a final Road Use Agreement, based on Final Order on ASC Attachment N, and provide a copy to the Department. [Public Services Condition 1, Final Order on ASC]
PRE-PS-02	At least 180-days prior to construction of any phase, the certificate holder shall provide to the Department and Morrow County a temporary housing plan for the construction workforce. The plan shall provide for coordination with contractors and local officials on housing options and strategies to minimize impacts to local housing supply based on an ongoing evaluation of patterns of uses and potential shortages or changes in housing demand. [Public Services Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRE-WF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Construction Wildfire Mitigation Plan, as provided in Attachment L to the Final Order on ASC. The final Construction Wildfire Mitigation Plan shall be submitted to the Department for review and approval. [Wildfire Prevention and Risk Mitigation Condition 1; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRE-WM-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall require contractors to develop and submit to the Department for review and approval, Construction Waste Management Plan(s) that, at a minimum, include the following: a. All sources and quantities of construction waste and wastewater, including damaged or dysfunctional energy facility components, and where feasible, estimated quantities that can be recycled. b. Process for disposal and recycling, including use of licensed haulers and disposal/recycling facilities; names and locations of licensed recycling and disposal facilities; collection, hauling and tracking requirements. c. Process for requesting a permit exemption from DEQ pursuant to OAR 340-093-0080 to ensure that concrete washout materials reused in foundation backfill are substantially the same as clean fill. d. Process for training workers and tracking compliance with the requirements of the plan. [Waste Minimization Condition 1; Final Order on ASC]
STANDARD: Noise Control Regulations (NC) [OAR 340-035-0035]	

Condition Number	Preconstruction (PRE) Conditions
PRE-NC-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the operational noise levels comply with OAR 345-035-0035(1)(b), based on an updated acoustic modeling analysis using final design/layout and equipment specifications. [Noise Control Condition 1; Final Order on ASC]
STANDARD: Other – Removal-Fill (WL)	
PRE-WL-01	Prior to construction of the facility, facility component or phase, as applicable, the certificate holder must provide documentation of a valid jurisdictional determination from the Oregon Department of State Lands demonstrating that no waterways subject to the State Removal-Fill law under ORS 196.795 through 196.990 are present within areas to be disturbed during construction or operation. [Removal-Fill Condition 1, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
PRE-WR-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Identify all water-related needs and estimate daily and annual water demand for each construction phase, as applicable. b. Provide, to the Department, a contract or purchase agreement demonstrating that adequate water supply to meet construction demand has been secured from sources with valid water rights. [Water Rights Condition 1, Final Order on ASC]

5.4 Construction (CON) Conditions

Condition Number	Construction (CON) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
CON-OE-01	The certificate holder shall contractually require all contractors and subcontractors to comply with all applicable laws and regulations and with the terms and conditions of the site certificate. The contractual obligation shall be required of each contractor and subcontractor prior to that firm working on the facility. Such contractual provisions shall not operate to relieve the certificate holder of responsibility under the site certificate. [Organizational Expertise Condition 3; Final Order on ASC]
CON-OE-02	During construction, the certificate holder shall: a. Maintain an onsite construction manager. b. Require that the construction manager implement and monitor all applicable construction related site certificate conditions. c. Within six months after beginning construction, and every six months thereafter during construction of the energy facility and related or supporting facilities, the certificate holder shall submit a semiannual construction progress report to the Department. In each construction progress report, the certificate holder shall describe any significant changes to major milestones for construction. The certificate holder shall report on the progress of construction and shall address the following: i. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. ii. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. iii. Compliance Report: A report describing the certificate holder’s compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate. iv. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0050. [Organizational Expertise Condition 9; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	

Condition Number	Construction (CON) Conditions
CON-SP-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Vegetation and Grading Plan. [Soil Protection Condition 2; Final Order on ASC]
CON-SP-02	During construction of the facility or phase, as applicable, the certificate holder shall: a. Conduct all work in compliance with the NPDES 1200-C Permit and Erosion and Sediment Control Plan (ESCP) or revised ESCP if applicable. The ESCP shall be revised if determined necessary by the certificate holder, certificate holder's contractor(s) or the Department. Any Department-required ESCP revisions shall be implemented within 14-days, unless otherwise agreed to by the Department based on a good faith effort to address erosion issues. b. Conduct all work in compliance with the Fugitive Dust Control Plan. The Fugitive Dust Control Plan may be amended, as needed, to ensure that control measures are effective at the site. [Soil Protection Condition 4; Final Order on ASC]
CON-SP-03	During construction, the certificate holder shall require that all onsite contractors and personnel adhere to the requirements of the SPCC Plan. Any SPCC revisions and updates shall be reported to the Department. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
CON-LU-01	During construction, the certificate holder shall implement and adhere to the Noxious Weed Control Plan required under Condition PRE-LU-02. [Land Use Condition 4, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
CON-RF-01	During construction, the certificate holder shall: a. Describe the status of the bond or letter of credit in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. b. If construction extends for more than 12 months, the certificate holder shall adjust the amount of the bond or letter of credit on an annual basis thereafter as described in under Condition PRE-RF-01. c. The Department and Council reserve the right to adjust the contingencies, as necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 5; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
CON-FW-01	During construction, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan, as applicable. [Fish and Wildlife Habitat Condition 2, Final Order on ASC]
CON-FW-02	During construction, the certificate holder shall adhere to the requirements of the Construction Wildlife Monitoring Plan (Attachment I of the Final Order on the ASC). Monitoring records shall be maintained throughout construction and included in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 8; Final Order on ASC]

Condition Number	Construction (CON) Conditions
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
CON-TE-01	Prior to and during construction of the facility or phase, as applicable, any incidentally identified occurrence(s) of Lawrence's milkvetch shall be avoided using a 100-foot buffer via mapping and flagging. [Threatened and Endangered Species Condition 2; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
CON-HC-01	During construction, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan, as submitted to the Department under PRE-HC-01. [Historic, Cultural and Archeological Condition 2; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
CON-PS-01	During construction, the certificate holder shall adhere to the terms and conditions of the Road Use Agreement executed under PRE-PS-01. [Public Services Condition 2; Final Order on ASC]
CON-PS-02	During construction, the certificate holder shall report to the Department the outcomes of the work completed under the temporary housing plan required under PRE-PS-02. The report shall be included in the construction progress report required under CON-OE-02, and shall include, at a minimum: a. Outcome of coordination with construction contractors to identify housing options for incoming workers, including aggregate data on the location (i.e. city) and type of housing used by workers. b. Documentation of coordination with local officials such as the Morrow County Planning Department, nearby cities and towns such as Lexington and Ione, the Lexington Community Development Group, the Ione Community Agri-Business Organization, the Boardman Community Development Association, the Willow Creek Valley Economic Development Group, and other housing providers to identify housing options and strategies to minimize that impacts to local housing supply. [Public Services Condition 4; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
CON-WF-01	During construction of the facility of phase, as applicable, the certificate holder shall implement and require all onsite contractors and employees to adhere to the Construction Wildfire Mitigation Plan required under Condition PRE-WF-01. Updates to the Wildfire Mitigation Plan may be required if determined necessary by the certificate holder, certificate holder's contractor(s), or the Department to address wildfire hazard to public health and safety. Any Department required updates shall be implemented within 14 days, unless otherwise agreed to by the Department based on a good faith effort to address wildfire hazard. [Wildfire Prevention and Risk Mitigation Condition 2; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	

Condition Number	Construction (CON) Conditions
CON-WM-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Construction Waste Management Plan(s) and maintain records of employee training and tracking compliance onsite and available upon Department request. [Waste Minimization Condition 2; Final Order on ASC]
CON-WM-02	During construction, on-site concrete washwater disposal is prohibited unless DEQ approval of a permit exemption for materials substantially similar to clean fill is obtained. If DEQ approval of a permit exemption is obtained, concrete washwater must be disposed of onsite via infiltration and evaporation in accordance with the DEQ-issued NPDES 1200-C permit required under Condition CON-SP-02. [Waste Minimization Condition 3; Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
CON-WR-01	During construction: a. All water used for construction activities shall be appropriated and used in accordance with the applicable provisions of ORS chapter 537 and OAR chapter 690. b. The certificate holder shall report the source and amount of water used during each month of construction under Condition CON-OE-02. The certificate holder shall maintain records adequate to substantiate reports (e.g., written logs and photographs of well meter readings, copies of invoices from water sources) and make such records available to the Department upon request. c. If a water right, limited water use license, or water rights transfer is needed and would not be obtained by a third-party, the certificate holder shall submit and obtain approval of the applicable water permit through the site certificate amendment process. [Water Rights Condition 2; Final Order on ASC]

5.5 Pre-Operational (PRO) Conditions

Condition Number	Pre-Operational (PRO) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRO-OE-01	Prior to operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 10; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRO-SP-01	Following the termination of the 1200-C, the certificate holder shall update the requirements of the Revegetation and Reclamation Plan, specific to the areas within the fenceline not occupied by facility infrastructure. Certificate holder shall provide evidence to the Department that the permit was terminated by DEQ. [Soil Protection Condition 5; Final Order on ASC]
PRO-SP-02	Prior to operation, the certificate holder shall submit to the Department an Operational Spill Prevention Control and Countermeasures (SPCC) Plan. [Soil Protection Condition 8; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRO-WF-01	Prior to operation, the certificate holder shall finalize the operational Wildfire Mitigation Plan (WMP) included as Attachment M to the Final Order on ASC. [Wildfire Prevention and Risk Mitigation Condition 3; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRO-WM-01	Prior to operation, the certificate holder shall develop an Operational Recycling Plan or protocol requiring that damaged or nonfunctional panels and lithium-ion batteries be recycled to the extent practicable. The certificate holder shall report in its annual report to the Department the quantities of panels and lithium-ion batteries recycled, reused or disposed of in a landfill. Requirements for lithium-ion battery recycling do not apply if the BESS is not constructed. [Waste Minimization Condition 4; Final Order on ASC]
STANDARD: Other - Water Rights (WR)	
PRO-WR-01	Prior to operation, the certificate holder shall provide, to the Department, a copy of the map, well log and all other information it provided to OWRD pursuant to ORS 537.545 and ORS 537.765 to qualify for an exempt ground water use for any onsite exempt wells. [Water Rights Condition 3; Final Order on ASC]

5.6 Operational (OPR) Conditions

Condition Number	Operational (OPR) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
OPR-GS-01	The certificate holder must submit a legal description of the site to the Department within 90 days after beginning operation of the facility. The legal description must include a description of metes and bounds or a description of the site by reference to a map and geographic data that clearly and specifically identify the outer boundaries that contain all parts of the facility. [Mandatory Condition OAR 345-025-0006(2); General Standard Condition 9]
OPR-GS-02	After January 1 but no later than April 30 of each year after beginning operation of the facility, the certificate holder shall submit an annual report to the Department. The Council Secretary and the certificate holder may, by mutual agreement, change the reporting date. a. The annual report must include the following information for the calendar year preceding the date of the report: 1. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. 2. Reliability and Efficiency of Power Production: For electric power plants, the plant availability and capacity factors for the reporting year. The certificate holder shall describe any equipment failures or plant breakdowns that had a significant impact on those factors and shall describe any actions taken to prevent the recurrence of such problems. 3. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. 4. Monitoring Report: A list and description of all significant monitoring and mitigation activities performed during the previous year in accordance with site certificate terms and conditions, a summary of the results of those activities and a discussion of any significant changes to any monitoring or mitigation program, including the reason for any such changes. 5. Compliance Report: A report describing the certificate holder’s compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate.

Condition Number	Operational (OPR) Conditions
	6. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0350. b. To the extent that information required by this rule is contained in reports the certificate holder submits to other state, federal or local agencies, the certificate holder may submit excerpts from such other reports to satisfy this rule. The Council reserves the right to request full copies of such excerpted reports. [Mandatory Condition 345-026-0080(1); General Standard Condition 10, Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
OPR-OE-01	During operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 11; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
OPR-SP-01	During operation, the certificate holder shall adhere to the requirements of the Operational SPCC Plan. Any SPCC updates shall be described and included in the Annual Report to the Department. Certificate holder shall report spill and cleanup activities to the Department within 72 hours and shall make inspection records available to the Department upon request. [Soil Protection Condition 9; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
OPR-LU-01	Following the fifth year of monitoring under the Noxious Weed Control Plan required under PRE-LU-03, the certificate holder shall submit a Long-term Noxious Weed Monitoring Plan to the Department, for review and approval. The certificate holder shall implement the plan for the remainder of the facility's operating life. [Land Use Condition 5, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
OPR-RF-01	During operation, the certificate holder shall: a. Annually adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. b. Any changes to the template made by the Council must be incorporated into the bond or letter or letter of credit whenever the amount is adjusted under Sub(a). c. The Department and Council reserve the right to adjust the contingencies, as

Condition Number	Operational (OPR) Conditions
	necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 6; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
OPR-FW-01	During operation, as applicable, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan. [Fish and Wildlife Habitat Condition 3, Final Order on ASC]
OPR-FW-02	During operation, the certificate holder shall provide reports from The Nature Conservancy on the status of long-term management and enhancement of the habitat mitigation area, consistent with the Habitat Mitigation Plan. [Fish and Wildlife Condition 6, Final Order on ASC]
OPR-FW-03	During operation, the certificate holder shall adhere to the requirements of the Operational Wildlife Monitoring Plan (Attachment J of the Final Order on the ASC). Monitoring records shall be maintained throughout operation and included in the annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 9; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
OPR-HC-01	During operations, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan (IDP), as provided for Condition PRE-HC-01. The IDP shall be reviewed and updated annually for current contact information. [Historic, Cultural and Archeological Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
OPR-WF-01	During operation, the certificate holder shall: a. Implement the Operational Wildfire Mitigation Plan finalized under Condition PRO-WF-01. b. Every 5 years after the first operational year, review and update the evaluation of wildfire risk under OAR 345-022-0115(1)(b) and submit the results in the annual report required under Condition CON-OE-02 for that year. c. Submit an updated Operational Wildfire Mitigation Plan to the Department if substantive changes are made to the plan because of the review under sub (b) of this condition, or at any other time substantiative revisions are made. [Wildfire Prevention and Risk Mitigation Condition 4; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
OPR-WM-01	During operation, the certificate holder shall adhere to the requirements of the Operational Recycling Plan or protocol developed under Condition PRO-WM-01. [Waste Minimization Condition 5; Final Order on ASC]
OPR-WM-02	During operation, the certificate holder shall: a. Prohibit use of chemicals, soaps, detergents and heated water unless Chemical Safety Data Sheets for low volatile organic compound/biodegradable cleaning chemicals and solvents are submitted to the Department for review and approval prior to use.

Condition Number	Operational (OPR) Conditions
	b. Ensure that washing is conducted in a manner that does not remove paint or other finishes. c. Discharge wash water through evaporation and infiltration only. [Waste Minimization Condition 6, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
OPR-WR-01	During operation, the certificate holder shall verify that any onsite exempt wells do not use more than 5,000 gallons of ground water a day, collectively, and shall monitor the volume of groundwater used on a daily basis, maintain a record of such use and make the monitoring records available to the Department upon request. [Water Rights Condition 4; Final Order on ASC]

5.7 Retirement (RET) Conditions

Condition Number	Retirement (RET) Conditions
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
RET-RF-01	The certificate holder must retire the facility if the certificate holder permanently ceases construction or operation of the facility. The certificate holder must retire the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410. The certificate holder must pay the actual cost to restore the site to a useful, non-hazardous condition at the time of retirement, notwithstanding the Council's approval in the site certificate of an estimated amount required to restore the site. [Mandatory Condition OAR 345-025-0006(9); Retirement and Financial Assurance Condition 2; Final Order on ASC]
RET-RF-02	If the Council finds that the certificate holder has permanently ceased construction or operation of the facility without retiring the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410, the Council must notify the certificate holder and request that the certificate holder submit a proposed final retirement plan to the Department within a reasonable time not to exceed 90 days. If the certificate holder does not submit a proposed final retirement plan by the specified date, the Council may direct the Department to prepare a proposed final retirement plan for the Council's approval. Upon the Council's approval of the final retirement plan, the Council may draw on the bond or letter of credit described in Condition PRE-RT-01 to restore the site to a useful, non-hazardous condition according to the final retirement plan, in addition to any penalties the Council may impose under OAR chapter 345, division 29. If the amount of the bond or letter of credit is insufficient to pay the actual cost of retirement, the certificate holder must pay any additional cost necessary to restore the site to a useful, non-hazardous condition. After completion of site restoration, the Council must issue an order to terminate the site certificate if the Council finds that the facility has been retired according to the approved final retirement plan. [Mandatory Condition OAR 345-025-0006(16); Retirement and Financial Assurance Condition 3; Final Order on ASC]

6.0 Successors and Assigns

To transfer this site certificate or any portion thereof or to assign or dispose of it in any other manner, directly or indirectly, the certificate holder shall comply with OAR 345-027-0400.

7.0 Severability and Construction

If any provision of this agreement and certificate is declared by a court to be illegal or in conflict with any law, the validity of the remaining terms and conditions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the agreement and certificate did not contain the particular provision held to be invalid.

8.0 Execution

This site certificate may be executed in counterparts and will become effective upon signature by the Chair of the Energy Facility Siting Council and the authorized representative of the certificate holder.

IN WITNESS THEREOF, this site certificate has been executed by the State of Oregon, acting by and through the Energy Facility Siting Council and Sunstone Solar, LLC (certificate holder).

ENERGY FACILITY SITING COUNCIL
Kent Howe
By: Kent Howe (Nov 19, 2024 16:21 PST)
Kent Howe, Chair
Date: 19-Nov-2024

SUNSTONE SOLAR, LLC
Jon Saxon
By: Jon Saxon (Nov 19, 2024 16:26 EST)
Jon Saxon, Authorized Representative
Date: 19-Nov-2024

Sunstone Solar Project 6

ENERGY FACILITY SITING COUNCIL
OF THE STATE OF OREGON

SITE CERTIFICATE FOR THE
SUNSTONE SOLAR PROJECT

6

ISSUE DATE

NOVEMBER 18, 2024

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Table of Contents

1.0 Introduction and Site Certification

This site certificate is a binding agreement between the State of Oregon (State), acting through the Energy Facility Siting Council (EFSC or Council), and Sunstone Solar 6, LLC (certificate holder), owned by Pine Gate Renewables, LLC (parent company). Both the State and certificate holder must abide by local ordinances, state law, and the rules of the Council in effect on the date this site certificate is executed. However, upon a clear showing of a significant threat to public health, safety, or the environment that requires application of later-adopted laws or rules, the Council may require compliance with such later-adopted laws or rules (ORS 469.401(2)).

This site certificate binds the State and all counties, cities and political subdivisions in Oregon as to the approval of the site and the construction, operation, and retirement of the facility as to matters that are addressed in and governed by this site certificate (ORS 469.401(3)). Each affected state agency, county, city, and political subdivision in Oregon with authority to issue a permit, license, or other approval addressed in or governed by this site certificate, shall upon submission of the proper application and payment of the proper fees, but without hearings or other proceedings, issue such permit, license or other approval subject only to conditions set forth in this site certificate. In addition, each state agency or local government agency that issues a permit, license or other approval for this facility shall continue to exercise enforcement authority over such permit, license or other approval (ORS 469.401(3)). For those permits, licenses, or other approvals addressed in and governed by this site certificate, the certificate holder shall comply with applicable state and federal laws adopted in the future to the extent that such compliance is required under the respective state agency statutes and rules (ORS 469.401(2)).

This site certificate does not address, and is not binding with respect to, matters that are not included in and governed by this site certificate, and such matters include, but are not limited to: employee health and safety; building code compliance; wage and hour or other labor regulations; local government fees and charges; other design or operational issues that do not relate to siting the facility (ORS 469.401(4)); and permits issued under statutes and rules for which the decision on compliance has been delegated by the federal government to a state agency other than the Council (ORS 469.503(3)).

The obligation of the certificate holder to report information to the Department or the Council under the conditions listed in this site certificate is subject to the provisions of ORS 192.502 *et seq.* and ORS 469.560. To the extent permitted by law, the Department and the Council will not publicly disclose information that may be exempt from public disclosure if the certificate holder has clearly labeled such information and stated the basis for the exemption at the time of submitting the information to the Department or the Council. If the Council or the Department receives a request for the disclosure of the information, the Council or the Department, as appropriate, will make a reasonable attempt to notify the

certificate holder and will refer the matter to the Attorney General for a determination of whether the exemption is applicable, pursuant to ORS 192.450.

Council shall have continuing authority over the site and may inspect, or direct the Oregon Department of Energy (Department) to inspect, or request another state agency or local government to inspect, the site at any time in order to ensure that the facility is being operated consistently with the terms and conditions of this site certificate (ORS 469.430).

The duration of this site certificate shall be the life of the facility, subject to termination pursuant to OAR 345-027-0110 or the rules in effect on the date that termination is sought, or revocation under ORS 469.440 and OAR 345-029-0100 or the statutes and rules in effect on the date that revocation is ordered. The Council shall not change the conditions of this site certificate except as provided for in OAR Chapter 345, Division 27.

In interpreting this site certificate, any ambiguity will be clarified by reference to the following, in order, incorporated herein by this reference: 1) *Final Order on the Application for Site Certificate for the Sunstone Solar Project* issued on November 18, 2024 (hereafter, *Final Order on the ASC*); 2) the record of the proceedings that led to the Final Order on the ASC.

The definitions in ORS 469.300 and OAR 345-001-0010 apply to the terms used in this site certificate, except where otherwise stated, or where the context clearly indicates otherwise.

2.0 Facility Location and Site Boundary

The facility is located within an approximately 1,246.5 ~~10,960-~~acre (1.9 ~~17~~ sq. mile) site in Morrow County. The site is located on both sides of State Route 207 and is approximately 15 miles northeast of the Town of Lexington and approximately 4.5 miles west of Butter Creek Junction. The site is approximately 3 miles west of the Umatilla County line at its closest point. Table 1 below provides the Township, Range, and Sections occupied wholly, or in part, by the site. Up to 1,215.6 acres~~9,442~~ of land within the site boundary would be occupied by facility components. The regional location of the facility site boundary~~, transmission line corridor,~~ and ~~approximately 1,518 acres~~ areas within the site boundary ~~are~~ excluded from development, as applicable, are~~as~~ shown on Attachment 1~~ASC Exhibit C, Figures C- 2, and C-2.1 to C-2.3, attached~~ to this site certificate ~~as Attachment 1~~.

Table 1: Township, Range, and Section for Areas Occupied by the Site Boundary

Township	Range	Sections
1N	26E	~~1, 2, 3,~~ 4, 5, 8, 9, 10~~, 11, 12, 14, 15~~
~~2N~~	~~26E~~	~~27, 28, 29, 30, 31, 32, 33, 34, 35, 36~~
Reference: SSPAPPDoc25-03 ASC Exhibit C Project Location, Table C-1. 2024-05-15.		

3.0 Facility Description

The energy facility is approved to include the components presented in Table 2 below. Additional details regarding specific components, and discussion of alternative designs or technologies under consideration are provided in the sections that follow.

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Site Boundary		
Site Boundary	1,246.5 ~~10,960~~	acres
Maximum Footprint	1,215.6 ~~9,442~~	acres
Permanent Impacts[1]	1,215.6 ~~9,442~~	acres
Solar Components		
PV Solar Modules		
Approx. total number	656,256~~3,937,536~~	modules
Max Height at full-tilt	15	feet
Posts		
Approx. total number (assumes concrete foundation)	89,176~~535,056~~	posts
Cabling		
Combiner Boxes	10,254~~61,524~~	each
Inverter Step Up (ISU) Transformer Units		
Approx. total number	54 ~~319~~	each
Noise level	89	dBA
Transformer oil-containing capacity	800	gallons
Related or Supporting Facility Components		
34.5 kV Collection System		
Collector line length, belowground	13 ~~82~~	miles
Collector line length, overhead (OH)	0.7 ~~4.3~~	miles
Wood Monopoles (max estimate for OH)	26 ~~151~~	each
Collector Substations		
Substations w SCADA; GSU transformers ~~per~~ each	1~~6~~; 1	each
Site size	1.6	acres
Transformer oil-containing capacity	16,000	gallons~~/each~~
Transformer noise level	100	dBA
Max height of structures	45	feet
~~Switchyards~~		

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[1] The energy facility would occupy approximately 1,215.6 ~~9,442~~ acres within up to 20 separately fenced areas. Most related or supporting facilities will be located within the energy facility's footprint; however, portions of the overhead 34.5 kV collector and 230-kV transmission lines running between solar array areas would result in additional temporary and permanent disturbance areas.

Table 2: Facility Component Summary

~~Component and Design Standard~~	~~No.~~	~~Unit~~
~~Stations; Transformers per each~~	~~2; 0~~	~~each~~
~~Site size (northern and/or within solar fence line); with foundations and graveled areas~~	~~3~~	~~acres~~
~~230 kV Transmission Line~~		
~~Length (total; northern line; southern line)~~	~~9.5; 3.2; 6.3~~	~~miles~~
~~Structures: Type (Wood or Galvanized Steel); quantity~~	~~H-frame; 50~~	~~each~~
~~Height of structures~~	~~70-180~~	~~feet~~
Battery Energy Storage System (Lithium-ion/Zinc)		
Zinc		
Approx. total battery containers on foundations with fans/heating systems; SCADA	2,491~~14,946~~	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	9.5 x 8 x 20	H x W x L; feet
Noise level (broadband)	66	dBA
Lithium-ion		
Approx. total battery containers on foundations with HVAC and fire suppression systems; SCADA	~~1~~2,000	each
Site size	0.2 to 0.4	acres
Approx. container dimensions	11.25 x 8.1 x 5.2	H x W x L; feet
Noise level (broadband)	66	dBA
~~O&M Building~~		
~~Quantity~~	~~4~~	~~each~~
~~Site size~~	~~2.8~~	~~acres~~
~~Height~~	~~20~~	~~feet~~
~~Appurtenances~~	~~On-site well, septic system, SCADA System~~	
Storage for Replacement Solar Panels		
Containers	8-9~~50~~	each
Approx. container dimensions	8.5 x 8 x 40	H x W x L; feet
Location	Dispersed within fence line ~~if not next to O&M~~, gravel base	
Facility Roads		
Length	6.8 ~~55~~	miles
Width	10- 20	feet
Perimeter Fence		
Length	7 ~~58~~	miles
Height	7-8	feet

Table 2: Facility Component Summary

Component and Design Standard	No.	Unit
Access/gates	8-9~~52~~	each
Temporary Construction Areas		
Quantity	4~~54~~	each
Site size	5	acres
Description	Gravel base; diesel/gas storage; within fence line	

Energy Facility

The facility includes a solar photovoltaic power generation facility with up to ~~1,~~200 MW of electric generation capacity. ~~The energy facility consists of up to 20 separately fenced solar arrays organized into six 200 MW blocks.~~

Photovoltaic Modules

Solar photovoltaic modules, or solar panels, convert sunlight into DC electric power. The typical module contains crystalline silicon photovoltaic cells arranged within glass panels equipped with an anti-reflective coating, a metal frame, and wire connectors.

Racking System

The photovoltaic modules are connected in series into strings and then mounted on a racking system. Each rack would contain 2 strings of 32 modules mounted on a single-axis tracking system. Multiple racks are organized into rows between 200 and 400 feet in length depending on topography. Rows would be spaced at least 10 feet apart and at least 15 feet from perimeter fencing to provide vehicle access.

Posts

Each row of tracker mounted modules is supported by multiple hollow, screw pile, or pile-type steel posts. Posts are typically installed to a depth of 6-8 feet below surface and extend 5 feet above grade. Posts at the end of rows may be installed at greater depths to withstand wind uplift. Posts may be installed directly in the ground or concrete backfill may be required in some soil conditions.

DC Cabling System

Combiner boxes or a Big Lead Assembly (BLA) harness system is used to aggregate the DC output of the photovoltaic modules for transmission to an inverter by low-voltage DC cables. Using the combiner boxes, strings of modules are connected to a pad-mounted combiner box installed at each row, which in turn, are connected to the inverters by low voltage DC cables

that are either mounted to the tracking system, installed in trays, or buried underground. Using the BLA system, strings are connected directly to a rack-mounted cabling system.

Inverters and Inverter Step Up (ISU) Transformers

Inverters convert the DC output of the photovoltaic modules to AC power that can be transmitted to the electric grid. A typical inverter in utility scale solar facilities converts the 900 to 1,500 volt DC module output to 660 volt AC output. After conversion, the output is sent to an inverter step-up (ISU) transformer to increase the voltage to 34.5 kV power for transmission to the collector substation via the electrical collector system. Inverters and ISU transformers are collocated on concrete slabs near each module block.

Related or Supporting Facilities

Related or supporting facilities include a battery energy storage system, ~~an interconnection substation,~~ one~~up to six~~ collector substation~~s~~, ~~up to four operations and maintenance buildings,~~ and other structures.

Battery Energy Storage System

The battery energy storage system (BESS) is designed to provide up to 1~~7~~.2 gigawatt-hours (GWh) of storage capacity. The BESS may use either Lithium-Ion (Li-ion) or Zinc-based battery technology. Under either technology, batteries are contained in pre-constructed modular containers, or “segments,” placed on concrete slab foundations.
The battery storage system includes, but is not limited to, the following elements:

- Batteries and containers, inverters, isolation transformers, and switchboards;
- Balance of plant equipment, which may include medium-voltage and low-voltage electrical systems, fire suppression and HVAC systems (for Li- ion technology, if selected), building auxiliary electrical systems, and network/SCADA systems;
- Cooling system, which may include a separate chiller plant located outside the battery racks with chillers, pumps, and heat exchangers (Li-ion only, if selected); zinc batteries will have fans and a heating unit for climate control; and
- High-voltage (HV) equipment, including a step-up transformer, circuit breaker, current transformers and voltage transformers, a packaged control building for the breaker and transformer equipment, towers, structures, and cabling.

The batteries and associated equipment may be oversized or periodically augmented in accordance with the manufacturer’s recommendations to ensure a minimum of 1~~7~~,200 MWh of energy storage capability over the life of the BESS, taking into account natural degradation of the batteries over time.

Li-ion batteries are currently the most common battery type used in utility-scale battery energy storage systems. If a Li-ion battery technology is used at the facility, it would use Li-ion phosphate batteries, which are more thermally stable than Li-ion cathode batteries. Each module contains approximately 10 hermetically sealed battery cells filled with a gel or liquid electrolyte. The module containers serve as secondary containment for the cells. Each container holds approximately 840 cells with a combined capacity of approximately 740 kilowatt-hour AC, and approximately ~~1~~2,000 containers would be required to meet the capacity needs of the facility.

The electrolyte used in Li-ion batteries is flammable and susceptible to overheating and vaporization, so Li-ion Battery Systems typically require cooling, ventilation, and fire suppression systems included in each container. If Li-ion battery technology is used at the site, it would implement the following design features and fire prevention and control methods to minimize fire and safety risks:

- Batteries would be stored in completely contained, leak-proof modules.
- Ample working space would be provided around the BESS for maintenance and safety purposes.
- An off-site, 24-hour monitoring system with shutdown capabilities would be implemented.
- Batteries would be transported in accordance with Department of Transportation Pipeline and Hazardous Material Administration regulations under 49 CFR 173.185
- Battery systems would be designed in accordance with applicable Underwriters Laboratories, National Electric Code, and National Fire Protection Association Standards, including but not limited to, UL 1642, 1741, 1973, and 9540A, and NFPA 855.
- An advanced and proven battery management system would be employed;
- Battery Containers would be equipped with:
  - Heating, ventilation, and air conditioning (HVAC) systems to maintain optimal battery temperatures;
  - Fire control panels with 24-hour battery backup;
  - Fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems;
  - Doors equipped with a contact that will shut down the battery container if opened;
  - Fire extinguishing and thermal insulation sheets between each individual battery cell;
  - Locks and fencing to prevent entry of unauthorized personnel;
  - Remote power disconnect switches with clear and visible signs identifying their location.[2]

Li-ion battery modules under consideration for this facility have an expected useful life of 20 years and it is expected that every module at the facility would need to be replaced at least once during the life of the facility. Used Li-ion batteries are generally considered to be

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[2] SSPAPPDoc25-02 ASC Exhibit B Project Description 2024-05-15, Section 2.7.1.

hazardous waste by the EPA and must be transported and disposed of according to the most current guidelines at end of life.

A typical zinc-based BESS container includes 144 zinc-hybrid cathode powered batteries with a combined 700 kWh capacity. Zinc batteries are estimated to have a lifespan of at least 20 years. Zinc battery systems can operate across a higher range of temperatures and only require cooling fans rather than a full HVAC system. Zinc batteries have a lower fire-risk than lithium-ion batteries and do not require fire suppression systems to be included in the container design.

The BESS may be designed either as a DC-coupled system, with containers distributed throughout the energy facility site near inverter/transformer station sites, or as an AC-coupled system with containers concentrated in a single area near the~~ switchyards~~ substation. In either case, the containers and other BESS equipment are located within the fenced solar array areas and may have their own additional fencing.

34.5 kV Electrical Collection System

The facility includes up to 13~~86~~ miles of 34.5 kV electrical collector lines that connects energy facility components to the collector substation~~s~~ described below. The majority of the collector lines are buried underground; however, overhead lines are installed at long "home run" stretches, stream or canyon crossings, and other areas where burial is infeasible. The collector lines are generally located within the energy facility footprint except at road crossings and crossings between fenced solar array areas.

Communication and SCADA System

The facility includes a system of fiber optic and copper communication lines that connect the solar arrays, BESS, and substation~~s~~ to Supervisory Control and Data Acquisition (SCADA) system control rooms within the~~each~~ collector substation (to be shared with all projects, see below). The communication lines are collocated with the 34.5 kV electrical collection system described above. The SCADA system monitors meteorological conditions, critical operating parameters, and power output, for each solar string, battery energy storage system, and substation. The SCADA system is monitored by a remote operations center. Smoke and fire detectors placed around the site also connect to the SCADA system and will contact local emergency responders in the event of a fire at the site.

Collector Substations

The facility includes up to one~~six~~ collector substation~~s~~ at the site. The~~Each~~ substation includes a generator-step up (GSU) transformer and control building, and may also include circuit-breakers and fuses, transmission line termination structures, power transformers, bus bars and insulators, disconnect switches, relaying, battery and charger, surge arresters, AC and DC

supplies, control systems, metering equipment, grounding, a lightning protection system and associated control wiring.

The GSU transformer~~s~~ increases the 34.5-kV ISU transformer output to 230-kV power. The GSU transformer~~s~~ is~~are~~ ground-mounted units constructed on concrete pads. The~~Each of the six~~ GSU transformer is~~s are~~ filled with up to 16,000 gallons of non-toxic oil such as mineral or seed oil.

The~~Each~~ GSU transformer is equipped with a secondary spill containment catchment system designed to minimize the possibility of accidental leakage. The concrete catchment system is sized to contain approximately 1.25 times the amount of oil inside the transformer.

All substation structures and components are surrounded by a graveled area and enclosed by an 8-foot-tall chain-link fence with three strands of barbed wire one foot above the top. Access to substation sites is limited with a locked gate.

~~230-kV Transmission Line~~

~~The facility includes up to two 230-kV overhead transmission lines that connect the collector substations to the two primary interconnection switchyards located at the point of interconnection. The transmission lines are supported by steel or wood monopole or H-Frame structures, spaced approximately 1,000 feet between structures, and ve a combined length of approximately 9.5 miles. The northern line connects two collector substations along the south side of Alpine Lane to the switchyard and extends approximately 3.2 miles. The southern line connects four collector substations across the southern portion of the site and extend approximately 6.3 miles. The two lines run in parallel for approximately 1-mile between Bombing Range Road and the switchyards.~~

~~The transmission lines are located within the fenced solar array areas except where the lines span roads or corridors between areas and between the switchyards and the point of interconnection. All transmission line components are sited within the facility lease boundary.~~

~~No new or expanded right-of-way will be required, but some portions of the transmission lines are located within existing public rights-of-way. A portion of the transmission line that runs along the western boundary of energy facility footprint is within the public right-of-way on the east side of Bombing Range Road. Additionally, portions of the transmission line that connect solar array areas in the southern portion of the site cross Doherty Road and the Lexington-Echo Highway.~~

~~Project Switchyards and~~ Interconnection Facilities

The facility interconnects with the existing Umatilla Electric Cooperative 230kV Blue Ridge Line at the northwest corner of the facility where the shared switchyard is located (see below). ~~Two switchyards are approved to be located within a separately fenced site either within or adjacent to the energy facility footprint, each~~

~~approximately 3 acres. The interconnection switchyards do not contain transformers and are constructed on foundations with surrounding gravel areas.~~

~~Operations and Maintenance Buildings~~

~~The facility includes up to four operations and maintenance (O&M) buildings, each including a utility room, storage for maintenance supplies and equipment, and a SCADA control room. The buildings each have an on-site well and septic system. Power is supplied by a local service provider using overhead and/or underground lines. Each O&M building site also has graveled parking and storage areas.~~

~~Small quantities of chemical materials, including cleaners, insecticides or herbicides, paint, lubricants, degreasers, and solvents, may be stored at the O&M buildings during construction and operation of the facility. No extremely hazardous materials would be stored on site; other chemicals will be handled in accordance with label instructions as well as state and federal standards.~~

~~The facility includes an aboveground fuel storage tank with capacity to store up to 500 gallons of diesel fuel or gasoline at each O&M building site.~~

~~The O&M buildings are equipped with basic firefighting equipment for use on-site during maintenance activities, such as shovels, beaters, portable water for hand sprayers, fire extinguishers, and other equipment.~~

Replacement Solar Panel Storage

To store spare solar panels and associated equipment, the facility is approved to store materials either at the O&M building sites~~ ~~(to be shared with all projects, but not related/supporting infrastructure for this phase, see below) or within approximately 50 locked Conex storage containers distributed throughout the site (to be shared with all projects, see below). The containers may be placed directly on the ground or on gravel pads. The containers would store up to the approximately 204,720 replacement panels needed over the life of the facility.

Access and Service Roads

The facility includes up to 6.8~~ 55~~ miles of new roads (graded and graveled to meet load requirements for all equipment) to provide access to facility components; some roads will be shared with all projects, see below. Corridors between module racking are at least 10 feet wide and racking are no closer than 15 feet from perimeter fencing. Some new road construction is required to access site features. Roads will be 10 to 20 feet in width, with some exceptions, including access to the substation~~s~~ and main travel corridors where two-way traffic is required. In these cases, roads will be 20 feet wide. A 5-foot maintained vegetative surface or noncombustible base, approved by the fire code official, will be maintained along the fenced perimeter of the site boundary. Use of the roads may continue

after construction, or new roads may be removed and the land reclaimed to pre-construction conditions.

Security Fencing and Gates

The facility includes approximately 7 ~~58~~ miles of security fence to enclose each solar array area, and substation~~, and switchyard site~~. The perimeter fencing has lockable vehicle and pedestrian access gates to provide access to the site.

Temporary Construction Areas

The facility includes up to 4~~54~~ temporary construction areas within the energy facility footprint to support construction, store supplies and equipment, and facilitate the delivery and assembly of materials and equipment. Each area consists of a 5-acre site that would be cleared and graveled prior to construction.

Up to five above-ground diesel tanks and one temporary above-ground gasoline tank may be stored in the temporary construction areas (to be shared with all projects, see below). The tanks each hold up to 1,000 gallons of fuel. Most fuel containers have self-contained secondary containment (e.g., double-walled containers) that provide capacity for the entire container plus precipitation, but in some cases may be placed in a constructed secondary containment area that is impervious and is diked or otherwise contained to provide the required fuel and precipitation capacity.

Shared Related or Supporting Facilities

The certificate holder is authorized to share related or supporting facilities between the Sunstone Solar Projects 1-6, including the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary constructions areas (including fuel tanks). These related or supporting facilities are split accordingly between the Sunstone Solar Projects 1-6, as demonstrated in their associated site certificates. Similarly, compliance with site certificate conditions and EFSC standards which apply to these shared related or supporting facilities are also split accordingly between Sunstone Solar Projects’ 1-6 site certificates and certificate holders. In accordance with Condition GEN-GS-07 if either certificate holder substantially modifies a shared related or supporting facility or ceases facility operation, the applicable/relevant certificate holder is obligated to submit an amendment determination request or request for amendment to the Department to determine the appropriate process for evaluating the change and ensuring full regulatory coverage under each site certificate, or remaining site certificate if either is terminated, in the future. Additionally, each certificate holder is obligated to demonstrate to the Department that a “Common Facilities Agreement” or similarly legally binding agreement has been fully executed between certificate holders to ensure approval and agreement of access to the shared resources has been obtained prior to operation of shared facilities.

4.0 Facility Development

4.1 Construction

The initial applicant proposed to construct the originally permitted~~proposed~~ facility in six phases, with each phase including approximately 200 MWs of generating capacity, one of which is the subject of this Site Certificate.

Portions of the site, including the substation~~sites~~, inverter and battery energy storage system sites, and access roads will be cleared and graded, prior to construction of the applicable facility components. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems in the energy facility footprint are left intact during construction to the maximum extent practicable to minimize soil and erosion impacts, and that grading in solar arrays is limited to those areas where the slope and gradient are outside of panel and racking tolerances. Typical grading tolerances within the array are 10% maximum on North slopes and 15% maximum in other directions. Following construction, operational requirements include long-term site stabilization and revegetation of disturbed areas.

Adherence to the requirements of a Fugitive Dust Control Plan is required under Condition PRE-SP-02. Measures implemented under this plan include maintaining existing vegetative root systems, applying dust suppressants, and restricting traffic speeds on-site. Typically, water is

applied as a dust suppressant on access roads, but under drought conditions, alternative dust suppressants including synthetic polymer emulsions, chemical suppressants, organic glues, and wood fiber materials may be applied at the site by qualified vendors.

Construction of the originally permitted facility for all six projects will generate 910 commuting trips and 250 truck trips per day over approximately 1,224 construction workdays. At the peak of construction, it is estimated a maximum of approximately 1,266 commuting trips per day and 250 truck trips per day. The primary route to the site would be Bombing Range Road via Interstate Highway 84 (I-84) at the I-84/Irrigon Junction. Alternate routes would be via OR-207 via I-84 south of Hermiston.

4.2 Operations and Maintenance

Operation and maintenance activities include routine inspections, replacement of solar modules and battery components, panel washing, and vegetation management. Up to 10 permanent employees would operate and maintain the facility (staff to be shared by all six projects), with occasional delivery truck accessing the site during operations depending on the type of maintenance activity.

Individual batteries associated with the BESS will be inspected according to the manufacturer's recommendations and will need to be replaced approximately every 20 years, and every battery will be replaced during the life of the facility. Each type of electrical facility component would have routine inspections as designated in the operational Wildfire Mitigation Plan. The solar panels may require periodic washing during operations, and other incidental water use for sanitation and equipment washing.

Vegetation will be cleared and maintained along access roads to provide a vegetation clearance area for fire safety. This includes mowing to a height of no more than 12 inches. Use of the roads may continue after construction, or new roads may be removed, and the land reclaimed to pre-construction conditions.

An aboveground 500-gallon fuel storage tank sized may be installed at each O&M building (to be shared with all projects, but not related/supporting infrastructure for this phase). Secondary containment and refueling procedures for on-site fuel storage during operations will continue to follow the SPCC Plan and requirements for secondary containment. No extremely hazardous materials are expected to be produced, used, stored, transported, or disposed of at the facility during operation.

4.3 Retirement

The estimated useful life of the proposed facility is 40 years. Operational jobs would be eliminated after the facility ceased operating; however, some short-term contract jobs to monitor restored areas may be added to facilitate retirement activities. Decommissioning requires similar workforce numbers as required for the construction of the originally permitted facility/six projects in total and is estimated to require a similar duration of up to 47 months.

Final retirement activities will be designated in a retirement plan but would begin with disconnecting all electrical equipment disassembling equipment and components such and the battery storage units, solar panels and transformers. Larger containers and equipment would be removed, trucked off-site and recycled and disposed of. Solar panels would be disconnected, and piles would be removed including the excavation of any concrete foundations. Gravel and foundations from the inverters and transformers, O&M buildings (to be shared with all projects, but not related/supporting infrastructure for this phase), substation~~s~~, and battery unit~~s~~ would be removed by trenching and excavation. The facility site would then be restored through grading, filling, and revegetation with plants or seed mix consistent with applicable plans and conditions discussed in this order or landowner interests.

5.0 Site Certificate Conditions

The conditions of this Site Certificate are organized and coded to indicate the phase of implementation, the standard the condition is required to satisfy, and an identification number (1, 2, 3, etc.).[3] The table below presents a "key" for phase of implementation:

Key	Type of Conditions/Phase of Implementation
GEN	General Conditions: Design, Construction and Operation
PRE	Pre-Construction Conditions
CON	Construction Conditions
PRO	Pre-Operational Conditions
OPR	Operational Conditions
RET	Retirement Conditions

To align with the phased construction approach, preconditions requiring applicant actions prior to construction allow for phased compliance. These apply specifically to the area in which the phased activities would occur, rather than the entirety of the site.

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[3] The identification number is not representative of an order that conditions must be implemented; it is intended

only to represent a numerical value for identifying the condition.

5.1 General (GEN) Conditions: Design, Construction and Operations

Condition Number	General (GEN) Conditions
STANDARD: GENERAL STANDARD OF REVIEW (GS) [OAR 345-022-0000]	
GEN-GS-01	The certificate holder must design, construct, operate and retire the facility: a. Substantially as described in the site certificate; b. In compliance with the requirements of ORS Chapter 469, applicable Council rules, and applicable state and local laws, rules and ordinances in effect at the time the site certificate was issued; and c. In compliance with all applicable permit requirements of other state agencies. [Mandatory Condition OAR 345-025-0006(10); General Standard Condition 1; Final Order on ASC]
GEN-GS-02	The certificate holder must begin and complete construction of the facility ~~or facility phase~~ by the following dates: a. Construction of the facility ~~or first facility phase~~ must begin on or before November 18, 2028~~7~~. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site. ~~b. Construction of the final facility phase must begin on or before November 18, 2028. Within 7 days of construction commencement, the certificate holder must provide the Department with written verification that it has met the deadline by satisfying applicable preconstruction conditions and completing at least $250,000 work at the site.~~ c. All facility construction must be completed on or before November 18, 2030~~within 2 years after the date construction of the final facility phase (under (b)) begins~~. Within 7 days after completing construction, the certificate holder shall provide the Department written verification that it has met the deadline. [General Standard Condition 2; Final Order on ASC]
GEN-GS-03	If the certificate holder becomes aware of a significant environmental change or impact attributable to the facility, the certificate holder must, as soon as possible, submit a written report to the Department describing the impact on the facility and any affected site certificate conditions. [Mandatory Condition OAR 345-025-0006(6); General Standard Condition 3; Final Order on ASC]
GEN-GS-04	The certificate holder must prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder. [Mandatory Condition OAR 345-025-0006(7); General Standard Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-GS-05	Upon completion of construction, the certificate holder must restore vegetation to the extent practicable and must landscape all areas disturbed by construction in a manner compatible with the surroundings and proposed use. Upon completion of construction, the certificate holder must remove all temporary structures not required for facility operation and dispose of all timber, brush, refuse and flammable or combustible material resulting from clearing of land and construction of the facility. [Mandatory Condition OAR 345-025-0006(11); General Standard Condition 6; Final Order on ASC]
~~GEN-GS-06~~	~~The certificate holder is authorized to construct the 230 kV transmission lines anywhere within the approved transmission line corridors, subject to the conditions in the site certificate. The approved transmission line corridor includes:~~ ~~a. Southern transmission line: Approximately 6.3 miles, extending between the facility switchyard to four collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~b. Northern transmission line: Approximately 3.2 miles, extending between the facility switchyard to two collector substations, as further described in ASC Exhibit B and C as presented in Attachment 1 of the site certificate.~~ ~~[Site Specific Condition OAR 345-025-0010(5); General Standard Condition 7; Final Order on ASC]~~
GEN-GS-07	The certificate holder may operationally share the following related or supporting facilities between Sunstone Solar Projects 1-6: the switchyard, transmission line, O&M buildings, replacement solar panel storage (as needed), access roads, SCADA system, and temporary construction areas, subject to the following: a. Within 30 days of use by certificate holders of the shared facilities, the certificate holder must provide evidence to the Department that the certificate holders of the shared facilities have an executed agreement for shared use of any constructed shared facilities. The Shared Use Agreements must allow operation and maintenance personnel and contractors access to the shared facilities of Sunstone Solar Projects 1-6.
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
GEN-OE-01	Before any transfer of ownership of the facility or ownership of the site certificate holder, the certificate holder must inform the Department of the proposed new owners. The requirements of OAR 345-027-0400 apply to any transfer of ownership that requires a transfer of the site certificate. [Organizational Expertise Condition 1; Final Order on ASC]
GEN-OE-02	Any matter of non-compliance under the site certificate is the responsibility of the certificate holder. Any notice of violation issued under the site certificate will be issued to the certificate holder. Any civil penalties under the site certificate will be levied on the certificate holder. [Organizational Expertise Condition 4; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-OE-03	The certificate holder must notify the Department within 72 hours of any occurrence of the following: a. There is an attempt by anyone to interfere with the facility’s safe operation. b. There is a significant nature event such as a fire, earthquake, flood, tsunami or tornado, or human-caused event such as a fire or explosion. c. There is any fatal injury at the facility. [Organizational Expertise Condition 5; Final Order on ASC]
GEN-OE-04	The certificate holder shall, as soon as reasonably possible: a. Report incidents or circumstances that may violate the terms or conditions of the site certificate, terms or conditions of any order of the Council, or the terms or conditions of any order issued under OAR 345-027-0230, to the Department. In the report to the Department, the certificate holder shall provide all pertinent facts including an estimate of how long the conditions or circumstances existed, how long they are expected to continue before they can be corrected, and whether the conditions or circumstances were discovered as a result of a regularly scheduled compliance audit; b. Initiate and complete appropriate action to correct the conditions or circumstances and to minimize the possibility of recurrence; c. Submit a written report within 30 days of discovery to the Department. The report must refer to the language in (d) of the condition and contain: i. A discussion of the cause of the reported conditions or circumstances; ii. The date of discovery of the conditions or circumstances by the responsible party; iii. A description of immediate actions taken to correct the reported conditions or circumstances; iv. A description of actions taken or planned to minimize the possibility of recurrence; and v. For conditions or circumstances that may violate the terms or conditions of a site certificate, an assessment of the impact on the resources considered under the standards of OAR Chapter 345 Divisions 22 and 24 as a result of the reported conditions or circumstances. d. Upon receipt of the written report in sub(c) of this condition, the Department may review the facility record for incidents or circumstances reported or reportable under sub(a) related to public health and safety, the environment, or other resources protected under Council standards. If these incidences are determined by the Department to impact the adequacy of the facility decommissioning cost, the Department or Council may adjust the contingencies identified in Final Order on ASC Table 4 and shall request and receive an updated bond or letter of credit from certificate holder in the adjusted amount. [Organizational Expertise Condition 6; Final Order on ASC]
STANDARD: Structural Standard (SS) [OAR 345-022-0020]	

Condition Number	General (GEN) Conditions
GEN-SS-01	The certificate holder must design, engineer and construct the facility to avoid dangers to human safety and the environment presented by seismic hazards affecting the site that are expected to result from all maximum probable seismic events. "Seismic hazards" include ground shaking, ground failure, landslide, liquefaction triggering and consequences (including flow failure, settlement buoyancy, and lateral spreading), cyclic softening of clays and silts, fault rupture, directivity effects and soil-structure interaction. [Mandatory Condition OAR 345-025-0006(12); Structural Standard Condition 1; Final Order on ASC]
GEN-SS-02	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if site investigations or trenching reveal that conditions in the foundation rocks differ significantly from those described in the application for a site certificate. After the Department receives the notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(13); Structural Standard Condition 2; Final Order on ASC]
GEN-SS-03	The certificate holder must notify the Department, the State Building Codes Division and the Department of Geology and Mineral Industries promptly if shear zones, artesian aquifers, deformations or clastic dikes are found at or in the vicinity of the site. After the Department receives notice, the Council may require the certificate holder to consult with the Department of Geology and Mineral Industries and the Building Codes Division to propose and implement corrective or mitigation actions. [Mandatory Condition OAR 345-025-0006(14); Structural Standard Condition 3; Final Order on ASC]
GEN-SS-04	The certificate holder shall design, engineer, and construct the facility in accordance with the versions of the International Building Code, Oregon Structural Specialty Code, and local building codes in effect at the time of construction. [Structural Standard Condition 5; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
GEN-LU-01	The certificate holder shall provide evidence to the Department of coordination with the owners of adjacent lands dedicated to agricultural use. Coordination must include information about the facility that could impact agricultural activities. The certificate holder must document any recommendations made by adjacent landowners regarding measures to reduce or avoid any adverse impacts to farm practices on surrounding lands and to avoid any increase in farming costs as well as any responses made to these recommendations. [Land Use Condition 9; Final Order on ASC]

Condition Number	General (GEN) Conditions
GEN-LU-02	The certificate holder must adhere to the terms of the Memorandum of Agreement for Agricultural Mitigation Fund included in Attachment F of the Final Order on the ASC, or subsequently amended. It is the certificate holder's responsibility to ensure that the Council and Department receive all reports and notifications required by the agreement. [Land Use Condition 12; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
GEN-RF-01	The certificate holder shall prevent the development of any conditions on the site that would preclude restoration of the site to a useful, non-hazardous condition to the extent that prevention of such site conditions is within the control of the certificate holder.
	[Mandatory Condition OAR 345-025-0006(7); Retirement and Financial Assurance Condition 1; Final Order on ASC]
STANDARD: Siting Standards for Transmission Lines (TL) [OAR 345-024-0090]	
~~GEN-TL-01~~	~~The certificate holder shall:~~ ~~a. Design, construct and operate the transmission lines in accordance with the requirements of the National Electrical Safety Code as approved by the American National Standards Institute; and~~ ~~b. Develop and implement a program that provides reasonable assurance that all fences, gates, cattle guards, trailers, or other objects or structures of a permanent nature that could become inadvertently charged with electricity are grounded or bonded throughout the life of the line.~~ ~~[Siting Standards for Transmission Line Condition 1; Final Order on ASC]~~

5.3 Pre-Construction (PRE) Conditions

Condition Number	Preconstruction (PRE) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
PRE-GS-01	Except as necessary for the initial survey, the certificate holder may not begin construction of the facility or phase, or create a clearing on any part of the site of the facility or phase, as applicable, until the certificate holder has the legal right to engage in construction activities on the relevant parts of the site for the facility or phase. [Mandatory Condition OAR 345-025-0006(5); General Standard Condition 5; Final Order on ASC]
PRE-GS-02	At least 90 days prior to construction of the facility or phase, as applicable (unless otherwise agreed to by the Department), the certificate holder shall submit to the Department a compliance plan documenting and demonstrating actions completed or to be completed to satisfy the requirements of all site certificate terms and conditions and applicable statutes and rules. The plan shall be provided to the Department for review and compliance determination for each requirement. The Department may request additional information or evaluation deemed necessary to demonstrate compliance. [OAR 345-026-0048, General Standard Condition 8; Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRE-OE-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall notify the Department of the identity and qualifications of the major design, engineering and construction contractor(s). The certificate holder shall select contractors that have substantial experience in the design, engineering and construction of similar facilities. The certificate holder shall report to the Department any changes of major contractors. [Organizational Expertise Condition 2; Final Order on ASC]
PRE-OE-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall select a construction contractor with a low rate of historic environmental and safety compliance citations. Certificate holder shall provide the following documentation to the Department: a. Qualifications and contact information of the of the major design, engineering and construction contractor(s) and subcontractors, as applicable. b. Construction contractor compliance history. c. Contract excerpt affirming that contractors are required to comply with the terms and conditions of the site certificate, including selecting design layout and construction materials that minimize impacts to resources protected under Council standards. [Organizational Expertise Condition 7; Final Order on ASC]
PRE-OE-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide to the Department the qualifications and contact information of the certificate holder’s construction manager.

Condition Number	Preconstruction (PRE) Conditions
	[Organizational Expertise Condition 8; Final Order on ASC]
PRE-OE-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Provide the Department a list of federal, state and local permits, including any third-party permits related to facility siting; and a schedule for obtaining identified permits. b. Once obtained, provide copies of all permits, including third-party permits, required for facility siting to the Department. [Organizational Expertise Condition 12; Final Order on ASC]
STANDARD: Structural (SS) [OAR 345-022-0020]	
PRE-SS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a site-specific geotechnical investigation report, consistent with the Oregon State Board of Geologist Examiners Guideline for Preparing Engineering Geologic Reports, or newer guidelines if available to the Department, for review in consultation with its third-party consultant. [Structural Standard Condition 4; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRE-SP-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide a Vegetation and Grading Plan that demonstrates contractors are required to adhere to the following: a. Existing vegetation (e.g., crop stubble, fallow vegetation) and associated root systems shall be left intact to the maximum extent practicable. b. Grading within solar arrays shall be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically 10% maximum on North slopes and 15% maximum in other directions). [Soil Protection Condition 1; Final Order on ASC]
PRE-SP-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Obtain a NPDES 1200-C Permit from DEQ. A copy of the approved permit and attached Erosion and Sediment Control Plan (ESCP) must be submitted to the Department. b. Finalize the Fugitive Dust Control Plan, as provided in the Final Order on ASC Attachment D. Finalization includes verification of names and contact information of individuals responsible for implementation, measures to be implemented and forms to be used for monitoring and reporting. [Soil Protection Condition 3; Final Order on ASC]
PRE-SP-03	Prior to construction of the facility or phase, as applicable, the certificate holder must submit to the Department a Construction Spill Prevention Countermeasures and Control (SPCC) Plan. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-01	Prior to construction of the facility or phase, as applicable, the certificate holder must provide to the Department a copy of the approved Conditional Use Permit and applicable Zoning Permit(s). [Land Use Condition 1; Final Order on ASC]
~~PRE-LU-02~~	~~Prior to construction of the 230 kV transmission lines, the certificate holder shall demonstrate to the Department that the transmission lines will be sited within the exiting road rights-of-way, unless Morrow County Public Works Department and Oregon Department of Transportation, as applicable, confirm that use of the existing road rights-of-way is not feasible.~~ ~~[Land Use Condition 2; Final Order on ASC]~~
PRE-LU-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the draft Noxious Weed Control Plan, as provided in the Final Order on ASC Attachment E, and submit to the Department for review and approval in consultation with the Morrow County Weed Department. [Land Use Condition 3; Final Order on ASC]
PRE-LU-04	Prior to construction of the facility or phase, as applicable, the certificate holder must submit an executed document prohibiting the certificate holder, and the certificate holder's successors in interest, from pursuing a claim for relief or cause of action alleging injury from farming or forest practices as defined in ORS 30.930(2) and (4), and provide evidence that the document has been recorded in the deed records for Morrow County. [Land Use Condition 6; Final Order on ASC]
PRE-LU-05	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the final design adheres to the following setbacks: a. All facility structures and above-ground components except the perimeter fenceline must be sited: 1. At least 20 feet from a property line fronting the right-of-way of a local minor collector or marginal access street, including but not limited to Sand Hollow Road, Grieb Lane, Alpine Lane, Doherty Road, or Melville Road. 2. At least 30 feet from a property line fronting the right-of-way, of a major collector, including but not limited to, Bombing Range Road. 3. At least 80 feet from a property line fronting the right-of-way for an arterial road, including but not limited to State Highway 207. b. All facility structures, and all on-site septic systems or other sewage disposal systems must be set back at least 100 feet from delineated waterways. [Land Use Condition 7; Final Order on ASC]
PRE-LU-06	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit a final site plan that includes all information required by MCZO 4.165.E to the County and the Department. The Department may defer review and approval to the County. [Land Use Condition 8; Final Order on ASC]

Condition Number	Preconstruction (PRE) Conditions
PRE-LU-07	Prior to construction of the facility or phase, as applicable, the certificate holder must complete the preconstruction requirements identified in the Memorandum of Agreement for Agricultural Mitigation Fund, as provided in the Final Order on ASC Attachment F, or subsequently amended. [Land Use Condition 11; Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
PRE-RF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit to the State of Oregon, through the Council, a bond or letter of credit naming the State of Oregon, acting by and through the Council, as beneficiary or payee. The approved bond or letter of credit amount of $23,440,771.91~~117p,945,000~~ (Q4~~1~~ 2025~~3~~ dollars) may be adjusted based on the design configuration of the facility, or phase of the facility, as provided in Sub(a) and adjusted to the year and quarter of issuance as provided under Sub(b). a. The bond or letter of credit amount may be adjusted based on actual design/number of components of the facility or phase, as applicable, and shall use the same unit costs and contingencies presented in the Final Order on the ASC Table 8. b. Adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. c. The bond or letter of credit must be issued by a financial institution that is included on the Council's pre-approved financial institution list. The certificate holder may request to have a financial institution added to the list at any time. d. The bond or letter of credit must be prepared using the most recent Council-approved template. [Retirement and Financial Assurance Condition 4; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
PRE-FW-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Revegetation and Reclamation Plan, based on Attachment G of the Final Order on the ASC, and submit to the Department for review and approval. [Fish and Wildlife Habitat Condition 1]
PRE-FW-02	Prior to construction of the facility or phase, as applicable, the certificate holder shall submit the draft legal agreement for review and approval by the Department, in consultation with ODFW. The legal agreement shall ensure that payment provided for long-term management and enhancement of the mitigation area is adequate to cover the permanent habitat loss from the facility.

Condition Number	Preconstruction (PRE) Conditions
	[Fish and Wildlife Condition 4, Final Order on ASC]
PRE-FW-03	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Habitat Mitigation Plan, as provided in Attachment H of the Final Order on ASC, based on the impacts associated with the final facility design and the legal agreement, as approved by the Department. [Fish and Wildlife Condition 5, Final Order on ASC]
PRE-FW-04	Prior to construction of the facility or phase, as applicable, the certificate holder shall provide evidence to the Department that the design measures included in the Construction Wildlife Monitoring Plan (Final Order on ASC Attachment I) have been included in the final facility design and construction contractor contracts, as applicable. [Fish and Wildlife Condition 7; Final Order on ASC]
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
PRE-TE-01	If construction commences after April 2025, certificate holder shall, prior to construction of the facility or phase, as applicable, conduct protocol-level Washington ground squirrel (WAGS) surveys within areas of planned facility construction that are within suitable WAGS habitat. The certificate holder shall: a. Submit a protocol-level survey plan for surveys to be conducted within suitable WAGS habitat, for review and approval by the Department in consultation with ODFW. At a minimum, the survey plan shall specify the survey area (all areas of suitable habitat within 1,000 feet of ground disturbing activities except where there is a habitat barrier (e.g., a paved road) or access restrictions); and survey timing (February 15 to May 31, unless otherwise approved by ODFW). b. Complete protocol-level WAGS surveys based on the protocol approved per (a). c. Submit survey reports to the Department and ODFW. The certificate holder shall not begin construction within 1,000 feet of Category 1 or Category 2 WAGS habitat until the identified boundaries of Category 1 WAGS habitat have been approved by the Department, in consultation with ODFW. Category 1 habitat includes a 785-foot buffer from an identified active burrow, and the area within the perimeter of multiple active burrows. Category 2 WAGS habitat consists of a 4,136-foot buffer from the exterior boundary of all Category 1 WAGS habitat. The survey results are valid for 3-years. d. Develop maps and worker training materials to inform of sensitive Category 1 and Category 2 habitat. Submit to the Department final facility design maps demonstrating that Category 1 habitat, including 785-buffer from any colonies identified per (b), is avoided. e. Install flagging or other demarcation, as appropriate, to inform workers of sensitive WGS habitat and of avoidance requirement. [Threatened and Endangered Species Condition 1; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	

Condition Number	Preconstruction (PRE) Conditions
PRE-HC-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall update the contact information provided in the Final Order on ASC Attachment K, Inadvertent Discovery Plan. [Historic, Cultural and Archeological Condition 1; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
PRE-PS-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall execute a final Road Use Agreement, based on Final Order on ASC Attachment N, and provide a copy to the Department. [Public Services Condition 1, Final Order on ASC]
PRE-PS-02	At least 180-days prior to construction of any phase, the certificate holder shall provide to the Department and Morrow County a temporary housing plan for the construction workforce. The plan shall provide for coordination with contractors and local officials on housing options and strategies to minimize impacts to local housing supply based on an ongoing evaluation of patterns of uses and potential shortages or changes in housing demand. [Public Services Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRE-WF-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall finalize the Construction Wildfire Mitigation Plan, as provided in Attachment L to the Final Order on ASC. The final Construction Wildfire Mitigation Plan shall be submitted to the Department for review and approval. [Wildfire Prevention and Risk Mitigation Condition 1; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRE-WM-01	Prior to construction of the facility, or phase, as applicable, the certificate holder shall require contractors to develop and submit to the Department for review and approval, Construction Waste Management Plan(s) that, at a minimum, include the following: a. All sources and quantities of construction waste and wastewater, including damaged or dysfunctional energy facility components, and where feasible, estimated quantities that can be recycled. b. Process for disposal and recycling, including use of licensed haulers and disposal/recycling facilities; names and locations of licensed recycling and disposal facilities; collection, hauling and tracking requirements. c. Process for requesting a permit exemption from DEQ pursuant to OAR 340-093-0080 to ensure that concrete washout materials reused in foundation backfill are substantially the same as clean fill. d. Process for training workers and tracking compliance with the requirements of the plan. [Waste Minimization Condition 1; Final Order on ASC]
STANDARD: Noise Control Regulations (NC) [OAR 340-035-0035]	

Condition Number	Preconstruction (PRE) Conditions
PRE-NC-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall demonstrate that the operational noise levels comply with OAR 345-035-0035(1)(b), based on an updated acoustic modeling analysis using final design/layout and equipment specifications. [Noise Control Condition 1; Final Order on ASC]
STANDARD: Other – Removal-Fill (WL)	
PRE-WL-01	Prior to construction of the facility, facility component or phase, as applicable, the certificate holder must provide documentation of a valid jurisdictional determination from the Oregon Department of State Lands demonstrating that no waterways subject to the State Removal-Fill law under ORS 196.795 through 196.990 are present within areas to be disturbed during construction or operation. [Removal-Fill Condition 1, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
PRE-WR-01	Prior to construction of the facility or phase, as applicable, the certificate holder shall: a. Identify all water-related needs and estimate daily and annual water demand for each construction phase, as applicable. b. Provide, to the Department, a contract or purchase agreement demonstrating that adequate water supply to meet construction demand has been secured from sources with valid water rights. [Water Rights Condition 1, Final Order on ASC]

5.4 Construction (CON) Conditions

Condition Number	Construction (CON) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
CON-OE-01	The certificate holder shall contractually require all contractors and subcontractors to comply with all applicable laws and regulations and with the terms and conditions of the site certificate. The contractual obligation shall be required of each contractor and subcontractor prior to that firm working on the facility. Such contractual provisions shall not operate to relieve the certificate holder of responsibility under the site certificate. [Organizational Expertise Condition 3; Final Order on ASC]
CON-OE-02	During construction, the certificate holder shall: a. Maintain an onsite construction manager. b. Require that the construction manager implement and monitor all applicable construction related site certificate conditions. c. Within six months after beginning construction, and every six months thereafter during construction of the energy facility and related or supporting facilities, the certificate holder shall submit a semiannual construction progress report to the Department. In each construction progress report, the certificate holder shall describe any significant changes to major milestones for construction. The certificate holder shall report on the progress of construction and shall address the following: i. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. ii. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. iii. Compliance Report: A report describing the certificate holder’s compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate. iv. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0050. [Organizational Expertise Condition 9; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	

Condition Number	Construction (CON) Conditions
CON-SP-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Vegetation and Grading Plan. [Soil Protection Condition 2; Final Order on ASC]
CON-SP-02	During construction of the facility or phase, as applicable, the certificate holder shall: a. Conduct all work in compliance with the NPDES 1200-C Permit and Erosion and Sediment Control Plan (ESCP) or revised ESCP if applicable. The ESCP shall be revised if determined necessary by the certificate holder, certificate holder's contractor(s) or the Department. Any Department-required ESCP revisions shall be implemented within 14-days, unless otherwise agreed to by the Department based on a good faith effort to address erosion issues. b. Conduct all work in compliance with the Fugitive Dust Control Plan. The Fugitive Dust Control Plan may be amended, as needed, to ensure that control measures are effective at the site. [Soil Protection Condition 4; Final Order on ASC]
CON-SP-03	During construction, the certificate holder shall require that all onsite contractors and personnel adhere to the requirements of the SPCC Plan. Any SPCC revisions and updates shall be reported to the Department. [Soil Protection Condition 6; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
CON-LU-01	During construction, the certificate holder shall implement and adhere to the Noxious Weed Control Plan required under Condition PRE-LU-02. [Land Use Condition 4, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
CON-RF-01	During construction, the certificate holder shall: a. Describe the status of the bond or letter of credit in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. b. If construction extends for more than 12 months, the certificate holder shall adjust the amount of the bond or letter of credit on an annual basis thereafter as described in under Condition PRE-RF-01. c. The Department and Council reserve the right to adjust the contingencies, as necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 5; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
CON-FW-01	During construction, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan, as applicable. [Fish and Wildlife Habitat Condition 2, Final Order on ASC]
CON-FW-02	During construction, the certificate holder shall adhere to the requirements of the Construction Wildlife Monitoring Plan (Attachment I of the Final Order on the ASC). Monitoring records shall be maintained throughout construction and included in the semi-annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 8; Final Order on ASC]

Condition Number	Construction (CON) Conditions
STANDARD: Threatened and Endangered Species (TE) [OAR 345-022-0070]	
CON-TE-01	Prior to and during construction of the facility or phase, as applicable, any incidentally identified occurrence(s) of Lawrence's milkvetch shall be avoided using a 100-foot buffer via mapping and flagging. [Threatened and Endangered Species Condition 2; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
CON-HC-01	During construction, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan, as submitted to the Department under PRE-HC-01. [Historic, Cultural and Archeological Condition 2; Final Order on ASC]
STANDARD: Public Services (PS) [OAR 345-022-0100]	
CON-PS-01	During construction, the certificate holder shall adhere to the terms and conditions of the Road Use Agreement executed under PRE-PS-01. [Public Services Condition 2; Final Order on ASC]
CON-PS-02	During construction, the certificate holder shall report to the Department the outcomes of the work completed under the temporary housing plan required under PRE-PS-02. The report shall be included in the construction progress report required under CON-OE-02, and shall include, at a minimum: a. Outcome of coordination with construction contractors to identify housing options for incoming workers, including aggregate data on the location (i.e. city) and type of housing used by workers. b. Documentation of coordination with local officials such as the Morrow County Planning Department, nearby cities and towns such as Lexington and Ione, the Lexington Community Development Group, the Ione Community Agri-Business Organization, the Boardman Community Development Association, the Willow Creek Valley Economic Development Group, and other housing providers to identify housing options and strategies to minimize that impacts to local housing supply. [Public Services Condition 4; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
CON-WF-01	During construction of the facility of phase, as applicable, the certificate holder shall implement and require all onsite contractors and employees to adhere to the Construction Wildfire Mitigation Plan required under Condition PRE-WF-01. Updates to the Wildfire Mitigation Plan may be required if determined necessary by the certificate holder, certificate holder's contractor(s), or the Department to address wildfire hazard to public health and safety. Any Department required updates shall be implemented within 14 days, unless otherwise agreed to by the Department based on a good faith effort to address wildfire hazard. [Wildfire Prevention and Risk Mitigation Condition 2; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	

Condition Number	Construction (CON) Conditions
CON-WM-01	During construction, as applicable, the certificate holder shall require that contractors adhere to the requirements of the Construction Waste Management Plan(s) and maintain records of employee training and tracking compliance onsite and available upon Department request. [Waste Minimization Condition 2; Final Order on ASC]
CON-WM-02	During construction, on-site concrete washwater disposal is prohibited unless DEQ approval of a permit exemption for materials substantially similar to clean fill is obtained. If DEQ approval of a permit exemption is obtained, concrete washwater must be disposed of onsite via infiltration and evaporation in accordance with the DEQ-issued NPDES 1200-C permit required under Condition CON-SP-02. [Waste Minimization Condition 3; Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
CON-WR-01	During construction: a. All water used for construction activities shall be appropriated and used in accordance with the applicable provisions of ORS chapter 537 and OAR chapter 690. b. The certificate holder shall report the source and amount of water used during each month of construction under Condition CON-OE-02. The certificate holder shall maintain records adequate to substantiate reports (e.g., written logs and photographs of well meter readings, copies of invoices from water sources) and make such records available to the Department upon request. c. If a water right, limited water use license, or water rights transfer is needed and would not be obtained by a third-party, the certificate holder shall submit and obtain approval of the applicable water permit through the site certificate amendment process. [Water Rights Condition 2; Final Order on ASC]

5.5 Pre-Operational (PRO) Conditions

Condition Number	Pre-Operational (PRO) Conditions
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
PRO-OE-01	Prior to operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 10; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
PRO-SP-01	Following the termination of the 1200-C, the certificate holder shall update the requirements of the Revegetation and Reclamation Plan, specific to the areas within the fenceline not occupied by facility infrastructure. Certificate holder shall provide evidence to the Department that the permit was terminated by DEQ. [Soil Protection Condition 5; Final Order on ASC]
PRO-SP-02	Prior to operation, the certificate holder shall submit to the Department an Operational Spill Prevention Control and Countermeasures (SPCC) Plan. [Soil Protection Condition 8; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
PRO-WF-01	Prior to operation, the certificate holder shall finalize the operational Wildfire Mitigation Plan (WMP) included as Attachment M to the Final Order on ASC. [Wildfire Prevention and Risk Mitigation Condition 3; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
PRO-WM-01	Prior to operation, the certificate holder shall develop an Operational Recycling Plan or protocol requiring that damaged or nonfunctional panels and lithium-ion batteries be recycled to the extent practicable. The certificate holder shall report in its annual report to the Department the quantities of panels and lithium-ion batteries recycled, reused or disposed of in a landfill. Requirements for lithium-ion battery recycling do not apply if the BESS is not constructed. [Waste Minimization Condition 4; Final Order on ASC]
STANDARD: Other - Water Rights (WR)	
PRO-WR-01	Prior to operation, the certificate holder shall provide, to the Department, a copy of the map, well log and all other information it provided to OWRD pursuant to ORS 537.545 and ORS 537.765 to qualify for an exempt ground water use for any onsite exempt wells. [Water Rights Condition 3; Final Order on ASC]

5.6 Operational (OPR) Conditions

Condition Number	Operational (OPR) Conditions
STANDARD: General Standard of Review (GS) [OAR 345-022-0000]	
OPR-GS-01	The certificate holder must submit a legal description of the site to the Department within 90 days after beginning operation of the facility. The legal description must include a description of metes and bounds or a description of the site by reference to a map and geographic data that clearly and specifically identify the outer boundaries that contain all parts of the facility. [Mandatory Condition OAR 345-025-0006(2); General Standard Condition 9]
OPR-GS-02	After January 1 but no later than April 30 of each year after beginning operation of the facility, the certificate holder shall submit an annual report to the Department. The Council Secretary and the certificate holder may, by mutual agreement, change the reporting date. a. The annual report must include the following information for the calendar year preceding the date of the report: 1. Facility Status: An overview of site conditions, the status of facilities under construction and a summary of the operating experience of facilities that are in operation. The certificate holder shall describe any unusual events, such as earthquakes, extraordinary windstorms, major accidents or the like that occurred during the year and that had a significant adverse impact on the facility. 2. Reliability and Efficiency of Power Production: For electric power plants, the plant availability and capacity factors for the reporting year. The certificate holder shall describe any equipment failures or plant breakdowns that had a significant impact on those factors and shall describe any actions taken to prevent the recurrence of such problems. 3. Status of Surety Information: Documentation demonstrating that bonds or letters of credit as described in the site certificate are in full force and effect and will remain in full force and effect for the term of the next reporting period. 4. Monitoring Report: A list and description of all significant monitoring and mitigation activities performed during the previous year in accordance with site certificate terms and conditions, a summary of the results of those activities and a discussion of any significant changes to any monitoring or mitigation program, including the reason for any such changes. 5. Compliance Report: A report describing the certificate holder's compliance with all site certificate conditions that are applicable during the reporting period. For ease of review, the certificate holder shall, in this section of the report, use numbered subparagraphs corresponding to the applicable sections of the site certificate.

Condition Number	Operational (OPR) Conditions
	6. Facility Modification Report: A summary of changes to the facility that the certificate holder has made during the reporting period without an amendment of the site certificate in accordance with OAR 345-027-0350. b. To the extent that information required by this rule is contained in reports the certificate holder submits to other state, federal or local agencies, the certificate holder may submit excerpts from such other reports to satisfy this rule. The Council reserves the right to request full copies of such excerpted reports. [Mandatory Condition 345-026-0080(1); General Standard Condition 10, Final Order on ASC]
STANDARD: Organizational Expertise (OE) [OAR 345-022-0010]	
OPR-OE-01	During operation, the certificate holder shall provide to the Department the qualifications and contact information of the individuals responsible for monitoring facility operations, including individuals or third-party entity responsible for onsite maintenance. [Organizational Expertise Condition 11; Final Order on ASC]
STANDARD: Soil Protection (SP) [OAR 345-022-0020]	
OPR-SP-01	During operation, the certificate holder shall adhere to the requirements of the Operational SPCC Plan. Any SPCC updates shall be described and included in the Annual Report to the Department. Certificate holder shall report spill and cleanup activities to the Department within 72 hours and shall make inspection records available to the Department upon request. [Soil Protection Condition 9; Final Order on ASC]
STANDARD: Land Use (LU) [OAR 345-022-0030]	
OPR-LU-01	Following the fifth year of monitoring under the Noxious Weed Control Plan required under PRE-LU-03, the certificate holder shall submit a Long-term Noxious Weed Monitoring Plan to the Department, for review and approval. The certificate holder shall implement the plan for the remainder of the facility's operating life. [Land Use Condition 5, Final Order on ASC]
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
OPR-RF-01	During operation, the certificate holder shall: a. Annually adjust the amount of the bond or letter of credit using the U.S. Gross Domestic Product Implicit Price Deflator, Chain Weight, as published in the Oregon Department of Administrative Services' "Oregon Economic and Revenue Forecast" or by any successor agency by using the index value for the year and quarter of the nominal value and the quarterly index value for the date of issuance of the new bond or letter of credit. If at any time the index is no longer published, the Council shall select a comparable calculation to adjust the amount for inflation. b. Any changes to the template made by the Council must be incorporated into the bond or letter or letter of credit whenever the amount is adjusted under Sub(a). c. The Department and Council reserve the right to adjust the contingencies, as

Condition Number	Operational (OPR) Conditions
	necessary to ensure that costs to restore the site are adequate. [Retirement and Financial Assurance Condition 6; Final Order on ASC]
STANDARD: Fish and Wildlife Habitat (FW) [OAR 345-022-0060]	
OPR-FW-01	During operation, as applicable, the certificate holder shall implement and adhere to the Revegetation and Reclamation Plan. [Fish and Wildlife Habitat Condition 3, Final Order on ASC]
OPR-FW-02	During operation, the certificate holder shall provide reports from The Nature Conservancy on the status of long-term management and enhancement of the habitat mitigation area, consistent with the Habitat Mitigation Plan. [Fish and Wildlife Condition 6, Final Order on ASC]
OPR-FW-03	During operation, the certificate holder shall adhere to the requirements of the Operational Wildlife Monitoring Plan (Attachment J of the Final Order on the ASC). Monitoring records shall be maintained throughout operation and included in the annual report submitted to the Department pursuant to OAR 345-026-0080. [Fish and Wildlife Condition 9; Final Order on ASC]
STANDARD: Historic, Cultural and Archeological (HC) [OAR 345-022-0090]	
OPR-HC-01	During operations, the certificate holder shall require all onsite employees and contractors to implement and adhere to the requirements of the Inadvertent Discovery Plan (IDP), as provided for Condition PRE-HC-01. The IDP shall be reviewed and updated annually for current contact information. [Historic, Cultural and Archeological Condition 3; Final Order on ASC]
STANDARD: Wildfire Prevention and Risk Mitigation (WF) [OAR 345-022-0115]	
OPR-WF-01	During operation, the certificate holder shall: a. Implement the Operational Wildfire Mitigation Plan finalized under Condition PRO-WF-01. b. Every 5 years after the first operational year, review and update the evaluation of wildfire risk under OAR 345-022-0115(1)(b) and submit the results in the annual report required under Condition CON-OE-02 for that year. c. Submit an updated Operational Wildfire Mitigation Plan to the Department if substantive changes are made to the plan because of the review under sub (b) of this condition, or at any other time substantiative revisions are made. [Wildfire Prevention and Risk Mitigation Condition 4; Final Order on ASC]
STANDARD: Waste Minimization (WM) [OAR 345-022-0120]	
OPR-WM-01	During operation, the certificate holder shall adhere to the requirements of the Operational Recycling Plan or protocol developed under Condition PRO-WM-01. [Waste Minimization Condition 5; Final Order on ASC]
OPR-WM-02	During operation, the certificate holder shall: a. Prohibit use of chemicals, soaps, detergents and heated water unless Chemical Safety Data Sheets for low volatile organic compound/biodegradable cleaning chemicals and solvents are submitted to the Department for review and approval prior to use.

Condition Number	Operational (OPR) Conditions
	b. Ensure that washing is conducted in a manner that does not remove paint or other finishes. c. Discharge wash water through evaporation and infiltration only. [Waste Minimization Condition 6, Final Order on ASC]
STANDARD: Other – Water Rights (WR)	
OPR-WR-01	During operation, the certificate holder shall verify that any onsite exempt wells do not use more than 5,000 gallons of ground water a day, collectively, and shall monitor the volume of groundwater used on a daily basis, maintain a record of such use and make the monitoring records available to the Department upon request. [Water Rights Condition 4; Final Order on ASC]

5.7 Retirement (RET) Conditions

Condition Number	Retirement (RET) Conditions
STANDARD: Retirement and Financial Assurance (RF) [OAR 345-022-0050]	
RET-RF-01	The certificate holder must retire the facility if the certificate holder permanently ceases construction or operation of the facility. The certificate holder must retire the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410. The certificate holder must pay the actual cost to restore the site to a useful, non-hazardous condition at the time of retirement, notwithstanding the Council's approval in the site certificate of an estimated amount required to restore the site. [Mandatory Condition OAR 345-025-0006(9); Retirement and Financial Assurance Condition 2; Final Order on ASC]
RET-RF-02	If the Council finds that the certificate holder has permanently ceased construction or operation of the facility without retiring the facility according to a final retirement plan approved by the Council, as described in OAR 345-027-0410, the Council must notify the certificate holder and request that the certificate holder submit a proposed final retirement plan to the Department within a reasonable time not to exceed 90 days. If the certificate holder does not submit a proposed final retirement plan by the specified date, the Council may direct the Department to prepare a proposed final retirement plan for the Council's approval. Upon the Council's approval of the final retirement plan, the Council may draw on the bond or letter of credit described in Condition PRE-RT-01 to restore the site to a useful, non-hazardous condition according to the final retirement plan, in addition to any penalties the Council may impose under OAR chapter 345, division 29. If the amount of the bond or letter of credit is insufficient to pay the actual cost of retirement, the certificate holder must pay any additional cost necessary to restore the site to a useful, non-hazardous condition. After completion of site restoration, the Council must issue an order to terminate the site certificate if the Council finds that the facility has been retired according to the approved final retirement plan. [Mandatory Condition OAR 345-025-0006(16); Retirement and Financial Assurance Condition 3; Final Order on ASC]

6.0 Successors and Assigns

To transfer this site certificate or any portion thereof or to assign or dispose of it in any other manner, directly or indirectly, the certificate holder shall comply with OAR 345-027-0400.

7.0 Severability and Construction

If any provision of this agreement and certificate is declared by a court to be illegal or in conflict with any law, the validity of the remaining terms and conditions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the agreement and certificate did not contain the particular provision held to be invalid.

8.0 Execution

This site certificate may be executed in counterparts and will become effective upon signature by the Chair of the Energy Facility Siting Council and the authorized representative of the certificate holder.

IN WITNESS THEREOF, this site certificate has been executed by the State of Oregon, acting by and through the Energy Facility Siting Council and Sunstone Solar, LLC (certificate holder).

ENERGY FACILITY SITING COUNCIL
Kent Howe
By: Kent Howe (Nov 19, 2024 16:21 PST)
Kent Howe, Chair
Date: 19-Nov-2024

SUNSTONE SOLAR, LLC
Jon Saxon
By: Jon Saxon (Nov 19, 2024 16:26 EST)
Jon Saxon, Authorized Representative
Date: 19-Nov-2024

Attachment 2. Articles of Incorporation

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Secretary of State
Corporation Division
255 Capitol Street NE, Suite 151
Salem, OR 97310-1327

Phone: (503) 986-2200
FAX: (503) 378-4381
sos.oregon.gov/business

REGISTRY NUMBER: **236814794**
TYPE: DOMESTIC LIMITED LIABILITY COMPANY

Next Renewal Date: 2/19/2026

SUNSTONE SOLAR 1, LLC
130 ROBERTS STREET
ASHEVILLE NC 28801

Acknowledgment Letter

The document you submitted was recorded as shown below. Please review and verify the information listed for accuracy.

DOCUMENT	**FILED ON**	**STATUS**
ARTICLES OF ORGANIZATION	2/19/2025	ACTIVE

NAME
SUNSTONE SOLAR 1, LLC

JURISDICTION
OREGON

PRINCIPAL PLACE OF BUSINESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

REGISTERED AGENT
COGENCY GLOBAL INC.
698 12TH STREET SE, SUITE 200
SALEM, OR 97301

MAILING ADDRESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

MEMBER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

MANAGER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

Corporate Transparency Act

Visit **www.FinCEN.gov/BOI** for the latest information regarding beneficial ownership reporting requirements.

Articles of Organization - Limited Liability Company

Secretary of State - Corporation Division - 255 Capitol St. NE, Suite 151 - Salem, OR 97310-1327 - sos.oregon.gov/business - Phone: (503) 986-2200

FILED: FEB 19, 2025
OREGON SECRETARY OF STATE
236814794-27380993
SUNSTONE SOLAR 1, LLC **NEWORG**

REGISTRY NUMBER: 236814794

In accordance with Oregon Revised Statute 192.410-192.490, the information on this applicatio
We must release this information to all parties upon request and it will be posted on our website

Please Type or Print Legibly in **Black** ink. **Attach Additional Sheet if Necessary**

1. **NAME OF LIMITED LIABILITY COMPANY:** (Must contain the words "Limited Liability Company" or the abbreviations "LLC" or "L.L.C.")

Sunstone Solar 1, LLC

2. **DURATION:** (Please check one.)

☒ Duration shall be perpetual.

☐ Latest date upon which the Limited Liability Company is to dissolve is __________

3. **PRINCIPAL OFFICE:** (Must be a physical street address)

130 Roberts Street
Asheville, NC 28801

4. **REGISTERED AGENT:** (Individual or entity that will accept legal service for this business)

Cogency Global Inc.

5. **REGISTERED AGENT'S PUBLICLY AVAILABLE ADDRESS:** (**Must be an Oregon Street Address**, which is identical to the registered agent's office.)

698 12th Street SE, Suite 200
Salem, OR 97301

6. **ADDRESS WHERE THE DIVISION MAY MAIL NOTICES:**

130 Roberts Street
Asheville, NC 28801

7. **HOW WILL THIS LIMITED LIABILITY COMPANY BE MANAGED?**

☐ This LLC will be member-managed by one or more members.

☒ This LLC will be manager-managed by one or more managers.

8. **IF RENDERING A LICENSED PROFESSIONAL SERVICE OR SERVICES, DESCRIBE THE SERVICE(S) BEING RENDERED:** ORS 58.015(5)(m)

9. **OPTIONAL PROVISIONS:** (Attach a separate sheet if necessary.)

☐ BENEFIT COMPANY: The Limited Liability Company is a benefit company subject to sections 1 to 11 of chapter 269, Oregon Laws 2013. (additional requirements apply)

☐ INDEMNIFICATION: The company elects to indemnify its members, managers, employees, agents for liability and related expenses under ORS 63.160 - 63.170.

☐ SEE ATTACHED

10. **NAME AND ADDRESS OF EACH PERSON WHO IS FORMING THIS BUSINESS:** (ORGANIZER)

Chaye Besherse
130 Roberts Street
Asheville, NC 28801

LIST MEMBERS AND/OR MANAGERS NAMES AND ADDRESSES (MAY BE REQUIRED BY YOUR BANK)

11. **OWNERS: (MEMBERS)** (Names and Addresses)

FP 2021 Dev Holdco, LLC
130 Roberts Street
Asheville, NC 28801

12. **MANAGERS: (MANAGERS)** (Names and Addresses)

FP 2021 Dev Holdco, LLC
130 Roberts Street
Asheville, NC 28801

13. **INDIVIDUAL WITH DIRECT KNOWLEDGE** (Name and Address)
List the name and address of at least one individual who is a member or manager of the LLC or an authorized representative with direct knowledge of the operations and business activities of the LLC.

Benjamin Catt
130 Roberts Street
Asheville, NC 28801

14. **EXECUTION/SIGNATURE OF EACH PERSON WHO IS FORMING THIS BUSINESS:** (Organizer)

I declare as an authorized signer, under penalty of perjury, that this document does not fraudulently conceal, fraudulently obscure, fraudulently alter or otherwise misrepresent the identity of the person or any members, managers, employees or agents of the limited liability company. This filing has been examined by me and is, to the best of my knowledge and belief, true, correct, and complete. Making false statements in this document is against the law and may be penalized by fines, imprisonment or both.

SIGNATURE:	PRINTED NAME:	TITLE:
CBesherse	Chaye Besherse, Authorized Signatory	Organizer

CONTACT NAME: (To resolve questions with this filing)

PHONE NUMBER: (Include area code)

FEES

Required Processing Fee $100

Processing Fees are nonrefundable. Please make check payable to "Corporation Division".

Free copies are available at sos.oregon.gov/business using the Business Name Search program.

Secretary of State
Corporation Division
255 Capitol Street NE, Suite 151
Salem, OR 97310-1327

Phone: (503) 986-2200
FAX: (503) 378-4381
sos.oregon.gov/business

REGISTRY NUMBER: **236814992**
TYPE: DOMESTIC LIMITED LIABILITY COMPANY

Next Renewal Date: 2/19/2026

SUNSTONE SOLAR 2, LLC
130 ROBERTS STREET
ASHEVILLE NC 28801

Acknowledgment Letter

The document you submitted was recorded as shown below. Please review and verify the information listed for accuracy.

DOCUMENT	FILED ON	STATUS
ARTICLES OF ORGANIZATION	2/19/2025	ACTIVE

NAME
SUNSTONE SOLAR 2, LLC

JURISDICTION
OREGON

PRINCIPAL PLACE OF BUSINESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

REGISTERED AGENT
COGENCY GLOBAL INC.
698 12TH STREET SE, SUITE 200
SALEM, OR 97301

MAILING ADDRESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

MEMBER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

MANAGER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

Corporate Transparency Act

Visit **www.FinCEN.gov/BOI** for the latest information regarding beneficial ownership reporting requirements.

Articles of Organization - Limited Liability Company

Secretary of State - Corporation Division - 255 Capitol St. NE, Suite 151 - Salem, OR 97310-1327 - sos.oregon.gov/business - Phone: (503) 986-2200

FILED: FEB 19, 2025
OREGON SECRETARY OF STATE
236814992-27381014
SUNSTONE SOLAR 2, LLC
NEWORG

REGISTRY NUMBER: 236814992

In accordance with Oregon Revised Statute 192.410-192.490, the information on this application is p
We must release this information to all parties upon request and it will be posted on our website.

Please Type or Print Legibly in **Black** ink. **Attach Additional Sheet if Necessary**.

1. **NAME OF LIMITED LIABILITY COMPANY:** (Must contain the words "Limited Liability Company" or the abbreviations "LLC" or "L.L.C.")

Sunstone Solar 2, LLC

2. **DURATION:** (Please check one.)

☒ Duration shall be perpetual.

☐ Latest date upon which the Limited Liability Company is to dissolve is

3. **PRINCIPAL OFFICE:** (Must be a physical street address)

130 Roberts Street
Asheville, NC 28801

4. **REGISTERED AGENT:** (Individual or entity that will accept legal service for this business)

Cogency Global Inc.

5. **REGISTERED AGENT'S PUBLICLY AVAILABLE ADDRESS:** **(Must be an Oregon Street Address**, which is identical to the registered agent's office.)

698 12th Street SE, Suite 200
Salem, OR 97301

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130 Roberts Street
Asheville, NC 28801

7. **HOW WILL THIS LIMITED LIABILITY COMPANY BE MANAGED?**

☐ This LLC will be member-managed by one or more members.

☒ This LLC will be manager-managed by one or more managers.

8. **IF RENDERING A LICENSED PROFESSIONAL SERVICE OR SERVICES, DESCRIBE THE SERVICE(S) BEING RENDERED:** ORS 58.015(5)(m)

9. **OPTIONAL PROVISIONS:** (Attach a separate sheet if necessary.)

☐ BENEFIT COMPANY: The Limited Liability Company is a benefit company subject to sections 1 to 11 of chapter 269, Oregon Laws 2013. (additional requirements apply)

☐ INDEMNIFICATION: The company elects to indemnify its members, managers, employees, agents for liability and related expenses under ORS 63.160 - 63.170.

☐ SEE ATTACHED

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Chaye Besherse
130 Roberts Street
Asheville, NC 28801

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Asheville, NC 28801

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FP 2021 Dev Holdco, LLC
130 Roberts Street
Asheville, NC 28801

13. **INDIVIDUAL WITH DIRECT KNOWLEDGE** (Name and Address)
List the name and address of at least one individual who is a member or manager of the LLC or an authorized representative with direct knowledge of the operations and business activities of the LLC.

Benjamin Catt
130 Roberts Street
Asheville, NC 28801

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I declare as an authorized signer, under penalty of perjury, that this document does not fraudulently conceal, fraudulently obscure, fraudulently alter or otherwise misrepresent the identity of the person or any members, managers, employees or agents of the limited liability company. This filing has been examined by me and is, to the best of my knowledge and belief, true, correct, and complete. Making false statements in this document is against the law and may be penalized by fines, imprisonment or both.

SIGNATURE:	**PRINTED NAME:**	**TITLE:**
CBesherse	Chaye Besherse, Authorized Signatory	Organizer

CONTACT NAME: (To resolve questions with this filing)

PHONE NUMBER: (Include area code)

FEES

Required Processing Fee $100

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Free copies are available at sos.oregon.gov/business using the Business Name Search program.

Secretary of State
Corporation Division
255 Capitol Street NE, Suite 151
Salem, OR 97310-1327

Phone: (503) 986-2200
FAX: (503) 378-4381
sos.oregon.gov/business

REGISTRY NUMBER: 236815999
TYPE: DOMESTIC LIMITED LIABILITY COMPANY

Next Renewal Date: 2/19/2026

SUNSTONE SOLAR 3, LLC
130 ROBERTS STREET
ASHEVILLE NC 28801

Acknowledgment Letter

The document you submitted was recorded as shown below. Please review and verify the information listed for accuracy.

DOCUMENT	FILED ON	STATUS
ARTICLES OF ORGANIZATION	2/19/2025	ACTIVE

NAME
SUNSTONE SOLAR 3, LLC

JURISDICTION
OREGON

PRINCIPAL PLACE OF BUSINESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

MAILING ADDRESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

MANAGER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

REGISTERED AGENT
COGENCY GLOBAL INC.
698 12TH STREET SE, SUITE 200
SALEM, OR 97301

MEMBER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

Corporate Transparency Act

Visit **www.FinCEN.gov/BOI** for the latest information regarding beneficial ownership reporting requirements.

Articles of Organization - Limited Liability Company

Secretary of State - Corporation Division - 255 Capitol St. NE, Suite 151 - Salem, OR 97310-1327 - sos.oregon.gov/business - Phone: (503) 986-2200

FILED: FEB 19, 2025
OREGON SECRETARY OF STATE
236815999-27381053
SUNSTONE SOLAR 3, LLC **NEWORG**

REGISTRY NUMBER: 236815999

In accordance with Oregon Revised Statute 192.410-192.490, the information on this application is pu
We must release this information to all parties upon request and it will be posted on our website.

Please Type or Print Legibly in **Black** ink. **Attach Additional Sheet if Necessary**

1. **NAME OF LIMITED LIABILITY COMPANY:** (Must contain the words "Limited Liability Company" or the abbreviations "LLC" or "L.L.C.")

Sunstone Solar 3, LLC

2. **DURATION:** (Please check one.)

☒ Duration shall be perpetual.

☐ Latest date upon which the Limited Liability Company is to dissolve is ______

3. **PRINCIPAL OFFICE:** (Must be a physical street address)

130 Roberts Street
Asheville, NC 28801

4. **REGISTERED AGENT:** (Individual or entity that will accept legal service for this business)

Cogency Global Inc.

5. **REGISTERED AGENT'S PUBLICLY AVAILABLE ADDRESS:** **(Must be an Oregon Street Address**, which is identical to the registered agent's office.)

698 12th Street SE, Suite 200
Salem, OR 97301

6. **ADDRESS WHERE THE DIVISION MAY MAIL NOTICES:**

130 Roberts Street
Asheville, NC 28801

7. **HOW WILL THIS LIMITED LIABILITY COMPANY BE MANAGED?**

☐ This LLC will be member-managed by one or more members.

☒ This LLC will be manager-managed by one or more managers.

8. **IF RENDERING A LICENSED PROFESSIONAL SERVICE OR SERVICES, DESCRIBE THE SERVICE(S) BEING RENDERED:** ORS 58.015(5)(m)

______

9. **OPTIONAL PROVISIONS:** (Attach a separate sheet if necessary.)

☐ BENEFIT COMPANY: The Limited Liability Company is a benefit company subject to sections 1 to 11 of chapter 269, Oregon Laws 2013. (additional requirements apply)

☐ INDEMNIFICATION: The company elects to indemnify its members, managers, employees, agents for liability and related expenses under ORS 63.160 - 63.170.

☐ SEE ATTACHED

10. **NAME AND ADDRESS OF EACH PERSON WHO IS FORMING THIS BUSINESS:** (ORGANIZER)

Chaye Besherse
130 Roberts Street
Asheville, NC 28801

LIST MEMBERS AND/OR MANAGERS NAMES AND ADDRESSES (MAY BE REQUIRED BY YOUR BANK)

11. **OWNERS: (MEMBERS)** (Names and Addresses)

FP 2021 Dev Holdco, LLC
130 Roberts Street
Asheville, NC 28801

12. **MANAGERS: (MANAGERS)** (Names and Addresses)

FP 2021 Dev Holdco, LLC
130 Roberts Street
Asheville, NC 28801

13. **INDIVIDUAL WITH DIRECT KNOWLEDGE** (Name and Address) **List the name and address of at least one individual who is a member or manager of the LLC or an authorized representative with direct knowledge of the operations and business activities of the LLC.**

Benjamin Catt
130 Roberts Street
Asheville, NC 28801

14. **EXECUTION/SIGNATURE OF EACH PERSON WHO IS FORMING THIS BUSINESS:** (Organizer)

I declare as an authorized signer, under penalty of perjury, that this document does not fraudulently conceal, fraudulently obscure, fraudulently alter or otherwise misrepresent the identity of the person or any members, managers, employees or agents of the limited liability company. This filing has been examined by me and is, to the best of my knowledge and belief, true, correct, and complete. Making false statements in this document is against the law and may be penalized by fines, imprisonment or both.

SIGNATURE:	PRINTED NAME:	TITLE:
C Besherse	Chaye Besherse, Authorized Signatory	Organizer

CONTACT NAME: (To resolve questions with this filing)

______

PHONE NUMBER: (Include area code)

______

FEES

Required Processing Fee $100

Processing Fees are nonrefundable. Please make check payable to "Corporation Division".

Free copies are available at sos.oregon.gov/business using the Business Name Search program.

Secretary of State
Corporation Division
255 Capitol Street NE, Suite 151
Salem, OR 97310-1327

Phone: (503) 986-2200
FAX: (503) 378-4381
sos.oregon.gov/business

REGISTRY NUMBER: 236816195
TYPE: DOMESTIC LIMITED LIABILITY COMPANY

Next Renewal Date: 2/19/2026

SUNSTONE SOLAR 4, LLC
130 ROBERTS STREET
ASHEVILLE NC 28801

Acknowledgment Letter

The document you submitted was recorded as shown below. Please review and verify the information listed for accuracy.

DOCUMENT	**FILED ON**	**STATUS**
ARTICLES OF ORGANIZATION	2/19/2025	ACTIVE

NAME
SUNSTONE SOLAR 4, LLC

JURISDICTION
OREGON

PRINCIPAL PLACE OF BUSINESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

REGISTERED AGENT
COGENCY GLOBAL INC.
698 12TH STREET SE, SUITE 200
SALEM, OR 97301

MAILING ADDRESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

MEMBER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

MANAGER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

Corporate Transparency Act

Visit **www.FinCEN.gov/BOI** for the latest information regarding beneficial ownership reporting requirements.

1859

Articles of Organization - Limited Liability Company

Secretary of State - Corporation Division - 255 Capitol St. NE, Suite 151 - Salem, OR 97310-1327 - sos.oregon.gov/business - Phone: (503) 986-2200

FILED: FEB 19, 2025
OREGON SECRETARY OF STATE
236816195-27381071
SUNSTONE SOLAR 4, LLC
NEWORG

REGISTRY NUMBER: 236816195

In accordance with Oregon Revised Statute 192.410-192.490, the information on this application is public re
We must release this information to all parties upon request and it will be posted on our website.

Please Type or Print Legibly in **Black** ink. **Attach Additional Sheet if Necessary**

1. **NAME OF LIMITED LIABILITY COMPANY:** (Must contain the words "Limited Liability Cc L.L.C.)

Sunstone Solar 4, LLC

2. **DURATION:** (Please check one.)

☒ Duration shall be perpetual.

☐ Latest date upon which the Limited Liability Company is to dissolve is ______

3. **PRINCIPAL OFFICE:** (Must be a physical street address)

130 Roberts Street
Asheville, NC 28801

4. **REGISTERED AGENT:** (Individual or entity that will accept legal service for this business)

Cogency Global Inc.

5. **REGISTERED AGENT'S PUBLICLY AVAILABLE ADDRESS:** **(Must be an Oregon Street Address,** which is identical to the registered agent's office.)

698 12th Street SE, Suite 200
Salem, OR 97301

6. **ADDRESS WHERE THE DIVISION MAY MAIL NOTICES:**

130 Roberts Street
Asheville, NC 28801

7. **HOW WILL THIS LIMITED LIABILITY COMPANY BE MANAGED?**

☐ This LLC will be member-managed by one or more members.

☒ This LLC will be manager-managed by one or more managers.

8. **IF RENDERING A LICENSED PROFESSIONAL SERVICE OR SERVICES, DESCRIBE THE SERVICE(S) BEING RENDERED:** ORS 58.015(5)(m)

______

9. **OPTIONAL PROVISIONS:** (Attach a separate sheet if necessary.)

☐ BENEFIT COMPANY: The Limited Liability Company is a benefit company subject to sections 1 to 11 of chapter 269, Oregon Laws 2013. (additional requirements apply)

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☐ SEE ATTACHED

10. **NAME AND ADDRESS OF EACH PERSON WHO IS FORMING THIS BUSINESS:** (ORGANIZER)

Chaye Besherse
130 Roberts Street
Asheville, NC 28801

LIST MEMBERS AND/OR MANAGERS NAMES AND ADDRESSES **(MAY BE REQUIRED BY YOUR BANK)**

11. **OWNERS: (MEMBERS)** (Names and Addresses)

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130 Roberts Street
Asheville, NC 28801

12. **MANAGERS: (MANAGERS)** (Names and Addresses)

FP 2021 Dev Holdco, LLC
130 Roberts Street
Asheville, NC 28801

13. **INDIVIDUAL WITH DIRECT KNOWLEDGE** (Name and Address) **List the name and address of at least one individual who is a member or manager of the LLC or an authorized representative with direct knowledge of the operations and business activities of the LLC.**

Benjamin Catt
130 Roberts Street
Asheville, NC 28801

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SIGNATURE:	**PRINTED NAME:**	**TITLE:**
CBesherse	Chaye Besherse, Authorized Signatory	Organizer

CONTACT NAME: (To resolve questions with this filing)

______

PHONE NUMBER: (Include area code)

______

FEES

Required Processing Fee $100

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Free copies are available at sos.oregon.gov/business using the Business Name Search program.

1859

Secretary of State
Corporation Division
255 Capitol Street NE, Suite 151
Salem, OR 97310-1327

Phone: (503) 986-2200
FAX: (503) 378-4381
sos.oregon.gov/business

REGISTRY NUMBER: **236816591**
TYPE: DOMESTIC LIMITED LIABILITY COMPANY

Next Renewal Date: 2/19/2026

SUNSTONE SOLAR 5, LLC
130 ROBERTS STREET
ASHEVILLE NC 28801

Acknowledgment Letter

The document you submitted was recorded as shown below. Please review and verify the information listed for accuracy.

DOCUMENT	**FILED ON**	**STATUS**
ARTICLES OF ORGANIZATION	2/19/2025	ACTIVE

NAME
SUNSTONE SOLAR 5, LLC

JURISDICTION
OREGON

PRINCIPAL PLACE OF BUSINESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

REGISTERED AGENT
COGENCY GLOBAL INC.
698 12TH STREET SE, SUITE 200
SALEM, OR 97301

MAILING ADDRESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

MEMBER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

MANAGER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

Corporate Transparency Act

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1859

Articles of Organization - Limited Liability Company

Secretary of State - Corporation Division - 255 Capitol St. NE, Suite 151 - Salem, OR 97310-1327 - sos.oregon.gov/business - Phone: (503) 986-2200

FILED: FEB 19, 2025
OREGON SECRETARY OF STATE
236816591-27381087
SUNSTONE SOLAR 5, LLC
NEWORG

REGISTRY NUMBER: 236816591

In accordance with Oregon Revised Statute 192.410-192.490, the information on this application is pu
We must release this information to all parties upon request and it will be posted on our website.

Please Type or Print Legibly in **Black** ink. **Attach Additional Sheet if Necessary**

1. **NAME OF LIMITED LIABILITY COMPANY:** (Must contain the words "Limited Liabi

Sunstone Solar 5, LLC

2. **DURATION:** (Please check one.)

☒ Duration shall be perpetual.

☐ Latest date upon which the Limited Liability Company is to dissolve is ______

3. **PRINCIPAL OFFICE:** (Must be a physical street address)

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Asheville, NC 28801

4. **REGISTERED AGENT:** (Individual or entity that will accept legal service for this business)

Cogency Global Inc.

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130 Roberts Street
Asheville, NC 28801

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FP 2021 Dev Holdco, LLC
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C Besherse	Chaye Besherse, Authorized Signatory	Organizer

CONTACT NAME: (To resolve questions with this filing)

PHONE NUMBER: (Include area code)

FEES

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Secretary of State
Corporation Division
255 Capitol Street NE, Suite 151
Salem, OR 97310-1327

Phone: (503) 986-2200
FAX: (503) 378-4381
sos.oregon.gov/business

REGISTRY NUMBER: 236816997
TYPE: DOMESTIC LIMITED LIABILITY COMPANY

Next Renewal Date: 2/19/2026

SUNSTONE SOLAR 6, LLC
130 ROBERTS STREET
ASHEVILLE NC 28801

Acknowledgment Letter

The document you submitted was recorded as shown below. Please review and verify the information listed for accuracy.

DOCUMENT	**FILED ON**	**STATUS**
ARTICLES OF ORGANIZATION	2/19/2025	ACTIVE

NAME
SUNSTONE SOLAR 6, LLC

JURISDICTION
OREGON

PRINCIPAL PLACE OF BUSINESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

REGISTERED AGENT
COGENCY GLOBAL INC.
698 12TH STREET SE, SUITE 200
SALEM, OR 97301

MAILING ADDRESS
130 ROBERTS STREET
ASHEVILLE, NC 28801

MEMBER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

MANAGER
FP 2021 DEV HOLDCO, LLC
130 ROBERTS STREET
ASHEVILLE, NC 28801

Corporate Transparency Act

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1859

Articles of Organization - Limited Liability Company

Secretary of State - Corporation Division - 255 Capitol St. NE, Suite 151 - Salem, OR 97310-1327 - sos.oregon.gov/business - Phone: (503) 986-2200

FILED: FEB 19, 2025
OREGON SECRETARY OF STATE
236816997-27381103
SUNSTONE SOLAR 6, LLC
NEWORG

REGISTRY NUMBER: 236816997

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Sunstone Solar 6, LLC

2. **DURATION:** (Please check one.)

☒ Duration shall be perpetual.

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4. **REGISTERED AGENT:** (Individual or entity that will accept legal service for this business)

Cogency Global Inc.

5. **REGISTERED AGENT'S PUBLICLY AVAILABLE ADDRESS:** **(Must be an Oregon Street Address,** which is identical to the registered agent's office.)

698 12th Street SE, Suite 200
Salem, OR 97301

6. **ADDRESS WHERE THE DIVISION MAY MAIL NOTICES:**

130 Roberts Street
Asheville, NC 28801

7. **HOW WILL THIS LIMITED LIABILITY COMPANY BE MANAGED?**

☐ This LLC will be member-managed by one or more members.

☒ This LLC will be manager-managed by one or more managers.

8. **IF RENDERING A LICENSED PROFESSIONAL SERVICE OR SERVICES, DESCRIBE THE SERVICE(S) BEING RENDERED:** ORS 58.015(5)(m)

9. **OPTIONAL PROVISIONS:** (Attach a separate sheet if necessary.)

☐ BENEFIT COMPANY: The Limited Liability Company is a benefit company subject to sections 1 to 11 of chapter 269, Oregon Laws 2013. (additional requirements apply)

☐ INDEMNIFICATION: The company elects to indemnify its members, managers, employees, agents for liability and related expenses under ORS 63.160 - 63.170.

☐ SEE ATTACHED

10. **NAME AND ADDRESS OF EACH PERSON WHO IS FORMING THIS BUSINESS:** (ORGANIZER)

Chaye Besherse
130 Roberts Street
Asheville, NC 28801

LIST MEMBERS AND/OR MANAGERS NAMES AND ADDRESSES (MAY BE REQUIRED BY YOUR BANK)

11. **OWNERS: (MEMBERS)** (Names and Addresses)

FP 2021 Dev Holdco, LLC
130 Roberts Street
Asheville, NC 28801

12. **MANAGERS: (MANAGERS)** (Names and Addresses)

FP 2021 Dev Holdco, LLC
130 Roberts Street
Asheville, NC 28801

13. **INDIVIDUAL WITH DIRECT KNOWLEDGE** (Name and Address) **List the name and address of at least one individual who is a member or manager of the LLC or an authorized representative with direct knowledge of the operations and business activities of the LLC.**

Benjamin Catt
130 Roberts Street
Asheville, NC 28801

14. **EXECUTION/SIGNATURE OF EACH PERSON WHO IS FORMING THIS BUSINESS:** (Organizer)

I declare as an authorized signer, under penalty of perjury, that this document does not fraudulently conceal, fraudulently obscure, fraudulently alter or otherwise misrepresent the identity of the person or any members, managers, employees or agents of the limited liability company. This filing has been examined by me and is, to the best of my knowledge and belief, true, correct, and complete. Making false statements in this document is against the law and may be penalized by fines, imprisonment or both.

SIGNATURE:	**PRINTED NAME:**	**TITLE:**
CBesherse	Chaye Besherse, Authorized Signatory	Organizer

CONTACT NAME: (To resolve questions with this filing)

PHONE NUMBER: (Include area code)

FEES

Required Processing Fee $100

Processing Fees are nonrefundable. Please make check payable to "Corporation Division".

Free copies are available at sos.oregon.gov/business using the Business Name Search program.

Attachment 3. Mitigation Plans

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Sunstone Solar Project 1

Sunstone Solar Project 1
Draft Fugitive Dust Control Plan

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 1, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

Table of Contents

List of Attachments

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1.0 Introduction

This Fugitive Dust Control Plan (Plan) has been developed by Sunstone Solar 1, LLC (Certificate Holder), a subsidiary of Pine Gate Renewables, LLC, for the approved Sunstone Solar Project 1 (Facility) in Morrow County, Oregon. The purpose of this Plan is to reduce fugitive dust emissions associated with construction-related activities of a photovoltaic energy generation facility with up to 200 megawatts (MW) alternating current and related or supporting facilities, as well as a 1,200 MW-hour distributed battery energy storage system. The majority of the site consists of a mix of fallow fields and fields in small grain production, primarily dryland wheat; no farmlands within the site boundary receive irrigation (the application of water to land for purposes of growing agricultural products; Sunstone Solar 2024). This Plan summarizes the sources of and regulatory issues that relate to fugitive dust emissions; identifies responsibilities, monitoring, and training; and provides reasonable available control methods for fugitive dust in a table for easy reference in the field (Attachment 1).

This is an owner-imposed Plan that is expected to be implemented, maintained, and adaptively managed by the selected contractor throughout all phases of construction. The performance criteria and suggested measures identified in this Plan are minimums, and the contractor is expected to identify and implement additional measures as needed to fully meet all regulatory and public safety performance criteria. As identified in this Plan, the contractor may propose alternative approaches for consideration by the owner.

1.1 Fugitive Dust Sources

The Natural Resources Conservation Service (NRCS) Web Soil Survey identified five major soil types within the project area (NRCS 2025). Approximately 99 percent of the site is composed of Warden silt loam, which is moderately or severely susceptible to erosion from ground disturbance, wind, and vehicle traffic on unpaved roads due to its composition of hemic organic soil materials and very fine sand (NRCS 2025, NRCS 2011). Due to their composition, the retention of moisture in these sediments is thus restricted. Furthermore, these sediment particles have a low resistance to dust propagation and would be transported or drift to adjacent lands due to the lack of water through irrigation; thus, these soils are considered at high risk for fugitive dust.

Fugitive dust can arise from a variety of construction and operational activities associated with solar development. The sources can be grouped into three general categories: dust created from ground-disturbing activities such as clearing and grading, dust created from wind action on bare soils and stockpiles such as those not fully stabilized post-construction with either vegetation or a tackifier, and dust created from traffic on unpaved roads. Sediment is the basis for fugitive dust, meaning that sediment particles can become fugitive dust if they are windborne. Therefore, the thresholds for treating sediment and erosion on the site will be similar if not the same as the thresholds for treating fugitive dust. Maintaining existing vegetation and root systems is the single most effective method for avoiding fugitive dust and sediment. Where existing vegetation and root systems are disturbed, quickly reestablishing vegetation is critical.

1.2 Regulatory Compliance

Fugitive dust is a source of particulate matter with a mean diameter less than 10 microns (PM_{10}) which is one of the seven air pollutants the U.S. Environmental Protection Agency (EPA) regulates under the National Ambient Air Quality Standards (NAAQS). To a lesser extent, fugitive dust is a source of particulate matter with a mean diameter less than 2.5 microns ($PM_{2.5}$), which has proposed regulations pending under NAAQS. These soil particles are very small, can remain suspended in the air for long periods of time, and are easily inhaled into the lungs. Increased risks of death and disease have been linked to periods of high outdoor PM_{10} and $PM_{2.5}$ concentrations. These fine particles can potentially be lifted thousands of feet into the atmosphere and transported across continents and oceans creating global health, ecological, and climate change impacts.

The EPA shares responsibility with the Oregon Department of Environmental Quality (ODEQ) for the implementation of Clean Air Act (CAA) criteria in Oregon. ODEQ implements the CAA rules under the EPA-approved Oregon Administrative Rules (Chapter 340, Division 21 General Emission Standards for Particulate Matter). Fugitive dust is the primary concern related to the CAA at the Project. Fugitive dust is defined by ODEQ as dust that visibly leaves the project site for a period of more than **18 seconds in a 6-minute period,** determined by the attached EPA Method 22 (ODEQ 2019) at the downwind property boundary (Oregon Administrative Rules [OAR] 340-208-0210 (2)-a and -b).

The ODEQ Rule 340-208-0210 contains the following requirements for fugitive dust:

- Reasonable precautions must be taken to prevent particulate matter from becoming airborne. This includes, but is not limited to, the use of water or other chemicals to control dust during construction, on unpaved roads, and during the transport of materials; enclosure of materials stockpiles and covering of open-body trucks; and prompt removal from paved streets of earth or other material.
- If fugitive dust is discovered, ODEQ may require the Facility to cease work until the fugitive dust emissions are controlled. Emissions are considered controlled when fugitive dust is no longer leaving the Facility site for more than 18 seconds in a 6-minute period.

Further, ODEQ Rule 340-208-0300 specifies that it is prohibited to cause or allow any air contaminants (e.g., fugitive dust) to create a nuisance. If ODEQ determines that a nuisance has been created, the agency may pursue informal or formal enforcement actions to abate the nuisance.

A National Pollutant Discharge Elimination System Construction Stormwater Discharge Permit (Oregon 1200-C Construction Stormwater Permit), pursuant to Oregon Revised Statutes 468.050 and Section 402 of the federal Clean Water Act, will be obtained from ODEQ. This permit requires the permit holder to "Prevent wind-blown soil and dust from areas with exposed soil through the appropriate application of water or other dust suppression techniques to control the generation of pollutants that could be discharged in stormwater from the site" (Section 2.2.9) and requires permit holders to implement measures including monitoring, record keeping, reporting of exceedances, and installation, maintenance, and adaptive management of best management practices (BMPs) to control both stormwater and fugitive dust discharges. Implementation of these measures is intended to reduce fugitive dust to a negligible impact and ensure compliance with applicable air quality regulations.

The Morrow County Code regulates nuisances through the Oregon State Statute Chapter 203. Controlling fugitive dust emissions is required to avoid creating a public nuisance, which is defined as “any thing, substance, or act that is a threat to the public health, safety or welfare” (Morrow County Code Enforcement Ordinance ORD-2021-4).

2.0 Fugitive Dust Control Plan

2.1 Responsibility

The expectation is that the Contractor will implement and adaptively manage this Plan, controlling fugitive dust emissions and meeting all regulatory and public safety performance criteria throughout construction. As described in Section 1.2 above, the holder of the Oregon 1200-C permit is required to control fugitive dust emissions, including ensuring compliance by all subcontractors and outside service providers.

If the Certificate Holder identifies that the regulatory and public safety performance criteria are not being met, the Certificate Holder will implement enforcement measures, including but not limited to:

- Issuance of a Non-Conformance and/or Non-Compliance Report.
- Contractor to prepare and submit a corrective action plan.
- Contractor to document corrective actions taken and performance criteria met.
- Partial or full stoppage of work on site through activation of shut-down clause in contract.
- At the Certificate Holder’s sole discretion, an outside contractor may be contracted to implement corrective actions, to be reimbursed by the Contractor.

Additionally, the Certificate Holder may establish a Community Action Council to create an open and ongoing pathway for communication with stakeholders for the Project, including controlling fugitive dust emissions and avoiding the creation of nuisances. The Community Action Council could include representatives from the Morrow County Commissioners’ Office, Morrow County Planning Department, Oregon Department of Transportation, and neighboring landowners. The Contractor will work with the Certificate Holder to determine whether this Community Action Council will be established, and if so, the details of its establishment.

2.2 Monitoring

As required by the 1200-C permit, the permit holder will perform visual monitoring and recordkeeping by a Certified Erosion and Sediment Control or Storm Water Quality Inspector (inspector). The Contractor's construction site manager and inspector will be responsible for ensuring that the measures in this Plan are implemented, monitored, and adaptively managed, and that any exceedances are immediately reported to the Certificate Holder.

The visual monitoring required by the 1200-C permit must occur at least once every 14 calendar days. However, because OAR 340-208-0210 restricts visible fugitive emissions on a continuous standard to a maximum of 18 seconds in a given 6-minute period, and because fugitive dust emissions may provide an immediate public safety concern in this location, this Plan requires that fugitive dust be monitored and controlled on an ongoing basis.

Monitoring for fugitive dust emissions shall include:

- Use of EPA Method 22 (ODEQ 2019; see Attachment 2) as specified in OAR 340-208-0210, at least once a day.
- The observation shall be performed during times of peak construction activity at the downwind property boundary.
- Recording of observations in a fugitive dust inspection log that is kept on site and shall be available digitally to the Certificate Holder. This log shall include all information required in EPA Method 22 and shall also include photos and/or video taken during the observation period to document conditions.
- Installation and operation of a weather station, recording (at a minimum) wind speed and direction.

Triggers for additional, more frequent monitoring will include:

- Observation of visible fugitive dust emissions by Contractor, agency, or the Certificate Holder staff.
- Request by a member of the Community Action Council established by the Certificate Holder.
- Wind speeds greater than 15 miles per hour.
- Receipt of complaints or concerns through the Project Dust Control Hotline.

2.3 Training

EPA Method 22 (ODEQ 2019) does not require a specific certification, but it is necessary that the person responsible for observations completed for this method be knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in the references cited in Method 22 (EPA 2019) or from the lecture portion of the EPA Method 9 certification course. The Contractor shall document in the inspection log how the person responsible for observations meets this requirement.

Construction workers will attend a Worker Environmental Awareness Program training prior to conducting construction activities. This training will include a summary of fugitive dust control measures included in this Plan and the responsibilities of personnel working on the Facility related to fugitive dust control.

2.4 Fugitive Dust Prevention and Management

This document and the attached table are intended to provide guidance to construction personnel on measures intended to minimize impacts and control fugitive dust emissions during construction. It is the responsibility of the Contractor to monitor and adaptively manage the site to maintain compliance with all local, state, and federal requirements. Additionally, this Plan is supplemental to the Contractor's Erosion and Sediment Control Plan and does not substitute for any requirements of ODEQ or other agencies.

This Plan is performance-based. As shown in the flow chart in Figure 1, if fugitive dust emissions in excess of the ODEQ criteria of **18 seconds in a 6-minute period** occur, the Contractor shall:

- Implement adaptive management actions, including altering work operations and/or pause work until the fugitive dust emissions are controlled.
- Document that fugitive dust emissions have been controlled, including monitoring with EPA Method 22.
- In addition to any reporting requirements required in the 1200-C permit, report noncompliance incidents and adaptive management actions taken by the Certificate Holder within 24 hours of occurrence.

The Contractor shall maintain and implement this Plan during all phases of construction. The table in Attachment 1 provides suggested Reasonable Available Control Measures (RACMs) for anticipated fugitive dust sources based on industry-standard BMPs and reasonable precautions specified in the Oregon 1200-C permit, ODEQ's Construction Stormwater Best Management Practices Manual (Manual) (ODEQ 2021), and OAR 340-208-0210. Supplemental RACMs are identified in the table in case initial RACMs are not effective in controlling fugitive dust or are not feasible to implement (Attachment 1).

The Contractor shall identify and implement additional RACMs as needed to control fugitive dust emissions. Additionally, the Contractor may propose alternative approaches and RACMs for controlling fugitive dust. This proposal shall be made in writing and is subject to the approval of the Certificate Holder.

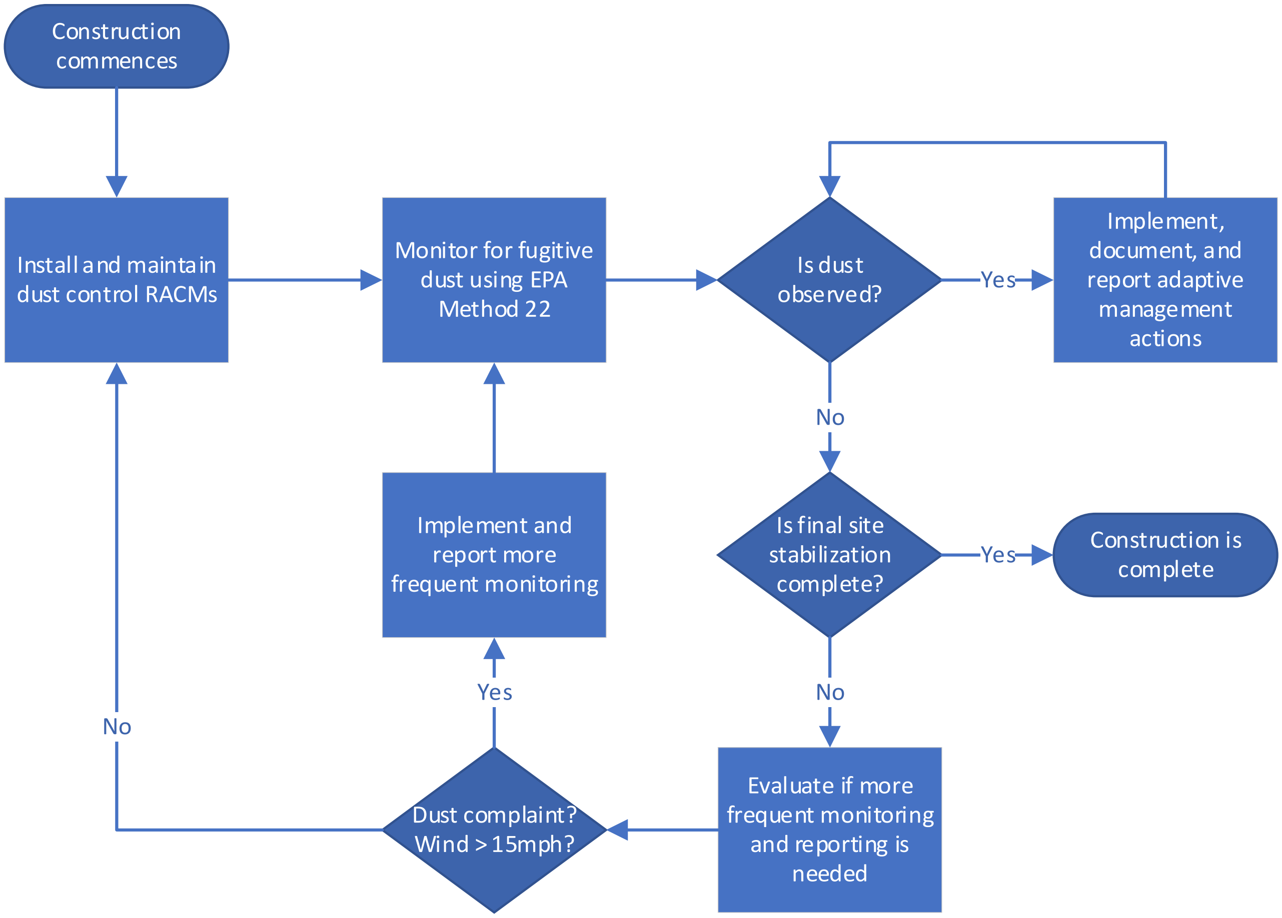

Figure 1. Dust Control Plan Flow Chart

3.0 References

NRSC (Natural Resources Conservation Service). 2011. United States Department of Agriculture, Natural Resources Conservation Service, National Agronomy Manual 190-V-NAM, 4th Edition.

NRCS. 2025. Web Soil Survey. Accessed June 2025. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

ODEQ (Oregon Department of Environmental Quality). 2019. OAR 340-208-0210 EPA Method 22. https://secure.sos.state.or.us/oard/viewAttachment.action?ruleVrsnRsn=256141.

ODEQ. 2021. Construction Stormwater Best Management Practices Manual. https://www.oregon.gov/deq/wq/Documents/wqpBMPManual.pdf.

Sunstone Solar. 2024. Complete Application for Site Certificate, Exhibit K Land Use. Prepared for Sunstone Solar, LLC by Tetra Tech, Inc. May 2024. https://www.oregon.gov/energy/facilities-safety/facilities/Pages/ESP.aspx.

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Attachment 1: Fugitive Dust Sources and Reasonable Available Control Measures

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Fugitive Dust Sources and Reasonable Available Control Measures

Construction Phase	RACM(s)	Supplemental RACM(s)
All Phases of Construction	Daily fugitive dust monitoring and record keeping.	Increase frequency of monitoring.
	Prominent display of Dust Control Hotline signs, providing direct access to the Contractor's site manager or inspector.	If established, proactive engagement with Community Action Council.
	If established, Worker Environmental Awareness Program training for all construction employees.	Additional trainings and refreshers for employees.
	Maintain stockpile of BMPs on site, including sufficient palliatives for a single treatment of all site access roads and sufficient palliatives, mulch, and/or hydromulch for a minimum of 25 percent of the total disturbed area, and machinery for application.	Increase stockpile of palliatives, mulch, and/or hydromulch and add additional BMPs.
	Documentation and reporting of adaptive management actions.	Development and submittal of revised Fugitive Dust Control Plan.
Site Access	Install and maintain stabilized construction entrances at ingress/egress locations and restrict traffic to these locations.	Add additional construction entrance BMPs (e.g., wheel wash).
	Daily sweeping up of sediment from paved surfaces utilizing vacuum sweeper with HEPA filtration.	Increase sweeper frequency.
	Access roads shall be graveled.	Road maintenance and reapplication of gravel.
	Access roads will be stabilized with water or palliative sufficient to eliminate visible and sustained dust from vehicular travel and wind erosion. Reapply stabilization as necessary to maintain dust-free condition.	If water is unavailable or ineffective, or if water use is limited by any agency or regulation, access roads will be stabilized with longer-lasting palliatives.
	Restrict construction traffic to established and stabilized access routes.	Install fencing or barricades to prevent traffic outside of established routes.
	Limit traffic speeds to 15 miles per hour on stabilized unpaved roads within the site as long as such speeds do not create significant visible dust emissions. Traffic speed signs shall be displayed prominently at all site entrances and exits.	Limit traffic speeds within the site to 5 or 10 miles per hour.

Construction Phase	RACM(s)	Supplemental RACM(s)
Clearing, Grading, and Unstable Surfaces	Maintain the natural topography and vegetation of the site to the extent possible, including by limited grading and limited establishment of temporary access roads.	Reduce area being actively worked and stabilize unworked areas.
	Phase construction to expose the minimum amount of soil necessary.	Increase construction phasing to further minimize exposed soil.
	Leave existing vegetation intact to the extent possible.	Utilize mowing and rolling techniques to maintain plant root systems for soil stabilization.
	Minimize disturbance areas and soil exposure to the maximum extent feasible.	Limit work to a portion of the disturbed area until all disturbed areas receive temporary or final stabilization.
	When wind speeds exceed 15 miles per hour, minimize new disturbances to the extent possible and/or mobilize additional water trucks or palliatives to minimize fugitive dust from exposed surfaces.	Stop all ground disturbing activities and apply additional dust control measures until measures are effective or wind speeds slow and fugitive emissions stop.
	Separate and cover topsoil.	Increase maintenance frequency for topsoil cover. Combine methods, such as mulch plus tackifier.
	Stabilize exposed soils within the timeframes established in the 1200-C permit. Stabilize exposed soils in stages based on site conditions and weather.	Stabilize exposed soils more frequently, even if additional work is anticipated within the timeframe established in the 1200-C permit. Reapply stabilization measures following any additional disturbances.
	Temporarily stabilize exposed surfaces to prohibit significant and sustained visible fugitive dust from wind erosion. Utilize BMPs such as mulch, hydromulch with or without seeds, tackifier, spreading stone or gravel, and trackwalking.	Combine stabilization methods, such as mulch plus tackifier, or trackwalking plus hydromulch. Increase frequency of maintenance of stabilization.
	Seed exposed surfaces during the appropriate season with approved temporary or permanent seed mixes.	Reapply seed to newly disturbed areas or areas with poor germination. Use temporary seeding even if additional work is anticipated before final stabilization. Use irrigation to enhance seeding success.
	Gate seals should be tight on dump trucks. Soil load shall be kept below 6 inches of the freeboard of the truck. Drop heights shall be minimized when loaders dump soil into trucks.	Cover haul trucks with a tarp or other suitable cover.

Attachment 2: EPA Method 22

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State of Oregon Department of Environmental Quality

OAR 340-208-0210

EPA Method 22

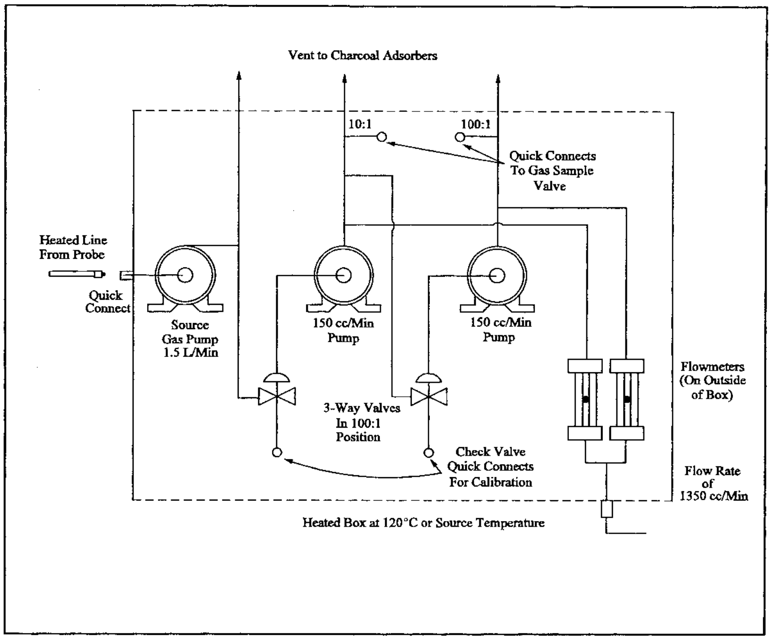


Figure 18-13. Schematic Diagram of the Heated Box Required for Dilution of Sample Gas.

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST

[Respond with initials or number as appropriate]

1. Presurvey data:
    - A. Grab sample collected ☐ ______
        - B. Grab sample analyzed for composition ☐ ______
        - Method GC ☐ ______
            - GC/MS ☐ ______
            - Other ☐ ______
    - C. GC-FID analysis performed ☐ ______
2. Laboratory calibration data:
    - A. Calibration curves prepared ☐ ______
        - Number of components ☐ ______
        - Number of concentrations/component (3 required). ☐ ______
    - B. Audit samples (optional):
    - Analysis completed ☐ ______
    - Verified for concentration ☐ ______
    - OK obtained for field work ☐ ______
3. Sampling procedures:
    - A. Method:
        - Bag sample ☐ ______
        - Direct interface ☐ ______
        - Dilution interface ☐ ______
    - B. Number of samples collected ☐ ______
4. Field Analysis:
    - A. Total hydrocarbon analysis performed ☐ ______
    - B. Calibration curve prepared ☐ ______
        - Number of components ☐ ______
        - Number of concentrations per component (3 required). ☐ ______

Gaseous Organic Sampling and Analysis Data

Date ____________________

Location ____________________

Plant ____________________

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST (RESPOND WITH INITIALS OR NUMBER AS APPROPRIATE)

	Date
1. Pre-survey data	
A. Grab sample collected	____
B. Grab sample analyzed for composition	____
Method GC	____
GC/MS	____
Other____________	____
C. GC–FID analysis performed	____
2. Laboratory calibration curves prepared	____
A. Number of components	____
B. Number of concentrations per component (3 required)	____
C. OK obtained for field work	____
3. Sampling procedures.	
A. Method.	
Bag sample	____
Direct interface	____
Dilution interface	____
B. Number of samples collected	____
4. Field Analysis.	
A. Total hydrocarbon analysis performed	____
B. Calibration curve prepared	____
Number of components	____
Number of concentrations per component (3 required)	____

Figure 18–14. Sampling and Analysis Sheet

[36 FR 24877, Dec. 23, 1971]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting appendix A–6 to part 60, see the List of CFR sections Affected, which appears in the Finding Aids section of the printed volume and at *www.fdsys.gov*.

APPENDIX A–7 TO PART 60—TEST METHODS 19 THROUGH 25E

Method 19—Determination of sulfur dioxide removal efficiency and particulate, sulfur dioxide and nitrogen oxides emission rates

Method 20—Determination of nitrogen oxides, sulfur dioxide, and diluent emissions from stationary gas turbines

Method 21—Determination of volatile organic compound leaks

Method 22—Visual determination of fugitive emissions from material sources and smoke emissions from flares

Method 23—Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans From Stationary Sources

Method 24—Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

Method 24A—Determination of volatile matter content and density of printing inks and related coatings

Method 25—Determination of total gaseous nonmethane organic emissions as carbon

Method 25A—Determination of total gaseous organic concentration using a flame ionization analyzer

Method 25B—Determination of total gaseous organic concentration using a nondispersive infrared analyzer

Method 25C—Determination of nonmethane organic compounds (NMOC) in MSW landfill gases

Method 25D—Determination of the Volatile Organic Concentration of Waste Samples

Method 25E—Determination of Vapor Phase Organic Concentration in Waste Samples

The test methods in this appendix are referred to in §60.8 (Performance Tests) and §60.11 (Compliance With Standards and Maintenance Requirements) of 40 CFR part 60, subpart A (General Provisions). Specific uses of these test methods are described in the standards of performance contained in the subparts, beginning with Subpart D.

Within each standard of performance, a section title ‘‘Test Methods and Procedures’’ is provided to: (1) Identify the test methods to be used as reference methods to the facility subject to the respective standard and (2) identify any special instructions or conditions to be followed when applying a method to the respective facility. Such instructions (for example, establish sampling rates, volumes, or temperatures) are to be used either in addition to, or as a substitute for procedures in a test method. Similarly, for sources subject to emission monitoring requirements, specific instructions pertaining to any use of a test method as a reference method are provided in the subpart or in Appendix B.

Inclusion of methods in this appendix is not intended as an endorsement or denial of their applicability to sources that are not subject to standards of performance. The methods are potentially applicable to other sources; however, applicability should be confirmed by careful and appropriate evaluation of the conditions prevalent at such sources.

The approach followed in the formulation of the test methods involves specifications for equipment, procedures, and performance. In concept, a performance specification approach would be preferable in all methods because this allows the greatest flexibility to the user. In practice, however, this approach is impractical in most cases because performance specifications cannot be established. Most of the methods described herein, therefore, involve specific equipment specifications and procedures, and only a few methods in this appendix rely on performance criteria.

Minor changes in the test methods should not necessarily affect the validity of the results and it is recognized that alternative and equivalent methods exist. section 60.8 provides authority for the Administrator to specify or approve (1) equivalent methods, (2) alternative methods, and (3) minor changes in the methodology of the test methods. It should be clearly understood that unless otherwise identified all such methods and changes must have prior approval of the Administrator. An owner employing such methods or deviations from the test methods without obtaining prior approval does so at the risk of subsequent disapproval and retesting with approved methods.

Within the test methods, certain specific equipment or procedures are recognized as being acceptable or potentially acceptable and are specifically identified in the methods. The items identified as acceptable options may be used without approval but must be identified in the test report. The potentially approvable options are cited as ‘‘subject to the approval of the Administrator’’ or as ‘‘or equivalent.’’ Such potentially approvable techniques or alternatives may be used at the discretion of the owner without prior approval. However, detailed descriptions for applying these potentially approvable techniques or alternatives are not provided in the test methods. Also, the potentially approvable options are not necessarily acceptable in all applications. Therefore, an owner electing to use such potentially approvable techniques or alternatives is responsible for: (1) assuring that the techniques or alternatives are in fact applicable and are properly executed; (2) including a written description of the alternative method in the test report (the written method must be clear and must be capable of being performed without additional instruction, and the degree of detail should be similar to the detail contained in the test methods); and (3) providing any rationale or supporting data necessary to show the validity of the alternative in the particular application. Failure to meet these requirements can result in the Administrator's disapproval of the alternative.

METHOD 19—DETERMINATION OF SULFUR DIOXIDE REMOVAL EFFICIENCY AND PARTICULATE MATTER, SULFUR DIOXIDE, AND NITROGEN OXIDE EMISSION RATES

1.0 Scope and Application

1.1 Analytes. This method provides data reduction procedures relating to the following pollutants, but does not include any sample collection or analysis procedures.

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X), including:		
Nitric oxide (NO)	10102–43–9	N/A
Nitrogen dioxide (NO_2)	10102–44–0.	
Particulate matter (PM)	None assigned	N/A
Sulfur dioxide (SO_2)	7499–09–05	N/A

1.2 Applicability. Where specified by an applicable subpart of the regulations, this method is applicable for the determination of (a) PM, SO_2, and NO_X emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions.

2.0 Summary of Method

2.1 Emission Rates. Oxygen (O_2) or carbon dioxide (CO_2) concentrations and appropriate F factors (ratios of combustion gas volumes to heat inputs) are used to calculate pollutant emission rates from pollutant concentrations.

2.2 Sulfur Reduction Efficiency and SO_2 Removal Efficiency. An overall SO_2 emission reduction efficiency is computed from the efficiency of fuel pretreatment systems, where applicable, and the efficiency of SO_2 control devices.

2.2.1 The sulfur removal efficiency of a fuel pretreatment system is determined by fuel sampling and analysis of the sulfur and heat contents of the fuel before and after the pretreatment system.

2.2.2 The SO_2 removal efficiency of a control device is determined by measuring the SO_2 rates before and after the control device.

2.2.2.1 The inlet rates to SO_2 control systems (or, when SO_2 control systems are not used, SO_2 emission rates to the atmosphere) are determined by fuel sampling and analysis.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety [Reserved]

6.0 Equipment and Supplies [Reserved]

7.0 Reagents and Standards [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transport [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedures [Reserved]

12.0 Data Analysis and Calculations

12.1 Nomenclature

B_{wa} = Moisture fraction of ambient air, percent.

B_{ws} = Moisture fraction of effluent gas, percent.

%C = Concentration of carbon from an ultimate analysis of fuel, weight percent.

C_d = Pollutant concentration, dry basis, ng/scm (lb/scf)

$\%CO_{2d}$,$\%CO_{2w}$ = Concentration of carbon dioxide on a dry and wet basis, respectively, percent.

C_w = Pollutant concentration, wet basis, ng/scm (lb/scf).

D = Number of sampling periods during the performance test period.

E = Pollutant emission rate, ng/J (lb/million Btu).

E_a = Average pollutant rate for the specified performance test period, ng/J (lb/million Btu).

E_{ao}, E_{ai} = Average pollutant rate of the control device, outlet and inlet, respectively, for the performance test period, ng/J (lb/million Btu).

E_{bi} = Pollutant rate from the steam generating unit, ng/J (lb/million Btu)

E_{bo} = Pollutant emission rate from the steam generating unit, ng/J (lb/million Btu).

E_{ci} = Pollutant rate in combined effluent, ng/J (lb/million Btu).

E_{co} = Pollutant emission rate in combined effluent, ng/J (lb/million Btu).

E_d = Average pollutant rate for each sampling period (*e.g.*, 24-hr Method 6B sample or 24-hr fuel sample) or for each fuel lot (*e.g.*, amount of fuel bunkered), ng/J (lb/million Btu).

E_{di} = Average inlet SO_2 rate for each sampling period d, ng/J (lb/million Btu)

E_g = Pollutant rate from gas turbine, ng/J (lb/million Btu).

E_{ga} = Daily geometric average pollutant rate, ng/J (lbs/million Btu) or ppm corrected to 7 percent O_2.

E_{jo},E_{ji} = Matched pair hourly arithmetic average pollutant rate, outlet and inlet, respectively, ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

E_h = Hourly average pollutant, ng/J (lb/million Btu).

E_{hj} = Hourly arithmetic average pollutant rate for hour ''j,'' ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

EXP = Natural logarithmic base (2.718) raised to the value enclosed by brackets.

F_d, F_w, F_c = Volumes of combustion components per unit of heat content, scm/J (scf/million Btu).

GCV = Gross calorific value of the fuel consistent with the ultimate analysis, kJ/kg (Btu/lb).

GCV_p, GCV_r = Gross calorific value for the product and raw fuel lots, respectively, dry basis, kJ/kg (Btu/lb).

%H = Concentration of hydrogen from an ultimate analysis of fuel, weight percent.

H = Total number of operating hours for which pollutant rates are determined in the performance test period.

H_b = Heat input rate to the steam generating unit from fuels fired in the steam generating unit, J/hr (million Btu/hr).

H_g = Heat input rate to gas turbine from all fuels fired in the gas turbine, J/hr (million Btu/hr).

$\%H_2O$ = Concentration of water from an ultimate analysis of fuel, weight percent.

H_r = Total numbers of hours in the performance test period (*e.g.*, 720 hours for 30-day performance test period).

K = Conversion factor, 10^{-5} (kJ/J)/(%) [10^6 Btu/million Btu].

K_c = (9.57 scm/kg)/% [(1.53 scf/lb)/%].

K_{cc} = (2.0 scm/kg)/% [(0.321 scf/lb)/%].

K_{hd} = (22.7 scm/kg)/% [(3.64 scf/lb)/%].

K_{hw} = (34.74 scm/kg)/% [(5.57 scf/lb)/%].

K_n = (0.86 scm/kg)/% [(0.14 scf/lb)/%].

K_o = (2.85 scm/kg)/% [(0.46 scf/lb)/%].

K_s = (3.54 scm/kg)/% [(0.57 scf/lb)/%].

K_w = (1.30 scm/kg)/% [(0.21 scf/lb)/%].

ln = Natural log of indicated value.

L_p,L_r = Weight of the product and raw fuel lots, respectively, metric ton (ton).

%N = Concentration of nitrogen from an ultimate analysis of fuel, weight percent.

N = Number of fuel lots during the averaging period.

n = Number of fuels being burned in combination.

n_d = Number of operating hours of the affected facility within the performance test period for each E_d determined.

n_t = Total number of hourly averages for which paired inlet and outlet pollutant rates are available within the 24-hr midnight to midnight daily period.

%O = Concentration of oxygen from an ultimate analysis of fuel, weight percent.

$\%O_{2d}$, $\%O_{2w}$ = Concentration of oxygen on a dry and wet basis, respectively, percent.

P_s = Potential SO_2 emissions, percent.

$\%R_f$ = SO_2 removal efficiency from fuel pretreatment, percent.

$\%R_g$ = SO_2 removal efficiency of the control device, percent.

$\%R_{ga}$ = Daily geometric average percent reduction.

$\%R_o$ = Overall SO_2 reduction, percent.

%S = Sulfur content of as-fired fuel lot, dry basis, weight percent.

S_e = Standard deviation of the hourly average pollutant rates for each performance test period, ng/J (lb/million Btu).

$\%S_f$ = Concentration of sulfur from an ultimate analysis of fuel, weight percent.

S_i = Standard deviation of the hourly average inlet pollutant rates for each performance test period, ng/J (lb/million Btu).

S_o = Standard deviation of the hourly average emission rates for each performance test period, ng/J (lb/million Btu).

$\%S_p$, $\%S_r$ = Sulfur content of the product and raw fuel lots respectively, dry basis, weight percent.

$t_{0.95}$ = Values shown in Table 19–3 for the indicated number of data points n.

X_k = Fraction of total heat input from each type of fuel k.

12.2 Emission Rates of PM, SO_2, and NO_X. Select from the following sections the applicable procedure to compute the PM, S_{O2}, or NO_X emission rate (E) in ng/J (lb/million Btu). The pollutant concentration must be in ng/scm (lb/scf) and the F factor must be in scm/J (scf/million Btu). If the pollutant concentration (C) is not in the appropriate units, use Table 19–1 in section 17.0 to make the proper conversion. An F factor is the ratio of the gas volume of the products of combustion to the heat content of the fuel. The dry F factor (F_d) includes all components of combustion less water, the wet F factor (F_w) includes all components of combustion, and the carbon F factor (F_c) includes only carbon dioxide.

NOTE: Since F_w factors include water resulting only from the combustion of hydrogen in the fuel, the procedures using F_w factors are not applicable for computing E from steam generating units with wet scrubbers or with other processes that add water (*e.g.*, steam injection).

12.2.1 Oxygen-Based F Factor, Dry Basis. When measurements are on a dry basis for both O ($\%O_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_d \frac{20.9}{\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-1}$$

12.2.2 Oxygen-Based F Factor, Wet Basis. When measurements are on a wet basis for both O_2 ($\%O_{2w}$) and pollutant (C_w) concentrations, use either of the following:

12.2.2.1 If the moisture fraction of ambient air (B_{wa}) is measured:

$$E = C_w F_w \frac{20.9}{\left[20.9\left(1 - B_{wa}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-2}$$

Instead of actual measurement, B_{wa} may be estimated according to the procedure below.

NOTE: The estimates are selected to ensure that negative errors will not be larger than −1.5 percent. However, positive errors, or over-estimation of emissions by as much as 5 percent may be introduced depending upon the geographic location of the facility and the associated range of ambient moisture.

12.2.2.1.1 B_{wa} = 0.027. This value may be used at any location at all times.

12.2.2.1.2 B_{wa} = Highest monthly average of B_{wa} that occurred within the previous calendar year at the nearest Weather Service Station. This value shall be determined annually and may be used as an estimate for the entire current calendar year.

12.2.2.1.3 B_{wa} = Highest daily average of Bwa that occurred within a calendar month at the nearest Weather Service Station, calculated from the data from the past 3 years. This value shall be computed for each month and may be used as an estimate for the current respective calendar month.

12.2.2.2 If the moisture fraction (B_{ws}) of the effluent gas is measured:

$$E = C_w F_d \frac{20.9}{\left[20.9\left(1 - B_{ws}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-3}$$

12.2.3 Oxygen-Based F Factor, Dry/Wet Basis.

12.2.3.1 When the pollutant concentration is measured on a wet basis (C_w) and O_2 concentration is measured on a dry basis ($\%O_{2d}$), use the following equation:

$$E = \frac{\left(C_w F_d\right)(20.9)}{\left(1 - B_{ws}\right)\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-4}$$

12.2.3.2 When the pollutant concentration is measured on a dry basis (C_d) and the O_2 concentration is measured on a wet basis ($\%O_{2w}$), use the following equation:

$$E = \frac{C_d F_d \, 20.9}{\dfrac{\left(20.9 - \%O_{2w}\right)}{\left(1 - B_{ws}\right)}} \qquad \text{Eq. 19-5}$$

12.2.4 Carbon Dioxide-Based F Factor, Dry Basis. When measurements are on a dry basis for both CO_2 ($\%CO_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_c \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-6}$$

12.2.5 Carbon Dioxide-Based F Factor, Wet Basis. When measurements are on a wet basis for both CO_2 ($\%CO_{2w}$) and pollutant (C_w) concentrations, use the following equation:

$$E = C_w F_c \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-7}$$

12.2.6 Carbon Dioxide-Based F Factor, Dry/Wet Basis.

12.2.6.1 When the pollutant concentration is measured on a wet basis (C_w) and CO_2 concentration is measured on a dry basis ($\%CO_{2d}$), use the following equation:

$$E = \frac{C_w F_c}{\left(1 - B_{ws}\right)} \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-8}$$

12.2.6.2 When the pollutant concentration is measured on a dry basis (C_d) and CO_2 concentration is measured on a wet basis ($\%CO_{2w}$), use the following equation:

$$E = C_d F_c \left(1 - B_{ws}\right) \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-9}$$

12.2.7 Direct-Fired Reheat Fuel Burning. The effect of direct-fired reheat fuel burning (for the purpose of raising the temperature of the exhaust effluent from wet scrubbers to above the moisture dew-point) on emission rates will be less than 1.0 percent and, therefore, may be ignored.

12.2.8 Combined Cycle-Gas Turbine Systems. For gas turbine-steam generator combined cycle systems, determine the emissions from the steam generating unit or the percent reduction in potential SO_2 emissions as follows:

12.2.8.1 Compute the emission rate from the steam generating unit using the following equation:

$$E_{bo} = E_{co} + \frac{H_g}{H_b}\left(E_{co} - E_g\right) \qquad \text{Eq. 19-10}$$

12.2.8.1.1 Use the test methods and procedures section of 40 CFR Part 60, Subpart GG to obtain E_{co} and E_g. Do not use F_w factors for determining E_g or E_{co}. If an SO_2 control device is used, measure E_{co} after the control device.

12.2.8.1.2 Suitable methods shall be used to determine the heat input rates to the steam generating units (H_b) and the gas turbine (H_g).

12.2.8.2 If a control device is used, compute the percent of potential SO_2 emissions (P_s) using the following equations:

$$E_{bi} = E_{ci} - \frac{H_g}{H_b}\left(E_{ci} - E_g\right) \qquad \text{Eq. 19-11}$$

$$P_s = 100\left(1 - \frac{E_{bo}}{E_{bi}}\right) \qquad \text{Eq. 19-12}$$

NOTE: Use the test methods and procedures section of Subpart GG to obtain E_{ci} and E_g. Do not use F_w factors for determining E_g or E_{ci}.

12.3 F Factors. Use an average F factor according to section 12.3.1 or determine an applicable F factor according to section 12.3.2. If combined fuels are fired, prorate the applicable F factors using the procedure in section 12.3.3.

12.3.1 Average F Factors. Average F factors (F_d, F_w, or F_c) from Table 19–2 in section 17.0 may be used.

12.3.2 Determined F Factors. If the fuel burned is not listed in Table 19–2 or if the owner or operator chooses to determine an F factor rather than use the values in Table 19–2, use the procedure below:

12.3.2.1 Equations. Use the equations below, as appropriate, to compute the F factors:

$$F_d = \frac{K\left(K_{hd}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O\right)}{GCV} \qquad \text{Eq. 19-13}$$

$$F_w = \frac{K\left[K_{hw}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O + K_w\%H_2O\right]}{GCV_w} \qquad \text{Eq. 19-14}$$

$$F_c = \frac{K\left(K_{cc}\%C\right)}{GCV} \qquad \text{Eq. 19-15}$$

NOTE: Omit the $\%H_2O$ term in the equations for F_w if %H and %O include the unavailable hydrogen and oxygen in the form of H_2O.)

12.3.2.2 Use applicable sampling procedures in section 12.5.2.1 or 12.5.2.2 to obtain samples for analyses.

12.3.2.3 Use ASTM D 3176–74 or 89 (all cited ASTM standards are incorporated by reference—see §60.17) for ultimate analysis of the fuel.

12.3.2.4 Use applicable methods in section 12.5.2.1 or 12.5.2.2 to determine the heat content of solid or liquid fuels. For gaseous fuels, use ASTM D 1826–77 or 94 (incorporated by reference—see §60.17) to determine the heat content.

12.3.3 F Factors for Combination of Fuels. If combinations of fuels are burned, use the following equations, as applicable unless otherwise specified in an applicable subpart:

$$F_d = \sum_{k=1}^{n}\left(X_k F_{dk}\right) \qquad \text{Eq. 19-16}$$

$$F_w = \sum_{k=1}^{n}\left(X_k F_{wk}\right) \qquad \text{Eq. 19-17}$$

$$F_c = \sum_{k=1}^{n}\left(X_k F_{ck}\right) \qquad \text{Eq. 19-18}$$

12.4 Determination of Average Pollutant Rates.

12.4.1 Average Pollutant Rates from Hourly Values. When hourly average pollutant rates (E_h), inlet or outlet, are obtained (*e.g.*, CEMS values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{1}{H}\sum_{j=1}^{n} E_{hj} \qquad \text{Eq. 19-19}$$

12.4.2 Average Pollutant Rates from Other than Hourly Averages. When pollutant rates are determined from measured values representing longer than 1-hour periods (*e.g.*, daily fuel sampling and analyses or Method 6B values), or when pollutant rates are determined from combinations of 1-hour and longer than 1-hour periods (*e.g.*, CEMS and Method 6B values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{\sum_{j=1}^{D}\left(n_d E_d\right)_j}{\sum_{j=1}^{D} n_{dj}} \qquad \text{Eq. 19-20}$$

12.4.3 Daily Geometric Average Pollutant Rates from Hourly Values. The geometric average pollutant rate (E_{ga}) is computed using the following equation:

$$E_{ga} = \exp\left[\frac{1}{n_t}\sum_{j=1}^{n_t}\left[\ln\left(E_{hj}\right)\right]\right] \qquad \text{Eq. 19-21}$$

12.5 Determination of Overall Reduction in Potential Sulfur Dioxide Emission.

12.5.1 Overall Percent Reduction. Compute the overall percent SO_2 reduction ($\%R_o$) using the following equation:

$$\%R_o = 100\left[1.0-\left(1.0-\frac{\%R_f}{100}\right)\left(1.0-\frac{\%R_g}{100}\right)\right] \qquad \text{Eq. 19-22}$$

12.5.2 Pretreatment Removal Efficiency (Optional). Compute the SO_2 removal efficiency from fuel pretreatment ($\%R_f$) for the averaging period (*e.g.*, 90 days) as specified in the applicable regulation using the following equation:

$$\%R_f = 100\left[1.0-\frac{\sum_{j=1}^{N}\left(\frac{\%S_{pj}}{GCV_{pj}}\right)L_{pj}}{\sum_{j=1}^{N}\left(\frac{\%S_{rj}}{GCV_{rj}}\right)L_{rj}}\right] \qquad \text{Eq. 19-23}$$

NOTE: In calculating $\%R_f$, include %S and GCV values for all fuel lots that are not pretreated and are used during the averaging period.

12.5.2.1 Solid Fossil (Including Waste) Fuel/Sampling and Analysis.

NOTE: For the purposes of this method, raw fuel (coal or oil) is the fuel delivered to the desulfurization (pretreatment) facility. For oil, the input oil to the oil desulfurization process (*e.g.*, hydrotreatment) is considered to be the raw fuel.

12.5.2.1.1 Sample Increment Collection. Use ASTM D 2234–76, 96, 97a, or 98 (incorporated by reference—see §60.17), Type I, Conditions A, B, or C, and systematic spacing. As used in this method, systematic spacing is intended to include evenly spaced increments in time or increments based on equal weights of coal passing the collection area. As a minimum, determine the number and weight of increments required per gross sample representing each coal lot according to Table 2 or Paragraph 7.1.5.2 of ASTM D 2234. Collect one gross sample for each lot of raw coal and one gross sample for each lot of product coal.

12.5.2.1.2 ASTM Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of product coal is the weight of product coal from one type of raw coal. The lot size of raw coal is the weight of raw coal used to produce one lot of product coal. Typically, the lot size is the weight of coal processed in a 1-day (24-hour) period. If more than one type of coal is treated and produced in 1 day, then gross samples must be collected and analyzed for each type of coal. A coal lot size equaling the 90-day quarterly fuel quantity for a steam generating unit may be used if representative sampling can be conducted for each raw coal and product coal.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.1.3 Gross Sample Analysis. Use ASTM D 2013–72 or 86 to prepare the sample, ASTM D 3177–75 or 89 or ASTM D 4239–85, 94, or 97 to determine sulfur content (%S), ASTM D 3173–73 or 87 to determine moisture content, and ASTM D 2015–77 (Reapproved 1978) or 96, D 3286–85 or 96, or D 5865–98 or 10 to determine gross calorific value (GCV) (all standards cited are incorporated by reference—see §60.17 for acceptable versions of the standards) on a dry basis for each gross sample.

12.5.2.2 Liquid Fossil Fuel-Sampling and Analysis. See Note under section 12.5.2.1.

12.5.2.2.1 Sample Collection. Follow the procedures for continuous sampling in ASTM D 270 or D 4177–95 (incorporated by reference—see §60.17) for each gross sample from each fuel lot.

12.5.2.2.2 Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of a product oil is the weight of product oil from one pretreatment facility and intended as one shipment (ship load, barge load, etc.). The lot size of raw oil is the weight of each crude liquid fuel type used to produce a lot of product oil.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.2.3 Sample Analysis. Use ASTM D 129–64, 78, or 95, ASTM D 1552–83 or 95, or ASTM D 4057–81 or 95 to determine the sulfur content (%S) and ASTM D 240–76 or 92 (all standards cited are incorporated by reference—see §60.17) to determine the GCV of each gross sample. These values may be assumed to be on a dry basis. The owner or operator of an affected facility may elect to determine the GCV by sampling the oil combusted on the first steam generating unit operating day of each calendar month and then using the lowest GCV value of the three GCV values per quarter for the GCV of all oil combusted in that calendar quarter.

12.5.2.3 Use appropriate procedures, subject to the approval of the Administrator, to determine the fraction of total mass input derived from each type of fuel.

12.5.3 Control Device Removal Efficiency. Compute the percent removal efficiency ($\%R_g$) of the control device using the following equation:

$$\%R_g = 100\left(1.0 - \frac{E_{ao}}{E_{ai}}\right) \qquad \text{Eq. 19-24}$$

12.5.3.1 Use continuous emission monitoring systems or test methods, as appropriate, to determine the outlet SO_2 rates and, if appropriate, the inlet SO_2 rates. The rates may be determined as hourly (E_h) or other sampling period averages (E_d). Then, compute the average pollutant rates for the performance test period (E_{ao} and E_{ai}) using the procedures in section 12.4.

12.5.3.2 As an alternative, as-fired fuel sampling and analysis may be used to determine inlet SO_2 rates as follows:

12.5.3.2.1 Compute the average inlet SO_2 rate (E_{di}) for each sampling period using the following equation:

$$E_{di} = K\frac{\%S}{GCV} \qquad \text{Eq. 19-25}$$

Where:

$$K = 2\times10^7\left(\frac{\text{ng SO}_2}{\%\text{S}}\right)\left(\frac{(\text{kJ})}{\text{J}}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^4\left(\frac{\text{lb SO}_2}{\%\text{S}}\right)\left(\frac{\text{Btu}}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4 to determine the average inlet SO_2 rate for the performance test period (E_{ai}).

12.5.3.2.2 Collect the fuel samples from a location in the fuel handling system that provides a sample representative of the fuel bunkered or consumed during a steam generating unit operating day. For the purpose of as-fired fuel sampling under section 12.5.3.2 or section 12.6, the lot size for coal is the weight of coal bunkered or consumed during each steam generating unit operating day. The lot size for oil is the weight of oil supplied to the ‘‘day’’ tank or consumed during each steam generating unit operating day. For reporting and calculation purposes, the gross sample shall be identified with the calendar day on which sampling began. For steam generating unit operating days when a coal-fired steam generating unit is operated without coal being added to the bunkers, the coal analysis from the previous ‘‘as bunkered’’ coal sample shall be used until coal is bunkered again. For steam generating unit operating days when an oil-fired steam generating unit is operated without oil being added to the oil ‘‘day’’ tank, the oil analysis from the previous day shall be used until the ‘‘day’’ tank is filled again. Alternative definitions of fuel lot size may be used, subject to prior approval of the Administrator.

12.5.3.2.3 Use ASTM procedures specified in section 12.5.2.1 or 12.5.2.2 to determine %S and GCV.

12.5.4 Daily Geometric Average Percent Reduction from Hourly Values. The geometric average percent reduction ($\%R_{ga}$) is computed using the following equation:

$$\%R_{ga} = 100\left[1 - \text{EXP}\left(\frac{1}{n_t}\sum_{j=1}^{n_t} \ln\frac{E_{jo}}{E_{ji}}\right)\right] \qquad \text{Eq. 19-26}$$

NOTE: The calculation includes only paired data sets (hourly average) for the inlet and outlet pollutant measurements.

12.6 Sulfur Retention Credit for Compliance Fuel. If fuel sampling and analysis procedures in section 12.5.2.1 are being used to determine average SO_2 emission rates (E_{as}) to the atmosphere from a coal-fired steam generating unit when there is no SO_2 control device, the following equation may be used to adjust the emission rate for sulfur retention credits (no credits are allowed for oil-fired systems) (E_{di}) for each sampling period using the following equation:

$$E_{di} = 0.97K \frac{\%S}{GDV} \qquad \text{Eq. 19-27}$$

Where:

$$K = 2\times10^{7}\left(\frac{\text{ng } SO_2}{\%S}\right)\left(\frac{kJ}{J}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^{4}\left(\frac{\text{lb } SO_2}{\%S}\right)\left(\frac{Btu}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4.2 to determine the average SO_2 emission rate to the atmosphere for the performance test period (E_{ao}).

12.7 Determination of Compliance When Minimum Data Requirement Is Not Met.

12.7.1 Adjusted Emission Rates and Control Device Removal Efficiency. When the minimum data requirement is not met, the Administrator may use the following adjusted emission rates or control device removal efficiencies to determine compliance with the applicable standards.

12.7.1.1 Emission Rate. Compliance with the emission rate standard may be determined by using the lower confidence limit of the emission rate (E_{ao}*) as follows:

$$E_{ao}^{*} = E_{ao} - t_{0.95} S_o \qquad \text{Eq. 19-28}$$

12.7.1.2 Control Device Removal Efficiency. Compliance with the overall emission reduction ($\%R_o$) may be determined by using the lower confidence limit of the emission rate (E_{ao}*) and the upper confidence limit of the inlet pollutant rate (E_{ai}*) in calculating the control device removal efficiency ($\%R_g$) as follows:

$$\%R_g = 100\left(1.0 - \frac{E_{ao}^{*}}{E_{ai}^{*}}\right) \qquad \text{Eq. 19-29}$$

$$E_{ai}^{*} = E_{ai} + t_{0.95} S_i \qquad \text{Eq. 19-30}$$

12.7.2 Standard Deviation of Hourly Average Pollutant Rates. Compute the standard deviation (S_e) of the hourly average pollutant rates using the following equation:

$$S_e = \sqrt{\frac{1}{H} - \frac{1}{H_r}}\,\sqrt{\frac{\sum_{j=1}^{H}\left(E_{hj} - E_a\right)^2}{H-1}} \qquad \text{Eq. 19-31}$$

Equation 19–19 through 19–31 may be used to compute the standard deviation for both the outlet (S_o) and, if applicable, inlet (S_i) pollutant rates.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References [Reserved]

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION

From	To	Multiply by
g/scm	ng/scm	10^9
mg/scm	ng/scm	10^6
lb/scf	ng/scm	1.602×10^{13}

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION—Continued

From	To	Multiply by
ppm SO_2	ng/scm	2.66×10^6
ppm NO_X	ng/scm	1.912×10^6
ppm SO_2	lb/scf	1.660×10^{-7}
ppm NO_X	lb/scf	1.194×10^{-7}

TABLE 19–2—F FACTORS FOR VARIOUS FUELS[1]

Fuel Type	F_d		F_w		F_c	
	dscm/J	dscf/10^6 Btu	wscm/J	wscf/10^6 Btu	scm/J	scf/10^6 Btu
Coal:						
Anthracite[2]	2.71×10^{-7}	10,100	2.83×10^{-7}	10,540	0.530×10^{-7}	1,970
Bituminus[2]	2.63×10^{-7}	9,780	2.86×10^{-7}	10,640	0.484×10^{-7}	1,800
Lignite	2.65×10^{-7}	9,860	3.21×10^{-7}	11,950	0.513×10^{-7}	1,910
Oil[3]	2.47×10^{-7}	9,190	2.77×10^{-7}	10,320	0.383×10^{-7}	1,420
Gas:.						
Natural	2.34×10^{-7}	8,710	2.85×10^{-7}	10,610	0.287×10^{-7}	1,040
Propane	2.34×10^{-7}	8,710	2.74×10^{-7}	10,200	0.321×10^{-7}	1,190
Butane	2.34×10^{-7}	8,710	2.79×10^{-7}	10,390	0.337×10^{-7}	1,250
Wood	2.48×10^{-7}	9,240			0.492×10^{-7}	1,830
Wood Bark	2.58×10^{-7}	9,600			0.516×10^{-7}	1,920
Municipal Solid Waste	2.57×10^{-7}	9,570			0.488×10^{-7}	1,820

[1] Determined at standard conditions: 20 °C (68 °F) and 760 mm Hg (29.92 in Hg)

[2] As classified according to ASTM D 388.

[3] Crude, residual, or distillate.

TABLE 19–3—VALUES FOR $T_{0.95}$*

n[1]	$t_{0.95}$	n[1]	$t_{0.95}$	n[1]	$t_{0.95}$
2	6.31	8	1.89	22–26	1.71
3	2.42	9	1.86	27–31	1.70
4	2.35	10	1.83	32–51	1.68
5	2.13	11	1.81	52–91	1.67
6	2.02	12–16	1.77	92–151	1.66
7	1.94	17–21	1.73	152 or more	1.65

[1] The values of this table are corrected for n-1 degrees of freedom. Use n equal to the number (H) of hourly average data points.

METHOD 20—DETERMINATION OF NITROGEN OXIDES, SULFUR DIOXIDE, AND DILUENT EMISSIONS FROM STATIONARY GAS TURBINES

1.0 Scope and Application

What is Method 20?

Method 20 contains the details you must follow when using an instrumental analyzer to determine concentrations of nitrogen oxides, oxygen, carbon dioxide, and sulfur dioxide in the emissions from stationary gas turbines. This method follows the specific instructions for equipment and performance requirements, supplies, sample collection and analysis, calculations, and data analysis in the methods listed in section 2.0.

1.1 Analytes. What does this method determine?

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X) as nitrogen dioxide:	10102–43–9	Typically <2% of Calibration Span.
Nitric oxide (NO)	10102–44–0	
Nitrogen dioxide NO_2.		
Diluent oxygen (O_2) or carbon dioxide (CO_2)		Typically <2% of Calibration Span.
Sulfur dioxide (SO_X)	7446–09–5	Typically <2% of Calibration Span.

1.2 Applicability. When is this method required? The use of Method 20 may be required by specific New Source Performance Standards, Clean Air Marketing rules, and State Implementation Plans and permits where

measuring SO_2, NO_X, CO_2, and/or O_2 concentrations in stationary gas turbines emissions are required. Other regulations may also require its use.

1.3 Data Quality Objectives. How good must my collected data be? Refer to section 1.3 of Method 7E.

2.0 Summary of Method

In this method, NO_X, O_2 (or CO_2), and SO_X are measured using the following methods found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 3A—Determination of Oxygen and Carbon Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(c) Method 6C—Determination of Sulfur Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(d) Method 7E—Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(e) Method 19—Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates.

3.0 Definitions

Refer to section 3.0 of Method 7E for the applicable definitions.

4.0 Interferences

Refer to section 4.0 of Methods 3A, 6C, and 7E as applicable.

5.0 Safety

Refer to section 5.0 of Method 7E.

6.0 Equipment and Supplies

The measurement system design is shown in Figure 7E–1 of Method 7E. Refer to the appropriate methods listed in section 2.0 for equipment and supplies.

7.0 Reagents and Standards

Refer to the appropriate methods listed in section 2.0 for reagents and standards.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling Site and Sampling Points. Follow the procedures of section 8.1 of Method 7E. For the stratification test in section 8.1.2, determine the diluent-corrected pollutant concentration at each traverse point.

8.2 Initial Measurement System Performance Tests. You must refer to the appropriate methods listed in section 2.0 for the measurement system performance tests as applicable.

8.3 Interference Check. You must follow the procedures in section 8.3 of Method 3A or 6C, or section 8.2.7 of Method 7E (as appropriate).

8.4 Sample Collection. You must follow the procedures of section 8.4 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

8.5 Post-Run System Bias Check, Drift Assessment, and Alternative Dynamic Spike Procedure. You must follow the procedures of sections 8.5 and 8.6 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

9.0 Quality Control

Follow quality control procedures in section 9.0 of Method 7E.

10.0 Calibration and Standardization

Follow the procedures for calibration and standardization in section 10.0 of Method 7E.

11.0 Analytical Procedures

Because sample collection and analysis are performed together (see section 8), additional discussion of the analytical procedure is not necessary.

12.0 Calculations and Data Analysis

You must follow the procedures for calculations and data analysis in section 12.0 of the appropriate method listed in section 2.0. Follow the procedures in section 12.0 of Method 19 for calculating fuel-specific F factors, diluent-corrected pollutant concentrations, and emission rates.

13.0 Method Performance

The specifications for the applicable performance checks are the same as in section 13.0 of Method 7E.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures

Refer to section 16.0 of the appropriate method listed in section 2.0 for alternative procedures.

17.0 References

Refer to section 17.0 of the appropriate method listed in section 2.0 for references.

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Refer to section 18.0 of the appropriate method listed in section 2.0 for tables, diagrams, flowcharts, and validation data.

METHOD 21—DETERMINATION OF VOLATILE ORGANIC COMPOUND LEAKS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile Organic Compounds (VOC).	No CAS number assigned.

1.2 Scope. This method is applicable for the determination of VOC leaks from process equipment. These sources include, but are not limited to, valves, flanges and other connections, pumps and compressors, pressure relief devices, process drains, open-ended valves, pump and compressor seal system degassing vents, accumulator vessel vents, agitator seals, and access door seals.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A portable instrument is used to detect VOC leaks from individual sources. The instrument detector type is not specified, but it must meet the specifications and performance criteria contained in section 6.0. A leak definition concentration based on a reference compound is specified in each applicable regulation. This method is intended to locate and classify leaks only, and is not to be used as a direct measure of mass emission rate from individual sources.

3.0 Definitions

3.1 *Calibration gas* means the VOC compound used to adjust the instrument meter reading to a known value. The calibration gas is usually the reference compound at a known concentration approximately equal to the leak definition concentration.

3.2 *Calibration precision* means the degree of agreement between measurements of the same known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration.

3.3 *Leak definition concentration* means the local VOC concentration at the surface of a leak source that indicates that a VOC emission (leak) is present. The leak definition is an instrument meter reading based on a reference compound.

3.4 *No detectable emission* means a local VOC concentration at the surface of a leak source, adjusted for local VOC ambient concentration, that is less than 2.5 percent of the specified leak definition concentration. that indicates that a VOC emission (leak) is not present.

3.5 *Reference compound* means the VOC species selected as the instrument calibration basis for specification of the leak definition concentration. (For example, if a leak definition concentration is 10,000 ppm as methane, then any source emission that results in a local concentration that yields a meter reading of 10,000 on an instrument meter calibrated with methane would be classified as a leak. In this example, the leak definition concentration is 10,000 ppm and the reference compound is methane.)

3.6 *Response factor* means the ratio of the known concentration of a VOC compound to the observed meter reading when measured using an instrument calibrated with the reference compound specified in the applicable regulation.

3.7 *Response time* means the time interval from a step change in VOC concentration at the input of the sampling system to the time at which 90 percent of the corresponding final value is reached as displayed on the instrument readout meter.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Pollutants. Several of the compounds, leaks of which may be determined by this method, may be irritating or corrosive to tissues (*e.g.*, heptane) or may be toxic (*e.g.*, benzene, methyl alcohol). Nearly all are fire hazards. Compounds in emissions should be determined through familiarity with the source. Appropriate precautions can be found in reference documents, such as reference No. 4 in section 16.0.

6.0 Equipment and Supplies

A VOC monitoring instrument meeting the following specifications is required:

6.1 The VOC instrument detector shall respond to the compounds being processed. Detector types that may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption, and photoionization.

6.2 The instrument shall be capable of measuring the leak definition concentration specified in the regulation.

6.3 The scale of the instrument meter shall be readable to ±2.5 percent of the specified leak definition concentration.

6.4 The instrument shall be equipped with an electrically driven pump to ensure that a sample is provided to the detector at a constant flow rate. The nominal sample flow rate, as measured at the sample probe tip, shall be 0.10 to 3.0 l/min (0.004 to 0.1 ft^3/min) when the probe is fitted with a glass wool plug or filter that may be used to prevent plugging of the instrument.

6.5 The instrument shall be equipped with a probe or probe extension or sampling not to exceed 6.4 mm (¼ in) in outside diameter,

with a single end opening for admission of sample.

6.6 The instrument shall be intrinsically safe for operation in explosive atmospheres as defined by the National Electrical Code by the National Fire Prevention Association or other applicable regulatory code for operation in any explosive atmospheres that may be encountered in its use. The instrument shall, at a minimum, be intrinsically safe for Class 1, Division 1 conditions, and/or Class 2, Division 1 conditions, as appropriate, as defined by the example code. The instrument shall not be operated with any safety device, such as an exhaust flame arrestor, removed.

7.0 Reagents and Standards

7.1 Two gas mixtures are required for instrument calibration and performance evaluation:

7.1.1 Zero Gas. Air, less than 10 parts per million by volume (ppmv) VOC.

7.1.2 Calibration Gas. For each organic species that is to be measured during individual source surveys, obtain or prepare a known standard in air at a concentration approximately equal to the applicable leak definition specified in the regulation.

7.2 Cylinder Gases. If cylinder calibration gas mixtures are used, they must be analyzed and certified by the manufacturer to be within 2 percent accuracy, and a shelf life must be specified. Cylinder standards must be either reanalyzed or replaced at the end of the specified shelf life.

7.3 Prepared Gases. Calibration gases may be prepared by the user according to any accepted gaseous preparation procedure that will yield a mixture accurate to within 2 percent. Prepared standards must be replaced each day of use unless it is demonstrated that degradation does not occur during storage.

7.4 Mixtures with non-Reference Compound Gases. Calibrations may be performed using a compound other than the reference compound. In this case, a conversion factor must be determined for the alternative compound such that the resulting meter readings during source surveys can be converted to reference compound results.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Instrument Performance Evaluation. Assemble and start up the instrument according to the manufacturer's instructions for recommended warmup period and preliminary adjustments.

8.1.1 Response Factor. A response factor must be determined for each compound that is to be measured, either by testing or from reference sources. The response factor tests are required before placing the analyzer into service, but do not have to be repeated at subsequent intervals.

8.1.1.1 Calibrate the instrument with the reference compound as specified in the applicable regulation. Introduce the calibration gas mixture to the analyzer and record the observed meter reading. Introduce zero gas until a stable reading is obtained. Make a total of three measurements by alternating between the calibration gas and zero gas. Calculate the response factor for each repetition and the average response factor.

8.1.1.2 The instrument response factors for each of the individual VOC to be measured shall be less than 10 unless otherwise specified in the applicable regulation. When no instrument is available that meets this specification when calibrated with the reference VOC specified in the applicable regulation, the available instrument may be calibrated with one of the VOC to be measured, or any other VOC, so long as the instrument then has a response factor of less than 10 for each of the individual VOC to be measured.

8.1.1.3 Alternatively, if response factors have been published for the compounds of interest for the instrument or detector type, the response factor determination is not required, and existing results may be referenced. Examples of published response factors for flame ionization and catalytic oxidation detectors are included in References 1–3 of section 17.0.

8.1.2 Calibration Precision. The calibration precision test must be completed prior to placing the analyzer into service and at subsequent 3-month intervals or at the next use, whichever is later.

8.1.2.1 Make a total of three measurements by alternately using zero gas and the specified calibration gas. Record the meter readings. Calculate the average algebraic difference between the meter readings and the known value. Divide this average difference by the known calibration value and multiply by 100 to express the resulting calibration precision as a percentage.

8.1.2.2 The calibration precision shall be equal to or less than 10 percent of the calibration gas value.

8.1.3 Response Time. The response time test is required before placing the instrument into service. If a modification to the sample pumping system or flow configuration is made that would change the response time, a new test is required before further use.

8.1.3.1 Introduce zero gas into the instrument sample probe. When the meter reading has stabilized, switch quickly to the specified calibration gas. After switching, measure the time required to attain 90 percent of the final stable reading. Perform this test sequence three times and record the results. Calculate the average response time.

8.1.3.2 The instrument response time shall be equal to or less than 30 seconds. The instrument pump, dilution probe (if any), sample probe, and probe filter that will be used

during testing shall all be in place during the response time determination.

8.2 Instrument Calibration. Calibrate the VOC monitoring instrument according to section 10.0.

8.3 Individual Source Surveys.

8.3.1 Type I—Leak Definition Based on Concentration. Place the probe inlet at the surface of the component interface where leakage could occur. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained. Leave the probe inlet at this maximum reading location for approximately two times the instrument response time. If the maximum observed meter reading is greater than the leak definition in the applicable regulation, record and report the results as specified in the regulation reporting requirements. Examples of the application of this general technique to specific equipment types are:

8.3.1.1 Valves. The most common source of leaks from valves is the seal between the stem and housing. Place the probe at the interface where the stem exits the packing gland and sample the stem circumference. Also, place the probe at the interface of the packing gland take-up flange seat and sample the periphery. In addition, survey valve housings of multipart assembly at the surface of all interfaces where a leak could occur.

8.3.1.2 Flanges and Other Connections. For welded flanges, place the probe at the outer edge of the flange-gasket interface and sample the circumference of the flange. Sample other types of nonpermanent joints (such as threaded connections) with a similar traverse.

8.3.1.3 Pumps and Compressors. Conduct a circumferential traverse at the outer surface of the pump or compressor shaft and seal interface. If the source is a rotating shaft, position the probe inlet within 1 cm of the shaft-seal interface for the survey. If the housing configuration prevents a complete traverse of the shaft periphery, sample all accessible portions. Sample all other joints on the pump or compressor housing where leakage could occur.

8.3.1.4 Pressure Relief Devices. The configuration of most pressure relief devices prevents sampling at the sealing seat interface. For those devices equipped with an enclosed extension, or horn, place the probe inlet at approximately the center of the exhaust area to the atmosphere.

8.3.1.5 Process Drains. For open drains, place the probe inlet at approximately the center of the area open to the atmosphere. For covered drains, place the probe at the surface of the cover interface and conduct a peripheral traverse.

8.3.1.6 Open-ended Lines or Valves. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.7 Seal System Degassing Vents and Accumulator Vents. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.8 Access door seals. Place the probe inlet at the surface of the door seal interface and conduct a peripheral traverse.

8.3.2 Type II—''No Detectable Emission''. Determine the local ambient VOC concentration around the source by moving the probe randomly upwind and downwind at a distance of one to two meters from the source. If an interference exists with this determination due to a nearby emission or leak, the local ambient concentration may be determined at distances closer to the source, but in no case shall the distance be less than 25 centimeters. Then move the probe inlet to the surface of the source and determine the concentration as outlined in section 8.3.1. The difference between these concentrations determines whether there are no detectable emissions. Record and report the results as specified by the regulation. For those cases where the regulation requires a specific device installation, or that specified vents be ducted or piped to a control device, the existence of these conditions shall be visually confirmed. When the regulation also requires that no detectable emissions exist, visual observations and sampling surveys are required. Examples of this technique are:

8.3.2.1 Pump or Compressor Seals. If applicable, determine the type of shaft seal. Perform a survey of the local area ambient VOC concentration and determine if detectable emissions exist as described in section 8.3.2.

8.3.2.2 Seal System Degassing Vents, Accumulator Vessel Vents, Pressure Relief Devices. If applicable, observe whether or not the applicable ducting or piping exists. Also, determine if any sources exist in the ducting or piping where emissions could occur upstream of the control device. If the required ducting or piping exists and there are no sources where the emissions could be vented to the atmosphere upstream of the control device, then it is presumed that no detectable emissions are present. If there are sources in the ducting or piping where emissions could be vented or sources where leaks could occur, the sampling surveys described in section 8.3.2 shall be used to determine if detectable emissions exist.

8.3.3 Alternative Screening Procedure.

8.3.3.1 A screening procedure based on the formation of bubbles in a soap solution that is sprayed on a potential leak source may be used for those sources that do not have continuously moving parts, that do not have surface temperatures greater than the boiling point or less than the freezing point of the soap solution, that do not have open

areas to the atmosphere that the soap solution cannot bridge, or that do not exhibit evidence of liquid leakage. Sources that have these conditions present must be surveyed using the instrument technique of section 8.3.1 or 8.3.2.

8.3.3.2 Spray a soap solution over all potential leak sources. The soap solution may be a commercially available leak detection solution or may be prepared using concentrated detergent and water. A pressure sprayer or squeeze bottle may be used to dispense the solution. Observe the potential leak sites to determine if any bubbles are formed. If no bubbles are observed, the source is presumed to have no detectable emissions or leaks as applicable. If any bubbles are observed, the instrument techniques of section 8.3.1 or 8.3.2 shall be used to determine if a leak exists, or if the source has detectable emissions, as applicable.

9.0 Quality Control

Section	Quality control measure	Effect
8.1.2	Instrument calibration precision check	Ensure precision and accuracy, respectively, of instrument response to standard.
10.0	Instrument calibration.	

10.0 Calibration and Standardization

10.1 Calibrate the VOC monitoring instrument as follows. After the appropriate warmup period and zero internal calibration procedure, introduce the calibration gas into the instrument sample probe. Adjust the instrument meter readout to correspond to the calibration gas value.

NOTE: If the meter readout cannot be adjusted to the proper value, a malfunction of the analyzer is indicated and corrective actions are necessary before use.

11.0 Analytical Procedures [Reserved]

12.0 Data Analyses and Calculations [Reserved]

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Dubose, D.A., and G.E. Harris. Response Factors of VOC Analyzers at a Meter Reading of 10,000 ppmv for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81051. September 1981.

2. Brown, G.E., *et al.* Response Factors of VOC Analyzers Calibrated with Methane for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–022. May 1981.

3. DuBose, D.A. *et al.* Response of Portable VOC Analyzers to Chemical Mixtures. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–110. September 1981.

4. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 22—VISUAL DETERMINATION OF FUGITIVE EMISSIONS FROM MATERIAL SOURCES AND SMOKE EMISSIONS FROM FLARES

NOTE: This method is not inclusive with respect to observer certification. Some material is incorporated by reference from Method 9.

1.0 Scope and Application

This method is applicable for the determination of the frequency of fugitive emissions from stationary sources, only as specified in an applicable subpart of the regulations. This method also is applicable for the determination of the frequency of visible smoke emissions from flares.

2.0 Summary of Method

2.1 Fugitive emissions produced during material processing, handling, and transfer operations or smoke emissions from flares are visually determined by an observer without the aid of instruments.

2.2 This method is used also to determine visible smoke emissions from flares used for combustion of waste process materials.

2.3 This method determines the amount of time that visible emissions occur during the observation period (*i.e.,* the accumulated emission time). This method does not require that the opacity of emissions be determined. Since this procedure requires only the determination of whether visible emissions occur and does not require the determination of opacity levels, observer certification according to the procedures of Method 9 is not required. However, it is necessary that the observer is knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative

to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in References 1 and 2 or from the lecture portion of the Method 9 certification course.

3.0 Definitions

3.1 *Emission frequency* means the percentage of time that emissions are visible during the observation period.

3.2 *Emission time* means the accumulated amount of time that emissions are visible during the observation period.

3.3 *Fugitive emissions* means emissions generated by an affected facility which is not collected by a capture system and is released to the atmosphere. This includes emissions that (1) escape capture by process equipment exhaust hoods; (2) are emitted during material transfer; (3) are emitted from buildings housing material processing or handling equipment; or (4) are emitted directly from process equipment.

3.4 *Observation period* means the accumulated time period during which observations are conducted, not to be less than the period specified in the applicable regulation.

3.5 *Smoke emissions* means a pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission.

4.0 Interferences

4.1 Occasionally, fugitive emissions from sources other than the affected facility (*e.g.*, road dust) may prevent a clear view of the affected facility. This may particularly be a problem during periods of high wind. If the view of the potential emission points is obscured to such a degree that the observer questions the validity of continuing observations, then the observations shall be terminated, and the observer shall clearly note this fact on the data form.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment

6.1 Stopwatches (two). Accumulative type with unit divisions of at least 0.5 seconds.

6.2 Light Meter. Light meter capable of measuring illuminance in the 50 to 200 lux range, required for indoor observations only.

7.0 Reagents and Supplies [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transfer [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

11.1 Selection of Observation Location. Survey the affected facility, or the building or structure housing the process to be observed, and determine the locations of potential emissions. If the affected facility is located inside a building, determine an observation location that is consistent with the requirements of the applicable regulation (*i.e.*, outside observation of emissions escaping the building/structure or inside observation of emissions directly emitted from the affected facility process unit). Then select a position that enables a clear view of the potential emission point(s) of the affected facility or of the building or structure housing the affected facility, as appropriate for the applicable subpart. A position at least 4.6 m (15 feet), but not more than 400 m (0.25 miles), from the emission source is recommended. For outdoor locations, select a position where the sunlight is not shining directly in the observer's eyes.

11.2 Field Records.

11.2.1 Outdoor Location. Record the following information on the field data sheet (Figure 22–1): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record also the estimated wind speed, wind direction, and sky condition. Sketch the process unit being observed, and note the observer location relative to the source and the sun. Indicate the potential and actual emission points on the sketch.

11.2.2 Indoor Location. Record the following information on the field data sheet (Figure 22–2): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record as appropriate the type, location, and intensity of lighting on the data sheet. Sketch the process unit being observed, and note the observer location relative to the source. Indicate the potential and actual fugitive emission points on the sketch.

11.3 Indoor Lighting Requirements. For indoor locations, use a light meter to measure the level of illumination at a location as close to the emission source(s) as is feasible. An illumination of greater than 100 lux (10 foot candles) is considered necessary for proper application of this method.

11.4 Observations.

11.4.1 Procedure. Record the clock time when observations begin. Use one stopwatch to monitor the duration of the observation

period. Start this stopwatch when the observation period begins. If the observation period is divided into two or more segments by process shutdowns or observer rest breaks (see section 11.4.3), stop the stopwatch when a break begins and restart the stopwatch without resetting it when the break ends. Stop the stopwatch at the end of the observation period. The accumulated time indicated by this stopwatch is the duration of observation period. When the observation period is completed, record the clock time. During the observation period, continuously watch the emission source. Upon observing an emission (condensed water vapor is not considered an emission), start the second accumulative stopwatch; stop the watch when the emission stops. Continue this procedure for the entire observation period. The accumulated elapsed time on this stopwatch is the total time emissions were visible during the observation period (*i.e.,* the emission time.)

11.4.2 Observation Period. Choose an observation period of sufficient length to meet the requirements for determining compliance with the emission standard in the applicable subpart of the regulations. When the length of the observation period is specifically stated in the applicable subpart, it may not be necessary to observe the source for this entire period if the emission time required to indicate noncompliance (based on the specified observation period) is observed in a shorter time period. In other words, if the regulation prohibits emissions for more than 6 minutes in any hour, then observations may (optional) be stopped after an emission time of 6 minutes is exceeded. Similarly, when the regulation is expressed as an emission frequency and the regulation prohibits emissions for greater than 10 percent of the time in any hour, then observations may (optional) be terminated after 6 minutes of emission are observed since 6 minutes is 10 percent of an hour. In any case, the observation period shall not be less than 6 minutes in duration. In some cases, the process operation may be intermittent or cyclic. In such cases, it may be convenient for the observation period to coincide with the length of the process cycle.

11.4.3 Observer Rest Breaks. Do not observe emissions continuously for a period of more than 15 to 20 minutes without taking a rest break. For sources requiring observation periods of greater than 20 minutes, the observer shall take a break of not less than 5 minutes and not more than 10 minutes after every 15 to 20 minutes of observation. If continuous observations are desired for extended time periods, two observers can alternate between making observations and taking breaks.

11.5 Recording Observations. Record the accumulated time of the observation period on the data sheet as the observation period duration. Record the accumulated time emissions were observed on the data sheet as the emission time. Record the clock time the observation period began and ended, as well as the clock time any observer breaks began and ended.

12.0 Data Analysis and Calculations

If the applicable subpart requires that the emission rate be expressed as an emission frequency (in percent), determine this value as follows: Divide the accumulated emission time (in seconds) by the duration of the observation period (in seconds) or by any minimum observation period required in the applicable subpart, if the actual observation period is less than the required period, and multiply this quotient by 100.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

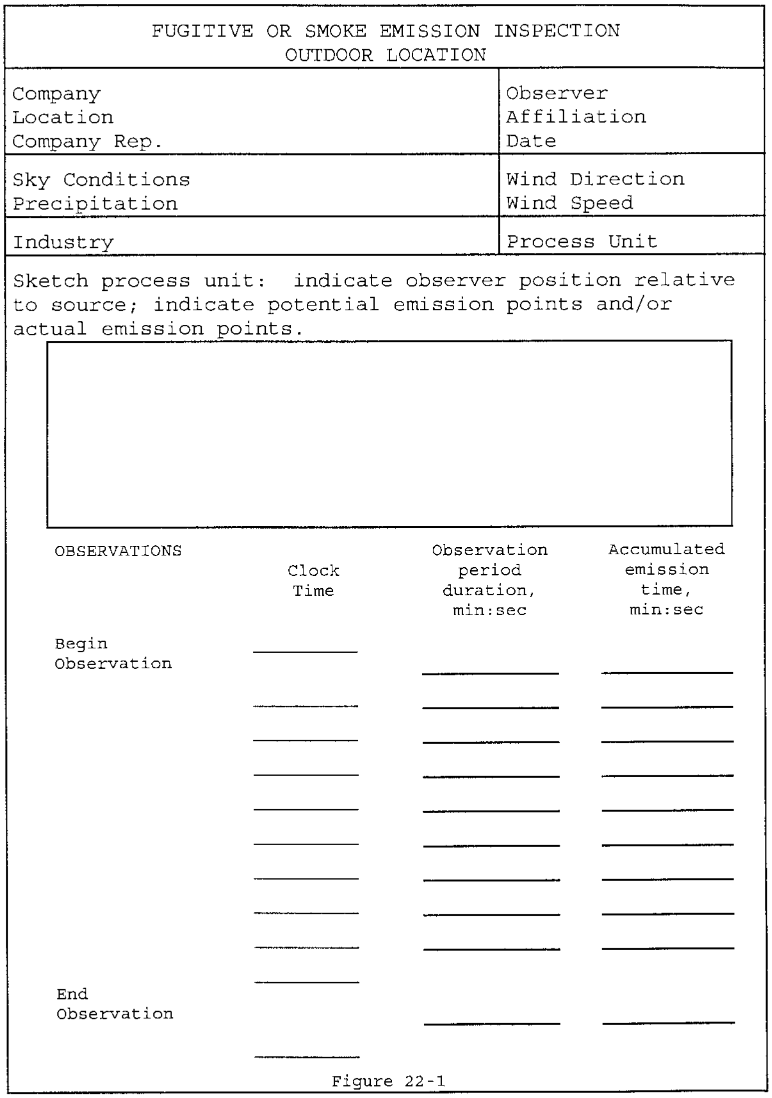
15.0 Waste Management [Reserved]

16.0 References

1. Missan, R., and A. Stein. Guidelines for Evaluation of Visible Emissions Certification, Field Procedures, Legal Aspects, and Background Material. EPA Publication No. EPA–340/1–75–007. April 1975.

2. Wohlschlegel, P., and D.E. Wagoner. Guideline for Development of a Quality Assurance Program: Volume IX—Visual Determination of Opacity Emissions from Stationary Sources. EPA Publication No. EPA–650/4–74–005i. November 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data



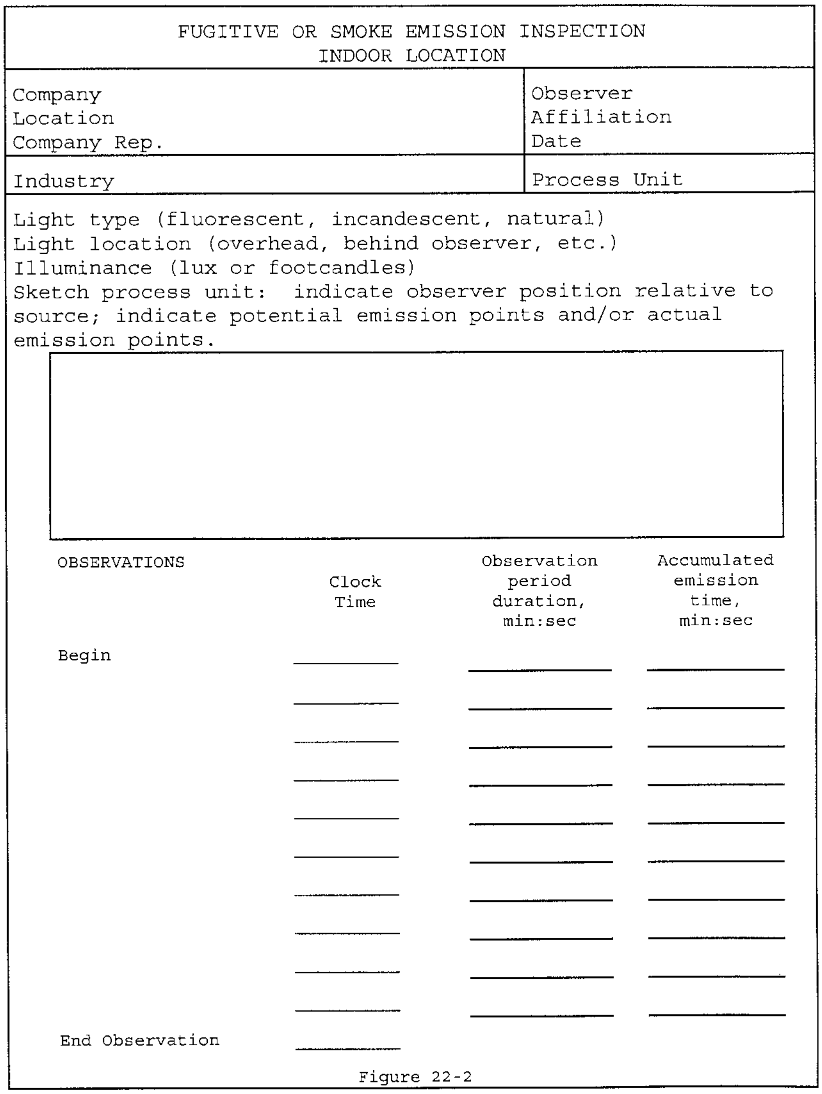
FUGITIVE OR SMOKE EMISSION INSPECTION
OUTDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Sky Conditions Precipitation	Wind Direction Wind Speed
Industry	Process Unit

Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin Observation			
End Observation			

Figure 22-1



FUGITIVE OR SMOKE EMISSION INSPECTION
INDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Industry	Process Unit

Light type (fluorescent, incandescent, natural)
Light location (overhead, behind observer, etc.)
Illuminance (lux or footcandles)
Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
End Observation	______		

Figure 22-2

METHOD 23—DETERMINATION OF POLYCHLORINATED DIBENZO-P-DIOXINS AND POLYCHLORINATED DIBENZOFURANS FROM STATIONARY SOURCES

1. Applicability and Principle

1.1 Applicability. This method is applicable to the determination of polychlorinated dibenzo-p-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) from stationary sources.

1.2 Principle. A sample is withdrawn from the gas stream isokinetically and collected in the sample probe, on a glass fiber filter, and on a packed column of adsorbent material. The sample cannot be separated into a particle vapor fraction. The PCDD's and

PCDF's are extracted from the sample, separated by high resolution gas chromatography, and measured by high resolution mass spectrometry.

2. Apparatus

2.1 Sampling. A schematic of the sampling train used in this method is shown in Figure 23–1. Sealing greases may not be used in assembling the train. The train is identical to that described in section 2.1 of Method 5 of this appendix with the following additions:

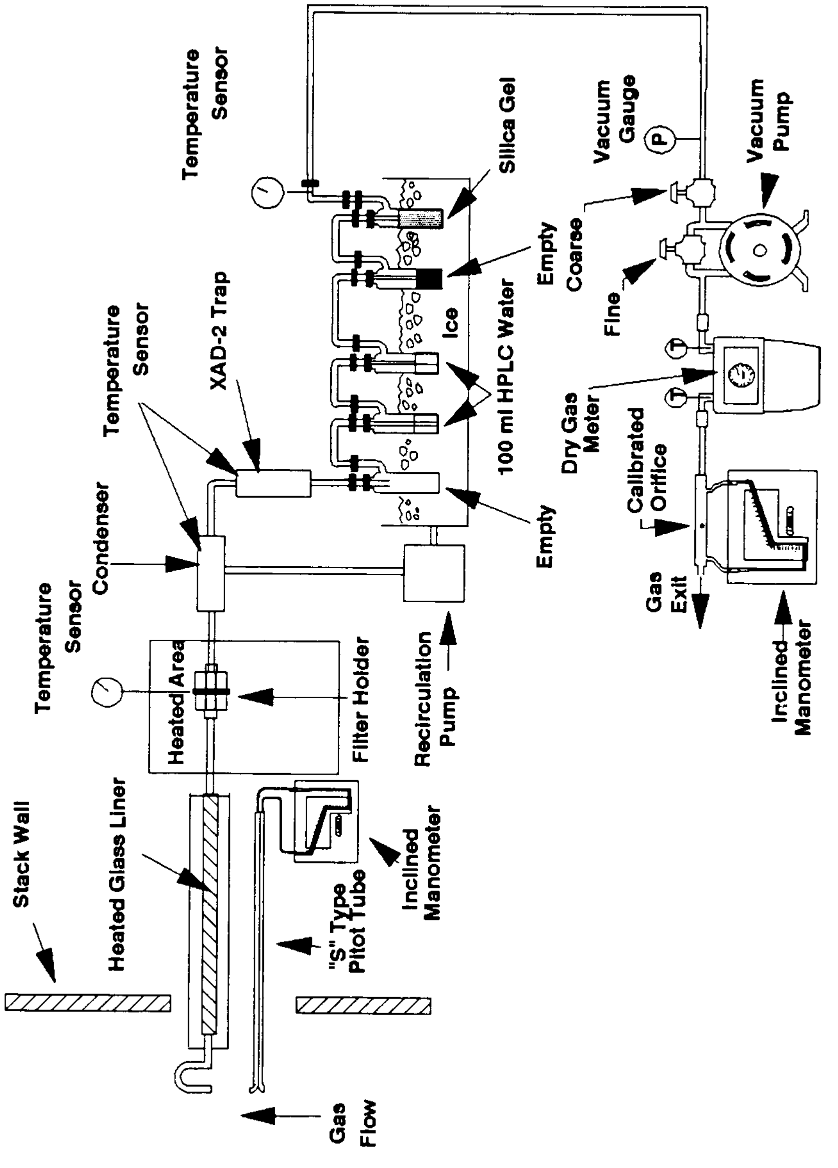


Figure 23.1 Sampling train

2.1.1 Nozzle. The nozzle shall be made of nickel, nickel-plated stainless steel, quartz, or borosilicate glass.

2.1.2 Sample Transfer Lines. The sample transfer lines, if needed, shall be heat traced, heavy walled TFE (½ in. OD with ⅛ in. wall) with connecting fittings that are capable of forming leak-free, vacuum-tight connections without using sealing greases. The line shall be as short as possible and must be maintained at 120 °C.

2.1.1 Filter Support. Teflon or Teflon-coated wire.

2.1.2 Condenser. Glass, coil type with compatible fittings. A schematic diagram is shown in Figure 23–2.

2.1.3 Water Bath. Thermostatically controlled to maintain the gas temperature exiting the condenser at <20 °C (68 °F).

2.1.4 Adsorbent Module. Glass container to hold the solid adsorbent. A shematic diagram is shown in Figure 23–2. Other physical configurations of the resin trap/condenser assembly are acceptable. The connecting fittings shall form leak-free, vacuum tight seals. No sealant greases shall be used in the sampling train. A coarse glass frit is included to retain the adsorbent.

2.2 Sample Recovery.

2.2.1 Fitting Caps. Ground glass, Teflon tape, or aluminum foil (Section 2.2.6) to cap off the sample exposed sections of the train.

2.2.2 Wash Bottles. Teflon, 500-ml.

2.2.3 Probe-Liner Probe-Nozzle, and Filter-Holder Brushes. Inert bristle brushes with precleaned stainless steel or Teflon handles. The probe brush shall have extensions of stainless steel or Teflon, at least as long as the probe. The brushes shall be properly sized and shaped to brush out the nozzle, probe liner, and transfer line, if used.

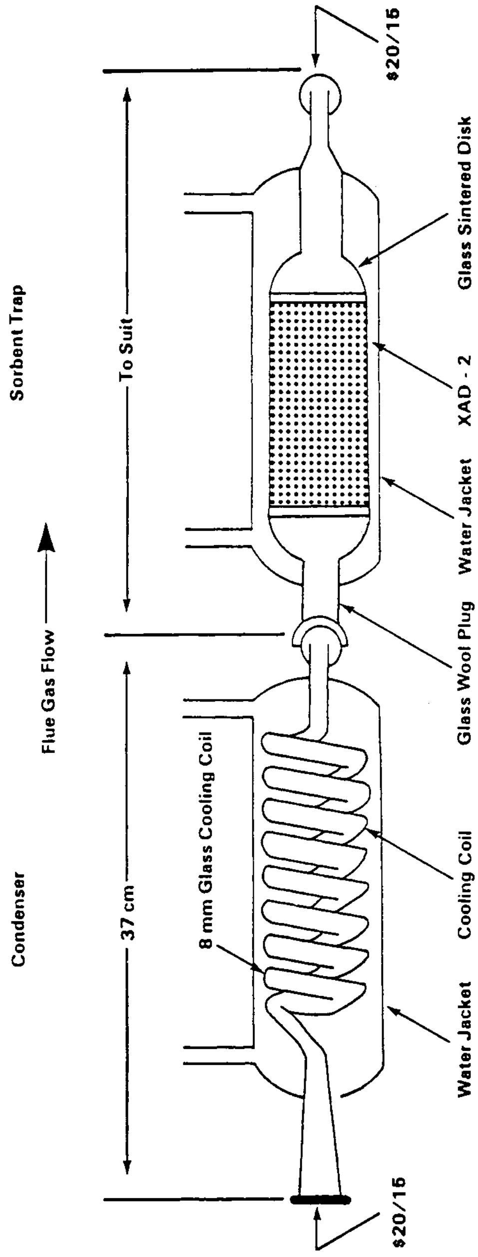


Figure 23.2. Condenser and adsorbent trap

2.2.4 Filter Storage Container. Sealed filter holder, wide-mouth amber glass jar with Teflon-lined cap, or glass petri dish.

2.2.5 Balance. Triple beam.

2.2.6 Aluminum Foil. Heavy duty, hexane-rinsed.

2.2.7 Storage Container. Air-tight container to store silica gel.

2.2.8 Graduated Cylinder. Glass, 250-ml with 2-ml graduation.

2.2.9 Glass Sample Storage Container. Amber glass bottle for sample glassware washes, 500- or 1000-ml, with leak free Teflon-lined caps.

2.3 Analysis.

2.3.1 Sample Container. 125- and 250-ml flint glass bottles with Teflon-lined caps.

2.3.2 Test Tube. Glass.

2.3.3 Soxhlet Extraction Apparatus. Capable of holding 43 × 123 mm extraction thimbles.

2.3.4 Extraction Thimble. Glass, precleaned cellulosic, or glass fiber.

2.3.5 Pasteur Pipettes. For preparing liquid chromatographic columns.

2.3.6 Reacti-vials. Amber glass, 2-ml, silanized prior to use.

2.3.7 Rotary Evaporator. Buchi/Brinkman RF–121 or equivalent.

2.3.8 Nitrogen Evaporative Concentrator. N-Evap Analytical Evaporator Model III or equivalent.

2.3.9 Separatory Funnels. Glass, 2-liter.

2.3.10 Gas Chromatograph. Consisting of the following components:

2.3.10.1 Oven. Capable of maintaining the separation column at the proper operating temperature ±°C and performing programmed increases in temperature at rates of at least 40 °C/min.

2.3.10.2 Temperature Gauge. To monitor column oven, detector, and exhaust temperatures ±1 °C.

2.3.10.3 Flow System. Gas metering system to measure sample, fuel, combustion gas, and carrier gas flows.

2.3.10.4 Capillary Columns. A fused silica column, 60 × 0.25 mm inside diameter (ID), coated with DB–5 and a fused silica column, 30 m × 0.25 mm ID coated with DB–225. Other column systems may be used provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

2.3.11 Mass Spectrometer. Capable of routine operation at a resolution of 1:10000 with a stability of ±5 ppm.

2.3.12 Data System. Compatible with the mass spectrometer and capable of monitoring at least five groups of 25 ions.

2.3.13 Analytical Balance. To measure within 0.1 mg.

3. Reagents

3.1 Sampling.

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Standard Method D 2986–71 (Reapproved 1978) (incorporated by reference—see § 60.17).

3.1.1.1 Precleaning. All filters shall be cleaned before their initial use. Place a glass extraction thimble and 1 g of silica gel and a plug of glass wool into a Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Place no more than 50 filters in the thimble onto the silica gel bed and top with the cleaned glass wool. Charge the Soxhlet with toluene and reflux for 16 hours. After extraction, allow the Soxhlet to cool, remove the filters, and dry them under a clean N_2 stream. Store the filters in a glass petri dish sealed with Teflon tape.

3.1.2 Adsorbent Resin. Amberlite XAD–2 resin. Thoroughly cleaned before initial use.

3.1.2.1 Cleaning Procedure. This procedure may be carried out in a giant Soxhlet extractor. An all-glass filter thimble containing an extra-course frit is used for extraction of XAD–2. The frit is recessed 10–15 mm above a crenelated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass wool plug and a stainless steel ring because it floats on methylene chloride. This process involves sequential extraction in the following order.

Solvent	Procedure
Water	Initial rinse: Place resin in a beaker, rinse once with water, and discard. Fill with water a second time, let stand overnight, and discard.
Water	Extract with water for 8 hours.
Methanol	Extract for 22 hours.
Methylene Chloride	Extract for 22 hours.
Toluene	Extract for 22 hours.

3.1.2.2 Drying.

3.1.2.2.1 Drying Column. Pyrex pipe, 10.2 cm ID by 0.6 m long, with suitable retainers.

3.1.2.2.2 Procedure. The adsorbent must be dried with clean inert gas. Liquid nitrogen from a standard commercial liquid nitrogen cylinder has proven to be a reliable source of large volumes of gas free from organic contaminants. Connect the liquid nitrogen cylinder to the column by a length of cleaned copper tubing, 0.95 cm ID, coiled to pass through a heat source. A convenient heat source is a water-bath heated from a steam line. The final nitrogen temperature should only be warm to the touch and not over 40 °C. Continue flowing nitrogen through the adsorbent until all the residual solvent is removed. The flow rate should be sufficient to gently agitate the particles but not so excessive as the cause the particles to fracture.

3.1.2.3 Quality Control Check. The adsorbent must be checked for residual toluene.

3.1.2.3.1 Extraction. Weigh 1.0 g sample of dried resin into a small vial, add 3 ml of toluene, cap the vial, and shake it well.

3.1.2.3.2 Analysis. Inject a 2 µl sample of the extract into a gas chromatograph operated under the following conditions:

Column: 6 ft × ⅛ in stainless steel containing 10 percent OV–101 on 100/120 Supelcoport.

Carrier Gas: Helium at a rate of 30 ml/min.

Detector: Flame ionization detector operated at a sensitivity of 4×10^{-11} A/mV.

Injection Port Temperature: 250 °C.

Detector Temperature: 305 °C.

Oven Temperature: 30 °C for 4 min; programmed to rise at 40 °C/min until it reaches 250 °C; return to 30 °C after 17 minutes.

Compare the results of the analysis to the results from the reference solution. Prepare the reference solution by injection 2.5 µl of methylene chloride into 100 ml of toluene. This corresponds to 100 µg of methylene chloride per g of adsorbent. The maximum acceptable concentration is 1000 µg/g of adsorbent. If the adsorbent exceeds this level, drying must be continued until the excess methylene chloride is removed.

3.1.2.4 Storage. The adsorbent must be used within 4 weeks of cleaning. After cleaning, it may be stored in a wide mouth amber glass container with a Teflon-lined cap or placed in one of the glass adsorbent modules tightly sealed with glass stoppers. If precleaned adsorbent is purchased in sealed containers, it must be used within 4 weeks after the seal is broken.

3.1.3 Glass Wool. Cleaned by sequential immersion in three aliquots of methylene chloride, dried in a 110 °C oven, and stored in a methylene chloride-washed glass jar with a Teflon-lined screw cap.

3.1.4 Water. Deionized distilled and stored in a methylene chloride-rinsed glass container with a Teflon-lined screw cap.

3.1.5 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175 °C (350 °F) for two hours. New silica gel may be used as received. Alternately other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.6 Chromic Acid Cleaning Solution. Dissolve 20 g of sodium dichromate in 15 ml of water, and then carefully add 400 ml of concentrated sulfuric acid.

3.2 Sample Recovery.

3.2.2 Acetone. Pesticide quality.

3.2.2 Methylene Chloride. Pesticide qualtity.

3.2.3 Toluene. Pesticide quality.

3.3 Analysis.

3.3.1 Potassium Hydroxide. ACS grade, 2-percent (weight/volume) in water.

3.3.2 Sodium Sulfate. Granulated, reagent grade. Purify prior to use by rinsing with methylene chloride and oven drying. Store the cleaned material in a glass container with a Teflon-lined screw cap.

3.3.3 Sulfuric Acid. Reagent grade.

3.3.4 Sodium Hydroxide. 1.0 N. Weigh 40 g of sodium hydroxide into a 1-liter volumetric flask. Dilute to 1 liter with water.

3.3.5 Hexane. Pesticide grade.

3.3.6 Methylene Chloride. Pesticide grade.

3.3.7 Benzene. Pesticide Grade.

3.3.8 Ethyl Acetate.

3.3.9 Methanol. Pesticide Grade.

3.3.10 Toluene. Pesticide Grade.

3.3.11 Nonane. Pesticide Grade.

3.3.12 Cyclohexane. Pesticide Grade.

3.3.13 Basic Alumina. Activity grade 1, 100–200 mesh. Prior to use, activate the alumina by heating for 16 hours at 130 °C before use. Store in a desiccator. Pre-activated alumina may be purchased from a supplier and may be used as received.

3.3.14 Silica Gel. Bio-Sil A, 100–200 mesh. Prior to use, activate the silica gel by heating for at least 30 minutes at 180 °C. After cooling, rinse the silica gel sequentially with methanol and methylene chloride. Heat the rinsed silica gel at 50 °C for 10 minutes, then increase the temperature gradually to 180 °C over 25 minutes and maintain it at this temperature for 90 minutes. Cool at room temperature and store in a glass container with a Teflon-lined screw cap.

3.3.15 Silica Gel Impregnated with Sulfuric Acid. Combine 100 g of silica gel with 44 g of concentrated sulfuric acid in a screw capped glass bottle and agitate thoroughly. Disperse the solids with a stirring rod until a uniform mixture is obtained. Store the mixture in a glass container with a Teflon-lined screw cap.

3.3.16 Silica Gel Impregnated with Sodium Hydroxide. Combine 39 g of 1 N sodium hydroxide with 100 g of silica gel in a screw capped glass bottle and agitate thoroughly. Disperse solids with a stirring rod until a uniform mixture is obtained. Store the mixture in glass container with a Teflon-lined screw cap.

3.3.17 Carbon/Celite. Combine 10.7 g of AX–21 carbon with 124 g of Celite 545 in a 250-ml glass bottle with a Teflon-lined screw cap. Agitate the mixture thoroughly until a uniform mixture is obtained. Store in the glass container.

3.3.18 Nitrogen. Ultra high purity.

3.3.19 Hydrogen. Ultra high purity.

3.3.20 Internal Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ‘‘Internal Standards’’ in 10 ml of nonane.

3.3.21 Surrogate Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ‘‘Surrogate Standards’’ in 10 ml of nonane.

3.3.22 Recovery Standard Solution. Prepare a stock standard solution containing the

isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Recovery Standards'' in 10 ml of nonane.

4. Procedure

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation.

4.1.1.1 Cleaning Glassware. All glass components of the train upstream of and including the adsorbent module, shall be cleaned as described in section 3A of the ''Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.'' Special care shall be devoted to the removal of residual silicone grease sealants on ground glass connections of used glassware. Any residue shall be removed by soaking the glassware for several hours in a chromic acid cleaning solution prior to cleaning as described above.

4.1.1.2 Adsorbent Trap. The traps must be loaded in a clean area to avoid contamination. They may not be loaded in the field. Fill a trap with 20 to 40 g of XAD–2. Follow the XAD–2 with glass wool and tightly cap both ends of the trap. Add 100 µl of the surrogate standard solution (section 3.3.21) to each trap.

4.1.1.3 Sample Train. It is suggested that all components be maintained according to the procedure described in APTD–0576. Alternative mercury-free thermometers may be used if the thermometers are, at a minimum, equivalent in terms of performance or suitably effective for the specific temperature measurement application.

4.1.1.4 Silica Gel. Weigh several 200 to 300 g portions of silica gel in an air tight container to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel may be weighed directly in its impinger or sampling holder just prior to sampling.

4.1.1.5 Filter. Check each filter against light for irregularities and flaws or pinhole leaks. Pack the filters flat in a clean glass container.

4.1.2 Preliminary Determinations. Same as section 4.1.2 of Method 5.

4.1.3 Preparation of Collection Train.

4.1.3.1 During preparation and assembly of the sampling train, keep all train openings where contamination can enter, sealed until just prior to assembly or until sampling is about to begin.

NOTE: Do not use sealant grease in assembling the train.

4.1.3.2 Place approximately 100 ml of water in the second and third impingers, leave the first and fourth impingers empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fifth impinger.

4.1.3.3 Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

4.1.3.4 Assemble the train as shown in Figure 23–1.

4.1.3.5 Turn on the adsorbent module and condenser coil recirculating pump and begin monitoring the adsorbent module gas entry temperature. Ensure proper sorbent temperature gas entry temperature before proceeding and before sampling is initiated. It is extremely important that the XAD–2 adsorbent resin temperature never exceed 50 °C because thermal decomposition will occur. During testing, the XAD–2 temperature must not exceed 20 °C for efficient capture of the PCDD's and PCDF's.

4.1.4 Leak-Check Procedure. Same as Method 5, section 4.1.4.

4.1.5 Sample Train Operation. Same as Method 5, section 4.1.5.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Seal the nozzle end of the sampling probe with Teflon tape or aluminum foil.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe. Remove the probe from the train and close off both ends with aluminum foil. Seal off the inlet to the train with Teflon tape, a ground glass cap, or aluminum foil.

Transfer the probe and impinger assembly to the cleanup area. This area shall be clean and enclosed so that the chances of losing or contaminating the sample are minimized. Smoking, which could contaminate the sample, shall not be allowed in the cleanup area.

Inspect the train prior to and during disassembly and note any abnormal conditions, e.g., broken filters, colored impinger liquid, etc. Treat the samples as follows:

4.2.1 Container No. 1. Either seal the filter holder or carefully remove the filter from the filter holder and place it in its identified container. Use a pair of cleaned tweezers to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the container any particulate matter and filter fibers which adhere to the filter holder gasket, by using a dry inert bristle brush and a sharp-edged blade. Seal the container.

4.2.2 Adsorbent Module. Remove the module from the train, tightly cap both ends, label it, cover with aluminum foil, and store it on ice for transport to the laboratory.

4.2.3 Container No. 2. Quantitatively recover material deposited in the nozzle, probe transfer lines, the front half of the filter holder, and the cyclone, if used, first, by

brushing while rinsing three times each with acetone and then, by rinsing the probe three times with methylene chloride. Collect all the rinses in Container No. 2.

Rinse the back half of the filter holder three times with acetone. Rinse the connecting line between the filter and the condenser three times with acetone. Soak the connecting line with three separate portions of methylene chloride for 5 minutes each. If using a separate condenser and adsorbent trap, rinse the condenser in the same manner as the connecting line. Collect all the rinses in Container No. 2 and mark the level of the liquid on the container.

4.2.4 Container No. 3. Repeat the methylene chloride-rinsing described in section 4.2.3 using toluene as the rinse solvent. Collect the rinses in Container No. 3 and mark the level of the liquid on the container.

4.2.5 Impinger Water. Measure the liquid in the first three impingers to within ±1 ml by using a graduated cylinder or by weighing it to within ±0.5 g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

Discard the liquid after measuring and recording the volume or weight.

4.2.7 Silica Gel. Note the color of the indicating silica gel to determine if it has been completely spent and make a mention of its condition. Transfer the silica gel from the fifth impinger to its original container and seal. If a moisture determination is made, follow the applicable procedures in sections 8.7.6.3 and 11.2.3 of Method 5 to handle and weigh the silica gel. If moisture is not measured, the silica gel may be disposed.

5. Analysis

All glassware shall be cleaned as described in section 3A of the ‘‘Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.’’ All samples must be extracted within 30 days of collection and analyzed within 45 days of extraction.

5.1 Sample Extraction.

5.1.1 Extraction System. Place an extraction thimble (section 2.3.4), 1 g of silica gel, and a plug of glass wool into the Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Remove the extraction thimble from the extraction system and place it in a glass beaker to catch the solvent rinses.

5.1.2 Container No. 1 (Filter). Transfer the contents directly to the glass thimble of the extraction system and extract them simultaneously with the XAD–2 resin.

5.1.3 Adsorbent Cartridge. Suspend the adsorbent module directly over the extraction thimble in the beaker (See section 5.1.1). The glass frit of the module should be in the up position. Using a Teflon squeeze bottle containing toluene, flush the XAD–2 into the thimble onto the bed of cleaned silica gel. Thoroughly rinse the glass module catching the rinsings in the beaker containing the thimble. If the resin is wet, effective extraction can be accomplished by loosely packing the resin in the thimble. Add the XAD–2 glass wool plug into the thimble.

5.1.4 Container No. 2 (Acetone and Methylene Chloride). Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus, at a temperature of less than 37 °C. Rinse the sample container three times with small portions of methylene chloride and add these to the concentrated solution and concentrate further to near dryness. This residue contains particulate matter removed in the rinse of the train probe and nozzle. Add the concentrate to the filter and the XAD–2 resin in the Soxhlet apparatus described in section 5.1.1.

5.1.5 Extraction. Add 100 µl of the internal standard solution (Section 3.3.20) to the extraction thimble containing the contents of the adsorbent cartridge, the contents of Container No. 1, and the concentrate from section 5.1.4. Cover the contents of the extraction thimble with the cleaned glass wool plug to prevent the XAD–2 resin from floating into the solvent reservoir of the extractor. Place the thimble in the extractor, and add the toluene contained in the beaker to the solvent reservoir. Pour additional toluene to fill the reservoir approximately ⅔ full. Add Teflon boiling chips and assemble the apparatus. Adjust the heat source to cause the extractor to cycle three times per hour. Extract the sample for 16 hours. After extraction, allow the Soxhlet to cool. Transfer the toluene extract and three 10-ml rinses to the rotary evaporator. Concentrate the extract to approximately 10 ml. At this point the analyst may choose to split the sample in half. If so, split the sample, store one half for future use, and analyze the other according to the procedures in sections 5.2 and 5.3. In either case, use a nitrogen evaporative concentrator to reduce the volume of the sample being analyzed to near dryness. Dissolve the residue in 5 ml of hexane.

5.1.6 Container No. 3 (Toluene Rinse). Add 100 µl of the Internal Standard solution (section 3.3.2) to the contents of the container. Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus at a temperature of less than 37 °C. Rinse the sample container apparatus at a temperature of less than 37 °C. Rinse the sample container three times with small portions of toluene and add these to the concentrated solution and concentrate further to near dryness. Analyze the extract separately according to the procedures in sections 5.2 and 5.3, but concentrate the solution in a rotary evaporator apparatus rather than a nitrogen evaporative concentrator.

5.2 Sample Cleanup and Fractionation.

5.2.1 Silica Gel Column. Pack one end of a glass column, 20 mm × 230 mm, with glass wool. Add in sequence, 1 g silica gel, 2 g of sodium hydroxide impregnated silica gel, 1 g silica gel, 4 g of acid-modified silica gel, and 1 g of silica gel. Wash the column with 30 ml of hexane and discard it. Add the sample extract, dissolved in 5 ml of hexane to the column with two additional 5-ml rinses. Elute the column with an additional 90 ml of hexane and retain the entire eluate. Concentrate this solution to a volume of about 1 ml using the nitrogen evaporative concentrator (section 2.3.7).

5.2.2 Basic Alumina Column. Shorten a 25-ml disposable Pasteur pipette to about 16 ml. Pack the lower section with glass wool and 12 g of basic alumina. Transfer the concentrated extract from the silica gel column to the top of the basic alumina column and elute the column sequentially with 120 ml of 0.5 percent methylene chloride in hexane followed by 120 ml of 35 percent methylene chloride in hexane. Discard the first 120 ml of eluate. Collect the second 120 ml of eluate and concentrate it to about 0.5 ml using the nitrogen evaporative concentrator.

5.2.3 AX–21 Carbon/Celite 545 Column. Remove the botton 0.5 in. from the tip of a 9-ml disposable Pasteur pipette. Insert a glass fiber filter disk in the top of the pipette 2.5 cm from the constriction. Add sufficient carbon/celite mixture to form a 2 cm column. Top with a glass wool plug. In some cases AX–21 carbon fines may wash through the glass wool plug and enter the sample. This may be prevented by adding a celite plug to the exit end of the column. Rinse the column in sequence with 2 ml of 50 percent benzene in ethyl acetate, 1 ml of 50 percent methylene chloride in cyclohexane, and 2 ml of hexane. Discard these rinses. Transfer the concentrate in 1 ml of hexane from the basic alumina column to the carbon/celite column along with 1 ml of hexane rinse. Elute the column sequentially with 2 ml of 50 percent methylene chloride in hexane and 2 ml of 50 percent benzene in ethyl acetate and discard these eluates. Invert the column and elute in the reverse direction with 13 ml of toluene. Collect this eluate. Concentrate the eluate in a rotary evaporator at 50 °C to about 1 ml. Transfer the concentrate to a Reacti-vial using a toluene rinse and concentrate to a volume of 200 μl using a stream of N_2. Store extracts at room temperature, shielded from light, until the analysis is performed.

5.3 Analysis. Analyze the sample with a gas chromatograph coupled to a mass spectrometer (GC/MS) using the instrumental parameters in sections 5.3.1 and 5.3.2. Immediately prior to analysis, add a 20 μl aliquot of the Recovery Standard solution from Table 1 to each sample. A 2 μl aliquot of the extract is injected into the GC. Sample extracts are first analyzed using the DB–5 capillary column to determine the concentration of each isomer of PCDD's and PCDF's (tetra-through octa-). If tetra-chlorinated dibenzofurans are detected in this analysis, then analyze another aliquot of the sample in a separate run, using the DB–225 column to measure the 2,3,7,8 tetra-chloro dibenzofuran isomer. Other column systems may be used, provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

5.3.1 Gas Chromatograph Operating Conditions.

5.3.1.1 Injector. Configured for capillary column, splitless, 250 °C.

5.3.1.2 Carrier Gas. Helium, 1–2 ml/min.

5.3.1.3 Oven. Initially at 150 °C. Raise by at least 40 °C/min to 190 °C and then at 3 °C/min up to 300 °C.

5.3.2 High Resolution Mass Spectrometer.

5.3.2.1 Resolution. 10000 m/e.

5.3.2.2 Ionization Mode. Electron impact.

5.3.2.3 Source Temperature 250 °C.

5.3.2.4 Monitoring Mode. Selected ion monitoring. A list of the various ions to be monitored is summarized in Table 3.

5.3.2.5 Identification Criteria. The following identification criteria shall be used for the characterization of polychlorinated dibenzodioxins and dibenzofurans.

1. The integrated ion-abundance ratio (M/M + 2 or M + 2/M + 4) shall be within 15 percent of the theoretical value. The acceptable ion-abundance ratio ranges for the identification of chlorine-containing compounds are given in Table 4.
2. The retention time for the analytes must be within 3 seconds of the corresponding ^{13}C-labeled internal standard, surrogate or alternate standard.
3. The monitored ions, shown in Table 3 for a given analyte, shall reach their maximum within 2 seconds of each other.
4. The identification of specific isomers that do not have corresponding ^{13}C-labeled standards is done by comparison of the relative retention time (RRT) of the analyte to the nearest internal standard retention time with reference (i.e., within 0.005 RRT units) to the comparable RRT's found in the continuing calibration.
5. The signal to noise ratio for all monitored ions must be greater than 2.5.
6. The confirmation of 2, 3, 7, 8–TCDD and 2, 3, 7, 8–TCDF shall satisfy all of the above identification criteria.
7. For the identification of PCDF's, no signal may be found in the corresponding PCDPE channels.

5.3.2.6 Quantification. The peak areas for the two ions monitored for each analyte are summed to yield the total response for each analyte. Each internal standard is used to quantify the indigenous PCDD's or PCDF's in its homologous series. For example, the $^{13}C_{12}$–2,3,7,8-tetra chlorinated dibenzodioxin is used to calculate the concentrations of all

other tetra chlorinated isomers. Recoveries of the tetra- and penta- internal standards are calculated using the $^{13}C_{12}$–1,2,3,4–TCDD. Recoveries of the hexa- through octa- internal standards are calculated using $^{13}C_{12}$–1,2,3,7,8,9–HxCDD. Recoveries of the surrogate standards are calculated using the corresponding homolog from the internal standard.

6. Calibration

Same as Method 5 with the following additions.

6.1 GC/MS System.

6.1.1 Initial Calibration. Calibrate the GC/MS system using the set of five standards shown in Table 2. The relative standard deviation for the mean response factor from each of the unlabeled analytes (Table 2) and of the internal, surrogate, and alternate standards shall be less than or equal to the values in Table 5. The signal to noise ratio for the GC signal present in every selected ion current profile shall be greater than or equal to 2.5. The ion abundance ratios shall be within the control limits in Table 4.

6.1.2 Daily Performance Check.

6.1.2.1 Calibration Check. Inject on µl of solution Number 3 from Table 2. Calculate the relative response factor (RRF) for each compound and compare each RRF to the corresponding mean RRF obtained during the initial calibration. The analyzer performance is acceptable if the measured RRF's for the labeled and unlabeled compounds for the daily run are within the limits of the mean values shown in Table 5. In addition, the ion-abundance ratios shall be within the allowable control limits shown in Table 4.

6.1.2.2 Column Separation Check. Inject a solution of a mixture of PCDD's and PCDF's that documents resolution between 2,3,7,8–TCDD and other TCDD isomers. Resolution is defined as a valley between peaks that is less than 25 percent of the lower of the two peaks. Identify and record the retention time windows for each homologous series.

Perform a similar resolution check on the confirmation column to document the resolution between 2,3,7,8 TCDF and other TCDF isomers.

6.2 Lock Channels. Set mass spectrometer lock channels as specified in Table 3. Monitor the quality control check channels specified in Table 3 to verify instrument stability during the analysis.

7. Quality Control

7.1 Sampling Train Collection Efficiency Check. Add 100 µl of the surrogate standards in Table 1 to the absorbent cartridge of each train before collecting the field samples.

7.2 Internal Standard Percent Recoveries. A group of nine carbon labeled PCDD's and PCDF's representing, the tetra-through octachlorinated homologues, is added to every sample prior to extraction. The role of the internal standards is to quantify the native PCDD's and PCDF's present in the sample as well as to determine the overall method efficiency. Recoveries of the internal standards must be between 40 to 130 percent for the tetra-through hexachlorinated compounds while the range is 25 to 130 percent for the higher hepta- and octachlorinated homologues.

7.3 Surrogate Recoveries. The five surrogate compounds in Table 2 are added to the resin in the adsorbent sampling cartridge before the sample is collected. The surrogate recoveries are measured relative to the internal standards and are a measure of collection efficiency. They are not used to measure native PCDD's and PCDF's. All recoveries shall be between 70 and 130 percent. Poor recoveries for all the surrogates may be an indication of breakthrough in the sampling train. If the recovery of all standards is below 70 percent, the sampling runs must be repeated. As an alternative, the sampling runs do not have to be repeated if the final results are divided by the fraction of surrogate recovery. Poor recoveries of isolated surrogate compounds should not be grounds for rejecting an entire set of the samples.

7.4 Toluene QA Rinse. Report the results of the toluene QA rinse separately from the total sample catch. Do not add it to the total sample.

8.0 [Reserved]

9. Calculations

Same as Method 5, section 6 with the following additions.

9.1 Nomenclature.

A_{ai} = Integrated ion current of the noise at the retention time of the analyte.

A^*_{ci} = Integrated ion current of the two ions characteristic of the internal standard i in the calibration standard.

A_{cij} = Integrated ion current of the two ions characteristic of compound i in the jth calibration standard.

A^*_{cij} = Integrated ion current of the two ions characteristic of the internal standard i in the jth calibration standard.

A_{csi} = Integrated ion current of the two ions characteristic of surrogate compound i in the calibration standard.

A_i = Integrated ion current of the two ions characteristic of compound i in the sample.

A^*_i = Integrated ion current of the two ions characteristic of internal standard i in the sample.

A_{rs} = Integrated ion current of the two ions characteristic of the recovery standard.

A_{si} = Integrated ion current of the two ions characteristic of surrogate compound i in the sample.

C_i = Concentration of PCDD or PCDF i in the sample, pg/M^3.

C_T = Total concentration of PCDD's or PCDF's in the sample, pg/M^3.

m_{ci} = Mass of compound i in the calibration standard injected into the analyzer, pg.

m_{rs} = Mass of recovery standard in the calibration standard injected into the analyzer, pg.

m_{si} = Mass of surrogate compound in the calibration standard, pg.

RRF_i = Relative response factor.

RRF_{rs} = Recovery standard response factor.

RRF_s = Surrogate compound response factor.

9.2 Average Relative Response Factor.

$$RRF_i = \frac{1}{n}\sum_{j=1}^{n}\frac{A_{cij}\, m^*_{ci}}{A^*_{cij}\, m_{ci}} \qquad \text{Eq. 23-1}$$

9.3 Concentration of the PCDD's and PCDF's.

$$C_i = \frac{m_i * A_i}{A_i * RRF_i V_{mstd}} \qquad \text{Eq. 23-2}$$

9.4 Recovery Standard Response Factor.

$$RRF_{rs} = \frac{A_{ci} * m_{rs}}{A_{rs} m_{ci} *} \qquad \text{Eq. 23-3}$$

9.5 Recovery of Internal Standards (R*).

$$R* = \frac{A_i * m_{rs}}{A_{rs} RF_{rs} m_i *} \times 100\% \qquad \text{Eq. 23-4}$$

9.6 Surrogate Compound Response Factor.

$$RRF_s = \frac{A_{ci} * m_s}{A_{cis} m_{ci} *} \qquad \text{Eq. 23-5}$$

9.7 Recovery of Surrogate Compounds (R_s).

$$R_s = \frac{A_s m_i *}{A_i * RRF_s m_s} \times 100\% \qquad \text{Eq. 23-6}$$

9.8 Minimum Detectable Limit (MDL).

$$MDL = \frac{2.5\ A_{ai} m_i *}{A_{ci} * RRF_i} \qquad \text{Eq. 23-7}$$

9.9 Total Concentration of PCDD's and PCDF's in the Sample.

$$C_{Tr} = \sum_{i=1}^{n} C_i \qquad \text{Eq. 23-8}$$

Any PCDD's or PCDF's that are reported as nondetected (below the MDL) shall be counted as zero for the purpose of calculating the total concentration of PCDD's and PCDF's in the sample.

10. Bibliography

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TABLE 1—COMPOSITION OF THE SAMPLE FORTIFICATION AND RECOVERY STANDARDS SOLUTIONS

Analyte	Concentration (pg/µl)
Internal Standards:	
^{13} C_{12}-2,3,7,8-TCDD	100
^{13} C_{12}-1,2,3,7,8-PeCDD	100
^{13} C_{12}-1,2,3,6,7,8-HxCDD	100
^{13} C_{12}-1,2,3,4,6,7,8-HpCDD	100
^{13} C_{12}-OCDD	100
^{13} C_{12}-2,3,7,8-TCDF	100
^{13} C_{12}-1,2,3,7,8-PeCDF	100
^{13} C_{12}-1,2,3,6,7,8-HxCDF	100
^{13} C_{12}-1,2,3,4,6,7,8-HpCDF	100
Surrogate Standards:	
^{37} Cl_4-2,3,7,8-TCDD	100
^{13} C_{12}-1,2,3,4,7,8-HxCDD	100
^{13} C_{12}-2,3,4,7,8-PeCDF	100
^{13} C_{12}-1,2,3,4,7,8-HxCDF	100
^{13} C_{12}-1,2,3,4,7,8,9-HpCDF	100
Recovery Standards:	
^{13} C_{12}-1,2,3,4-TCDD	500
^{13} C_{12}-1,2,3,7,8,9-HxCDD	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS

Compound	Concentrations (pg/µL)				
	Solution No.				
	1	2	3	4	5
Alternate Standard:					
^{13} C_{12}-1,2,3,7,8,9-HxCDF	2.5	5	25	250	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS—Continued

Compound	Concentrations (pg/μL)				
	Solution No.				
	1	2	3	4	5
Recovery Standards:					
${}^{13}C_{12}$-1,2,3,4-TCDD ..	100	100	100	100	100
${}^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100

TABLE 3—ELEMENTAL COMPOSITIONS AND EXACT MASSES OF THE IONS MONITORED BY HIGH RESOLUTION MASS SPECTROMETRY FOR PCDD'S AND PCDF'S

Descriptor No.	Accurate mass	Ion type	Elemental composition	Analyte
2	292.9825	LOCK	$C_{7}F_{11}$	PFK
	303.9016	M	$C_{12}H_{4}{}^{35}Cl_{4}O$	TCDF
	305.8987	M + 2	$C_{12}H_{4}{}^{35}Cl^{37}O$	TCDF
	315.9419	M	${}^{13}C_{12}H_{4}{}^{35}Cl_{4}O$	TCDF (S)
	317.9389	M + 2	${}^{13}C_{12}H_{4}{}^{35}Cl_{3}{}^{37}ClO$	TCDF (S)
	319.8965	M	$C_{12}H_{4}{}^{35}ClO_{2}$	TCDD
	321.8936	M + 2	$C_{12}H_{4}{}^{35}Cl_{3}{}^{37}ClO_{2}$	TCDD
	327.8847	M	$C_{12}H_{4}{}^{37}Cl_{4}O_{2}$	TCDD (S)
	330.9792	QC	$C_{7}F_{13}$	PFK
	331.9368	M	${}^{13}C_{12}H_{4}{}^{35}Cl_{4}O_{2}$	TCDD (S)
	333.9339	M + 2	${}^{13}C_{12}H_{4}{}^{35}Cl^{37}ClO_{2}$	TCDD (S)
	339.8597	M + 2	$C_{12}H_{3}{}^{35}Cl_{4}{}^{37}ClO$	PECDF
	341.8567	M + 4	$C_{12}H_{3}{}^{35}Cl_{3}{}^{37}Cl_{2}O$	PeCDF
	351.9000	M + 2	${}^{13}C_{12}H_{3}{}^{35}Cl_{4}{}^{37}ClO$	PeCDF (S)
	353.8970	M + 4	${}^{13}C_{12}H_{3}{}^{35}Cl^{3537}Cl_{2}O$	PeCDF (S)
	355.8546	M + 2	$C_{12}H_{3}{}^{35}Cl_{3}37ClO_{2}$	PeCDD
	357.8516	M + 4	$C_{12}H_{3}{}^{35}Cl_{3}{}^{37}Cl_{2}O_{2}$	PeCDD
	367.8949	M + 2	${}^{13}C_{12}H_{3}{}^{35}Cl_{4}{}^{37}ClO_{2}$	PeCDD (S)
	369.8919	M + 4	${}^{13}C_{12}H_{3}{}^{35}Cl_{3}{}^{37}\ Cl_{2}O_{2}$	PeCDD (S)
	375.8364	M + 2	$C_{12}H_{4}{}^{35}Cl_{5}{}^{37}ClO$	HxCDPE
	409.7974	M + 2	$C_{12}H_{3}{}^{35}Cl_{6}{}^{37}ClO$	HpCPDE
3	373.8208	M + 2	$C_{12}H_{2}35Cl_{5}{}^{37}ClO$	HxCDF
	375.8178	M + 4	$C_{12}H_{2}{}^{35}Cl_{4}{}^{37}Cl_{2}O$	HxCDF
	383.8639	M	${}^{13}C_{12}H_{2}{}^{35}Cl_{6}O$	HxCDF (S)
	385.8610	M + 2	${}^{13}C_{12}H_{2}{}^{35}Cl_{5}{}^{37}ClO$	HxCDF (S)
	389.8157	M + 2	$C_{12}H_{2}{}^{35}Cl_{5}{}^{37}ClO_{2}$	HxCDD
	391.8127	M + 4	$C_{12}H_{2}{}^{35}Cl_{4}{}^{37}Cl_{2}O_{2}$	HxCDD
	392.9760	LOCK	$C_{9}F_{15}$	PFK
	401.8559	M + 2	${}^{13}C_{12}H_{2}{}^{35}Cl_{5}{}^{37}ClO_{2}$	HxCDD (S)
	403.8529	M + 4	${}^{13}C_{12}H_{2}{}^{35}Cl_{4}{}^{37}Cl_{2}O$	HxCDD (S)
	445.7555	M + 4	$C_{12}H_{2}{}^{35}Cl_{6}{}^{37}Cl_{2}O$	OCDPE
	430.9729	QC	$C_{9}F_{17}$	PFK
4	407.7818	M + 2	$C_{12}H^{35}Cl_{6}{}^{37}ClO$	HpCDF
	409.7789	M + 4	$C_{12}H^{35}Cl_{5}{}^{37}Cl_{2}O$	HpCDF
	417.8253	M	${}^{13}C_{12}H^{35}Cl_{7}O$	HpCDF (S)
	419.8220	M + 2	${}^{13}C_{12}H^{35}Cl_{6}{}^{37}ClO$	HpCDF (S)
	423.7766	M + 2	$C_{12}H^{35}Cl_{6}{}^{37}ClO_{2}$	HpCDD
	425.7737	M + 4	$C_{12}H^{35}Cl_{5}{}^{37}Cl_{2}O_{2}$	HpCDD
	435.8169	M + 2	${}^{13}C_{12}H^{35}Cl_{6}{}^{37}ClO_{2}$	HpCDD (S)
	437.8140	M + 4	${}^{13}C_{12}H^{35}Cl_{5}{}^{37}Cl_{2}O_{2}$	HpCDD (S)
	479.7165	M + 4	$C_{12}H^{35}Cl_{7}{}^{37}Cl_{2}O$	NCPDE
	430.9729	LOCK	$C_{9}F_{17}$	PFK
	441.7428	M + 2	$C_{12}{}^{35}Cl_{7}{}^{37}ClO$	OCDF
	443.7399	M + 4	$C_{12}{}^{35}Cl_{6}{}^{37}Cl_{2}O$	OCDF
	457.7377	M + 2	$C_{12}{}^{35}Cl_{7}{}^{37}ClO_{2}$	OCDD
	459.7348	M + 4	$C_{12}{}^{35}Cl_{6}{}^{37}Cl_{2}O_{2}$	OCDD
	469.7779	M + 2	${}^{13}C_{12}{}^{35}Cl_{7}{}^{37}ClO_{2}$	OCDD (S)
	471.7750	M + 4	${}^{13}C_{12}{}^{35}Cl_{6}{}^{37}Cl_{2}O_{2}$	OCDD (S)
	513.6775	M + 4	$C_{12}{}^{35}Cl_{8}{}^{37}Cl_{2}O_{2}$	DCDPE
	442.9728	QC	$C_{10}F_{17}$	PFK

(a) The following nuclidic masses were used:
H = 1.007825
C = 12.000000
${}^{13}C$ = 13.003355
F = 18.9984
O = 15.994915
${}^{35}Cl$ = 34.968853
${}^{37}Cl$ = 36.965903

S = Labeled Standard
QC = Ion selected for monitoring instrument stability during the GC/MS analysis.

TABLE 4—ACCEPTABLE RANGES FOR ION-ABUNDANCE RATIOS OF PCDD'S AND PCDF'S

No. of chlorine atoms	Ion type	Theoretical ratio	Control limits	
			Lower	Upper
4	M/M + 2	0.77	0.65	0.89
5	M + 2/M + 4	1.55	1.32	1.78
6	M + 2/M + 4	1.24	1.05	1.43
6[a]	M/M + 2	0.51	0.43	0.59
7[b]	M/M + 2	0.44	0.37	0.51
7	M + 2/M + 4	1.04	0.88	1.20
8	M + 2/M + 4	0.89	0.76	1.02

[a] Used only for ^{13}C-HxCDF.
[b] Used only for ^{13}C-HpCDF.

TABLE 5—MINIMUM REQUIREMENTS FOR INITIAL AND DAILY CALIBRATION RESPONSE FACTORS

Compound	Relative response factors	
	Initial calibration RSD	Daily calibration % difference
Unlabeled Analytes:		
2,3,7,8-TCDD	25	25
2,3,7,8-TCDF	25	25
1,2,3,7,8-PeCDD	25	25
1,2,3,7,8-PeCDF	25	25
2,3,4,7,8-PeCDF	25	25
1,2,4,5,7,8-HxCDD	25	25
1,2,3,6,7,8-HxCDD	25	25
1,2,3,7,8,9-HxCDD	25	25
1,2,3,4,7,8-HxCDF	25	25
1,2,3,6,7,8-HxCDF	25	25
1,2,3,7,8,9-HxCDF	25	25
2,3,4,6,7,8-HxCDF	25	25
1,2,3,4,6,7,8-HpCDD	25	25
1,2,3,4,6,7,8-HpCDF	25	25
OCDD	25	25
OCDF	30	30
Internal Standards:		
$^{13}C_{12}$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-1,2,3,7,8-PeCDD	30	30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	25	25
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	30	30
$^{13}C_{12}$-OCDD	30	30
$^{13}C_{12}$-2,3,7,8-TCDF	30	30
$^{13}C_{12}$-1,2,3,7,8-PeCDF	30	30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	30	30
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	30	30
Surrogate Standards:		
$^{37}Cl_4$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-2,3,4,7,8-PeCDF	25	25
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	25	25
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	25	25
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	25	25
Alternate Standard:		
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	25	25

METHOD 24—DETERMINATION OF VOLATILE MATTER CONTENT, WATER CONTENT, DENSITY, VOLUME SOLIDS, AND WEIGHT SOLIDS OF SURFACE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds	No CAS Number assigned
Water.	7732–18–5

1.2 Applicability. This method is applicable for the determination of volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

1.3 Precision and Bias. Intra-and inter-laboratory analytical precision statements are presented in section 13.1. No bias has been identified.

2.0 Summary of Method

2.1 Standard methods are used to determine the volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

3.0 Definitions

3.1 *Waterborne coating* means any coating which contains more than 5 percent water by weight in its volatile fraction.

3.2 *Multicomponent coatings* are coatings that are packaged in two or more parts, which are combined before application. Upon combination a coreactant from one part of the coating chemically reacts, at ambient conditions, with a coreactant from another part of the coating.

3.3 *Ultraviolet (UV) radiation-cured coatings* are coatings which contain unreacted monomers that are polymerized by exposure to ultraviolet light.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Several of the compounds that may be contained in the coatings analyzed by this method may be irritating or corrosive to tissues (e.g., heptane) or may be toxic (e.g., benzene, methyl alcohol). Nearly all are fire hazards.

Appropriate precautions can be found in reference documents, such as Reference 3 of section 16.0.

6.0 Equipment and Supplies

The equipment and supplies specified in the ASTM methods listed in sections 6.1 through 6.6 (incorporated by reference—see § 60.17 for acceptable versions of the methods) are required:

6.1 ASTM D 1475–60, 80, or 90, Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products.

6.2 ASTM D 2369–81, 87, 90, 92, 93, or 95, Standard Test Method for Volatile Content of Coatings.

6.3 ASTM D 3792–79 or 91, Standard Test Method for Water Content of Water Reducible Paints by Direct Injection into a Gas Chromatograph.

6.4 ASTM D 4017–81, 90, or 96a, Standard Test Method for Water in Paints and Paint Materials by the Karl Fischer Titration Method.

6.5 ASTM 4457–85 91, Standard Test Method for Determination of Dichloromethane and 1,1,1-Trichloroethane in Paints and Coatings by Direct Injection into a Gas Chromatograph.

6.6 ASTM D 5403–93, Standard Test Methods for Volatile Content of Radiation Curable Materials.

6.7 ASTM D 6419–00, Test Method for Volatile Content of Sheet-Fed and Coldset Web Offset Printing Inks.

7.0 Reagents and Standards

7.1 The reagents and standards specified in the ASTM methods listed in sections 6.1 through 6.6 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 1 of section 16.0.

9.0 Quality Control

9.1 Reproducibility

NOTE: Not applicable to UV radiation-cured coatings). The variety of coatings that may be subject to analysis makes it necessary to verify the ability of the analyst and the analytical procedures to obtain reproducible results for the coatings tested. Verification is accomplished by running duplicate analyses on each sample tested (Sections 11.2 through 11.4) and comparing the results with the intra-laboratory precision statements (Section 13.1) for each parameter.

9.2 Confidence Limits for Waterborne Coatings. Because of the inherent increased imprecision in the determination of the VOC content of waterborne coatings as the weight percent of water increases, measured parameters for waterborne coatings are replaced with appropriate confidence limits (Section 12.6). These confidence limits are based on measured parameters and inter-laboratory precision statements.

10.0 Calibration and Standardization

10.1 Perform the calibration and standardization procedures specified in the ASTM methods listed in sections 6.1 through 6.6.

11.0 Analytical Procedure

Additional guidance can be found in Reference 2 of section 16.0.

11.1 Non Thin-film Ultraviolet Radiation-cured (UV radiation-cured) Coatings.

11.1.1 Volatile Content. Use the procedure in ASTM D 5403 to determine the volatile matter content of the coating except the curing test described in NOTE 2 of ASTM D 5403 is required.

11.1.2 Water Content. To determine water content, follow section 11.3.2.

11.1.3 Coating Density. To determine coating density, follow section 11.3.3.

11.1.4 Solids Content. To determine solids content, follow section 11.3.4.

11.1.5 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the equation in section 12.2. If C is less than 0.2 g and A is greater than or equal to 225 cm^2 (35 in^2) then the coating or ink is considered a thin-film UV radiation-cured coating and ASTM D 5403 is not applicable.

NOTE: As noted in section 1.4 of ASTM D 5403, this method may not be applicable to radiation curable materials wherein the volatile material is water.

11.2 Multi-component Coatings.

11.2.1 Sample Preparation.

11.2.1.1 Prepare about 100 ml of sample by mixing the components in a storage container, such as a glass jar with a screw top or a metal can with a cap. The storage container should be just large enough to hold the mixture. Combine the components (by weight or volume) in the ratio recommended by the manufacturer. Tightly close the container between additions and during mixing to prevent loss of volatile materials. However, most manufacturers mixing instructions are by volume. Because of possible error caused by expansion of the liquid when measuring the volume, it is recommended that the components be combined by weight. When weight is used to combine the components and the manufacturer's recommended ratio is by volume, the density must be determined by section 11.3.3.

11.2.1.2 Immediately after mixing, take aliquots from this 100 ml sample for determination of the total volatile content, water content, and density.

11.2.2 Volatile Content. To determine total volatile content, use the apparatus and

reagents described in ASTM D2369 (incorporated by reference; see §60.17 for the approved versions of the standard), respectively, and use the following procedures:

11.2.2.1 Weigh and record the weight of an aluminum foil weighing dish. Add 3 ±1 ml of suitable solvent as specified in ASTM D2369 to the weighing dish. Using a syringe as specified in ASTM D2369, weigh to 1 mg, by difference, a sample of coating into the weighing dish. For coatings believed to have a volatile content less than 40 weight percent, a suitable size is 0.3 + 0.10 g, but for coatings believed to have a volatile content greater than 40 weight percent, a suitable size is 0.5 ±0.1 g.

NOTE: If the volatile content determined pursuant to section 12.4 is not in the range corresponding to the sample size chosen repeat the test with the appropriate sample size. Add the specimen dropwise, shaking (swirling) the dish to disperse the specimen completely in the solvent. If the material forms a lump that cannot be dispersed, discard the specimen and prepare a new one. Similarly, prepare a duplicate. The sample shall stand for a minimum of 1 hour, but no more than 24 hours prior to being oven cured at 110 ±5 °C (230 ±9 °F) for 1 hour.

11.2.2.2 Heat the aluminum foil dishes containing the dispersed specimens in the forced draft oven for 60 min at 110 ±5 °C (230 ±9 °F). Caution—provide adequate ventilation, consistent with accepted laboratory practice, to prevent solvent vapors from accumulating to a dangerous level.

11.2.2.3 Remove the dishes from the oven, place immediately in a desiccator, cool to ambient temperature, and weigh to within 1 mg.

11.2.2.4 Run analyses in pairs (duplicate sets) for each coating mixture until the criterion in section 11.4 is met. Calculate W_V following Equation 24–2 and record the arithmetic average.

11.2.3 Water Content. To determine water content, follow section 11.3.2.

11.2.4 Coating Density. To determine coating density, follow section 11.3.3.

11.2.5 Solids Content. To determine solids content, follow section 11.3.4.

11.2.6 Exempt Solvent Content. To determine the exempt solvent content, follow section 11.3.5.

NOTE: For all other coatings (*i.e.,* water-or solvent-borne coatings) not covered by multicomponent or UV radiation-cured coatings, analyze as shown below:

11.3 Water-or Solvent-borne coatings.

11.3.1 Volatile Content. Use the procedure in ASTM D 2369 to determine the volatile matter content (may include water) of the coating.

11.3.1.1 Record the following information:

W_1 = weight of dish and sample before heating, g

W_2 = weight of dish and sample after heating, g

W_3 = sample weight, g.

11.3.1.2 Calculate the weight fraction of the volatile matter (W_v) for each analysis as shown in section 12.3.

11.3.1.3 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.1.4 Record the arithmetic average (W_v).

11.3.2 Water Content. For waterborne coatings only, determine the weight fraction of water (W_w) using either ASTM D 3792 or ASTM D 4017.

11.3.2.1 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.2.2 Record the arithmetic average (w_w).

11.3.3 Coating Density. Determine the density (Dc, kg/l) of the surface coating using the procedure in ASTM D 1475.

11.3.3.1 Run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement in section 13.1.

11.3.3.2 Record the arithmetic average (D_c).

11.3.4 Solids Content. Determine the volume fraction (V_s) solids of the coating by calculation using the manufacturer's formulation.

11.3.5 Exempt Solvent Content. Determine the weight fraction of exempt solvents (W_E) by using ASTM Method D4457. Run a duplicate set of determinations and record the arithmetic average (W_E).

11.4 Sample Analysis Criteria. For W_v and W_w, run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement for that parameter. For D_c, run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement. If, after several attempts, it is concluded that the ASTM procedures cannot be used for the specific coating with the established intra-laboratory precision (excluding UV radiation-cured coatings), the U.S. Environmental Protection Agency (EPA) will assume responsibility for providing the necessary procedures for revising the method or precision statements upon written request to: Director, Emissions, Monitoring, and Analysis Division, MD–14, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

12.0 Calculations and Data Analysis

12.1 Nomenclature.

A = Area of substrate, cm^2, (in^2).

C = Amount of coating or ink added to the substrate, g.

D_c = Density of coating or ink, g/cm^3 (g/in^3).

F = Manufacturer's recommended film thickness, cm (in).
W_o = Weight fraction of nonaqueous volatile matter, g/g.
W_s = Weight fraction of solids, g/g.
W_v = Weight fraction of the volatile matter, g/g.
W_w = Weight fraction of the water, g/g.

12.2 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the following equation:

$$C = F\,A\,D_c \qquad \text{Eq. 24-1}$$

12.3 Calculate W_v for each analysis as shown below:

$$W_v = \frac{W_1 - W_2}{W_3} \qquad \text{Eq. 24-2}$$

12.4 Nonaqueous Volatile Matter.

12.4.1 Solvent-borne Coatings.

$$W_o = W_v \qquad \text{Eq. 24-3}$$

12.4.2 Waterborne Coatings.

$$W_o = W_v - W_w \qquad \text{Eq. 24-4}$$

12.4.3 Coatings Containing Exempt Solvents.

$$W_o = W_v - W_E - W_w \qquad \text{Eq. 24-5}$$

12.5 Weight Fraction Solids.

$$W_s = 1 - W_v \qquad \text{Eq. 24-6}$$

12.6 Confidence Limit Calculations for Waterborne Coatings. To calculate the lower confidence limit, subtract the appropriate inter-laboratory precision value from the measured mean value for that parameter. To calculate the upper confidence limit, add the appropriate inter-laboratory precision value to the measured mean value for that parameter. For W_v and D_c, use the lower confidence limits; for W_w, use the upper confidence limit. Because W_s is calculated, there is no adjustment for this parameter.

13.0 Method Performance

13.1 Analytical Precision Statements. The intra-and inter-laboratory precision statements are given in Table 24–1 in section 17.0.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as specified in section 6.0, with the addition of the following:

1. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.
2. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A.

EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

3. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 24–1—ANALYTICAL PRECISION STATEMENTS

	Intra-laboratory	Inter-laboratory
Volatile matter content, W_v	±0.015 $\overline{W}_v$	±0.047 $\overline{\overline{W}}_v$
Water content, W_w	±0.029 $\overline{W}_w$	±0.075 $\overline{W}_w$
Density, D_c	±0.001 kg/l	±0.002 kg/l

METHOD 24A—DETERMINATION OF VOLATILE MATTER CONTENT AND DENSITY OF PUBLICATION ROTOGRAVURE INKS AND RELATED PUBLICATION ROTOGRAVURE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds (VOC).	No CAS number assigned.

1.2 Applicability. This method is applicable for the determination of the VOC content and density of solvent-borne (solvent-reducible) publication rotogravure inks and related publication rotogravure coatings.

2.0 Summary of Method

2.1 Separate procedures are used to determine the VOC weight fraction and density of the ink or related coating and the density of the solvent in the ink or related coating. The VOC weight fraction is determined by measuring the weight loss of a known sample quantity which has been heated for a specified length of time at a specified temperature. The density of both the ink or related coating and solvent are measured by a standard procedure. From this information, the VOC volume fraction is calculated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Some of the compounds that may be contained in the inks or related coatings analyzed by this method may be irritating or corrosive to tissues or may be toxic. Nearly all are fire hazards. Appropriate precautions can be found in reference documents, such as Reference 6 of section 16.0.

6.0 Equipment and Supplies

The following equipment and supplies are required for sample analysis:

6.1 Weighing Dishes. Aluminum foil, 58 mm (2.3 in.) in diameter by 18 mm (0.7 in.) high, with a flat bottom. There must be at least three weighing dishes per sample.

6.2 Disposable Syringe. 5 ml.

6.3 Analytical Balance. To measure to within 0.1 mg.

6.4 Oven. Vacuum oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) and an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) for 4 hours. Alternatively, a forced draft oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) for 24 hours.

6.5 The equipment and supplies specified in ASTM D 1475–60, 80, or 90 (incorporated by reference—see § 60.17).

7.0 Reagents and Standards

7.1 The reagents and standards specified in ASTM D 1475–60, 80, or 90 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 4 of section 16.0.

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

Additional guidance can be found in Reference 5 of section 16.0.

11.1 VOC Weight Fraction. Shake or mix the ink or related coating sample thoroughly to assure that all the solids are completely suspended. Label and weigh to the nearest 0.1 mg a weighing dish and record this weight (M_{x1}). Using a 5 ml syringe, without a needle, extract an aliquot from the ink or related coating sample. Weigh the syringe and aliquot to the nearest 0.1 mg and record this weight (M_{cy1}). Transfer 1 to 3 g of the aliquot to the tared weighing dish. Reweigh the syringe and remaining aliquot to the nearest 0.1 mg and record this weight (M_{cy2}). Heat the weighing dish with the transferred aliquot in a vacuum oven at an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) and a temperature of 120 ±2 °C (248 ±4 °F) for 4 hours. Alternatively, heat the weighing dish with the transferred aliquot in a forced draft oven at a temperature of 120 ±2 °C for 24 hours. After the weighing dish has cooled, reweigh it to the nearest 0.1 mg and record the weight (M_{x2}). Repeat this procedure two times for each ink or related coating sample, for a total of three samples.

11.2 Ink or Related Coating Density. Determine the density of the ink or related coating (D_c) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the ink or related coating density as the arithmetic average (D_c) of the three determinations.

11.3 Solvent Density. Determine the density of the solvent (D_o) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the solvent density as the arithmetic average (D_o) of the three determinations.

12.0 Calculations and Data Analysis

12.1 VOC Weight Fraction. For each determination, calculate the volatile organic content weight fraction (W_o) using the following equation:

$$W_o = \frac{M_{x1} + M_{cy1} - M_{cy2} - M_{x2}}{M_{cy1} - M_{cy2}} \qquad \text{Eq. 24A-1}$$

Make a total of three determinations. Report the VOC weight fraction as the arithmetic average ($\bar{W}_o$) of the three determinations.

12.2 VOC Volume Fraction. Calculate the volume fraction volatile organic content (V_o) using the following equation:

$$V_o = \frac{\overline{W}_o \overline{D}_c}{\overline{D}_o} \qquad \text{Eq. 24A-2}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. ASTM Designation D 1475.

2. Teleconversation. Wright, Chuck, Inmont Corporation with Reich, R., A., Radian Corporation. September 25, 1979, Gravure Ink Analysis.

3. Teleconversation. Oppenheimer, Robert, Gravure Research Institute with Burt, Rick, Radian Corporation, November 5, 1979, Gravure Ink Analysis.

4. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

5. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A. EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

6. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25—DETERMINATION OF TOTAL GASEOUS NONMETHANE ORGANIC EMISSIONS AS CARBON

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total gaseous nonmethane organic compounds (TGNMO)	N/A	Dependent upon analytical equipment.

1.2 Applicability.

1.2.1 This method is applicable for the determination of volatile organic compounds (VOC) (measured as total gaseous nonmethane organics (TGNMO) and reported as carbon) in stationary source emissions. This method is not applicable for the determination of organic particulate matter.

1.2.2 This method is not the only method that applies to the measurement of VOC. Costs, logistics, and other practicalities of source testing may make other test methods more desirable for measuring VOC contents of certain effluent streams. Proper judgment is required in determining the most applicable VOC test method. For example, depending upon the molecular composition of the organics in the effluent stream, a totally automated semicontinuous nonmethane organics (NMO) analyzer interfaced directly to the source may yield accurate results. This approach has the advantage of providing emission data semicontinuously over an extended time period.

1.2.3 Direct measurement of an effluent with a flame ionization detector (FID) analyzer may be appropriate with prior characterization of the gas stream and knowledge that the detector responds predictably to the organic compounds in the stream. If present, methane (CH_4) will, of course, also be measured. The FID can be used under any of the following limited conditions: (1) Where only one compound is known to exist; (2) when the organic compounds consist of only hydrogen and carbon; (3) where the relative percentages of the compounds are known or can be determined, and the FID responses to the compounds are known; (4) where a consistent mixture of the compounds exists before and after emission control and only the relative concentrations are to be assessed; or (5) where the FID can be calibrated against mass standards of the compounds emitted (solvent emissions, for example).

1.2.4 Another example of the use of a direct FID is as a screening method. If there is enough information available to provide a rough estimate of the analyzer accuracy, the FID analyzer can be used to determine the VOC content of an uncharacterized gas stream. With a sufficient buffer to account for possible inaccuracies, the direct FID can be a useful tool to obtain the desired results without costly exact determination.

1.2.5 In situations where a qualitative/quantitative analysis of an effluent stream is desired or required, a gas chromatographic FID system may apply. However, for sources emitting numerous organics, the time and expense of this approach will be formidable.

2.0 Summary of Method

2.1 An emission sample is withdrawn from the stack at a constant rate through a heated filter and a chilled condensate trap by means of an evacuated sample tank. After sampling is completed, the TGNMO are determined by independently analyzing the condensate trap and sample tank fractions and combining the analytical results. The organic content of the condensate trap fraction is determined by oxidizing the NMO to carbon dioxide (CO_2) and quantitatively collecting in the effluent in an evacuated vessel; then a portion of the CO_2 is reduced to CH_4 and measured by an FID. The organic content of the sample tank fraction is measured by injecting a portion of the sample into a gas chromatographic column to separate the NMO from carbon monoxide (CO), CO_2, and CH_4; the NMO are oxidized to CO_2, reduced to CH_4, and measured by an FID. In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 Carbon Dioxide and Water Vapor. When carbon dioxide (CO_2) and water vapor are present together in the stack, they can produce a positive bias in the sample. The magnitude of the bias depends on the concentrations of CO_2 and water vapor. As a guideline, multiply the CO_2 concentration, expressed as volume percent, times the water vapor concentration. If this product does not exceed 100, the bias can be considered insignificant. For example, the bias is not significant for a source having 10 percent CO_2 and 10 percent water vapor, but it might be significant for a source having 10 percent CO_2 and 20 percent water vapor.

4.2. Particulate Matter. Collection of organic particulate matter in the condensate trap would produce a positive bias. A filter is included in the sampling equipment to minimize this bias.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

6.1 Sample Collection. The sampling system consists of a heated probe, heated filter, condensate trap, flow control system, and sample tank (see Figure 25–1). The TGNMO sampling equipment can be constructed from commercially available components and components fabricated in a machine shop. The following equipment is required:

6.1.1 Heated Probe. 6.4-mm (¼-in.) OD stainless steel tubing with a heating system capable of maintaining a gas temperature at the exit end of at least 129 °C (265 °F). The probe shall be equipped with a temperature sensor at the exit end to monitor the gas temperature. A suitable probe is shown in Figure 25–1. The nozzle is an elbow fitting attached to the front end of the probe while the temperature sensor is inserted in the side arm of a tee fitting attached to the rear of the probe. The probe is wrapped with a suitable length of high temperature heating tape, and then covered with two layers of glass cloth insulation and one layer of aluminum foil or an equivalent wrapping.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.2 Filter Holder. 25-mm (15⁄16-in.) ID Gelman filter holder with 303 stainless steel body and 316 stainless steel support screen with the Viton O-ring replaced by a Teflon O-ring.

6.1.3 Filter Heating System.

6.1.3.1 A metal box consisting of an inner and an outer shell separated by insulating material with a heating element in the inner shell capable of maintaining a gas temperature at the filter of 121 ±3 °C (250 ±5 °F). The heating box shall include temperature sensors to monitor the gas temperature immediately upstream and immediately downstream of the filter.

6.1.3.2 A suitable heating box is shown in Figure 25–2. The outer shell is a metal box that measures 102 mm × 280 mm × 292 mm (4 in. × 11 in. × 11½ in.), while the inner shell is a metal box measuring 76 mm × 229 mm × 241 mm (3 in. × 9 in. × 9½ in.). The inner box is supported by 13-mm (½-in.) phenolic rods. The void space between the boxes is filled with ceramic fiber insulation which is sealed in place by means of a silicon rubber bead around the upper sides of the box. A removable lid made in a similar manner, with a 25-mm (1-in.) gap between the parts is used to cover the heating chamber. The inner box is heated with a 250-watt cartridge heater, shielded by a stainless steel shroud. The heater is regulated by a thermostatic temperature controller which is set to maintain a gas temperature of 121 °C (250 °F) as measured by the temperature sensor upstream of the filter.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.4 Condensate Trap. 9.5-mm (⅜-in.) OD 316 stainless steel tubing bent into a U-shape. Exact dimensions are shown in Figure

25–3. The tubing shall be packed with coarse quartz wool, to a density of approximately 0.11 g/cm^3 before bending. While the condensate trap is packed with dry ice in the Dewar, an ice bridge may form between the arms of the condensate trap making it difficult to remove the condensate trap. This problem can be prevented by attaching a steel plate between the arms of the condensate trap in the same plane as the arms to completely fill the intervening space.

6.1.5 Valve. Stainless steel control valve for starting and stopping sample flow.

6.1.6 Metering Valve. Stainless steel valve for regulating the sample flow rate through the sample train.

6.1.7 Rate Meter. Rotameter, or equivalent, capable of measuring sample flow in the range of 60 to 100 cm^3/min (0.13 to 0.21 ft^3/hr).

6.1.8 Sample Tank. Stainless steel or aluminum tank with a minimum volume of 4 liters (0.14 ft^3).

NOTE: Sample volumes greater than 4 liters may be required for sources with low organic concentrations.

6.1.9 Mercury Manometer. U-tube manometer or absolute pressure gauge capable of measuring pressure to within 1 mm Hg in the range of 0 to 900 mm.

6.1.10 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

6.2 Condensate Recovery. The system for the recovery of the organics captured in the condensate trap consists of a heat source, an oxidation catalyst, a nondispersive infrared (NDIR) analyzer, and an intermediate collection vessel (ICV). Figure 25–4 is a schematic of a typical system. The system shall be capable of proper oxidation and recovery, as specified in section 10.1.1. The following major components are required:

6.2.1 Heat Source. Sufficient to heat the condensate trap (including probe) to a temperature of 200 °C (390 °F). A system using both a heat gun and an electric tube furnace is recommended.

6.2.2 Heat Tape. Sufficient to heat the connecting tubing between the water trap and the oxidation catalyst to 100 °C (212 °F).

6.2.3 Oxidation Catalyst. A suitable length of 9.5 mm (3⁄8-in.) OD Inconel 600 tubing packed with 15 cm (6 in.) of 3.2 mm (3⁄8-in.) diameter 19 percent chromia on alumina pellets. The catalyst material is packed in the center of the catalyst tube with quartz wool packed on either end to hold it in place.

6.2.4 Water Trap. Leak-proof, capable of removing moisture from the gas stream.

6.2.5 Syringe Port. A 6.4-mm (1⁄4-in.) OD stainless steel tee fitting with a rubber septum placed in the side arm.

6.2.6 NDIR Detector. Capable of indicating CO_2 concentration in the range of zero to 5 percent, to monitor the progress of combustion of the organic compounds from the condensate trap.

6.2.7 Flow-Control Valve. Stainless steel, to maintain the trap conditioning system near atmospheric pressure.

6.2.8 Intermediate Collection Vessel. Stainless steel or aluminum, equipped with a female quick connect. Tanks with nominal volumes of at least 6 liters (0.2 ft^3) are recommended.

6.2.9 Mercury Manometer. Same as described in section 6.1.9.

6.2.10 Syringe. 10-ml gas-tight glass syringe equipped with an appropriate needle.

6.2.11 Syringes. 10-μl and 50-μl liquid injection syringes.

6.2.12 Liquid Sample Injection Unit. 316 Stainless steel U-tube fitted with an injection septum (see Figure 25–7).

6.3 Analysis.

6.3.1 NMO Analyzer. The NMO analyzer is a gas chromatograph (GC) with backflush capability for NMO analysis and is equipped with an oxidation catalyst, reduction catalyst, and FID. Figures 25–5 and 25–6 are schematics of a typical NMO analyzer. This semicontinuous GC/FID analyzer shall be capable of: (1) Separating CO, CO_2, and CH_4 from NMO, (2) reducing the CO_2 to CH_4 and quantifying as CH_4, and (3) oxidizing the NMO to CO_2, reducing the CO_2 to CH_4 and quantifying as CH_4, according to section 10.1.2. The analyzer consists of the following major components:

6.3.1.1 Oxidation Catalyst. A suitable length of 9.5-mm (3⁄8-in.) OD Inconel 600 tubing packed with 5.1 cm (2 in.) of 19 percent chromia on 3.2-mm (1⁄8-in.) alumina pellets. The catalyst material is packed in the center of the tube supported on either side by quartz wool. The catalyst tube must be mounted vertically in a 650 °C (1200 °F) furnace. Longer catalysts mounted horizontally may be used, provided they can meet the specifications of section 10.1.2.1.

6.3.1.2 Reduction Catalyst. A 7.6-cm (3-in.) length of 6.4-mm (1⁄4-in.) OD Inconel tubing fully packed with 100-mesh pure nickel powder. The catalyst tube must be mounted vertically in a 400 °C (750 °F) furnace.

6.3.1.3 Separation Column(s). A 30-cm (1-ft) length of 3.2-mm (1⁄8-in.) OD stainless steel tubing packed with 60/80 mesh Unibeads 1S followed by a 61-cm (2-ft) length of 3.2-mm (1⁄8-in.) OD stainless steel tubing packed with 60/80 mesh Carbosieve G. The Carbosieve and Unibeads columns must be baked separately at 200 °C (390 °F) with carrier gas flowing through them for 24 hours before initial use.

6.3.1.4 Sample Injection System. A single 10-port GC sample injection valve or a group of valves with sufficient ports fitted with a sample loop properly sized to interface with the NMO analyzer (1-cc loop recommended).

6.3.1.5 FID. An FID meeting the following specifications is required:

6.3.1.5.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.2.3.

6.3.1.5.2 Range. A full scale range of 10 to 50,000 ppm CH_4. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.3.1.6 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the analytical results.

6.3.2 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 1 mm Hg.

6.3.3 Temperature Sensor. Capable of measuring the laboratory temperature within 1 °C (2 °F).

6.3.4 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

7.0 Reagents and Standards

7.1 Sample Collection. The following reagents are required for sample collection:

7.1.1 Dry Ice. Solid CO2, crushed.

7.1.2 Coarse Quartz Wool. 8 to 15 um.

7.1.3 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Method D2986–71, 78, or 95a (incorporated by reference—see § 60.17). Test data from the supplier's quality control program are sufficient for this purpose.

7.2 NMO Analysis. The following gases are required for NMO analysis:

7.2.1 Carrier Gases. Helium (He) and oxygen (O_2) containing less than 1 ppm CO_2 and less than 0.1 ppm hydrocarbon.

7.2.2 Fuel Gas. Hydrogen (H_2), at least 99.999 percent pure.

7.2.3 Combustion Gas. Either air (less than 0.1 ppm total hydrocarbon content) or O_2 (purity 99.99 percent or greater), as required by the detector.

7.3 Condensate Analysis. The following are required for condensate analysis:

7.3.1 Gases. Containing less than 1 ppm carbon.

7.3.1.1 Air.

7.3.1.2 Oxygen.

7.3.2 Liquids. To conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society.

7.3.2.1 Hexane.

7.3.2.2 Decane.

7.4 Calibration. For all calibration gases, the manufacturer must recommend a maximum shelf life for each cylinder (i.e., the length of time the gas concentration is not expected to change more than ±5 percent from its certified value). The date of gas cylinder preparation, certified organic concentration, and recommended maximum shelf life must be affixed to each cylinder before shipment from the gas manufacturer to the buyer. The following calibration gases are required:

7.4.1 Oxidation Catalyst Efficiency Check Calibration Gas. Gas mixture standard with nominal concentration of 1 percent methane in air.

7.4.2 FID Linearity and NMO Calibration Gases. Three gas mixture standards with nominal propane concentrations of 20 ppm, 200 ppm, and 3000 ppm, in air.

7.4.3 CO_2 Calibration Gases. Three gas mixture standards with nominal CO_2 concentrations of 50 ppm, 500 ppm, and 1 percent, in air.

NOTE: Total NMO less than 1 ppm required for 1 percent mixture.

7.4.4 NMO Analyzer System Check Calibration Gases. Four calibration gases are needed as follows:

7.4.4.1 Propane Mixture. Gas mixture standard containing (nominal) 50 ppm CO, 50 ppm CH_4, 1 percent CO_2, and 20 ppm C_3H_8, prepared in air.

7.4.4.2 Hexane. Gas mixture standard containing (nominal) 50 ppm hexane in air.

7.4.4.3 Toluene. Gas mixture standard containing (nominal) 20 ppm toluene in air.

7.4.4.4 Methanol. Gas mixture standard containing (nominal) 100 ppm methanol in air.

8.0 Sample Collection, Preservation, Transport, and Storage

8.1 Sampling Equipment Preparation.

8.1.1 Condensate Trap Cleaning. Before its initial use and after each use, a condensate trap should be thoroughly cleaned and checked to ensure that it is not contaminated. Both cleaning and checking can be accomplished by installing the trap in the condensate recovery system and treating it as if it were a sample. The trap should be heated as described in section 11.1.3. A trap may be considered clean when the CO_2 concentration in its effluent gas drops below 10 ppm. This check is optional for traps that most recently have been used to collect samples which were then recovered according to the procedure in section 11.1.3.

8.1.2 Sample Tank Evacuation and Leak-Check. Evacuate the sample tank to 10 mm Hg absolute pressure or less. Then close the sample tank valve, and allow the tank to sit for 60 minutes. The tank is acceptable if a change in tank vacuum of less than 1 mm Hg is noted. The evacuation and leak-check may be conducted either in the laboratory or the field.

8.1.3 Sampling Train Assembly. Just before assembly, measure the tank vacuum using a mercury manometer. Record this vacuum, the ambient temperature, and the barometric pressure at this time. Close the sample tank valve and assemble the sampling

system as shown in Figure 25–1. Immerse the condensate trap body in dry ice at least 30 minutes before commencing sampling to improve collection efficiency. The point where the inlet tube joins the trap body should be 2.5 to 5 cm (1 to 2 in.) above the top of the dry ice.

8.1.4 Pretest Leak-Check. A pretest leak-check is required. Calculate or measure the approximate volume of the sampling train from the probe tip to the sample tank valve. After assembling the sampling train, plug the probe tip, and make certain that the sample tank valve is closed. Turn on the vacuum pump, and evacuate the sampling system from the probe tip to the sample tank valve to an absolute pressure of 10 mm Hg or less. Close the purge valve, turn off the pump, wait a minimum period of 10 minutes, and recheck the indicated vacuum. Calculate the maximum allowable pressure change based on a leak rate of 1 percent of the sampling rate using Equation 25–1, section 12.2. If the measured pressure change exceeds the allowable, correct the problem and repeat the leak-check before beginning sampling.

8.2 Sample Collection.

8.2.1 Unplug the probe tip, and place the probe into the stack such that the probe is perpendicular to the duct or stack axis; locate the probe tip at a single preselected point of average velocity facing away from the direction of gas flow. For stacks having a negative static pressure, seal the sample port sufficiently to prevent air in-leakage around the probe. Set the probe temperature controller to 129 °C (265 °F) and the filter temperature controller to 121 °C (250 °F). Allow the probe and filter to heat for about 30 minutes before purging the sample train.

8.2.2 Close the sample valve, open the purge valve, and start the vacuum pump. Set the flow rate between 60 and 100 cm^3/min (0.13 and 0.21 ft^3/hr), and purge the train with stack gas for at least 10 minutes.

8.2.3 When the temperatures at the exit ends of the probe and filter are within the corresponding specified ranges, check the dry ice level around the condensate trap, and add dry ice if necessary. Record the clock time. To begin sampling, close the purge valve and stop the pump. Open the sample valve and the sample tank valve. Using the flow control valve, set the flow through the sample train to the proper rate. Adjust the flow rate as necessary to maintain a constant rate (±10 percent) throughout the duration of the sampling period. Record the sample tank vacuum and flowmeter setting at 5-minute intervals. (See Figure 25–8.) Select a total sample time greater than or equal to the minimum sampling time specified in the applicable subpart of the regulations; end the sampling when this time period is reached or when a constant flow rate can no longer be maintained because of reduced sample tank vacuum.

NOTE: If sampling had to be stopped before obtaining the minimum sampling time (specified in the applicable subpart) because a constant flow rate could not be maintained, proceed as follows: After closing the sample tank valve, remove the used sample tank from the sampling train (without disconnecting other portions of the sampling train). Take another evacuated and leak-checked sample tank, measure and record the tank vacuum, and attach the new tank to the sampling train. After the new tank is attached to the sample train, proceed with the sampling until the required minimum sampling time has been exceeded.

8.3 Sample Recovery. After sampling is completed, close the flow control valve, and record the final tank vacuum; then record the tank temperature and barometric pressure. Close the sample tank valve, and disconnect the sample tank from the sample system. Disconnect the condensate trap at the inlet to the rate meter, and tightly seal both ends of the condensate trap. Do not include the probe from the stack to the filter as part of the condensate sample.

8.4 Sample Storage and Transport. Keep the trap packed in dry ice until the samples are returned to the laboratory for analysis. Ensure that run numbers are identified on the condensate trap and the sample tank(s).

9.0 Quality Control

Section	Quality control measure	Effect
10.1.1	Initial performance check of condensate recovery apparatus.	Ensure acceptable condensate recovery efficiency.
10.1.2, 10.2	NMO analyzer initial and daily performance checks.	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial Performance Checks.

10.1.1 Condensate Recovery Apparatus. Perform these tests before the system is first placed in operation, after any shutdown of 6 months or more, and after any major modification of the system, or at the frequency recommended by the manufacturer.

10.1.1.1 Carrier Gas and Auxiliary O_2 Blank Check. Analyze each new tank of carrier gas or auxiliary O_2 with the NMO analyzer to

check for contamination. Treat the gas cylinders as noncondensible gas samples, and analyze according to the procedure in section 11.2.3. Add together any measured CH_4, CO, CO_2, or NMO. The total concentration must be less than 5 ppm.

10.1.1.2 Oxidation Catalyst Efficiency Check.

10.1.1.2.1 With a clean condensate trap installed in the recovery system or a ⅛″ stainless steel connector tube, replace the carrier gas cylinder with the high level methane standard gas cylinder (Section 7.4.1). Set the four-port valve to the recovery position, and attach an ICV to the recovery system. With the sample recovery valve in vent position and the flow-control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

10.1.1.2.2 After the NDIR response has stabilized, switch the sample recovery valve from vent to collect. When the manometer or pressure gauge begins to register a slight positive pressure, open the flow-control valve. Keep the flow adjusted such that the pressure in the system is maintained within 10 percent of atmospheric pressure. Continue collecting the sample in a normal manner until the ICV is filled to a nominal gauge pressure of 300 mm Hg. Close the ICV valve, and remove the ICV from the system. Place the sample recovery valve in the vent position, and return the recovery system to its normal carrier gas and normal operating conditions. Analyze the ICV for CO_2 using the NMO analyzer; the catalyst efficiency is acceptable if the CO_2 concentration is within 2 percent of the methane standard concentration.

10.1.1.3 System Performance Check. Construct a liquid sample injection unit similar in design to the unit shown in Figure 25–7. Insert this unit into the condensate recovery and conditioning system in place of a condensate trap, and set the carrier gas and auxiliary O_2 flow rates to normal operating levels. Attach an evacuated ICV to the system, and switch from system vent to collect. With the carrier gas routed through the injection unit and the oxidation catalyst, inject a liquid sample (see sections 10.1.1.3.1 to 10.1.1.3.4) into the injection port. Operate the trap recovery system as described in section 11.1.3. Measure the final ICV pressure, and then analyze the vessel to determine the CO_2 concentration. For each injection, calculate the percent recovery according to section 12.7. Calculate the relative standard deviation for each set of triplicate injections according to section 12.8. The performance test is acceptable if the average percent recovery is 100 ±5 percent and the relative standard deviation is less than 2 percent for each set of triplicate injections.

10.1.1.3.1 50 μl hexane.

10.1.1.3.2 10 μl hexane.

10.1.1.3.3 50 μl decane.

10.1.1.3.4 10 μl decane.

10.1.2 NMO Analyzer. Perform these tests before the system is first placed in operation, after any shutdown longer than 6 months, and after any major modification of the system.

10.1.2.1 Oxidation Catalyst Efficiency Check. Turn off or bypass the NMO analyzer reduction catalyst. Make triplicate injections of the high level methane standard (Section 7.4.1). The oxidation catalyst operation is acceptable if the FID response is less than 1 percent of the injected methane concentration.

10.1.2.2 Reduction Catalyst Efficiency Check. With the oxidation catalyst unheated or bypassed and the heated reduction catalyst bypassed, make triplicate injections of the high level methane standard (Section 7.4.1). Repeat this procedure with both catalysts operative. The reduction catalyst operation is acceptable if the responses under both conditions agree within 5 percent of their average.

10.1.2.3 NMO Analyzer Linearity Check Calibration. While operating both the oxidation and reduction catalysts, conduct a linearity check of the analyzer using the propane standards specified in section 7.4.2. Make triplicate injections of each calibration gas. For each gas (*i.e.*, each set of triplicate injections), calculate the average response factor (area/ppm C) for each gas, as well as and the relative standard deviation (according to section 12.8). Then calculate the overall mean of the response factor values. The instrument linearity is acceptable if the average response factor of each calibration gas is within 2.5 percent of the overall mean value and if the relative standard deviation gas is less than 2 percent of the overall mean value. Record the overall mean of the propane response factor values as the NMO calibration response factor (RF_{NMO}). Repeat the linearity check using the CO_2 standards specified in section 7.4.3. Make triplicate injections of each gas, and then calculate the average response factor (area/ppm C) for each gas, as well as the overall mean of the response factor values. Record the overall mean of the response factor values as the CO_2 calibration response factor (RF_{CO2}). The RF_{CO2} must be within 10 percent of the RF_{NMO}.

10.1.2.4 System Performance Check. Check the column separation and overall performance of the analyzer by making triplicate injections of the calibration gases listed in section 7.4.4. The analyzer performance is acceptable if the measured NMO value for each gas (average of triplicate injections) is within 5 percent of the expected value.

10.2 NMO Analyzer Daily Calibration. The following calibration procedures shall be performed before and immediately after the

analysis of each set of samples, or on a daily basis, whichever is more stringent:

10.2.1 CO_2 Response Factor. Inject triplicate samples of the high level CO_2 calibration gas (Section 7.4.3), and calculate the average response factor. The system operation is adequate if the calculated response factor is within 5 percent of the RF_{CO2} calculated during the initial performance test (Section 10.1.2.3). Use the daily response factor (DRF_{CO2}) for analyzer calibration and the calculation of measured CO_2 concentrations in the ICV samples.

10.2.2 NMO Response Factors. Inject triplicate samples of the mixed propane calibration cylinder gas (Section 7.4.4.1), and calculate the average NMO response factor. The system operation is adequate if the calculated response factor is within 10 percent of the RF_{NMO} calculated during the initial performance test (Section 10.1.2.4). Use the daily response factor (DRF_{NMO}) for analyzer calibration and calculation of NMO concentrations in the sample tanks.

10.3 Sample Tank and ICV Volume. The volume of the gas sampling tanks used must be determined. Determine the tank and ICV volumes by weighing them empty and then filled with deionized distilled water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedure

11.1 Condensate Recovery. See Figure 25–9. Set the carrier gas flow rate, and heat the catalyst to its operating temperature to condition the apparatus.

11.1.1 Daily Performance Checks. Each day before analyzing any samples, perform the following tests:

11.1.1.1 Leak-Check. With the carrier gas inlets and the sample recovery valve closed, install a clean condensate trap in the system, and evacuate the system to 10 mm Hg absolute pressure or less. Monitor the system pressure for 10 minutes. The system is acceptable if the pressure change is less than 2 mm Hg.

11.1.1.2 System Background Test. Adjust the carrier gas and auxiliary oxygen flow rate to their normal values of 100 cc/min and 150 cc/min, respectively, with the sample recovery valve in vent position. Using a 10-ml syringe, withdraw a sample from the system effluent through the syringe port. Inject this sample into the NMO analyzer, and measure the CO_2 content. The system background is acceptable if the CO_2 concentration is less than 10 ppm.

11.1.1.3 Oxidation Catalyst Efficiency Check. Conduct a catalyst efficiency test as specified in section 10.1.1.2. If the criterion of this test cannot be met, make the necessary repairs to the system before proceeding.

11.1.2 Condensate Trap CO_2 Purge and Sample Tank Pressurization.

11.1.2.1 After sampling is completed, the condensate trap will contain condensed water and organics and a small volume of sampled gas. This gas from the stack may contain a significant amount of CO_2 which must be removed from the condensate trap before the sample is recovered. This is accomplished by purging the condensate trap with zero air and collecting the purged gas in the original sample tank.

11.1.2.2 Begin with the sample tank and condensate trap from the test run to be analyzed. Set the four-port valve of the condensate recovery system in the CO_2 purge position as shown in Figure 25–9. With the sample tank valve closed, attach the sample tank to the sample recovery system. With the sample recovery valve in the vent position and the flow control valve fully open, evacuate the manometer or pressure gauge to the vacuum of the sample tank. Next, close the vacuum pump valve, open the sample tank valve, and record the tank pressure.

11.1.2.3 Attach the dry ice-cooled condensate trap to the recovery system, and initiate the purge by switching the sample recovery valve from vent to collect position. Adjust the flow control valve to maintain atmospheric pressure in the recovery system. Continue the purge until the CO_2 concentration of the trap effluent is less than 5 ppm. CO_2 concentration in the trap effluent should be measured by extracting syringe samples from the recovery system and analyzing the samples with the NMO analyzer. This procedure should be used only after the NDIR response has reached a minimum level. Using a 10-ml syringe, extract a sample from the syringe port prior to the NDIR, and inject this sample into the NMO analyzer.

11.1.2.4 After the completion of the CO_2 purge, use the carrier gas bypass valve to pressurize the sample tank to approximately 1,060 mm Hg absolute pressure with zero air.

11.1.3 Recovery of the Condensate Trap Sample (See Figure 25–10).

11.1.3.1 Attach the ICV to the sample recovery system. With the sample recovery valve in a closed position, between vent and collect, and the flow control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

11.1.3.2 Begin auxiliary oxygen flow to the oxidation catalyst at a rate of 150 cc/min, then switch the four-way valve to the trap recovery position and the sample recovery valve to collect position. The system should now be set up to operate as indicated in Figure 25–10. After the manometer or pressure gauge begins to register a slight positive pressure, open the flow control valve. Adjust the flow-control valve to maintain atmospheric pressure in the system within 10 percent.

11.1.3.3 Remove the condensate trap from the dry ice, and allow it to warm to ambient temperature while monitoring the NDIR response. If, after 5 minutes, the CO_2 concentration of the catalyst effluent is below 10,000 ppm, discontinue the auxiliary oxygen flow to the oxidation catalyst. Begin heating the trap by placing it in a furnace preheated to 200 °C (390 °F). Once heating has begun, carefully monitor the NDIR response to ensure that the catalyst effluent concentration does not exceed 50,000 ppm. Whenever the CO_2 concentration exceeds 50,000 ppm, supply auxiliary oxygen to the catalyst at the rate of 150 cc/min. Begin heating the tubing that connected the heated sample box to the condensate trap only after the CO_2 concentration falls below 10,000 ppm. This tubing may be heated in the same oven as the condensate trap or with an auxiliary heat source such as a heat gun. Heating temperature must not exceed 200 °C (390 °F). If a heat gun is used, heat the tubing slowly along its entire length from the upstream end to the downstream end, and repeat the pattern for a total of three times. Continue the recovery until the CO_2 concentration drops to less than 10 ppm as determined by syringe injection as described under the condensate trap CO_2 purge procedure (Section 11.1.2).

11.1.3.4 After the sample recovery is completed, use the carrier gas bypass valve to pressurize the ICV to approximately 1060 mm Hg absolute pressure with zero air.

11.2 Analysis. Once the initial performance test of the NMO analyzer has been successfully completed (see section 10.1.2) and the daily CO_2 and NMO response factors have been determined (see section 10.2), proceed with sample analysis as follows:

11.2.1 Operating Conditions. The carrier gas flow rate is 29.5 cc/min He and 2.2 cc/min O_2. The column oven is heated to 85 °C (185 °F). The order of elution for the sample from the column is CO, CH_4, CO_2, and NMO.

11.2.2 Analysis of Recovered Condensate Sample. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (380 °F) as rapidly as possible. A rate of 30 °C/min (90 °F) has been shown to be adequate. Record the value obtained for the condensible organic material (C_{cm}) measured as CO_2 and any measured NMO. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average C_{cm}.

11.2.3 Analysis of Sample Tank. Perform the analysis as described in section 11.2.2, but record only the value measured for NMO (C_{tm}).

12.0 Data Analysis and Calculations

Carry out the calculations, retaining at least one extra significant figure beyond that of the acquired data. Round off figures after final calculations. All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature.

C = TGNMO concentration of the effluent, ppm C equivalent.
C_c = Calculated condensible organic (condensate trap) concentration of the effluent, ppm C equivalent.
C_{cm} = Measured concentration (NMO analyzer) for the condensate trap ICV, ppm CO_2.
C_t = Calculated noncondensible organic concentration (sample tank) of the effluent, ppm C equivalent.
C_{tm} = Measured concentration (NMO analyzer) for the sample tank, ppm NMO.
F = Sampling flow rate, cc/min.
L = Volume of liquid injected, µl.
M = Molecular weight of the liquid injected, g/g-mole.
M_c = TGNMO mass concentration of the effluent, mg C/dsm^3.
N = Carbon number of the liquid compound injected (N = 12 for decane, N = 6 for hexane).
n = Number of data points.
P_f = Final pressure of the intermediate collection vessel, mm Hg absolute.
P_b = Barometric pressure, cm Hg.
P_{ti} = Gas sample tank pressure before sampling, mm Hg absolute.
P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.
P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.
q = Total number of analyzer injections of intermediate collection vessel during analysis (where k = injection number, 1 * * * q).
r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 * * * r).
r = Density of liquid injected, g/cc.
T_f = Final temperature of intermediate collection vessel, °K.
T_{ti} = Sample tank temperature before sampling, °K.
T_t = Sample tank temperature at completion of sampling, °K.
T_{tf} = Sample tank temperature after pressurizing, °K.
V = Sample tank volume, m^3.
V_t = Sample train volume, cc.
V_v = Intermediate collection vessel volume, m^3.
V_s = Gas volume sampled, dsm^3.
x_i = Individual measurements.
$\bar{x}$ = Mean value.

ΔP = Allowable pressure change, cm Hg.
Θ = Leak-check period, min.

12.2 Allowable Pressure Change. For the pretest leak-check, calculate the allowable pressure change using Equation 25–1:

$$\Delta P = 0.01\,\frac{F P_b \Theta}{V_t} \qquad \text{Eq. 25-1}$$

12.3 Sample Volume. For each test run, calculate the gas volume sampled using Equation 25–2:

$$V_s = 0.3857\,V\left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}\right) \qquad \text{Eq. 25-2}$$

12.4 Noncondensible Organics. For each sample tank, determine the concentration of nonmethane organics (ppm C) using Equation 25–3:

$$C_t = \left(\frac{\dfrac{P_{tf}}{T_{tf}}}{\dfrac{P_t}{T_t} - \dfrac{P_{ti}}{T_{ti}}}\right)\left(\frac{1}{r}\sum_{j=1}^{r} C_{tm_j}\right) \qquad \text{Eq. 25-3}$$

12.5 Condensible Organics. For each condensate trap determine the concentration of organics (ppm C) using Equation 25–4:

$$C_c = 0.3857\,\frac{V_v P_f}{V_s T_f}\left(\frac{1}{q}\sum_{k=1}^{q} C_{cm_k}\right) \qquad \text{Eq. 25-4}$$

12.6 TGNMO Mass Concentration. Determine the TGNMO mass concentration as carbon for each test run, using Equation 25–5:

$$M_c = 0.4993\,(C_t + C_c) \qquad \text{Eq. 25-5}$$

12.7 Percent Recovery. Calculate the percent recovery for the liquid injections to the condensate recovery and conditioning system using Equation 25–6:

$$\text{Percent Recovery} = K\,\frac{M\,V_v P_t C_{cm}}{L\,P\,T_f N} \qquad \text{Eq. 25-6}$$

where K = 1.604 (°K)(g-mole)(%)/(mm Hg)(ml)(m^3)(ppm).

12.8 Relative Standard Deviation. Use Equation 25–7 to calculate the relative standard deviation (RSD) of percent recovery and analyzer linearity.

$$RSD = \frac{100}{\bar{x}}\left[\frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}{n-1}\right]^{\frac{1}{2}} \qquad \text{Eq. 25-7}$$

13.0 Method Performance

13.1 Range. The minimum detectable limit of the method has been determined to be 50 parts per million by volume (ppm). No upper limit has been established.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, A.E., S. Witz, and R.D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, MA. June 15–20, 1975.) 14 p.

2. Salo, A.E., W.L. Oaks, and R.D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, CO. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

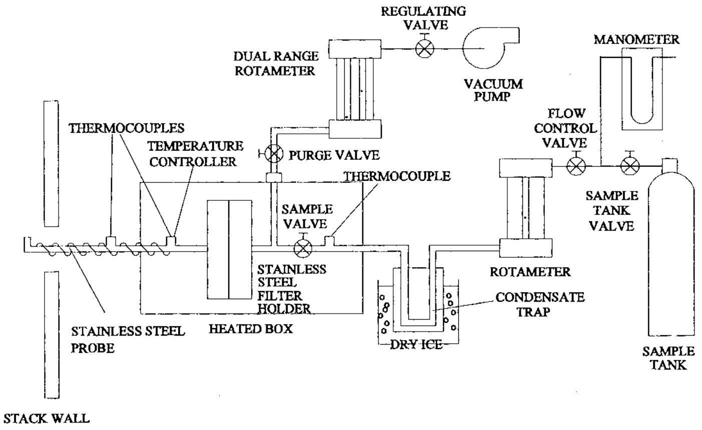


Figure 25-1. Sampling Train

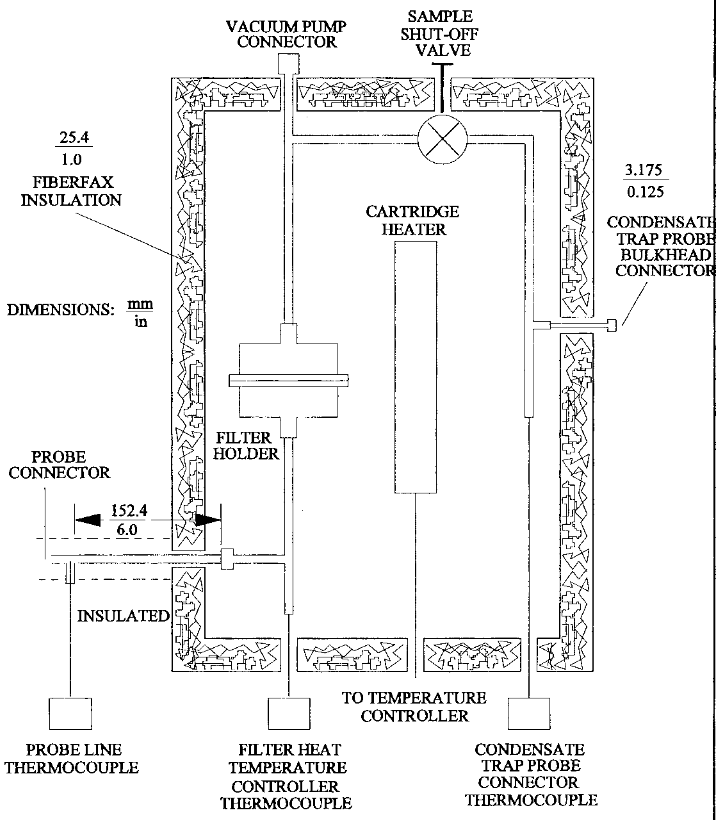


Figure 25-2. Out-of-stack Filter Box

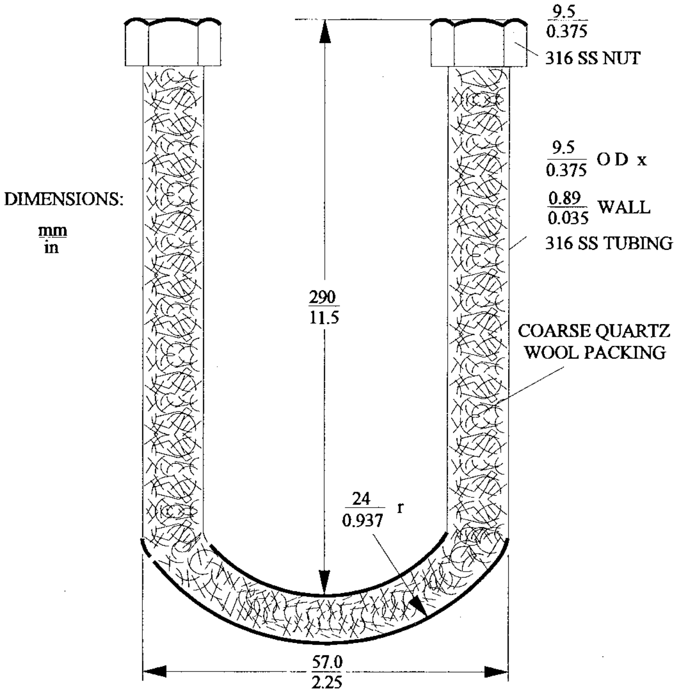


Figure 25-3. Condensate Trap

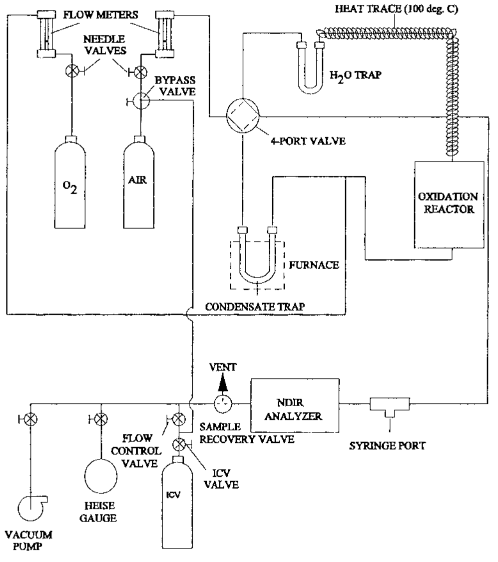


Figure 25-4. Condensate Recovery System

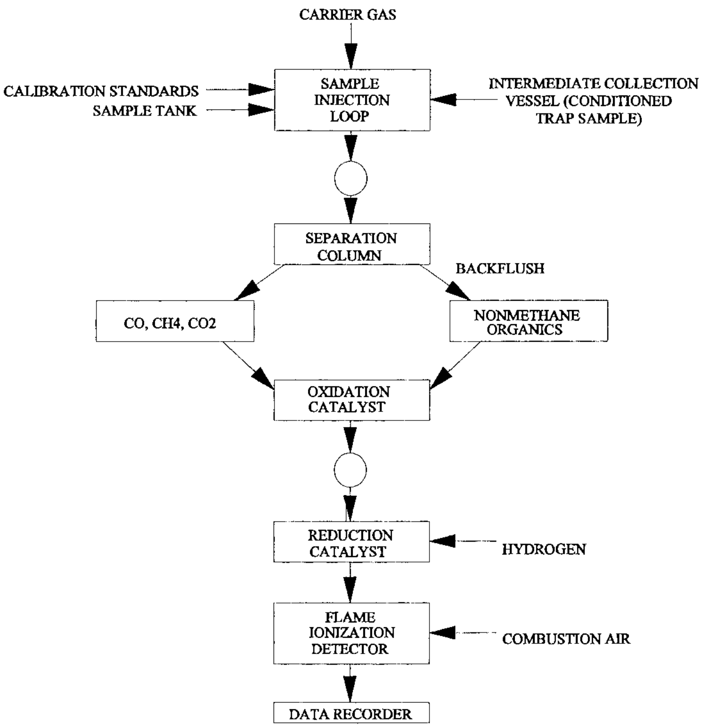


Figure 25-5. Simplified Schematic of Nonmethane Organic (NMO) Analyzer

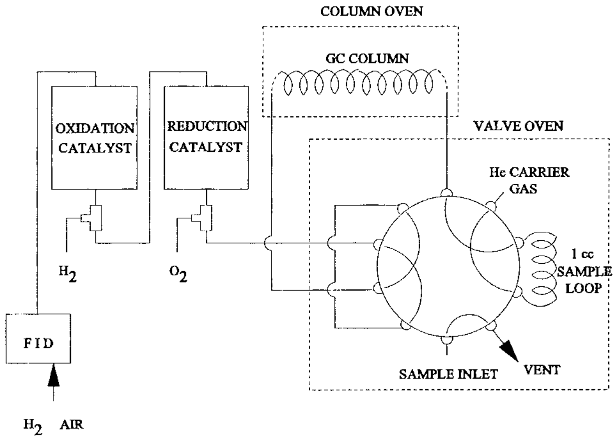


Figure 25-6. Nonmethane Organic Analyzer (NMO)

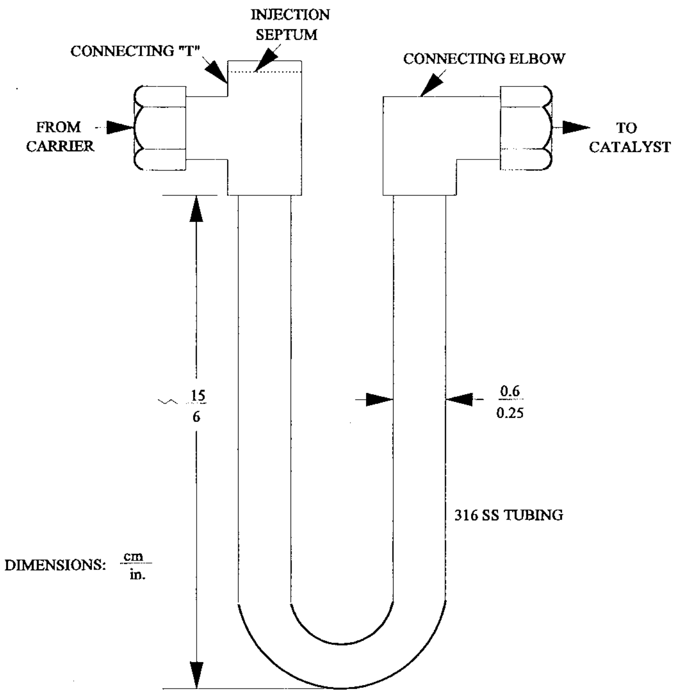
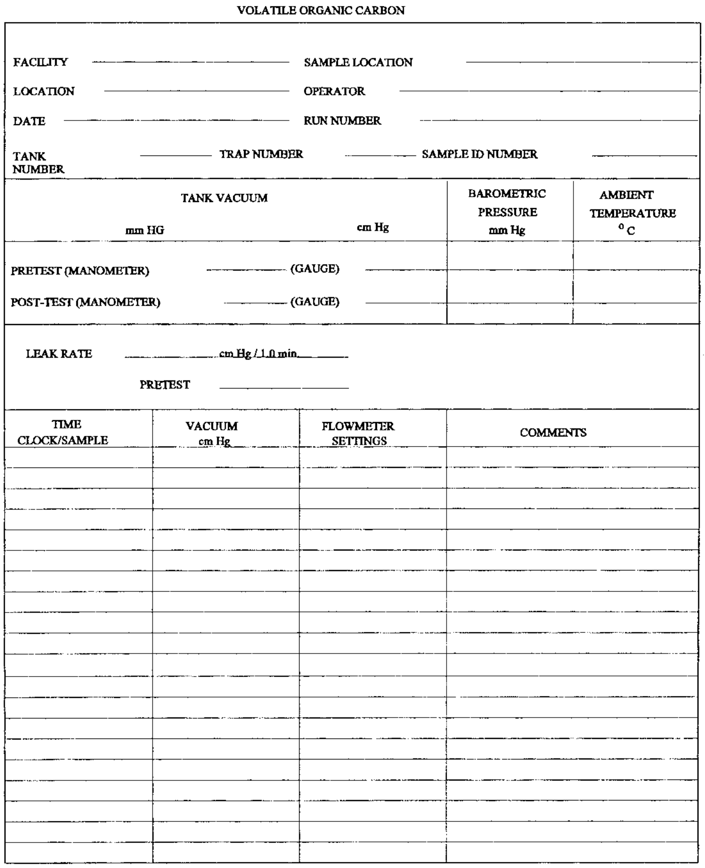


Figure 25-7. Liquid Sample Injection Unit



VOLATILE ORGANIC CARBON

FACILITY ____ SAMPLE LOCATION ____

LOCATION ____ OPERATOR ____

DATE ____ RUN NUMBER ____

TANK NUMBER ____ TRAP NUMBER ____ SAMPLE ID NUMBER ____

TANK VACUUM				BAROMETRIC PRESSURE mm Hg	AMBIENT TEMPERATURE °C
mm HG		cm Hg			
PRETEST (MANOMETER)	____	(GAUGE)	____		
POST-TEST (MANOMETER)	____	(GAUGE)	____		

LEAK RATE ____ cm Hg / 1.0 min ____

PRETEST ____

TIME CLOCK/SAMPLE	VACUUM cm Hg	FLOWMETER SETTINGS	COMMENTS

Figure 25-8. Example Field Data Form

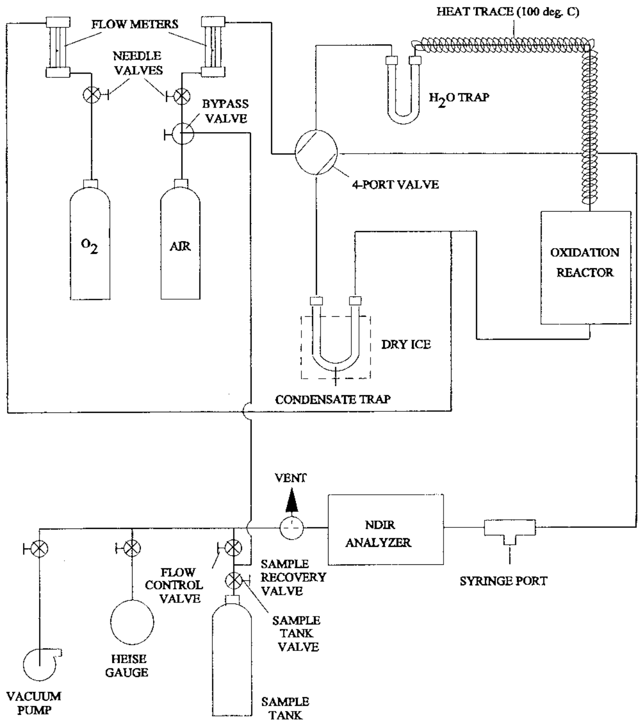


Figure 25-9. Condensate Recovery System, CO2 Purge

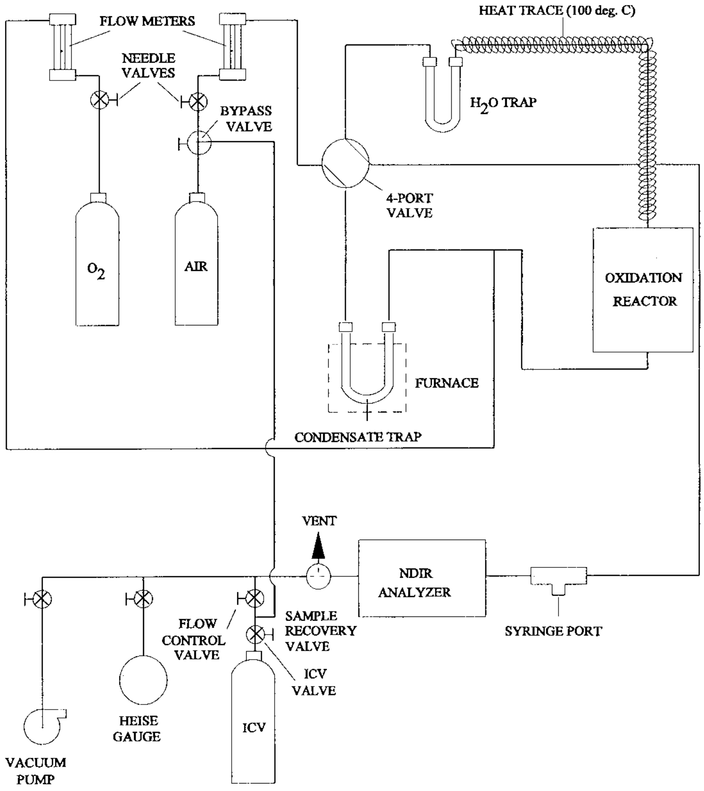


Figure 25-10. Condensate Recovery System, Collection of Trap Organics

METHOD 25A—DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A FLAME IONIZATION ANALYZER

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A gas sample is extracted from the source through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

3.1 *Calibration drift* means the difference in the measurement system response to a midlevel calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

3.2 *Calibration error* means the difference between the gas concentration indicated by the measurement system and the know concentration of the calibration gas.

3.3 *Calibration gas* means a known concentration of a gas in an appropriate diluent gas.

3.4 *Measurement system* means the total equipment required for the determination of the gas concentration. The system consists of the following major subsystems:

3.4.1 *Sample interface* means that portion of a system used for one or more of the following: sample acquisition, sample transportation, sample conditioning, or protection of the analyzer(s) from the effects of the stack effluent.

3.4.2 *Organic analyzer* means that portion of the measurement system that senses the gas to be measured and generates an output proportional to its concentration.

3.5 *Response time* means the time interval from a step change in pollutant concentration at the inlet to the emission measurement system to the time at which 95 percent of the corresponding final value is reached as displayed on the recorder.

3.6 *Span Value* means the upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the applicable emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected concentration. For convenience, the span value should correspond to 100 percent of the recorder scale.

3.7 *Zero drift* means the difference in the measurement system response to a zero level calibration gas before or after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

6.1 Measurement System. Any measurement system for total organic concentration that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 25A–1. All sampling components leading to the analyzer shall be heated ≥110 °C (220 °F) throughout the sampling period, unless safety reasons are cited (Section 5.2) The essential components of the measurement system are described below:

6.1.1 Organic Concentration Analyzer. A flame ionization analyzer (FIA) capable of meeting or exceeding the specifications of this method. The flame ionization detector block shall be heated >120 °C (250 °F).

6.1.2 Sample Probe. Stainless steel, or equivalent, three-hole rake type. Sample holes shall be 4 mm (0.16-in.) in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

6.1.3 Heated Sample Line. Stainless steel or Teflon'' tubing to transport the sample gas

to the analyzer. The sample line should be heated (≥110 °C) to prevent any condensation.

6.1.4 Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are applicable.

6.1.5 Particulate Filter. An in-stack or an out-of-stack glass fiber filter is recommended if exhaust gas particulate loading is significant. An out-of-stack filter should be heated to prevent any condensation.

6.1.6 Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

7.0 Reagents and Standards

7.1 Calibration Gases. The calibration gases for the gas analyzer shall be propane in air or propane in nitrogen. Alternatively, organic compounds other than propane can be used; the appropriate corrections for response factor must be made. Calibration gases shall be prepared in accordance with the procedure listed in Citation 2 of section 16. Additionally, the manufacturer of the cylinder should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change more than ±2 percent from the certified value. For calibration gas values not generally available (*i.e.*, organics between 1 and 10 percent by volume), alternative methods for preparing calibration gas mixtures, such as dilution systems (Test Method 205, 40 CFR Part 51, Appendix M), may be used with prior approval of the Administrator.

7.1.1 Fuel. A 40 percent H_2/60 percent N_2 gas mixture is recommended to avoid an oxygen synergism effect that reportedly occurs when oxygen concentration varies significantly from a mean value.

7.1.2 Zero Gas. High purity air with less than 0.1 part per million by volume (ppmv) of organic material (propane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

7.1.3 Low-level Calibration Gas. An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value.

7.1.4 Mid-level Calibration Gas. An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value.

7.1.5 High-level Calibration Gas. An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Selection of Sampling Site. The location of the sampling site is generally specified by the applicable regulation or purpose of the test (*i.e.*, exhaust stack, inlet line, etc.). The sample port shall be located to meet the testing requirements of Method 1.

8.2 Location of Sample Probe. Install the sample probe so that the probe is centrally located in the stack, pipe, or duct and is sealed tightly at the stack port connection.

8.3 Measurement System Preparation. Prior to the emission test, assemble the measurement system by following the manufacturer's written instructions for preparing sample interface and the organic analyzer. Make the system operable (Section 10.1).

8.4 Calibration Error Test. Immediately prior to the test series (within 2 hours of the start of the test), introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then introduce low-level and mid-level calibration gases successively to the measurement system. Record the analyzer responses for low-level and mid-level calibration gases and determine the differences between the measurement system responses and the predicted responses. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and must be replaced or repaired prior to testing. No adjustments to the measurement system shall be conducted after the calibration and before the drift check (Section 8.6.2). If adjustments are necessary before the completion of the test series, perform the drift checks prior to the required adjustments and repeat the calibration following the adjustments. If multiple electronic ranges are to be used, each additional range must be checked with a mid-level calibration gas to verify the multiplication factor.

8.5 Response Time Test. Introduce zero gas into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. Record the time from the concentration change to the measurement system response equivalent to 95 percent of the step change. Repeat the test three times and average the results.

8.6 Emission Measurement Test Procedure.

8.6.1 Organic Measurement. Begin sampling at the start of the test period, recording time and any required process information as appropriate. In particulate, note on the recording chart, periods of process interruption or cyclic operation.

8.6.2 Drift Determination. Immediately following the completion of the test period and hourly during the test period, reintroduce the zero and mid-level calibration gases, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until both the zero and calibration drift checks are made.) Record the analyzer response. If the drift values exceed the specified limits, invalidate the test results preceding the check and repeat the test following corrections to the measurement system. Alternatively, recalibrate the test measurement system as in section 8.4 and report the results using both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

NOTE: Note on the recording chart periods of process interruption or cyclic operation.

9.0 Quality Control

Method section	Quality control measure	Effect
8.4	Zero and calibration drift tests	Ensures that bias introduced by drift in the measurement system output during the run is no greater than 3 percent of span.

10.0 Calibration and Standardization

10.1 FIA equipment can be calibrated for almost any range of total organic concentrations. For high concentrations of organics (>1.0 percent by volume as propane), modifications to most commonly available analyzers are necessary. One accepted method of equipment modification is to decrease the size of the sample to the analyzer through the use of a smaller diameter sample capillary. Direct and continuous measurement of organic concentration is a necessary consideration when determining any modification design.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

12.1 Determine the average organic concentration in terms of ppmv as propane or other calibration gas. The average shall be determined by integration of the output recording over the period specified in the applicable regulation. If results are required in terms of ppmv as carbon, adjust measured concentrations using Equation 25A–1.

$$C_c = K\,C_{meas} \qquad \text{Eq. 25A-1}$$

Where:

C_c = Organic concentration as carbon, ppmv.
C_{meas} = Organic concentration as measured, ppmv.
K = Carbon equivalent correction factor.
= 2 for ethane.
= 3 for propane.
= 4 for butane.
= Appropriate response factor for other organic calibration gases.

13.0 Method Performance

13.1 Measurement System Performance Specifications.

13.1.1 Zero Drift. Less than ±3 percent of the span value.

13.1.2 Calibration Drift. Less than ±3 percent of span value.

13.1.3 Calibration Error. Less than ±5 percent of the calibration gas value.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Measurement of Volatile Organic Compounds—Guideline Series. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA–450/2–78–041. June 1978. p. 46–54.

2. EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards. U.S. Environmental Protection Agency, Quality Assurance and Technical Support Division. Research Triangle Park, N.C. September 1993.

3. Gasoline Vapor Emission Laboratory Evaluation—Part 2. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. EMB Report No. 75–GAS–6. August 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

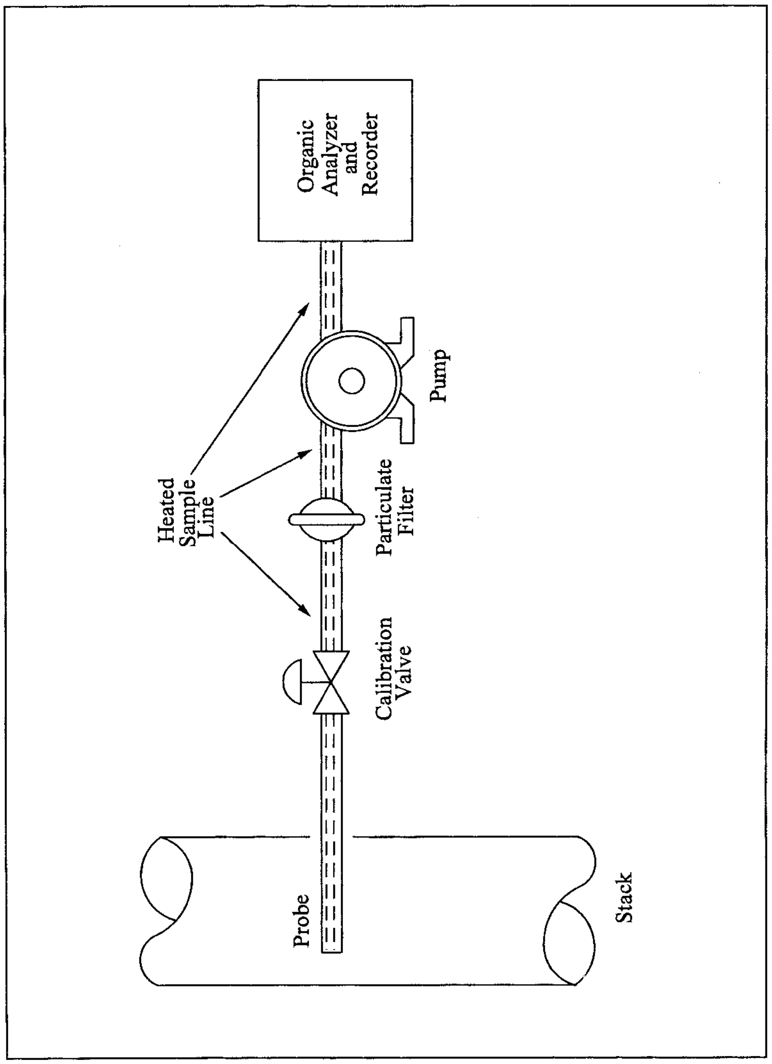


Figure 25A-1. Organic Concentration Measurement System.

METHOD 25B—DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A NONDISPERSIVE INFRARED ANALYZER

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 1, Method 6C, and Method 25A.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes. Other organic materials may be measured using the general procedure in this method, the appropriate calibration gas, and an analyzer set to the appropriate absorption band.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a nondispersive infrared analyzer (NDIR). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

Same as Method 25A, section 3.0.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

Same as Method 25A, section 6.0, with the exception of the following:

6.1 Organic Concentration Analyzer. A nondispersive infrared analyzer designed to measure alkane organics and capable of meeting or exceeding the specifications in this method.

7.0 Reagents and Standards

Same as Method 25A, section 7.1. No fuel gas is required for an NDIR.

8.0 Sample Collection, Preservation, Storage, and Transport

Same as Method 25A, section 8.0.

9.0 Quality Control

Same as Method 25A, section 9.0.

10.0 Calibration and Standardization

Same as Method 25A, section 10.0.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

Same as Method 25A, section 12.0.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as Method 25A, section 16.0.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25C—DETERMINATION OF NONMETHANE ORGANIC COMPOUNDS (NMOC) IN LANDFILL GASES

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling and analytical) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should also have a thorough knowledge of EPA Method 25.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Nonmethane organic compounds (NMOC).	No CAS number assigned.

1.2 Applicability. This method is applicable to the sampling and measurement of NMOC as carbon in landfill gases (LFG).

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A sample probe that has been perforated at one end is driven or augured to a depth of 0.9 m (3 ft) below the bottom of the landfill cover. A sample of the landfill gas is extracted with an evacuated cylinder. The NMOC content of the gas is determined by

injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4); the NMOC are oxidized to CO_2, reduced to CH_4, and measured by a flame ionization detector (FID). In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Since this method is complex, only experienced personnel should perform this test. LFG contains methane, therefore explosive mixtures may exist on or near the landfill. It is advisable to take appropriate safety precautions when testing landfills, such as refraining from smoking and installing explosion-proof equipment.

6.0 Equipment and Supplies

6.1 Sample Probe. Stainless steel, with the bottom third perforated. Teflon probe liners and sampling lines are also allowed. Non-perforated probes are allowed as long as they are withdrawn to create a gap equivalent to having the bottom third perforated. The sample probe must be capped at the bottom and must have a threaded cap with a sampling attachment at the top. The sample probe must be long enough to go through and extend no less than 0.9 m (3 ft) below the landfill cover. If the sample probe is to be driven into the landfill, the bottom cap should be designed to facilitate driving the probe into the landfill.

6.2 Sampling Train.

6.2.1 Rotameter with Flow Control Valve. Capable of measuring a sample flow rate of 100 ±10 ml/min. The control valve must be made of stainless steel.

6.2.2 Sampling Valve. Stainless steel.

6.2.3 Pressure Gauge. U-tube mercury manometer, or equivalent, capable of measuring pressure to within 1 mm Hg (0.5 in H_2O) in the range of 0 to 1,100 mm Hg (0 to 590 in H_2O).

6.2.4 Sample Tank. Stainless steel or aluminum cylinder, equipped with a stainless steel sample tank valve.

6.3 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg (5.4 in H_2O).

6.4 Purging Pump. Portable, explosion proof, and suitable for sampling NMOC.

6.5 Pilot Probe Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.1.

6.5.1 Pilot Probe. Tubing of sufficient strength to withstand being driven into the landfill by a post driver and an outside diameter of at least 6 mm (0.25 in.) smaller than the sample probe. The pilot probe shall be capped on both ends and long enough to go through the landfill cover and extend no less than 0.9 m (3 ft) into the landfill.

6.5.2 Post Driver and Compressor. Capable of driving the pilot probe and the sampling probe into the landfill. The Kitty Hawk portable post driver has been found to be acceptable.

6.6 Auger Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.2.

6.6.1 Auger. Capable of drilling through the landfill cover and to a depth of no less than 0.9 m (3 ft) into the landfill.

6.6.2 Pea Gravel.

6.6.3 Bentonite.

6.7 NMOC Analyzer, Barometer, Thermometer, and Syringes. Same as in sections 6.3.1, 6.3.2, 6.33, and 6.2.10, respectively, of Method 25.

7.0 Reagents and Standards

7.1 NMOC Analysis. Same as in Method 25, section 7.2.

7.2 Calibration. Same as in Method 25, section 7.4, except omit section 7.4.3.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sample Tank Evacuation and Leak-Check. Conduct the sample tank evacuation and leak-check either in the laboratory or the field. Connect the pressure gauge and sampling valve to the sample tank. Evacuate the sample tank to 10 mm Hg (5.4 in H_2O) absolute pressure or less. Close the sampling valve, and allow the tank to sit for 30 minutes. The tank is acceptable if no change more than ±2 mm is noted. Include the results of the leak-check in the test report.

8.2 Sample Probe Installation. The tester may use the procedure in section 8.2.1 or 8.2.2.

8.2.1 Pilot Probe Procedure. Use the post driver to drive the pilot probe at least 0.9 m (3 ft) below the landfill cover. Alternative procedures to drive the probe into the landfill may be used subject to the approval of the Administrator's designated representative.

8.2.1.1 Remove the pilot probe and drive the sample probe into the hole left by the pilot probe. The sample probe shall extend at least 0.9 m (3 ft) below the landfill cover and shall protrude about 0.3 m (1 ft) above the landfill cover. Seal around the sampling probe with bentonite and cap the sampling probe with the sampling probe cap.

8.2.2 Auger Procedure. Use an auger to drill a hole to at least 0.9 m (3 ft) below the landfill cover. Place the sample probe in the hole and backfill with pea gravel to a level 0.6 m (2 ft) from the surface. The sample probe shall protrude at least 0.3 m (1 ft) above the landfill cover. Seal the remaining area around the probe with bentonite. Allow 24

hours for the landfill gases to equilibrate inside the augured probe before sampling.

8.2.3 Driven Probes. Closed-point probes may be driven directly into the landfill in a single step. This method may not require backfilling if the probe is adequately sealed by its insertion. Unperforated probes that are inserted in this manner and withdrawn at a distance from a detachable tip to create an open space are also acceptable.

8.3 Sample Train Assembly. Just before assembling the sample train, measure the sample tank vacuum using the pressure gauge. Record the vacuum, the ambient temperature, and the barometric pressure at this time. Assemble the sampling probe purging system as shown in Figure 25C–1.

8.4 Sampling Procedure. Open the sampling valve and use the purge pump and the flow control valve to evacuate at least two sample probe volumes from the system at a flow rate of 500 ml/min or less. Close the sampling valve and replace the purge pump with the sample tank apparatus as shown in Figure 25C–2. Open the sampling valve and the sample tank valve and, using the flow control valve, sample at a flow rate of 500 ml/min or less until either a constant flow rate can no longer be maintained because of reduced sample tank vacuum or the appropriate composite volume is attained. Disconnect the sampling tank apparatus and pressurize the sample cylinder to approximately 1,060 mm Hg (567 in. H_2O) absolute pressure with helium, and record the final pressure. Alternatively, the sample tank may be pressurized in the lab.

8.4.1 The following restrictions apply to compositing samples from different probe sites into a single cylinder: (1) Individual composite samples per cylinder must be of equal volume; this must be verified by recording the flow rate, sampling time, vacuum readings, or other appropriate volume measuring data, (2) individual composite samples must have a minimum volume of 1 liter unless data is provided showing smaller volumes can be accurately measured, and (3) composite samples must not be collected using the final cylinder vacuum as it diminishes to ambient pressure.

8.4.2 Use Method 3C to determine the percent N_2 in each cylinder. The presence of N_2 indicates either infiltration of ambient air into the landfill gas sample or an inappropriate testing site has been chosen where anaerobic decomposition has not begun. The landfill gas sample is acceptable if the concentration of N_2 is less than 20 percent. Alternatively, Method 3C may be used to determine the oxygen content of each cylinder as an air infiltration test. With this option, the oxygen content of each cylinder must be less than 5 percent.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
8.4.2	Verify that landfill gas sample contains less than 20 percent N_2 or 5 percent O_2.	Ensures that ambient air was not drawn into the landfill gas sample and gas was sampled from an appropriate location.
10.1, 10.2	NMOC analyzer initial and daily performance checks.	Ensures precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial NMOC Analyzer Performance Test. Same as in Method 25, section 10.1, except omit the linearity checks for CO_2 standards.

10.2 NMOC Analyzer Daily Calibration.

10.2.1 NMOC Response Factors. Same as in Method 25, section 10.2.2.

10.3 Sample Tank Volume. The volume of the gas sampling tanks must be determined. Determine the tank volumes by weighing them empty and then filled with deionized water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedures

11.1 The oxidation, reduction, and measurement of NMOC's is similar to Method 25. Before putting the NMOC analyzer into routine operation, conduct an initial performance test. Start the analyzer, and perform all the necessary functions in order to put the analyzer into proper working order. Conduct the performance test according to the procedures established in section 10.1. Once the performance test has been successfully completed and the NMOC calibration response factor has been determined, proceed with sample analysis as follows:

11.1.1 Daily Operations and Calibration Checks. Before and immediately after the analysis of each set of samples or on a daily basis (whichever occurs first), conduct a calibration test according to the procedures established in section 10.2. If the criteria of the daily calibration test cannot be met, repeat

the NMOC analyzer performance test (Section 10.1) before proceeding.

11.1.2 Operating Conditions. Same as in Method 25, section 11.2.1.

11.1.3 Analysis of Sample Tank. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (383 °F) as rapidly as possible. A rate of 30 °C/min (54 °F/min) has been shown to be adequate. Record the value obtained for any measured NMOC. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average as C_{tm}.

12.0 Data Analysis and Calculations

NOTE: All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature

B_w = Moisture content in the sample, fraction.

C_{N2} = N_2 concentration in the diluted sample gas.

C_{mN2} = Measured N_2 concentration, fraction in landfill gas.

C_{mOx} = Measured Oxygen concentration, fraction in landfill gas.

C_{Ox} = Oxygen concentration in the diluted sample gas.

C_t = Calculated NMOC concentration, ppmv C equivalent.

C_{tm} = Measured NMOC concentration, ppmv C equivalent.

P_b = Barometric pressure, mm Hg.

P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.

P_{ti} = Gas sample tank pressure after evacuation, mm Hg absolute.

P_w = Vapor pressure of H_2O (from Table 25C–1), mm Hg.

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 . . . r).

T_t = Sample tank temperature at completion of sampling, °K.

T_{ti} = Sample tank temperature before sampling, °K.

T_{tf} = Sample tank temperature after pressuring, °K.

12.2 Water Correction. Use Table 25C–1 (Section 17.0), the LFG temperature, and barometric pressure at the sampling site to calculate B_w.

$$B_w = \frac{P_w}{P_b} \qquad \text{Eq. 25C-1}$$

12.3 Nitrogen Concentration in the landfill gas. Use equation 25C–2 to calculate the measured concentration of nitrogen in the original landfill gas.

$$C_{N2} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right) - \left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right] C_{mN2} \qquad \text{Eq.25C-2}$$

12.4 Oxygen Concentration in the landfill gas. Use equation 25C–3 to calculate the measured concentration of oxygen in the original landfill gas.

$$C_{Ox} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right) - \left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right] C_{mOx} \qquad \text{Eq.25C-3}$$

12.5 You must correct the NMOC Concentration for the concentration of nitrogen or oxygen based on which gas or gases passes the requirements in section 9.1.

12.5.1 NMOC Concentration with nitrogen correction. Use Equation 25C–4 to calculate the concentration of NMOC for each sample tank when the nitrogen concentration is less than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t}-\frac{P_{ti}}{T_{ti}}\right)\left(1-\frac{99}{78}C_{N2}\right)-B_w}\frac{1}{r}\sum_{j=1}^{r} C_{tm(j)} \qquad \text{Eq.25C-4}$$

12.5.2 NMOC Concentration with oxygen correction. Use Equation 25C–5 to calculate the concentration of NMOC for each sample tank if the landfill gas oxygen is less than 5 percent and the landfill gas nitrogen concentration is greater than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t}-\frac{P_{ti}}{T_{ti}}\right)\left(1-\frac{99}{21}C_{Ox}\right)-B_w}\frac{1}{r}\sum_{j=1}^{r} C_{tm(j)} \qquad \text{Eq.25C-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts. June 15–20, 1975.) 14 p.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

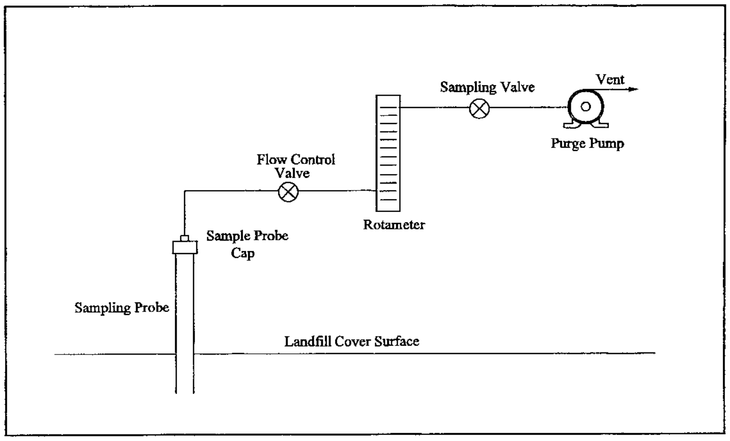


Figure 25C-1. Schematic of Sampling Probe Purging System

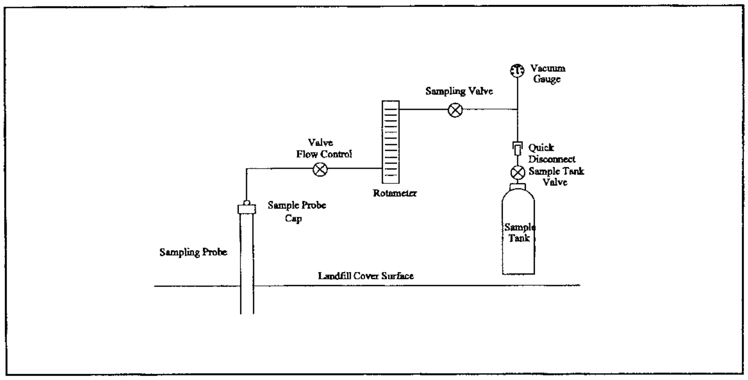


Figure 25C-2. Schematic of Sampling Train.

TABLE 25C–1—MOISTURE CORRECTION

Temperature, °C	Vapor Pressure of H_2O, mm Hg	Temperature, °C	Vapor Pressure of H_2O, mm Hg
4	6.1	18	15.5
6	7.0	20	17.5
8	8.0	22	19.8
10	9.2	24	22.4
12	10.5	26	25.2
14	12.0	28	28.3
16	13.6	30	31.8

METHOD 25D—DETERMINATION OF THE VOLATILE ORGANIC CONCENTRATION OF WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) or an electrolytic conductivity detector (ELCD) because knowledge beyond the scope of this presentation is required.

1.0 Scope and Application

1.1 Analyte. Volatile Organic Compounds. No CAS No. assigned.

1.2 Applicability. This method is applicable for determining the volatile organic (VO) concentration of a waste sample.

2.0 Summary of Method

2.1 Principle. A sample of waste is obtained at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). The sample is suspended in an organic/aqueous matrix, then heated and purged with nitrogen for 30 min. in order to separate certain organic compounds. Part of the sample is analyzed for carbon concentration, as methane, with an FID, and part of the sample is analyzed for chlorine concentration, as chloride, with an ELCD. The VO concentration is the sum of the carbon and chlorine content of the sample.

3.0 Definitions

3.1 *Well-mixed* in the context of this method refers to turbulent flow which results in multiple-phase waste in effect behaving as single-phase waste due to good mixing.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1 Sampling. The following equipment is required:

6.1.1 Sampling Tube. Flexible Teflon, 0.25 in. ID (6.35 mm).

6.1.2 Sample Container. Borosilicate glass, 40-mL, and a Teflon-lined screw cap capable of forming an air tight seal.

6.1.3 Cooling Coil. Fabricated from 0.25 in (6.35 mm). ID 304 stainless steel tubing with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Purging Apparatus. For separating the VO from the waste sample. A schematic of the system is shown in Figure 25D–1. The purging apparatus consists of the following major components.

6.2.1.1 Purging Flask. A glass container to hold the sample while it is heated and purged with dry nitrogen. The cap of the purging flask is equipped with three fittings: one for a purging lance (fitting with the #7 Ace-thread), one for the Teflon exit tubing (side fitting, also a #7 Ace-thread), and a third (a 50-mm Ace-thread) to attach the base of the purging flask as shown in Figure 25D–2. The base of the purging flask is a 50-mm ID (2 in) cylindrical glass tube. One end of the tube is open while the other end is sealed. Exact dimensions are shown in Figure 25D–2.

6.2.1.2 Purging Lance. Glass tube, 6-mm OD (0.2 in) by 30 cm (12 in) long. The purging end of the tube is fitted with a four-arm bubbler with each tip drawn to an opening 1 mm (0.04 in) in diameter. Details and exact dimensions are shown in Figure 25D–2.

6.2.1.3 Coalescing Filter. Porous fritted disc incorporated into a container with the same dimensions as the purging flask. The details of the design are shown in Figure 25D–3.

6.2.1.4 Constant Temperature Chamber. A forced draft oven capable of maintaining a uniform temperature around the purging flask and coalescing filter of 75 ±2 °C (167 ±3.6 °F).

6.2.1.5 Three-way Valve. Manually operated, stainless steel. To introduce calibration gas into system.

6.2.1.6 Flow Controllers. Two, adjustable. One capable of maintaining a purge gas flow rate of 6 ±0.06 L/min (0.2 ±0.002 ft^3/min) The other capable of maintaining a calibration gas flow rate of 1–100 mL/min (0.00004–0.004 ft^3/min).

6.2.1.7 Rotameter. For monitoring the air flow through the purging system (0–10 L/min)(0–0.4 ft^3/min).

6.2.1.8 Sample Splitters. Two heated flow restrictors (placed inside oven or heated to 120 ±10 °C (248 ±18 °F)). At a purge rate of 6 L/min (0.2 ft^3/min), one will supply a constant flow to the first detector (the rest of the flow will be directed to the second sample splitter). The second splitter will split the analytical flow between the second detector and the flow restrictor. The approximate flow to the FID will be 40 mL/min (0.0014 ft^3/min) and to the ELCD will be 15 mL/min (0.0005 ft^3/min), but the exact flow must be adjusted to be compatible with the individual detector and to meet its linearity requirement. The two sample splitters will be connected to each other by 1/8′ OD (3.175 mm) stainless steel tubing.

6.2.1.9 Flow Restrictor. Stainless steel tubing, 1/8′ OD (3.175 mm), connecting the second sample splitter to the ice bath. Length is determined by the resulting pressure in the purging flask (as measured by the pressure gauge). The resulting pressure from the use of the flow restrictor shall be 6–7 psig.

6.2.1.10 Filter Flask. With one-hole stopper. Used to hold ice bath. Excess purge gas is vented through the flask to prevent condensation in the flowmeter and to trap volatile organic compounds.

6.2.1.11 Four-way Valve. Manually operated, stainless steel. Placed inside oven, used to bypass purging flask.

6.2.1.12 On/Off Valves. Two, stainless steel. One heat resistant up to 130 °C (266 °F) and placed between oven and ELCD. The other a toggle valve used to control purge gas flow.

6.2.1.13 Pressure Gauge. Range 0–40 psi. To monitor pressure in purging flask and coalescing filter.

6.2.1.14 Sample Lines. Teflon, 1/4′ OD (6.35 mm), used inside the oven to carry purge gas to and from purging chamber and to and from coalescing filter to four-way valve. Also used to carry sample from four-way valve to first sample splitter.

6.2.1.15 Detector Tubing. Stainless steel, 1/8′ OD (3.175 mm), heated to 120 ±10 °C (248 ±18 °F) . Used to carry sample gas from each sample splitter to a detector. Each piece of tubing must be wrapped with heat tape and insulating tape in order to insure that no cold spots exist. The tubing leading to the ELCD will also contain a heat-resistant on-off valve (Section 6.2.1.12) which shall also be wrapped with heat-tape and insulation.

6.2.2 Volatile Organic Measurement System. Consisting of an FID to measure the carbon concentration of the sample and an ELCD to measure the chlorine concentration.

6.2.2.1 FID. A heated FID meeting the following specifications is required.

6.2.2.1.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.1.

6.2.2.1.2 Range. A full scale range of 50 pg carbon/sec to 50 μg carbon/sec. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.1.3 Data Recording System. A digital integration system compatible with the FID for permanently recording the output of the detector. The recorder shall have the capability to start and stop integration at points selected by the operator or it shall be capable of the ‘‘integration by slices’’ technique (this technique involves breaking down the chromatogram into smaller increments, integrating the area under the curve for each portion, subtracting the background for each portion, and then adding all of the areas together for the final area count).

6.2.2.2 ELCD. An ELCD meeting the following specifications is required. 1-propanol must be used as the electrolyte. The electrolyte flow through the conductivity cell shall be 1 to 2 mL/min (0.00004 to 0.00007 ft^3/min).

NOTE: A ¼-in. ID (6.35 mm) quartz reactor tube is strongly recommended to reduce carbon buildup and the resulting detector maintenance.

6.2.2.2.1 Linearity. A linear response (±10 percent) over the response range as demonstrated by the procedures in section 10.1.2.

6.2.2.2.2 Range. A full scale range of 5.0 pg/sec to 500 ng/sec chloride. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.2.3 Data Recording System. A digital integration system compatible with the output voltage range of the ELCD. The recorder must have the capability to start and stop integration at points selected by the operator or it shall be capable of performing the ‘‘integration by slices’’ technique.

7.0 Reagents and Standards

7.1 Sampling.

7.1.1 Polyethylene Glycol (PEG). Ninety-eight percent pure with an average molecular weight of 400. Before using the PEG, remove any organic compounds that might be detected as volatile organics by heating it to 120 °C (248 °F) and purging it with nitrogen at a flow rate of 1 to 2 L/min (0.04 to 0.07 ft^3/min) for 2 hours. The cleaned PEG must be stored under a 1 to 2 L/min (0.04 to 0.07 ft^3/min) nitrogen purge until use. The purge apparatus is shown in Figure 25D–4.

7.2 Analysis.

7.2.1 Sample Separation. The following are required for the sample purging step.

7.2.1.1 PEG. Same as section 7.1.1.

7.2.1.2 Purge Gas. Zero grade nitrogen (N_2), containing less than 1 ppm carbon.

7.2.2 Volatile Organics Measurement. The following are required for measuring the VO concentration.

7.2.2.1 Hydrogen (H_2). Zero grade H_2, 99.999 percent pure.

7.2.2.2 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2.2.3 Calibration Gas. Pressurized gas cylinder containing 10 percent propane and 1 percent 1,1-dichloroethylene by volume in nitrogen.

7.2.2.4 Water. Deionized distilled water that conforms to American Society for Testing and Materials Specification D 1193–74, Type 3, is required for analysis. At the option of the analyst, the $KMnO_4$ test for oxidizable organic matter may be omitted when high concentrations are not expected to be present.

7.2.2.5 1-Propanol. ACS grade or better. Electrolyte Solution. For use in the ELCD.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling.

8.1.1 Sampling Plan Design and Development. Use the procedures in chapter nine of Reference 1 in section 16 as guidance in developing a sampling plan.

8.1.2 Single Phase or Well-mixed Waste.

8.1.2.1 Install a sampling tap to obtain the sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). Assemble the sampling apparatus as shown in Figure 25D–5.

8.1.2.2 Prepare the sampling containers as follows: Pour 30 mL of clean PEG into the container. PEG will reduce but not eliminate the loss of organics during sample collection. Weigh the sample container with the screw cap, the PEG, and any labels to the nearest 0.01 g and record the weight (m_{st}). Store the containers in an ice bath until 1 hour before sampling (PEG will solidify at ice bath temperatures; allow the containers to reach room temperature before sampling).

8.1.2.3 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.1.2.4 After purging, stop the sample flow and direct the sampling tube to a preweighed sample container, prepared as described in section 8.1.2.2. Keep the tip of the tube below the surface of the PEG during sampling to minimize contact with the atmosphere. Sample at a flow rate such that the temperature of the waste is less than 10 °C (50 °F). Fill the sample container and immediately cap it (within 5 seconds) so that a minimum headspace exists in the container. Store immediately in a cooler and cover with ice.

8.1.3 Multiple-phase Waste. Collect a 10 g sample of each phase of waste generated using the procedures described in section 8.1.2 or 8.1.5. Each phase of the waste shall be analyzed as a separate sample. Calculate the weighted average VO concentration of the waste using Equation 25D–13 (Section 12.14).

8.1.4 Solid waste. Add approximately 10 g of the solid waste to a container prepared in the manner described in section 8.1.2.2, minimizing headspace. Cap and chill immediately.

8.1.5 Alternative to Tap Installation. If tap installation is impractical or impossible, fill a large, clean, empty container by submerging the container into the waste below the surface of the waste. Immediately fill a container prepared in the manner described in section 8.1.2.2 with approximately 10 g of the waste collected in the large container. Minimize headspace, cap and chill immediately.

8.1.6 Alternative sampling techniques may be used upon the approval of the Administrator.

8.2 Sample Recovery.

8.2.1 Assemble the purging apparatus as shown in Figures 25D–1 and 25D–2. The oven shall be heated to 75 ±2 °C (167 ±3.6 °F). The sampling lines leading from the oven to the detectors shall be heated to 120 ±10 °C (248 ±18 °F) with no cold spots. The flame ionization detector shall be operated with a heated block. Adjust the purging lance so that it reaches the bottom of the chamber.

8.2.2 Remove the sample container from the cooler, and wipe the exterior of the container to remove any extraneous ice, water, or other debris. Reweigh the sample container to the nearest 0.01 g, and record the weight (m_{sf}). Pour the contents of the sample container into the purging flask, rinse the sample container three times with a total of 20 mL of PEG (since the sample container originally held 30 mL of PEG, the total volume of PEG added to the purging flask will be 50 mL), transferring the rinsings to the purging flask after each rinse. Cap purging flask between rinses. The total volume of PEG in the purging flask shall be 50 mL. Add 50 mL of water to the purging flask.

9.0 Quality Control

9.1 Quality Control Samples. If audit samples are not available, prepare and analyze the two types of quality control samples (QCS) listed in Sections 9.1.1 and 9.1.2. Before placing the system in operation, after a shutdown of greater than six months, and after any major modifications, analyze each QCS in triplicate. For each detector, calculate the percent recovery by dividing measured concentration by theoretical concentration and multiplying by 100. Determine the mean percent recovery for each detector for each QCS triplicate analysis. The RSD for any triplicate analysis shall be ≤10 percent. For QCS 1 (methylene chloride), the percent recovery shall be ≥90 percent for carbon as methane, and ≥55 percent for chlorine as chloride. For QCS 2 (1,3-dichloro-2-propanol), the percent recovery shall be ≤15 percent for carbon as methane, and ≤6 percent for chlorine as chloride. If the analytical system does not meet the above-mentioned criteria for both detectors, check the system parameters (temperature, system pressure, purge rate, etc.), correct the problem, and repeat the triplicate analysis of each QCS.

9.1.1 QCS 1, Methylene Chloride. Prepare a stock solution by weighing, to the nearest 0.1 mg, 55 μL of HPLC grade methylene chloride in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 μL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze

the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 3.777×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 1.670×10^{-2}.

9.1.2 QCS 2, 1,3-dichloro-2-propanol. Prepare a stock solution by weighing, to the nearest 0.1 mg, 60 μL of high purity grade 1,3-dichloro-2-propanol in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 μL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 7.461×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 1.099×10^{-2}.

9.1.3 Routine QCS Analysis. For each set of compliance samples (in this context, set is per facility, per compliance test), analyze one QCS 1 and one QCS 2 sample. The percent recovery for each sample for each detector shall be ±13 percent of the mean recovery established for the most recent set of QCS triplicate analysis (Section 9.4). If the sample does not meet this criteria, check the system components and analyze another QCS 1 and 2 until a single set of QCS meet the ±13 percent criteria.

10.0 Calibration and Standardization

10.1 Initial Performance Check of Purging System. Before placing the system in operation, after a shutdown of greater than six months, after any major modifications, and at least once per month during continuous operation, conduct the linearity checks described in sections 10.1.1 and 10.1.2. Install calibration gas at the three-way calibration gas valve. See Figure 25D–1.

10.1.1 Linearity Check Procedure. Using the calibration standard described in section 7.2.2.3 and by varying the injection time, it is possible to calibrate at multiple concentration levels. Use Equation 25D–3 to calculate three sets of calibration gas flow rates and run times needed to introduce a total mass of carbon, as methane, (m_c) of 1, 5, and 10 mg into the system (low, medium and high FID calibration, respectively). Use Equation 25D–4 to calculate three sets of calibration gas flow rates and run times needed to introduce a total chloride mass (m_{ch}) of 1, 5, and 10 mg into the system (low, medium and high ELCD calibration, respectively). With the system operating in standby mode, allow the FID and the ELCD to establish a stable baseline. Set the secondary pressure regulator of the calibration gas cylinder to the same pressure as the purge gas cylinder and set the proper flow rate with the calibration flow controller (see Figure 25D–1). The calibration gas flow rate can be measured with a flowmeter attached to the vent position of the calibration gas valve. Set the four-way bypass valve to standby position so that the calibration gas flows through the coalescing filter only. Inject the calibration gas by turning the calibration gas valve from vent position to inject position. Continue the calibration gas flow for the appropriate period of time before switching the calibration valve to vent position. Continue recording the response of the FID and the ELCD for 5 min after switching off calibration gas flow. Make triplicate injections of all six levels of calibration.

10.1.2 Linearity Criteria. Calculate the average response factor (Equations 25D–5 and 25D–6) and the relative standard deviation (RSD) (Equation 25D–10) at each level of the calibration curve for both detectors. Calculate the overall mean of the three response factor averages for each detector. The FID linearity is acceptable if each response factor is within 5 percent of the overall mean and if the RSD for each set of triplicate injections is less than 5 percent. The ELCD linearity is acceptable if each response factor is within 10 percent of the overall mean and if the RSD for each set of triplicate injections is less than 10 percent. Record the overall mean value of the response factors for the FID and the ELCD. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2 Daily Calibrations.

10.2.1 Daily Linearity Check. Follow the procedures outlined in section 10.1.1 to analyze the medium level calibration for both the FID and the ELCD in duplicate at the start of the day. Calculate the response factors and the RSDs for each detector. For the FID, the calibration is acceptable if the average response factor is within 5 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 5 percent. For the ELCD, the calibration is acceptable if the average response factor is within 10 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 10 percent. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2.2 Calibration Range Check.

10.2.2.1 If the waste concentration for either detector falls below the range of calibration for that detector, use the procedure outlined in section 10.1.1 to choose two calibration points that bracket the new target

concentration. Analyze each of these points in triplicate (as outlined in section 10.1.1) and use the criteria in section 10.1.2 to determine the linearity of the detector in this ''mini-calibration'' range.

10.2.2.2 After the initial linearity check of the mini-calibration curve, it is only necessary to test one of the points in duplicate for the daily calibration check (in addition to the points specified in section 10.2.1). The average daily mini-calibration point should fit the linearity criteria specified in section 10.2.1. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat the calibration procedure mentioned in the first paragraph of section 10.2.2. A mini-calibration curve for waste concentrations above the calibration curve for either detector is optional.

10.3 Analytical Balance. Calibrate against standard weights.

11.0 Analysis

11.1 Sample Analysis.

11.1.1 Turn on the constant temperature chamber and allow the temperature to equilibrate at 75 ±2 °C (167 ±3.6 °F). Turn the four-way valve so that the purge gas bypasses the purging flask, the purge gas flowing through the coalescing filter and to the detectors (standby mode). Turn on the purge gas. Allow both the FID and the ELCD to warm up until a stable baseline is achieved on each detector. Pack the filter flask with ice. Replace ice after each run and dispose of the waste water properly. When the temperature of the oven reaches 75 ±2 °C (167 ±3.6 °F), start both integrators and record baseline. After 1 min, turn the four-way valve so that the purge gas flows through the purging flask, to the coalescing filter and to the sample splitters (purge mode). Continue recording the response of the FID and the ELCD. Monitor the readings of the pressure gauge and the rotameter. If the readings fall below established setpoints, stop the purging, determine the source of the leak, and resolve the problem before resuming. Leaks detected during a sampling period invalidate that sample.

11.1.2 As the purging continues, monitor the output of the detectors to make certain that the analysis is proceeding correctly and that the results are being properly recorded. Every 10 minutes read and record the purge flow rate, the pressure and the chamber temperature. Continue the purging for 30 minutes.

11.1.3 For each detector output, integrate over the entire area of the peak starting at 1 minute and continuing until the end of the run. Subtract the established baseline area from the peak area. Record the corrected area of the peak. See Figure 25D–6 for an example integration.

11.2 Water Blank. A water blank shall be analyzed for each batch of cleaned PEG prepared. Transfer about 60 mL of water into the purging flask. Add 50 mL of the cleaned PEG to the purging flask. Treat the blank as described in sections 8.2 and 8.3, excluding section 8.2.2. Calculate the concentration of carbon and chlorine in the blank sample (assume 10 g of waste as the mass). A VO concentration equivalent to ≤10 percent of the applicable standard may be subtracted from the measured VO concentration of the waste samples. Include all blank results and documentation in the test report.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A_b = Area under the water blank response curve, counts.

A_c = Area under the calibration response curve, counts.

A_s = Area under the sample response curve, counts.

C = Concentration of volatile organics in the sample, ppmw.

C_c = Concentration of carbon, as methane, in the calibration gas, mg/L.

C_{ch} = Concentration of chloride in the calibration gas, mg/L.

C_j = VO concentration of phase j, ppmw.

DR_t = Average daily response factor of the FID, mg CH_4/counts.

Dr_{th} = Average daily response factor of the ELCD, mg Cl^-/counts.

F_j = Weight fraction of phase j present in the waste.

m_c = Mass of carbon, as methane, in a calibration run, mg.

m_{ch} = Mass of chloride in a calibration run, mg.

m_s = Mass of the waste sample, g.

m_{sc} = Mass of carbon, as methane, in the sample, mg.

m_{sf} = Mass of sample container and waste sample, g.

m_{sh} = Mass of chloride in the sample, mg.

m_{st} = Mass of sample container prior to sampling, g.

m_{VO} = Mass of volatile organics in the sample, mg.

n = Total number of phases present in the waste.

P_p = Percent propane in calibration gas (L/L).

P_{vc} = Percent 1,1-dichloroethylene in calibration gas (L/L).

Q_c = Flow rate of calibration gas, L/min.

t_c = Length of time standard gas is delivered to the analyzer, min.

W = Weighted average VO concentration, ppmw.

12.2 Concentration of Carbon, as Methane, in the Calibration Gas.

$$C_c = (19.681 \times P_p) + (13.121 \times P_{vc}) \quad \text{Eq. 25D-1}$$

12.3 Concentration of Chloride in the Calibration Gas.

$$C_{ch} = 28.998 \times P_{vc} \quad \text{Eq. 25D-2}$$

12.4 Mass of Carbon, as Methane, in a Calibration Run.

$$M_c = C_c \times Q_c \times t_c \quad \text{Eq. 25D-3}$$

12.5 Mass of Chloride in a Calibration Run.

$$m_{ch} = C_{ch} \times Q_c \times t_c \quad \text{Eq. 25D-4}$$

12.6 FID Response Factor, mg/counts.

$$DR_t = \frac{m_c}{A_c} \quad \text{Eq. 25D-5}$$

12.7 ELCD Response Factor, mg/counts.

$$DR_{th} = \frac{m_{ch}}{A_c} \quad \text{Eq. 25D-6}$$

12.8 Mass of Carbon in the Sample.

$$m_{sc} = DR_t(A_s - A_b) \quad \text{Eq. 25D-7}$$

12.9 Mass of Chloride in the Sample.

$$m_{sh} = DR_{th}(A_s - A_b) \quad \text{Eq. 25D-8}$$

12.10 Mass of Volatile Organics in the Sample.

$$m_{vo} = m_{sc} + m_{sh} \quad \text{Eq. 25D-9}$$

12.11 Relative Standard Deviation.

$$RSD = \frac{100}{\bar{x}} \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} \quad \text{Eq. 25D-10}$$

12.12 Mass of Sample.

$$m_s = m_{sf} - m_{st} \quad \text{Eq. 25D-11}$$

12.13 Concentration of Volatile Organics in Waste.

$$C = \frac{(m_{vo} \times 1000)}{m_s} \quad \text{Eq. 25D-12}$$

12.14 Weighted Average VO Concentration of Multi-phase Waste.

$$W = \sum_{j=1}^{n} F_j \, x \, \overline{C}_j \quad \text{Eq. 25D-13}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. “Test Methods for Evaluating Solid Waste, Physical/Chemistry Methods”, U.S. Environmental Protection Agency. Publication SW–846, 3rd Edition, November 1986 as amended by Update I, November 1990.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

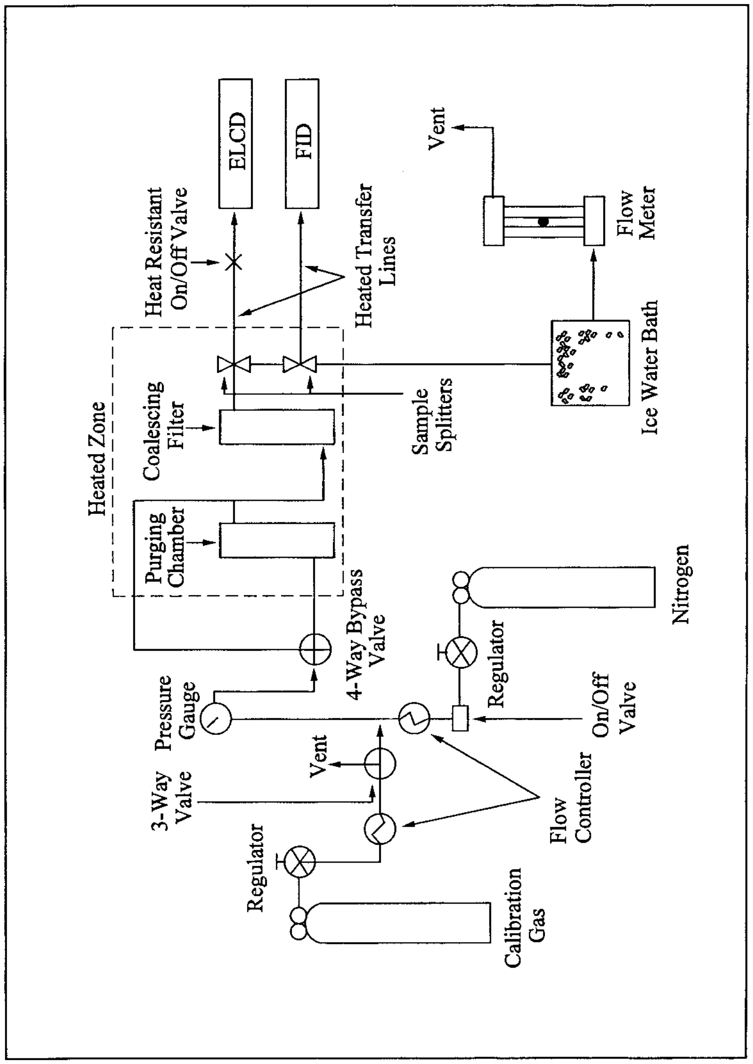


Figure 25D-1. Schematic of Purging Apparatus.

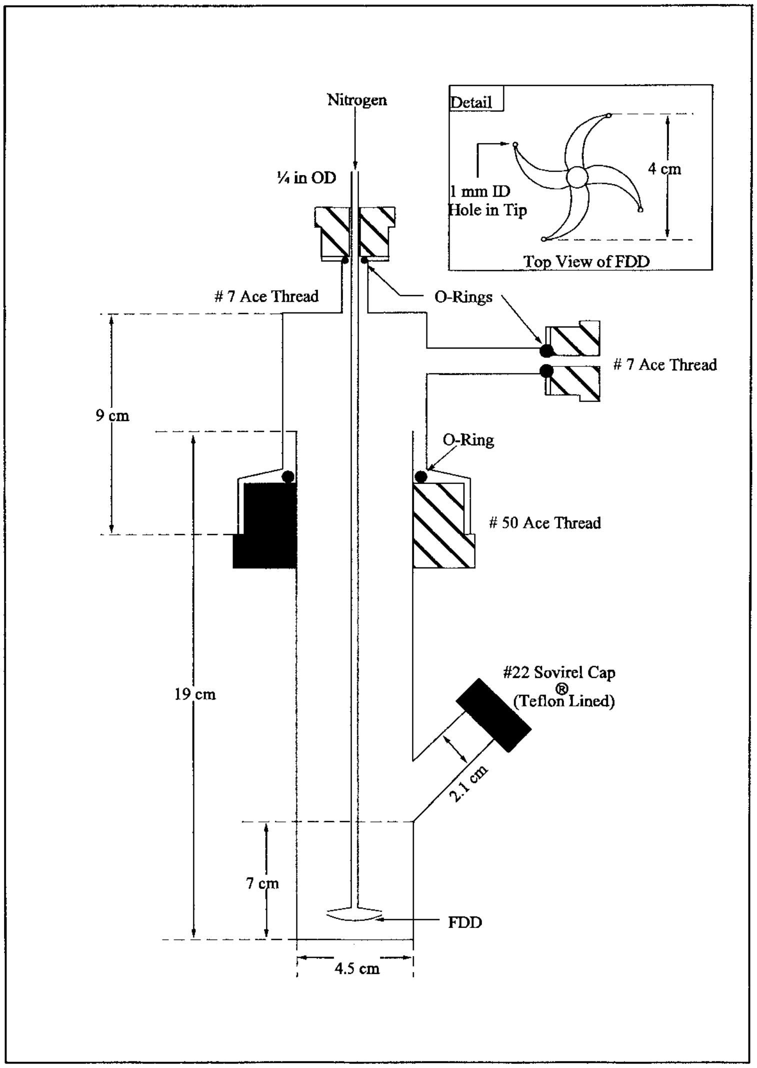
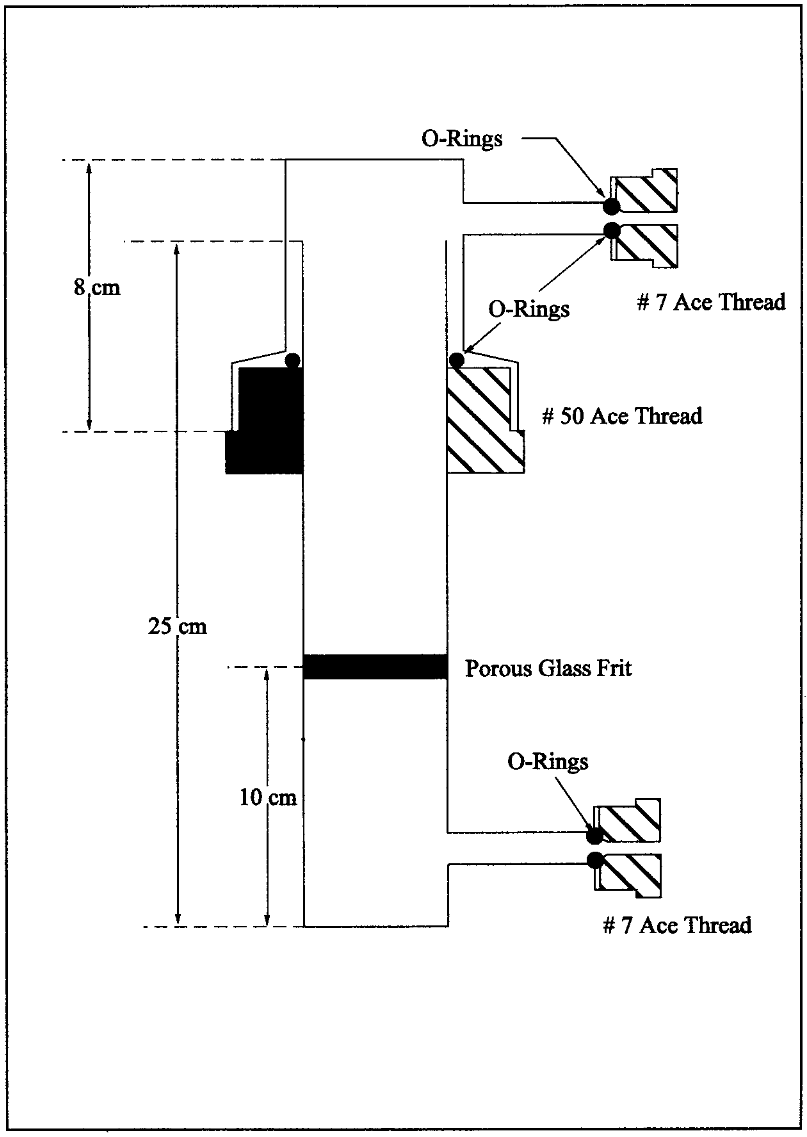


Figure 25D-2. Purging Lance.


O-Rings
8 cm
O-Rings
7 Ace Thread
50 Ace Thread
25 cm
Porous Glass Frit
O-Rings
10 cm
7 Ace Thread

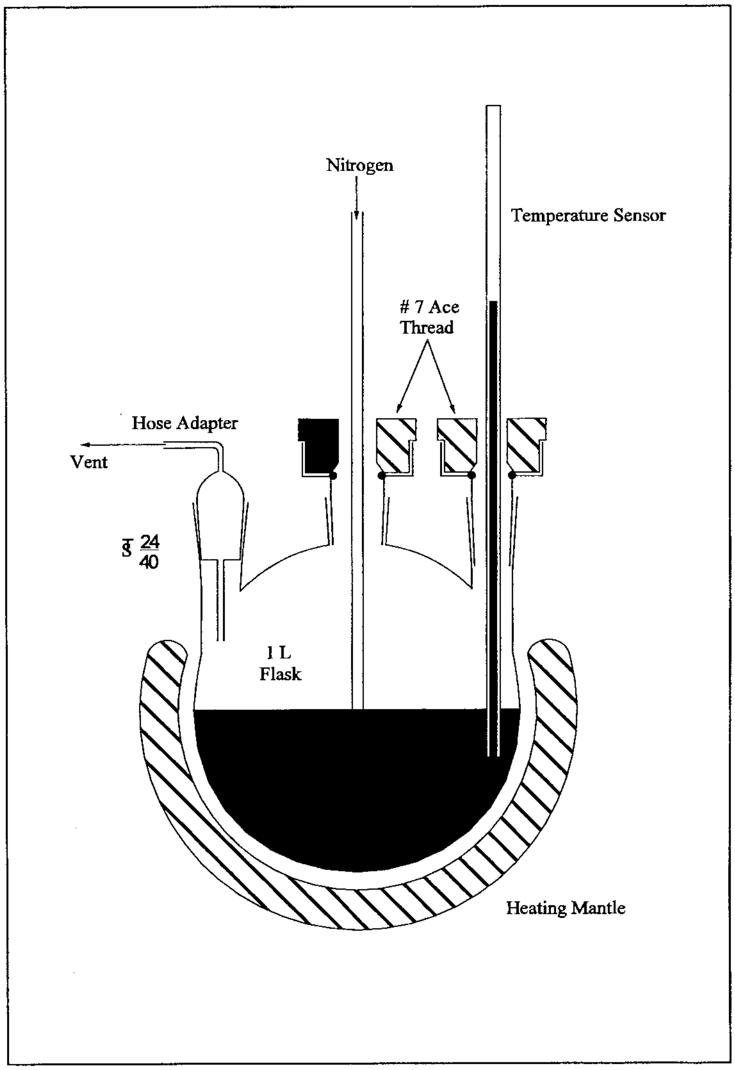


Figure 25D-4. Schematic of PEG Cleaning System.

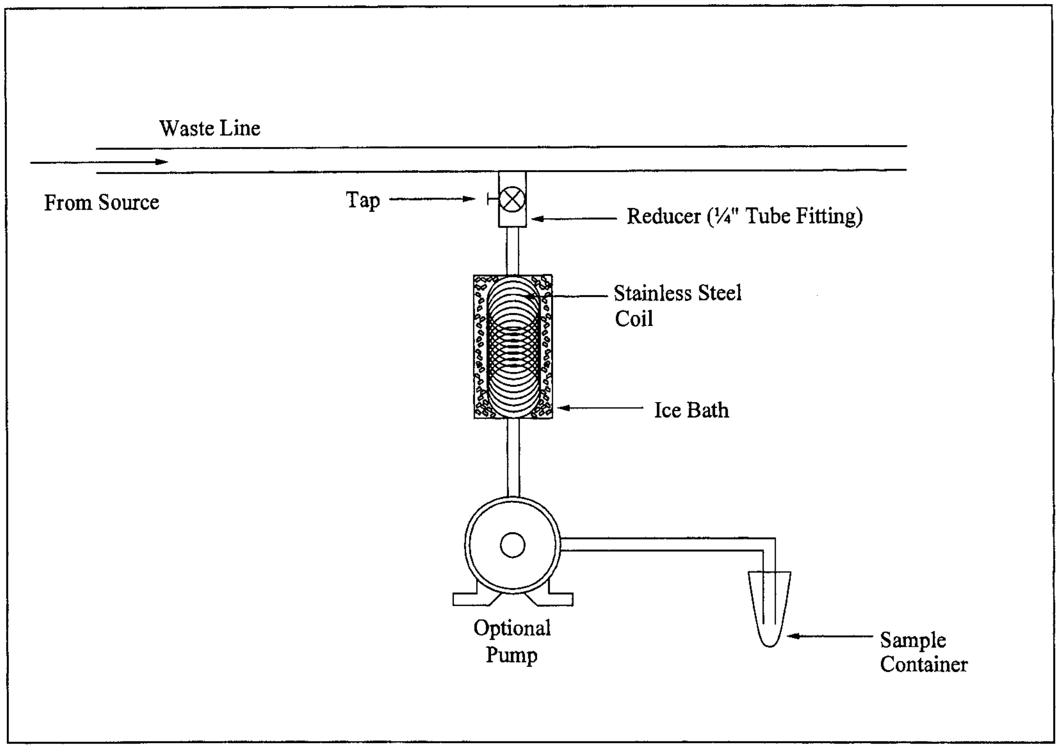


Figure 25D-5. Schematic of Sampling Apparatus.

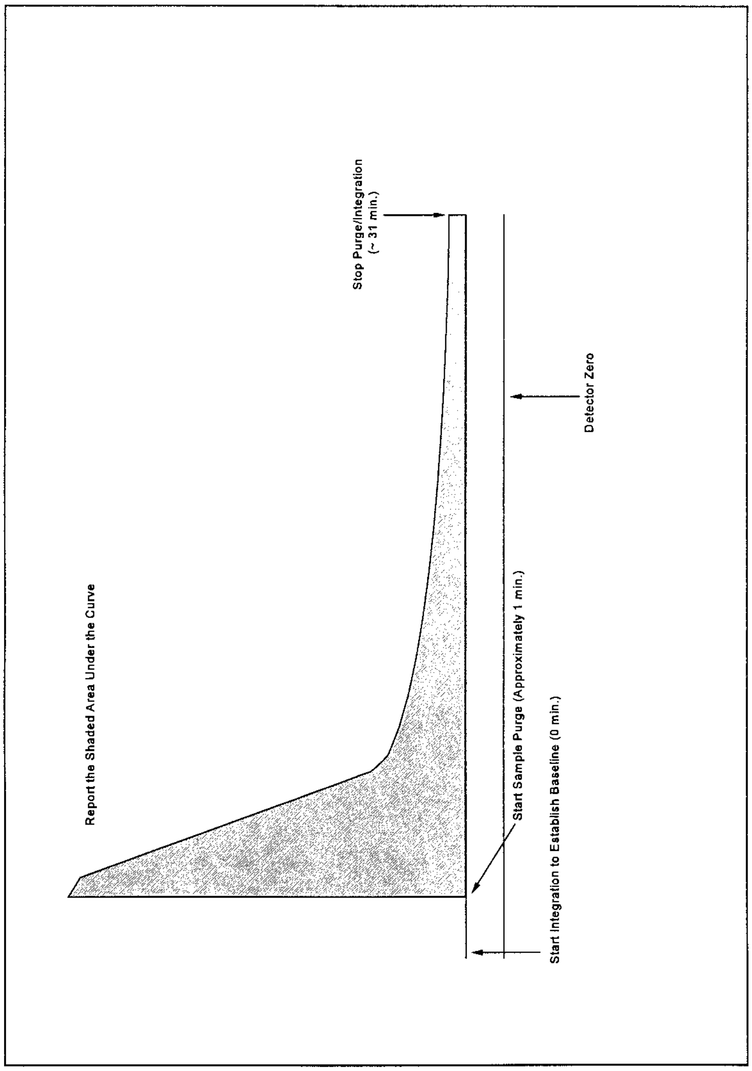


Figure 25D-6. Example Integration of Either Detector.

METHOD 25E—DETERMINATION OF VAPOR PHASE ORGANIC CONCENTRATION IN WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) nor by those who are unfamiliar with source sampling because knowledge beyond the scope of this presentation is required. This method is not inclusive with respect to specifications (*e.g.*, reagents and standards) and calibration procedures. Some material is incorporated by reference from other methods. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 106, part 61, Appendix B, and Method 18, part 60, Appendix A.

1.0 Scope and Application

1.1 Applicability. This method is applicable for determining the vapor pressure of waste cited by an applicable regulation.

1.2 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 The headspace vapor of the sample is analyzed for carbon content by a headspace analyzer, which uses an FID.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 The analyst shall select the operating parameters best suited to the requirements for a particular analysis. The analyst shall produce confirming data through an adequate supplemental analytical technique and have the data available for review by the Administrator.

5.0 Safety [Reserved]

6.0 Equipment and Supplies

6.1 Sampling. The following equipment is required:

6.1.1 Sample Containers. Vials, glass, with butyl rubber septa, Perkin-Elmer Corporation Numbers 0105–0129 (glass vials), B001–0728 (gray butyl rubber septum, plug style), 0105–0131 (butyl rubber septa), or equivalent. The seal must be made from butyl rubber. Silicone rubber seals are not acceptable.

6.1.2 Vial Sealer. Perkin-Elmer Number 105–0106, or equivalent.

6.1.3 Gas-Tight Syringe. Perkin-Elmer Number 00230117, or equivalent.

6.1.4 The following equipment is required for sampling.

6.1.4.1 Tap.

6.1.4.2 Tubing. Teflon, 0.25-in. ID.

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1.4.3 Cooling Coil. Stainless steel (304), 0.25 in.-ID, equipped with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Balanced Pressure Headspace Sampler. Perkin-Elmer HS–6, HS–100, or equivalent, equipped with a glass bead column instead of a chromatographic column.

6.2.2 FID. An FID meeting the following specifications is required.

6.2.2.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.2.

6.2.2.2 Range. A full scale range of 1 to 10,000 parts per million (ppm) propane (C_3H_8). Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.3 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the output of the detector.

6.2.4 Temperature Sensor. Capable of reading temperatures in the range of 30 to 60 °C (86 to 140 °F) with an accuracy of ±0.1 °C (±0.2 °F).

7.0 Reagents and Standards

7.1 Analysis. The following items are required for analysis.

7.1.1 Hydrogen (H_2). Zero grade hydrogen, as required by the FID.

7.1.2 Carrier Gas. Zero grade nitrogen, containing less than 1 ppm carbon (C) and less than 1 ppm carbon dioxide.

7.1.3 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2 Calibration and Linearity Check.

7.2.1 Stock Cylinder Gas Standard. 100 percent propane. The manufacturer shall: (a) Certify the gas composition to be accurate to ±3 percent or better (see section 7.2.1.1); (b) recommend a maximum shelf life over which the gas concentration does not change by greater than ±5 percent from the certified value; and (c) affix the date of gas cylinder preparation, certified propane concentration, and recommended maximum shelf life to the cylinder before shipment to the buyer.

7.2.1.1 Cylinder Standards Certification. The manufacturer shall certify the concentration of the calibration gas in the cylinder by (a) directly analyzing the cylinder and (b) calibrating his analytical procedure on the day of cylinder analysis. To calibrate his analytical procedure, the manufacturer shall use, as a minimum, a three-point calibration curve.

7.2.1.2 Verification of Manufacturer's Calibration Standards. Before using, the manufacturer shall verify each calibration standard by (a) comparing it to gas mixtures prepared in accordance with the procedure described in section 7.1 of Method 106 of Part 61, Appendix B, or by (b) calibrating it against Standard Reference Materials (SRM's) prepared by the National Bureau of Standards, if such SRM's are available. The agreement between the initially determined concentration value and the verification concentration value must be within ±5 percent. The manufacturer must reverify all calibration standards on a time interval consistent with the shelf life of the cylinder standards sold.

8.0 Sampling Collection, Preservation, Storage, and Transport

8.1 Install a sampling tap to obtain a sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to

the atmosphere). Assemble the sampling apparatus as shown in Figure 25E–1.

8.2 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.3 After purging, stop the sample flow and transfer the Teflon sampling tube to a sample container. Sample at a flow rate such that the temperature of the waste is <10 °C (<50 °F). Fill the sample container halfway (±5 percent) and cap it within 5 seconds. Store immediately in a cooler and cover with ice.

8.4 Alternative sampling techniques may be used upon the approval of the Administrator.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
10.2, 10.3	FID calibration and response check	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Use the procedures in sections 10.2 to calibrate the headspace analyzer and FID and check for linearity before the system is first placed in operation, after any shutdown longer than 6 months, and after any modification of the system.

10.2 Calibration and Linearity. Use the procedures in section 10 of Method 18 of Part 60, Appendix A, to prepare the standards and calibrate the flowmeters, using propane as the standard gas. Fill the calibration standard vials halfway (±5 percent) with deionized water. Purge and fill the airspace with calibration standard. Prepare a minimum of three concentrations of calibration standards in triplicate at concentrations that will bracket the applicable cutoff. For a cutoff of 5.2 kPa (0.75 psi), prepare nominal concentrations of 30,000, 50,000, and 70,000 ppm as propane. For a cutoff of 27.6 kPa (4.0 psi), prepare nominal concentrations of 200,000, 300,000, and 400,000 ppm as propane.

10.2.1 Use the procedures in section 11.3 to measure the FID response of each standard. Use a linear regression analysis to calculate the values for the slope (k) and the y-intercept (b). Use the procedures in sections 12.3 and 12.2 to test the calibration and the linearity.

10.3 Daily FID Calibration Check. Check the calibration at the beginning and at the end of the daily runs by using the following procedures. Prepare 2 calibration standards at the nominal cutoff concentration using the procedures in section 10.2. Place one at the beginning and one at the end of the daily run. Measure the FID response of the daily calibration standard and use the values for k and b from the most recent calibration to calculate the concentration of the daily standard. Use an equation similar to 25E–2 to calculate the percent difference between the daily standard and C_s. If the difference is within 5 percent, then the previous values for k and b can be used. Otherwise, use the procedures in section 10.2 to recalibrate the FID.

11.0 Analytical Procedures

11.1 Allow one hour for the headspace vials to equilibrate at the temperature specified in the regulation. Allow the FID to warm up until a stable baseline is achieved on the detector.

11.2 Check the calibration of the FID daily using the procedures in section 10.3.

11.3 Follow the manufacturer's recommended procedures for the normal operation of the headspace sampler and FID.

11.4 Use the procedures in sections 12.4 and 12.5 to calculate the vapor phase organic vapor pressure in the samples.

11.5 Monitor the output of the detector to make certain that the results are being properly recorded.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A = Measurement of the area under the response curve, counts.

b = y-intercept of the linear regression line.

C_a = Measured vapor phase organic concentration of sample, ppm as propane.

C_{ma} = Average measured vapor phase organic concentration of standard, ppm as propane.

C_m = Measured vapor phase organic concentration of standard, ppm as propane.

C_s = Calculated standard concentration, ppm as propane.

k = Slope of the linear regression line.

P_{bar} = Atmospheric pressure at analysis conditions, mm Hg (in. Hg).

P* = Organic vapor pressure in the sample, kPa (psi).

PD = Percent difference between the average measured vapor phase organic concentration (C_m) and the calculated standard concentration (C_s).

RSD = Relative standard deviation.

$\beta = 1.333 \times 10^{-7}$ kPa/[(mm Hg)(ppm)], $(4.91 \times 10^{-7}$ psi/[(in. Hg)(ppm)])

12.2 Linearity. Use the following equation to calculate the measured standard concentration for each standard vial.

$$C_m = kA + b \qquad \text{Eq. 25E-1}$$

12.2.1 Calculate the average measured standard concentration (C_{ma}) for each set of triplicate standards and use the following equation to calculate PD between C_{ma} and C_s. The instrument linearity is acceptable if the PD is within five for each standard.

$$PD = \frac{C_s - C_{ma}}{C_s} \times 100 \qquad \text{Eq. 25E-2}$$

12.3. Relative Standard Deviation (RSD). Use the following equation to calculate the RSD for each triplicate set of standards.

$$RSD = \frac{100}{C_{ma}} \sqrt{\frac{\sum \left(C_m - C_{ma}\right)^2}{2}} \qquad \text{Eq. 25E-3}$$

The calibration is acceptable if the RSD is within five for each standard concentration.

12.4 Concentration of organics in the headspace. Use the following equation to calculate the concentration of vapor phase organics in each sample.

$$C_a = kA + b \qquad \text{Eq. 25E-4}$$

12.5 Vapor Pressure of Organics in the Headspace Sample. Use the following equation to calculate the vapor pressure of organics in the sample.

$$P^* = \beta P_{bar} C_a \qquad \text{Eq. 25E-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. ‘‘Determination of Solvent Vapor Concentrations by Total Combustion Analysis: a Comparison of Infared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. ‘‘Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) p. 25.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

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Sunstone Solar Project 1

Draft Habitat Mitigation Plan

Prepared for

PINEGATE RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 1, LLC

Prepared by

TETRA TECH

October 2025

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List of Tables

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1.0 Introduction

Sunstone Solar 1, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 1 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 200 MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities and the anticipated phasing of construction are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Habitat Mitigation Plan (HMP) describes how the Certificate Holder will mitigate for unavoidable wildlife habitat disturbance from Facility construction and therefore, in conjunction with Exhibit P of the Application for Site Certificate (ASC[2]), demonstrates how the Certificate Holder will construct and operate the Facility consistent with the Oregon Department of Fish and Wildlife (ODFW) Fish and Wildlife Habitat Mitigation Policy, Oregon Administrative Rule (OAR) 635-415-0025. The Certificate Holder conducted habitat categorization surveys and other biological studies that inform habitat categorization in accordance with the ODFW Fish and Wildlife Habitat Mitigation Policy and avoided and minimized disturbance to wildlife and habitat as described in Exhibit P of the ASC. The actual disturbance acres and associated mitigation needs will be determined based on the final design and included in an updated HMP prior to construction. If disturbance to all wildlife habitats (i.e., habitat categories 2 through 5) are avoided during final design, no habitat mitigation plan would be required and in lieu of an updated HMP prior to construction, the Certificate Holder would provide a figure depicting wildlife habitat avoidance for this Facility phase.

2.0 Temporary and Permanent Disturbance

Construction and operation of the Facility will result in both permanent and temporary disturbance to wildlife and their habitats, although the disturbance has been minimized considerably as described in Exhibit P of the ASC. Due to the multi-year construction schedule of the Facility, both permanent and temporary disturbance to fish and wildlife habitat will occur in phases over this time period.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

[2] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

Permanent disturbance areas are those that will be converted from the existing condition to a different condition for the life of the Facility. The entire area within the fence is considered permanently disturbed and includes all solar components. Although it is considered permanently disturbed, vegetation within the solar array area fence will be retained and/or planted following construction, and as a result there will be residual value of these areas to wildlife.

Temporary disturbance areas include underground collector lines and transmission lines outside the solar array area fence, as well as temporary disturbance around the outside perimeter fencing. Restoration of the temporary disturbance areas will occur following construction, as will revegetation within portions of the solar array area fence line not occupied by permanent infrastructure. The duration of temporary disturbance to habitat will vary by habitat subtype. For example, the recovery period for temporarily disturbed agricultural areas could be as short as 1 to 3 years and grasslands generally recover within 3 to 7 years. The Certificate Holder will restore temporary disturbance areas consistent with the Draft Revegetation Plan; therefore, temporary disturbance will be mitigated through successful implementation of the Draft Revegetation Plan (Attachment P-4 to Exhibit P; updated for RFA 1, see Attachment 6).

Table 1 lists the acres that will be permanently or temporarily disturbed by Facility construction based on the permitted design, organized by habitat category and subtype. These habitats are described in Exhibit P of the ASC and in biological survey reports attached to Exhibit P (Exhibit P, Attachment P-1). Table 1 will be updated prior to construction to reflect the final disturbance acreage by habitat subtype for the final layout.

Table 1. Temporary and Permanent Disturbance by Habitat Category and Habitat Subtype

Habitat Category	Habitat Subtype	Disturbance (Acres)[1]	
		Permanent	Temporary
5	Eastside Grasslands	4.7	<0.1
	Category 5 Habitat Subtotal	**4.7**	**<0.1**
6	Orchards, Vineyards, Wheat Fields, Other Row Crops	1474	13.4
	Urban and Mixed Environs	0.2	0.1
	Category 6 Habitat Subtotal	**1,474**	**13.5**
	Grand Total	**1,479**	**13.5**

Note: Totals in this table may not sum correctly due to rounding; "-" means no disturbance while <0.1 means greater than zero but less than 0.05 acre disturbance.

1. Disturbance acres were calculated based on the layout permitted in the ASC and will be updated prior to construction.

3.0 Methods for Calculating Mitigation

Table 2 shows the methods for calculating mitigation required for permanent disturbance based on the permitted layout. No mitigation is proposed for temporary disturbance beyond habitat revegetation. No mitigation is required for disturbance to Category 6 areas.

Prior to construction of the Facility, the Certificate Holder will provide an estimate, in tabular format, of permanent disturbance acres and mitigation ratios shown in Table 2 to provide an updated estimate of mitigation needs.

Table 2. Mitigation Calculation

Habitat Category	Permanent Disturbance (acres)[1]	Mitigation Ratio[2]	Mitigation Need	Mitigation Description
5	4.7	0.5:1	2.4	The mitigation goal for Category 5 habitat is to provide net benefit in habitat quantity or quality. The mitigation strategy is actions that improve habitat conditions.
Grand Total	-	-	**2.4**	--

1. Acres of permanent disturbance requiring mitigation, which excludes habitat types and categories with less than a 0.05 acre mitigation need as well as Category 6 areas.
2. Acres mitigation per acres disturbed.

4.0 Mitigation

The Certificate Holder proposes to contribute funding to supplement ongoing conservation work being conducted by The Nature Conservancy (TNC) in Morrow County to meet mitigation needs of the Facility. This funding will allow additional conservation actions to occur that would not otherwise be conducted and would therefore benefit wildlife in the area. Supplementing existing conservation efforts will provide a greater benefit to wildlife across the landscape than creating a new easement not connected to an existing conservation area with known wildlife use. TNC identified the Lindsay Prairie Preserve, located less than 2 miles west of the Facility, as a potentially suitable site for Facility mitigation. The Lindsay Prairie Preserve is a 376-acre site owned by TNC since 1987 that is protected for restoration and preservation of native vegetation and wildlife. The preserve is a mix of grasslands and sagebrush communities that supports a large and consistent population of Washington ground squirrel (WAGS; *Urocitellus washingtoni*). In August 2018, a wildfire burned approximately 111 acres of the preserve, removing nearly all the sagebrush (*Artemisia tridentata*) and bitterbrush (*Purshia tridentata*) shrubs from the affected area. Thus, the site would benefit from habitat enhancements focused on restoring habitat that burned in 2018.

4.1 Site Description

According to TNC, habitat within the Lindsay Prairie Preserve is considered Category 1 per the ODFW Fish and Wildlife Habitat Mitigation Policy due to the presence of WAGS (personal communication with Jen Langevin, TNC Columbia Basin Program Manager, December 28, 2023). If WAGS were not present at the site, the habitat alone would be considered Category 2 native perennial grassland. TNC collected vegetation data in 2021 in two macroplots within the proposed mitigation area; at that time, cheatgrass (*Bromus tectorum*) was in less than 50 percent of the 1-meter plots, while perennial grasses, such as bluebunch wheatgrass (*Pseudoroegneria spicata*), was in greater than 85 percent of plots and Sandberg bluegrass (*Poa secunda*) was in greater than 98 percent of plots. The dominant grass observed was Sandberg bluegrass, with a diverse forb community also present, including the following species: milkvetch species (*Astragalus purshii* and *Astragalus lentiginous*), woolly plantain (*Plantago patagonica*), lomatium species (*Lomatium macrocarpum* and *Lomatium triternatum*), pussytoes (*Antennaria dimorpha*), phlox (*Phlox longifolia*), flax (*Linum lewisii*), slender hawksbeard (*Crepius atribarba*), and shaggy fleabane (*Erigeron pumilis*). Non-native or introduced forb species were present at a much lower percent frequency compared to native forb species. These data were collected 3 years after the wildfire in 2018 demonstrating a plant community resilient to disturbances such as wildfire, a unique trait in the local area.

4.2 Habitat Enhancements

As described in Section 3.0 above, 2.4 acres of habitat mitigation are needed for Facility disturbance to Category 5 habitat (goal of net benefit). Typically, mitigation for disturbance to Category 5 habitat includes less uplift or enhancement effort than mitigation for Category 4 habitat, given that Category 5 habitat does not have a no net loss goal. However, due to the few total number of acres needed for Facility mitigation, TNC requested that all mitigation acreage be considered Category 4 for the purpose of performing habitat enhancements to simplify logistics of mitigation implementation. Therefore, proposed mitigation habitat enhancements include treatment of the entire mitigation area at a level consistent with Category 4 mitigation goals, as described below.

Mitigation proposed to be conducted at the Lindsay Prairie Preserve includes funding of chemical purchase and application for annual grass treatment and planting shrub plugs as follows:

- <u>Treatment 1 (Year 1):</u> fall aerial application of imazapic (i.e., Plateau) and indaziflam (i.e., Rejuvra) to reduce competition from invasive annual grasses.
- <u>Treatment 2 (Year 1):</u> winter planting of sagebrush and bitterbrush plugs at 300 shrubs per acre. Exact species ratios will be determined prior to mitigation implementation.
    - In TNC's experience performing restoration at the Naval Weapons Systems Training Facility - Boardman and at the Boardman Conservation Area, the average survival of sagebrush plugs is about 50 percent and establishment of bitterbrush is extremely challenging with a survival rate significantly lower than sagebrush. Therefore, TNC proposed two times the ideal number of shrubs per acre to account for this anticipated survival rate.
- <u>Treatment 3 (Year 3, 4, or 5):</u> follow-up aerial application of Plateau and Rejuvra to continue a reduction in competition of invasive annual grasses to allow shrubs to become established.

This proposed mitigation would provide in-kind and in-proximity mitigation considering the Facility would disturb grassland habitat and this mitigation would provide uplift to grassland habitat, and considering the mitigation site's close proximity to the Facility. By mitigating Category 5 habitat disturbance with treatments sufficient to meet the ODFW mitigation goal for Category 4 habitat and including shrub plantings in addition to herbicide application to address the local need for post-fire shrub recovery at the Lindsay Prairie Preserve, the Certificate Holder is going above and beyond the minimum mitigation need for Facility disturbance under the ODFW Habitat Mitigation Policy.

5.0 Monitoring

The treatment area would be monitored for 5 to 6 years to document pre- and post-treatment conditions. This monitoring would be designed to document changes in species diversity and composition. Monitoring would be funded by the Certificate Holder and conducted by the TNC or its contractors and the results of monitoring would be reported to ODFW and the Oregon Department of Energy (ODOE) following each monitoring effort.

To document pre- and post-treatment conditions, baseline monitoring would be conducted during the growing season in the area to be treated in Year 0, followed by post-treatment monitoring during the growing season in Years 1 through 5, and possibly 6 (depending on the timing of the third treatment). Monitoring would occur for at least one-year post-application of the third treatment. TNC established long-term vegetation monitoring macroplots on the Lindsay Prairie Preserve where frequency data are collected. Two of these plots are within the proposed mitigation area (i.e., treatment area) and could be utilized for a portion of the monitoring protocol to determine the efficacy of the herbicide treatments. Prior to construction, the Certificate Holder will provide ODOE and ODFW with a copy of the monitoring protocol, which will be developed in coordination with TNC and subject to ODOE approval. Following ODOE approval, this plan will be amended to incorporate the monitoring protocol.

The mitigation treatments would be considered successful when all treatments have been performed and documented in accordance with the methods described in this HMP.

After initial monitoring of treatments is complete in Year 5 or 6, the Certificate Holder will continue to monitor the site every 5 years thereafter in years divisible by five for the life of the Facility to confirm the site is being maintained at the same habitat category or better as compared to the baseline condition of the mitigation area. This reporting will serve to demonstrate the Facility's mitigation needs are being met throughout the life of the Facility. If the habitat quality of the mitigation area shows evidence of decline the Certificate Holder will investigate the cause of the decline and consult with ODOE and ODFW to develop appropriate adaptive management measures to restore baseline habitat quality.

6.0 Legal Instrument

Prior to construction, the Certificate Holder will provide a map of the mitigation area to ODOE along with a copy of the legal agreement between TNC and the Certificate Holder that describes the scope of mitigation work and the legally enforceable mechanism to ensure implementation of mitigation consistent with the ODFW Habitat Mitigation Policy. The legal instrument will include assurance of durability for the life of the Facility to ensure the mitigation property will remain habitat if TNC ceases to own or manage the land prior to decommissioning of the Facility. The legal instrument will also contain an assurance that the land covered under the agreement will not be used to satisfy any other mitigation obligations other than those pertaining to this Facility. The final mitigation acreage, location, and treatments will be based on final Facility habitat disturbance and mitigation site conditions at the time of implementation and be sufficient to satisfy the ODFW Habitat Mitigation Policy Goals for disturbance to Category 5 habitat. This HMP will be updated, in coordination with ODOE, to reflect any changes in mitigation prior to construction of any Facility phase as described in Section 7.0, below, and consistent with the legal agreement between the TNC and the Certificate Holder at that time.

7.0 Amendment of the HMP

The HMP may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

Sunstone Solar Project 1
Draft Noxious Weed Control Plan

Prepared for

PINEGATE
RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 1, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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Appendices

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1.0 Introduction

Sunstone Solar 1, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 1 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Noxious Weed Control Plan has been prepared to comply with Oregon Administrative Rule 660-033-0130 (38)(h)(D), which states, in regard to photovoltaic solar power generation facilities, that:

> "C*onstruction or maintenance activities will not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. This provision may be satisfied by the submittal and county approval of a weed control plan prepared by an adequately qualified individual that includes a long-term maintenance agreement. The approved plan shall be attached to the decision as a condition of approval*."

Noxious weeds are non-native, aggressive plants with the potential to cause significant damage to native ecosystems and/or cause significant economic losses. Noxious weeds are opportunistic plant species that readily flourish in disturbed areas, are difficult to control, and thereby can compete with and/or prevent native plant species from re-establishing. Notably, the likelihood of introduction or explosion of noxious weeds is correlated with new disturbances in a region, such as large-scale construction projects. In addition, noxious weed species can adversely affect the structure, composition, and success of revegetation efforts associated with construction-related temporary disturbances.

The intent of this Plan is to provide clear methods to prevent the introduction and spread of designated noxious weeds from the construction and operation of the Facility, control existing populations of noxious weeds within construction areas, and monitor the success of efforts to prevent and control noxious weeds. The Certificate Holder and its contractors will be responsible for implementing the methods detailed in this Plan.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

Prior to construction, the Certificate Holder shall finalize this plan by completing the following:

- Conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform pre-construction weed treatment.
- Develop final noxious weed monitoring methods in consultation with ODOE and incorporate as an amendment to this plan upon ODOE approval.
- Update Table 2 in consultation with ODOE and the Morrow County Weed Department.
- Provide records demonstrating all personnel have been trained on noxious weed control.
- Provide evidence that existing noxious weed infestations have been identified and treated in a manner consistent with Morrow County recommendations.
- Consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern.

2.0 Regulatory Framework

2.1 State of Oregon

In Oregon, a noxious weed is defined under Oregon Revised Statutes (ORS) 569.175 as "a terrestrial, aquatic, or marine plant designated by the State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.". Noxious weeds have been declared by ORS 569.350 as a menace to public welfare, and control of these plants is the responsibility of private landowners and operators, as well as county, state, and federal governments.

The Oregon State Weed Board (OSWB) was created by the Oregon Department of Agriculture (ODA) under ORS 569.600. OSWB provides recommendations for noxious weed control at the state-level and is responsible for updating the State Noxious Weed List. The OSWB and the ODA classify noxious weeds in Oregon in accordance with the ODA Noxious Weed Policy and Classification System (ODA 2024). There are three designations under the State's system:

- **A Listed Weed:** A weed of known economic importance that occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent.
    - **Recommended Action:** Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed:** A weed of economic importance that is regionally abundant but may have limited distribution in some counties.

  - **Recommended Action:** Limited to intensive control at the state, county, or regional level as determined on a site-specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.

- **T-Designated Weed:** A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

2.2 Morrow County

The Morrow County Code Enforcement Ordinance establishes procedures for enforcing Morrow County Code through the authority granted to general law counties by ORS Chapter 203. Section 11 of the county Code Enforcement Ordinance, updated on July 5, 2021, establishes Morrow County as a weed control district, defines what is considered a noxious weed or weed of economic importance, identifies the responsibility of private landowners to control weeds, and outlines the authority of the weed control district and Morrow County Weed Program Manager/Inspector to administer and enforce weed control in the ordinance (Morrow County 2021).

Morrow County has its own weed classification system that differs from the state. Morrow County defines two classifications of weeds (Morrow County 2025):

- **Noxious Weeds - "A List":** Any plant that is determined by the weed advisory board and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land, or property under provisions of Oregon State Statute and thus mandated for control.
- **Weeds of Economic Importance - "B List":** Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

2.3 State and County Weed Lists

The ODA lists 46 Class A species and 88 Class B species for the state of Oregon, 19 of which are T-designated (ODA 2024; Appendix A). Morrow County specifically recognizes 36 species of noxious weeds (Appendix B; Morrow County 2025). Although not all the Morrow County listed noxious weeds noted in Appendix B occur in the vicinity of the Facility, the Certificate Holder and its contractors should be aware of the entire list while monitoring and controlling weeds. Noxious weeds known to occur in the vicinity of the site boundary are discussed in Section 3.0.

3.0 Noxious Weeds Identified at the Facility

In June, 2022 Tetra Tech completed rare plant and habitat categorization surveys within and adjacent to the original Sunstone Solar Project site boundary[2]. During those surveys, four listed noxious weed species were documented, including three ODA-listed noxious weed species and four Morrow County listed species noxious weed species. Table 1 lists the noxious weed species observed, their noxious weed designation (i.e., status), and the frequency of observations. Locations of these noxious weeds documented during surveys are included in Exhibit P, Attachment P-1 of the ASC[3]. Three of the four noxious weed species observed were state and/or County "B" listed weeds (Table 1; Morrow County 2025, ODA 2024). One species, rush skeletonweed (*Chondrilla juncea*), is an "A" List Weed in Morrow County and a state "T"-designated weed, meaning that ODA has targeted this species for prevention and control (Morrow County 2025; ODA 2024). Note that none of these noxious weed species observations are located within the Sunstone Solar Project 1/Facility site boundary, however, due to the likelihood that these species could be found at the Facility in the future, they are retained for awareness and noxious weed prevention purposes.

Cereal rye (*Secale cereale*) was abundant in the previously disturbed areas outside of active crop fields and was generally found in previously disturbed ground. Rush skeletonweed was found in isolated small populations or single individuals on the hillside between active cropland and a gravel county road. Puncturevine (*Tribulus terrestris*) and jointed goatgrass (*Aegilops cylindrica*) were found in the highly disturbed border in between active cropland and roads. The Certificate Holder will conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform management actions. The Certificate Holder may coordinate with landowners regarding noxious weed presence. Identified noxious weed infestations will be treated prior to construction.

Table 1. Noxious Weeds Observed during Surveys in 2022

Scientific Name	Common Name	Oregon State Status[1]	Morrow County Status[1]	Frequency
Aegilops cylindrica	Jointed goatgrass	B	B	Few small patches.
Chondrilla juncea	Rush skeletonweed	B*, T	A	Occasional single plants.
Secale cereale	Cereal rye	Not listed	B	Scattered large-sized patches.
Tribulus terrestris	Puncturevine	B*	B	Few small to large-sized patches.

1. Definitions for state and county noxious weed status are provided in Sections 2.1 and 2.2, respectively. Species marked with a (*) are targeted for biocontrol (ODA 2024).

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[2] Site Certificate for the Sunstone Solar Project, November 18, 2024.

[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

In addition to noxious weeds, cheatgrass, an invasive annual grass, was identified in grassland habitats within the Sunstone Solar Project site boundary. While this species is not listed as a noxious weed by the state or county, it and other invasive annual grasses can adversely impact habitat and can increase fire risk. To address these issues and maintain compliance with the requirements of the Revegetation Plan required under Condition PRE-FW-01, the certificate holder will monitor the spread of these species as explained in Section 4.3 and 4.4.

4.0 Noxious Weed Management

This section of this Plan describes the steps the Certificate Holder will take to prevent and control the establishment and spread of noxious weed species during both construction and operation of the Facility. Noxious weed control methods for the Facility described in this Plan have been developed utilizing information from the ODA Noxious Weed Control Program and the Morrow County Weed Department.

The management of noxious weeds will be considered throughout all stages of construction and operation of the Facility and will include:

- **Prevention:** Implementing measures to prevent the spread of noxious weeds during construction, operation, and maintenance activities.
- **Treatment:** Treating noxious weed populations with their appropriate control methods, at appropriate time intervals.
- **Monitoring:** Assessing noxious weed changes within the Facility site boundary over time and ensuring that legacy as well as new weed populations are not increasing their distributions.

The Certificate Holder's objective is to prevent the introduction of new noxious weed populations and the spread of existing noxious weed populations. The methods described below will be implemented to minimize the spread of noxious weeds during construction activities. New noxious weeds detected during post-construction revegetation will be considered a result of construction activities and will be controlled accordingly.

4.1 Prevention

Prior to the start of construction, all personnel will be trained on the importance of noxious weed control. As part of start-up activities, and to help facilitate the avoidance of existing infestations and identification of new infestations, the Certificate Holder or their construction contractor will provide information and training to all construction personnel regarding noxious weed identification and prevention strategies. Operations and maintenance personnel will be similarly informed. The importance of preventing the spread of noxious weeds in areas not currently infested and controlling the proliferation of noxious weeds already present within or near the Facility will be emphasized.

The Certificate Holder will implement the following best management practices to minimize the spread of noxious weeds during construction activities, revegetation efforts, and operation and maintenance activities. The following practices center around ensuring that noxious weed seeds or reproductive plant fragments are not unintentionally dispersed within or outside of the Facility boundaries by personnel or their vehicles. These practices allow for responsible movement around sites with noxious weeds already present, and ensure that new populations or species are not accidentally introduced into the Facility boundaries.

- Flagging and treating areas of noxious weed infestations prior to construction to alert construction personnel;
- Limiting vehicle access to designated routes, whether existing roads or newly constructed roads, and the outer limits of construction disturbances per the final design for the Facility;
- Limiting vehicle traffic in noxious weed-infested areas;
- Cleaning construction vehicles each time they enter or exit the Facility at a wash station located inside the Facility at vehicle ingress/egress points;
- Cleaning vehicles and equipment associated with ground disturbance and movement of topsoil utilizing a mobile wash station after performing work in noxious weed-infested areas and prior to performing work in non-infested areas;
- Where feasible, not moving topsoil and other soils from noxious weed infested areas outside of the infested areas and returning them to their previous location during reclamation activities;
- Treating soils from infested areas with a pre-emergent herbicide prior to initiation of revegetation efforts;
- Providing information regarding target noxious weed species at the operations and maintenance buildings;
- Treating noxious weeds via biological, mechanical or chemical control (see Section 4.2);
- Preventing conditions favorable for noxious weed germination and spread by revegetating temporarily disturbed areas as soon as practicable;
- Monitoring areas of disturbance for noxious weeds after construction (see Section 4.3), during the normal course of revegetation maintenance of temporary workspaces, and implementing control measures as appropriate;
- Revegetating the site with appropriate, local native seed or native plants; when these are not available, non-invasive, and non-persistent non-native species may be used; and
- Ensuring that seed and straw mulch used for site rehabilitation and revegetation are certified free of noxious weed seed and propagules.

4.2 Treatment

Control of noxious weeds and other invasive weed species will be implemented through biological, mechanical, chemical, or biological control measures. The control method used will depend on the

weed species and size of infestation, time of year, proximity to intact native habitats, and resources available (Tu et al. 2003). Generally, mechanical control is best suited for small infestations of tap-rooted weeds that can be hand pulled or large occurrences in areas where mowing or soil disturbance is acceptable. Chemical control is used for most occurrences of perennial weeds with rhizomes or stolons and large occurrences of any weed in areas where mowing or soil disturbance are not recommended. Successful noxious weed control programs typically combine mechanical and chemical treatment strategies (USEPA 2008).

The Certificate Holder will be responsible for hiring a qualified contractor to implement the treatment of noxious weeds. The Certificate Holder will ensure that noxious weed management actions will be conducted by specialists with the following qualifications:

- Experience in native plant, non-native and invasive plants, and noxious weed identification;
- Experience in noxious weed mapping;
- If chemical control is used, specialists must possess a Commercial or Public Pesticide Applicator License from the ODA or possess an Immediately Supervised Pesticide Trainee License and be supervised by a licensed applicator;
- Training in noxious weed management or Integrated Pest Management with an emphasis in noxious weeds;
- Experience in coordination with agencies and private landowners; and
- No recent (within one year) violations on the contractor's record.

Existing noxious weed populations will be prevented from expanding in size and density and will not be spread to new sites. Existing populations of A listed noxious weeds will be eliminated. If it is determined that noxious weeds have invaded areas immediately adjacent to the Facility (e.g., areas visible just beyond the outer limits of construction disturbances associated with the Facility or along access roads) as a result of construction, the Certificate Holder will contact the landowner and seek approval to treat those noxious weed populations.

Long-term weed control methods will be described in a long-term monitoring plan as described in Section 4.3. The main factor in long-term weed control is successful revegetation with non-weedy species as described in the Draft Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). If feasible, long-term management of vegetation within the Facility solar array fence line may include prescriptive sheep and goat grazing by an authorized contractor, if approved by Morrow County, ODFW and ODOE. As noted above, short-term noxious weed control will be done through mechanical or chemical treatment. However, it will be important to ensure that the short-term treatment does not affect the establishment of the native perennial cover that will help provide the long-term control. Additionally, early detection and control of small noxious weed populations before they can expand into larger populations is extremely important for successful weed control efforts.

Noxious weed control will continue for the life of the Facility to meet the identified success criteria described in Section 4.3. Supplemental seeding of desirable species may be needed to meet and/or

maintain compliance with success criteria. Fertilizer application will be limited in areas treated for noxious weeds, as fertilizer can stimulate the growth of noxious weeds, and the timing of revegetation activities will need to be coordinated with noxious weed treatments.

4.2.1 Biological

Biological control involves the use of prescribed insects, fungi and livestock to control noxious weeds to achieve management objectives. Biological control methods are typically targeted to a specific species or plant to control its persistence. They are also used for maintenance in targeted areas for vegetation management control in height and density that includes mitigating fire risk and erosion. Biological control is environmentally friendly and should be the first consideration when applicable.

4.2.2 Mechanical Treatment

Mechanical treatment will be the preferred method of treatment for existing noxious weed populations where appropriate within the boundaries of the Facility. Mechanical control methods rely on removal of plants, seed heads, and/or cutting roots with a shovel or other hand tools or equipment that can be used to remove, mow, or disc noxious weed populations. Hand removal of plants is also included under this treatment method. Mechanical methods are useful for smaller, isolated populations of noxious weeds in areas of sensitive habitats. Additionally, hand removal of small infestations can minimize soil disturbance, allowing desirable species to remain and limiting conditions favorable for noxious weeds.

For some large noxious weed occurrences, mowing, tilling, discing, or other mechanical techniques may be used to reduce thatch prior to chemical application so that herbicide can more effectively make contact with the target species. However, some rhizomatous plants can spread by discing or tillage. In addition, rush skeletonweed, which was identified near the Facility (Section 3.0), can reproduce vegetatively from small segments of root, and discing or tilling can facilitate the spread of this species. As such, implementation of discing will be species-specific and avoided in areas where rush skeletonweed individuals have been found.

If tilling or discing is employed in areas that will be revegetated following construction, subsequent seeding will be conducted to re-establish desirable vegetative cover that will stabilize the soils and slow the potential re-invasion of noxious weeds. Discing, tilling, or other mechanical treatments that disturb the soil surface within native habitats will also be avoided in favor of herbicide application, which is an effective means of reducing the size of noxious weed populations as well as preventing the establishment of new infestations. Previously unbroken ground or fallow areas should not be tilled or rod-weeded to maintain native biocrusts and prevent exposing weed seeds.

4.2.3 Chemical Treatment

Chemical control can effectively remove noxious weeds through use of selective herbicide when mechanical control is not feasible. The specific herbicide used and the timing of application will be

chosen based on the specific noxious weed being treated, as appropriate herbicides differ between species and types of plants (i.e., dicots such as rush skeletonweed versus monocots such as jointed goatgrass). Example treatment methods, as well as the recommended timing of treatments for the four target noxious weeds identified within the Facility, are summarized in Table 2. The status of herbicide approval (e.g., confirming herbicides are approved for use by the U.S. Environmental Protection Agency [EPA] and ODA) will be checked annually.

Prior to construction and every fall season during facility operation, the Certificate Holder or its contractor will consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern, to allow for adaptive weed management given changes in weed control effectiveness from noxious weed species tolerance to herbicide treatment over time. Results of the consultation shall be reported in the Certificate Holder's annual monitoring report. Any alternative control methods can be proposed by the Certificate Holder or its contractors after consulting with the Morrow County Weed Department and included in the Certificate Holder's annual monitoring report.

Herbicides will be applied on identified, treatable, noxious weed infestations. The Certificate Holder or their contractors will coordinate with the Morrow County Weed Department to determine which populations are treatable and will notify landowners of proposed herbicide use on their lands prior to application. If a noxious weed population is deemed to be untreatable (e.g., too widespread and established in an area to successfully control), the Certificate Holder will implement the applicable prevention measures discussed in Section 4.1, except for treatment with herbicides.

Table 2. Example Treatment for Target Noxious Weed Species

Scientific Name	Common Name	Treatment Method and Timing
Aegilops cylindrica	Jointed goatgrass	**Glyphosate** – Apply to actively growing plants emerged before bolt stage (i.e., stage of growth where growth is focused on seed development versus leaf development). • Rate: 0.38 to 0.75 lb ae/a[1] **Imazapic –** Apply pre-emergence in fall. Due to the residual effect of this herbicide, it will not be used in areas to be revegetated. • Rate: 0.063 to 0.188 lb/a[1] **Sulfometuron** – Apply in fall or in late winter before jointed goatgrass is 3 inches tall. • Rate: 1 to 1.5 oz ai/a (1.33 to 2 oz/a)[1]
Chondrilla juncea	Rush skeletonweed	**2,4-D or MCPA –** Apply to rosettes in the spring immediately before or during bolting. • Rate: 2 lb ae/a[1] **Aminopyralid (Milestone) –** Spring or fall when rosettes are present. • Rate: 1.75 oz ae/a (7 fluid oz/a Milestone)[1] **Clopyralid –** Apply to rosettes in fall or up to early bolting in spring. • Rate: 0.25 to 0.375 lb ae/a (0.66 to 1 pint/a)[1]

Scientific Name	Common Name	Treatment Method and Timing
		Picloram – Apply from late fall to early spring. For best results, apply just before or during bolting. - Rate: 1 lb ae/a[1]
Secale cereale	Cereal rye	Postemergence, non-selective herbicides such as glyphosate can control cereal rye. Glyphosate does not provide residual weed control, so any plants that emerge after treatment will not be controlled. Other herbicides that have found to provide control include Clethodim, Hexazinone, Rimsulfuron, Sethoxydim, and Sulfometuron.
Tribulus terrestris	Puncturevine	**2,4-D amine or 2,4-D LV ester–** Apply every 3 weeks during growing season or when new seedlings appear. - Rate: 1 to 2 lb ae in 10 to 20 gal water for spot treatments **Bentazon (Basagran) + imazamox (Raptor)–** Apply to small, actively growing puncture vine - Rate: 0.75 to 1 lb ai/A bentazon + 0.031 lb ai/a imazamox (4 oz/A Raptor) **Bromacil + diuron–** Apply before weeds emerge. - Rate: 8 lb ai/A (10 lb/a)[1] **Chlorsulfuron–** Apply late fall or late winter preemergence to growth. Needs moisture to activate. - Rate: 1 oz ai/a (1.5 oz/a)[1] **Fomesafen –** Apply pre- and postemergence, depending on crop. - Rate: 1 to 2 pints/A (0.25 to 0.5 lb ai/a)[1] **Imazapic –** Apply early postemergence when plants are cracking. - Rate: 0.125 to 0.188 lb ai/a[1] **Indaziflam –** Apply at least several weeks prior to expected germination of puncture vine. Apply to dry soils when rain is not expected for at least 48 hours. Can be successfully applied several months in advance of weed germination. - Rate: Grazed areas 0.046 to 0.065 lb ai/a (3.5 to 5 oz/a Rejuvra); areas not grazed or cut for hay 0.046 to 0.09 lb ai/A (3.5 to 7 oz/a Rejuvra). Use lower rates only where weed pressure is light and shorter period of residual activity is desired. **Norflurazon –** Apply in fall to spring, before puncture vine emerges. - Rate: Refer to label. Adjust rates depending on soil texture and organic matter **Paraquat –** Apply as a postemergence spray to puncture vine foliage - Rate: 0.38 to 0.49 lb ai/a[1] -

Sources: DiTomaso e al. 2013; LCNWCB 2022; Prather and Peachey 2022.

[1] a = acre; ae = acid equivalent; ai = active ingredient; lb= pound; oz = ounces

4.2.3.1 Herbicide Application and Handling

Herbicide application will occur within the appropriate season and during the appropriate timeframe to achieve desired results, as approved by ODOE and the county weed departments. Herbicide application will adhere to EPA and ODA standards. Only those herbicides that are approved by the EPA and ODA will be used. In general, application of herbicides will not occur when the following conditions exists:

- Wind velocity exceeds 15 miles per hour for granular application, or exceeds 10 miles per hour for liquid applications;
- Snow or ice covers the foliage of target species; or
- Adverse weather conditions are forecasted within the next few days.

Hand application methods (e.g., backpack spraying) may be used in roadless areas or in rough terrain. Vehicle-mounted sprayers (e.g., handgun, boom, and injector) will be used mainly in open areas that are readily accessible by vehicle. Calibration checks of equipment will be conducted prior to spraying activities, as well as periodically throughout use, to ensure that appropriate application rates are achieved.

Herbicides will be transported to the Facility daily with the following stipulations:

- Only the quantity needed for that day's work will be transported.
- Concentrate will be transported in approved containers only, and in a manner that will prevent spilling, stored separately from food, clothing, and safety equipment.
- Mixing will be done off-site and at a distance greater than 200 feet from open or flowing water, wetlands, or other sensitive species' habitat. No herbicides will be applied at these areas unless authorized by the appropriate regulatory agencies.
- All herbicide equipment and containers will be inspected daily for leaks.
- Herbicides use will be in accordance with all manufacture's label recommendations and warnings.

4.2.3.2 Herbicide Spills and Cleanups

All appropriate precautions will be taken to avoid herbicide spills. In the event of a spill, cleanup will be immediate. Contractors will keep spill kits in their vehicles and in an appropriate storage shed to allow for quick and effective response to spills. Items included in the spill kit will be:

- Protective clothing and gloves;
- Adsorptive clay, "kitty litter," or other commercial adsorbent;
- Plastic bags and a bucket;
- A shovel;
- A fiber brush and screw-in handle;
- A dustpan;

- Caution tape;
- Highway flares (use on existing hard-top roads only); and
- Detergent.

Response to an herbicide spill will vary with the size and location of the spill, but general procedures include:

- Stopping the leak;
- Containing the spilled material;
- Traffic control;
- Dressing the clean-up team in protective clothing;
- Cleaning up and removing the spilled herbicide, as well as the contaminated adsorptive material and soil; and
- Transporting the spilled herbicide and contaminated material to an authorized disposal site.

4.2.3.3 Herbicide Spill Reporting

All herbicide contractors will have readily available copies of the appropriate material safety data sheets for the herbicides used at their disposal and will keep copies of the material safety data sheets in the application vehicle. If an herbicide spill of any size occurs, the appropriate agency and spill coordinators will be notified promptly. In case of a spill into wetlands and waterbodies, the appropriate federal, state, and county agencies will be notified immediately. All herbicide spills equal to or greater than 200 pounds or 25 gallons of pesticide residue will be reported to the Oregon Emergency Response System in accordance with applicable laws and requirements (OAR 340-142-0050; ODEQ 2024). The Certificate Holder will report all herbicide spills to ODOE by phone or email within 24 hours with follow up reporting as appropriate.

4.3 Monitoring

Weed inspections will occur across the entire Facility through visual inspection of the site while driving and/or walking. Final monitoring methods will be determined in consultation with ODOE prior to construction and will be incorporated as an amendment to this plan upon ODOE approval. Monitoring will be conducted by a qualified botanist or weed specialist and will begin in the first growing season after seeding. Monitoring for noxious weeds and other undesirable weed species will occur at least five times per year including in the spring, June, July, and August for summer annuals and in the fall during the first two years following construction to capture the different life cycles of noxious weed species. This will allow real-time assessment of weed growth and inform proactive weed control measures to prevent large scale infestations. Frequent checks during early revegetation efforts will enable the Certificate Holder to respond to new weed infestations in a timely manner and ensure the success of the site’s revegetation. These inspections will be used to inform ongoing weed control efforts.

The initial monitoring survey will be scheduled slightly before herbicide application, as applicable, to identify any noxious weed species within the areas to be treated, with a focus on target noxious weed species observed prior to construction (Table 1), or other populations of target noxious weeds not previously observed.

Monitoring will assess the success of noxious weed treatments and will document any new noxious weed infestations observed. During the first two years following construction, the Certificate Holder will meet with ODOE and the Morrow County Weed Department at least once per season to provide updates on weed infestations and control measures at the Facility. These results will also be summarized in annual monitoring reports that describe the treatments performed, treatment success, make recommendations to improve treatment success (if necessary), and note any new target noxious weed species or emergence. Reports will be submitted to the Oregon Department of Energy (ODOE), Oregon Department of Fish and Wildlife (ODFW), and Morrow County annually.

Based on the success of control efforts after the second year of monitoring, the Certificate Holder will consult with ODOE and ODFW to determine if the monitoring cycle can be reduced for years three to five. After five years of monitoring, the Certificate Holder will design a long-term weed control plan in consultation with ODOE and the Morrow County Weed Department. The Certificate Holder will maintain ongoing communication with individual landowners, the Morrow County Weed Department, and ODOE regarding noxious weeds within the Facility. Landowners may also contact the Certificate Holder directly to report the presence of noxious weeds related to Facility activity. The Certificate Holder will control the noxious weeds on a case-by-case basis and prepare a summary of measures taken for that landowner. During the operational period of the Facility, the Certificate Holder will control noxious weeds as described in the long-term weed control plan. The Certificate Holder will report the investigator's findings and recommendations regarding weed control in the Facility's annual report required per OAR 345-026-0080.

The following contact information for the Morrow County Weed Program Manager will be used and updated as needed:

Corey Sweeney, Weed Program Manager
Morrow County Public Works
365 West Highway 74
Lexington, OR 97839
(541) 989-9502
mcweed@co.morrow.or.us

4.4 Success Criteria

Success criteria outlined below are designed to demonstrate compliance with OAR 660-033-0130(38)(D) to prevent the introduction and spread of noxious weed species. In each annual monitoring report, the Certificate Holder will include an assessment of whether the Facility is meeting or trending toward meeting the noxious weed control success criteria. Compliance with the Facility Site Certificate will be demonstrated through documentation of meeting these success criteria for the life of the Facility.

- Class A and Class B noxious weed presence within the solar array fence line will not exceed 15 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Class T noxious weed presence within the solar array fence line will not exceed 5 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Invasive Annual Grasses and other Undesirable Species will not exceed more then 50 percent cover within any 1 acre area or more than 30 percent cover within the solar array fence line.
- During revegetation of temporary disturbance areas outside of the solar array fence line presence and cover of noxious weeds is 75 percent or less than that of the reference site.

5.0 Roles and Responsibilities

The Certificate Holder is the overall responsible party for construction and operation of the Facility and implementation of the noxious weed management activities described in this Plan. However, the Certificate Holder may use contractors to complete tasks associated with noxious weed management and monitoring. Example responsible parties and their roles may include:

Monitoring Contractor

- Perform site visits to document noxious weed occurrences.
- Provide summary memo after each visit to Certificate Holder's operations manager outlining findings and treatment recommendations.
- Communicate directly with Weed Management Contractor and provide maps, and photos of noxious weed species locations to Weed Management Contractor.
- Communicate with Morrow County Weed Program Manager, and ODA about noxious weed survey findings and treatment plans.
- Prepare annual report for the Facility describing noxious weed monitoring findings and treatments.
- Organize and attend quarterly calls with the Certificate Holder and Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Certificate Holder Site Manager

- Communicate findings and recommendations from Monitoring Contractor to the Weed Management Contractor.
- Document the work performed by the Weed Management Contractor and provide documentation to Monitoring Contractor. Documentation should include type and quantity

of herbicides applied, dates applied, and any associated EPA/U.S. Department of Environmental Quality licensing/documentation of chemicals used.

- Reviews annual reports to ensure all treatments performed by the Weed Management Contractor are documented.
- Maintain landowner communications, providing guidance to the Monitoring Contractor and Weed Management Contractor regarding landowner restrictions/requests for performing noxious weed monitoring/treatment on their properties.
- Attend quarterly calls with Monitoring Contractor and the Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Weed Management Contractor

- Review Monitoring Contractor memos describing noxious weed occurrences and recommendations and plan appropriate treatment to address those issues.
- Communicate treatment plan to the Certificate Holder.
- Maintain records of when, where, and what type of noxious weed treatments are being performed.
- Maintain all appropriate documentation of chemicals applied. Shares documentation during the quarterly calls with the Certificate Holder and Monitoring Contractor, and prior to Annual Report preparation.
- Attend quarterly calls with Monitoring Contractor and Certificate Holder.

Morrow County

- Review Monitoring Contractor memos describing weed occurrences and recommendations.
- Attend quarterly calls and provide recommendations.

6.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE. This Plan may also be amended periodically as the Certificate Holder continues to evaluate and modify, as needed, agricultural dual use activities at the Facility.

7.0 References

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Appendix A: Oregon State Noxious Weed List

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OREGON
DEPARTMENT OF
AGRICULTURE

Noxious Weed Policy and Classification System
2024

Noxious Weed Control Program

Address: 635 Capitol Street NE, Salem, Oregon 97301

Phone: (503) 986-4625 **Fax:** (503) 986-4786

www.oregon.gov/ODA/programs/Weeds/Pages/AboutWeeds.aspx

Mission Statement

To protect Oregon’s natural resources and agricultural economy from the invasion and proliferation of invasive noxious weeds.

Program Overview

The Oregon Department of Agriculture (ODA) Noxious Weed Control Program provides statewide leadership for coordination and management of state listed noxious weeds. The state program focuses on noxious weed control efforts by implementing early detection and rapid response projects for new invasive noxious weeds, implementing biological control, implementing statewide inventory and survey, assisting the public and cooperators through technology transfer and noxious weed education, maintaining noxious weed data and maps for priority listed noxious weeds, and assisting land managers and cooperators with integrated weed management projects. The Noxious Weed Control Program also supports the Oregon State Weed Board (OSWB) with administration of the OSWB Grant Program, developing statewide management objectives, developing weed risk assessments, and maintaining the state noxious weed list.

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Noxious Weed Control Policy and Classification System

Definition

“Noxious weed” means a terrestrial, aquatic or marine plant designated by the Oregon State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.

Noxious weeds have become so thoroughly established and are spreading so rapidly on private, state, county, and federally owned lands, that they have been declared by ORS 569.350 to be a menace to public welfare. Steps leading to eradication, where possible, and intensive control are necessary. It is further recognized that the responsibility for eradication and intensive control rests not only on the private landowner and operator, but also on the county, state, and federal governments.

Weed Control Policy

Therefore, it shall be the policy of ODA to:

1. Assess non-native plants through risk assessment processes and make recommendations to the Oregon State Weed Board for potential listing.
2. Rate and classify weeds at the state level.
3. Prevent the establishment and spread of listed noxious weeds.
4. Encourage and implement the control or containment of infestations of listed noxious weed species and, if possible, eradicate them.
5. Develop and manage a biological weed control program.
6. Increase awareness of potential economic losses and other undesirable effects of existing and newly invading noxious weeds, and to act as a resource center for the dissemination of information.
7. Encourage and assist in the organization and operation of noxious weed control programs with government agencies and other weed management entities.
8. Develop partnerships with county weed control districts, universities, and other cooperators in the development of control methods.
9. Conduct statewide noxious weed surveys and weed control efficacy studies.

Weed Classification System

The purpose of this Classification System is to:

1. Act as the ODA's official guideline for prioritizing and implementing noxious weed control projects.
2. Assist the ODA in the distribution of available funds through the Oregon State Weed Board to assist county weed programs, cooperative weed management groups, private landowners, and other weed management entities.
3. Serve as a model for private and public sectors in developing noxious weed classification systems that aid in setting effective noxious weed control strategies.

Criteria for Determining Economic and Environmental Significance

Detrimental Effects

1. A plant species that causes or has the potential to cause severe negative impacts to Oregon's agricultural economy and natural resources.
2. A plant species that has the potential to or does endanger native flora and fauna by its encroachment into forest, range, aquatic and conservation areas.
3. A plant species that has the potential or does hamper the full utilization and enjoyment of recreational areas.
4. A plant species that is poisonous, injurious, or otherwise harmful to humans and/or animals.

Plant Reproduction

1. A plant that reproduces by seed capable of being dispersed over wide areas or that is long-lived, or produced in large numbers.
2. A plant species that reproduces and spreads by tubers, creeping roots, stolons, rhizomes, or other natural vegetative means.

Distribution

1. A weed of known economic importance which occurs in Oregon in small enough infestations to make eradication/containment possible; or not known to occur, but its presence in neighboring states makes future occurrence seem imminent.
2. A weed of economic or ecological importance and of limited distribution in Oregon.
3. A weed that has not infested the full extent of its potential habitat in Oregon.

Difficulty of Control

A plant species that is not easily controlled with current management practices such as chemical, cultural, biological, and physical methods.

Noxious Weed Control Classification Definitions

Noxious weeds, for the purpose of this system, shall be listed as either A or B, and may also be designated as T, which are priority targets for control, as directed by the Oregon State Weed Board.

- **A Listed Weed**:
  A weed of known economic importance which occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent (Table I).
  Recommended action: Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed**:
  A weed of economic importance which is regionally abundant, but which may have limited distribution in some counties (Table II).
  Recommended action: Limited to intensive control at the state, county or regional level as determined on a site specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.
- **T-Designated Weed (T)**:
  A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

Weed Biological Control

Oregon implements biological control, or “biocontrol” as part of its integrated pest management approach to managing noxious weeds. This is the practice of using host-specific natural enemies such as insects or pathogens to control noxious weeds. The Oregon Department of Agriculture Noxious Weed Program has adopted the International Code of Best Practices for biological control of weeds. Only safe, effective, and federally-approved natural enemies will be used for biocontrol.

Table I: A Listed Weeds

Common Name	Scientific Name
African rue	*Peganum harmala*
Camelthorn	*Alhagi pseudalhagi*
Cape-ivy	*Delairea odorata*
Coltsfoot	*Tussilago farfara*
Common frogbit	*Hydrocharis morsus-ranae*
Cordgrass	
Common	*Spartina anglica*
Dense-flowered	*Spartina densiflora*
Saltmeadow	*Spartina patens*
Smooth	*Spartina alterniflora*
Delta arrowhead	*Sagittaria platyphyla*
European water chestnut	*Trapa natans*
Flowering rush	*Butomus umbellatus*
Garden yellow loosestrife	*Lysimachia vulgaris*
Giant hogweed	*Heracleum mantegazzianum*
Goatgrass	
Barbed	*Aegilops triuncialis*
Ovate	*Aegilops ovata*
Goatsrue	*Galega officinalis*
Hawkweed	
King-devil	*Hieracium piloselloides*
Mouse-ear	*Hieracium pilosella*
Orange	*Hieracium aurantiacum*
Yellow	*Hieracium floribundum*
Hoary alyssum	*Berteroa incana*
Hydrilla	*Hydrilla verticillata*
Japanese dodder	*Cuscuta japonica*
Kudzu	*Pueraria lobata*
Matgrass	*Nardus stricta*
Oblong spurge	*Euphorbia oblongata*
Palmer amaranth	*Amaranthus palmeri*
Paterson's curse	*Echium plantagineum*
Purple nutsedge	*Cyperus rotundus*
Ravennagrass	*Saccharum ravennae*
Squarrose knapweed	*Centaurea virgata*

(Continued) Table I: A Listed Weeds

Common Name	Scientific Name
Starthistle	
Iberian	*Centaurea iberica*
Purple	*Centaurea calcitrapa*
Thistle	
Plumeless	*Carduus acanthoides*
Smooth distaff	*Carthamus baeticus*
Taurian	*Onopordum tauricum*
Turkish	*Carduus cinereus*
Welted (curly plumeless)	*Carduus crispus*
Woolly distaff	*Carthamus lanatus*
Water soldiers	*Stratiotes aloides*
West Indian spongeplant	*Limnobium laevigatum*
White bryonia	*Bryonia alba*
Yellow floating heart	*Nymphoides peltata*
Yellowtuft	*Alyssum murale, A. corsicum*

Table II: B Listed Weeds

Common Name	Scientific Name
Armenian (Himalayan) blackberry	*Rubus armeniacus (R. procerus, R. discolor)*
Biddy-biddy	*Acaena novae-zelandiae*
Broom	
French*	*Genista monspessulana*
Portuguese (T)	*Cytisus striatus*
Scotch*	*Cytisus scoparius*
Spanish	*Spartium junceum*
Butterfly bush	*Buddleja davidii (B. variabilis)*
Common bugloss (T)	*Anchusa officinalis*
Common crupina **(T)**	*Crupina vulgaris*
Common reed	*Phragmities australis ssp. australis*
Common viper's bugloss (T)	*Echium vulgare*
Cutleaf teasel	*Dipsacus laciniatus*
Dyer's woad (T)	*Isatis tinctoria*
English hawthorn	*Crataegus monogyna*
Eurasian watermilfoil	*Myriophyllum spicatum*
False brome	*Brachypodium sylvaticum*
Field bindweed	*Convolvulus arvensis*
Garlic mustard (T)	*Alliaria petiolata*
Geranium	
Herb Robert	*Geranium robertianum*
Shiny leaf	*Geranium lucidum*
Giant reed (T)	*Arundo donax*
Gorse* (T)	*Ulex europaeus*
Halogeton	*Halogeton glomeratus*
Houndstongue	*Cynoglossum officinale*

* Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Indigo bush	*Amorpha fruticosa*
Ivy	
Atlantic	*Hedera hibernica*
English	*Hedera helix*
Jointed goatgrass	*Aegilops cylindrica*
Jubata grass	*Cortaderia jubata*
Knapweed	
Diffuse*****	*Centaurea diffusa*
Meadow*****	*Centaurea pratensis*
Russian*****	*Acroptilon repens*
Spotted*****	*Centaurea stoebe (C. maculosa)*
Knotweed	
Bohemian*****	*Fallopia x bohemica*
Giant*****	*Fallopia sachalinensis (Polygonum)*
Himalayan	*Polygonum polystachyum*
Japanese*****	*Fallopia japonica (Polygonum)*
Kochia	*Kochia scoparia*
Lesser celandine	*Ranunculus ficaria*
Meadow hawkweed (T)	*Pilosella caespitosum (Hieracium)*
Mediterranean sage*	*Salvia aethiopis*
Medusahead rye	*Taeniatherum caput-medusae*
Old man's beard	*Clematis vitalba*
Parrot feather	*Myriophyllum aquaticum*
Perennial peavine	*Lathyrus latifolius*
Perennial pepperweed (T)	*Lepidium latifolium*
Pheasant's eye	*Adonis aestivalis*
Pine echium (T)	*Echium pininana*
Poison hemlock*****	*Conium maculatum*
Policeman's helmet	*Impatiens glandulifera*
Primrose-willow	
Large-flower (T)	*Ludwigia grandiflora*
Water primrose (T)	*Ludwigia hexapetala*
Floating (T)	*Ludwigia peploides*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Puncturevine*****	*Tribulus terrestris*
Purple loosestrife*****	*Lythrum salicaria*
Ribbongrass (T)	*Phalaris arundinacea var. Picta*
Rose	
Dog	*Rosa canina*
Sweetbriar	*Rosa rubiginosa*
Rush skeletonweed***** (T)	*Chondrilla juncea*
Saltcedar***** (T)	*Tamarix ramosissima*
Small broomrape	*Orabanche minor*
South American waterweed	*Egeria densa (Elodea)*
Spanish heath	*Erica lusitanica*
Spurge laurel	*Daphne laureola*
Spurge	
Leafy***** (T)	*Euphorbia esula*
Myrtle	*Euphorbia myrsinites*
St. Johnswort	*Hypericum perforatum*
Sulfur cinquefoil	*Potentilla recta*
Swainsonpea	*Sphaerophysa salsula*
Tansy ragwort***** (T)	*Senecio jacobaea (Jacobaea vulgaris)*
Thistle	
Bull	*Cirsium vulgare*
Canada*****	*Cirsium arvense*
Italian	*Carduus pycnocephalus*
Milk	*Silybum marianum*
Musk	*Carduus nutans*
Scotch	*Onopordum acanthium*
Slender-flowered	*Carduus tenuiflorus*
Toadflax	
Dalmatian*****	*Linaria dalmatica*
Yellow*****	*Linaria vulgaris*
Tree of heaven	*Ailanthus altissima*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Ventenata grass	*Ventenata dubia*
Whitetop	
Hairy	*Lepidium pubescens*
Lens-podded	*Lepidium chalepensis*
Whitetop (hoary cress)*****	*Lepidium draba*
Yellow archangel	*Lamiastrum galeobdolon*
Yellow flag iris	*Iris pseudacorus*
Yellow nutsedge	*Cyperus esculentus*
Yellow starthistle*	*Centaurea solstitialis*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

Appendix B: Morrow County Noxious Weed List

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Morrow County Weed List:

NOXIOUS WEEDS

Noxious Weeds – "A" List" – Any plant that is determined by the weed advisory board, and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land or property under provisions of Oregon State Statute and thus mandated for control.

Rush Skeletonweed

Yellow Starthistle

Tansy Ragwort

Yellow Toadflax

Dalmatian Toadflax

Mediterranean Sage

Leafy Spurge

Spikeweed

Musk Thistle

Scotch Thistle

Purple Loosestrife

Common Crupina

Whitetop (Hoary Cress)

Houndstongue

Flowering Rush

Yellow Flag Iris

Plumeless Thistle

WEEDS OF ECONOMIC IMPORTANCE

Weeds of Economic Importance – “B” List – Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

Poison Hemlock

Canada Thistle

Jointed Goatgrass

St. Johnswort

Perennial Sowthistle

Field Bindweed

Cereal Rye

Johnsongrass

Russian Knapweed

Diffuse Knapweed

Spotted Knapweed

Field Dodder

Water Hemlock

Medusahead Rye

Puncturevine

Kochia

Perennial Pepperweed

Myrtle Spurge

Ventenata

Morrow County Weed Advisory Board

The Morrow Soil and Water Conservation District Board also serves as the Weed Advisory Board

Sunstone Solar Project 1
Draft Revegetation and Reclamation Plan

Prepared for

PINEGATE
RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 1, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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1.0 Introduction

Sunstone Solar 1, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 1 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon (Figure 1). The proposed Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 200 MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Revegetation and Reclamation Plan (Plan) has been prepared to guide revegetation of areas temporarily disturbed during construction of the Facility, as well as revegetation within the solar array fence in compliance with Site Certificate Conditions PRE-FW-01 and PRE-SP-01. This Plan will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE), the Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Agriculture (ODA), and Morrow County Weed Department to reflect the final layout of the Facility.

Prior to construction, this Plan shall be finalized based on the following:

1. Certificate Holder shall finalize the Plan based on impacts associated with the final design/layout by disturbance level and habitat type and category.
2. Certificate Holder shall develop and incorporate maps showing anticipated construction disturbance levels along with the total acreage and major activities associated with each level.
3. Certificate Holder shall update Table 1 prior to construction to reflect the disturbance acreage by habitat subtype for the final layout.
4. Certificate Holder shall develop and incorporate revegetation methods for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department.

Prior to construction, the following shall be completed:

1. Certificate Holder shall provide shapefiles showing anticipated construction disturbance levels at the site as a submittal to ODOE.
2. Certificate Holder shall provide the revegetation and seeding contractor’s qualifications and scope of work as a submittal to ODOE.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

3. Certificate Holder shall submit baseline soil compaction sample locations and baseline compaction results to ODOE.
4. Certificate Holder shall hold a kick-off meeting with their environmental contractor, construction contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
5. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the construction contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.

Prior to initiation of revegetation, the following shall be completed:

1. Certificate Holder shall hold a kick-off meeting with their environmental contractor, revegetation and seeding contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
2. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the revegetation and seeding contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.
3. Certificate Holder shall complete post-construction soil compaction testing and submit results for review and approval to ODOE.

Throughout construction, revegetation, and operation activities, the Certificate Holder will take appropriate actions to prevent the spread of state and county listed noxious weeds. A stand-alone Draft Noxious Weed Control Plan has also been prepared (see Exhibit P, Attachment P-3[2]; updated for RFA 1, see Attachment 6), which contains information on state and Morrow County listed noxious weeds, noxious weeds observed during surveys, and treatment and monitoring of noxious weeds.

2.0 Site Description

The Facility includes a 1,539-acre site boundary within which all Facility components will be located. The Facility lies within the Columbia Plateau Ecoregion at elevations from 960 to 1,165 feet. The Facility is sited entirely on private land, which primarily consists of agriculture land used for growing dryland wheat. Native vegetation within the site boundary has been modified primarily through agricultural conversion, but also through the introduction of exotic grasses and other non-native vegetation.

Habitat mapping and categorization of the site boundary were conducted for the Facility in 2022. Habitat types within the site boundary include Agriculture, Pasture, and Mixed Environs (habitat subtype: Orchards, Vineyards, Wheat Fields, Other Row Crops); Developed (habitat subtype: Urban and Mixed Environs); and Upland Grassland, Shrub-steppe, and Shrubland (habitat subtype:

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[2] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

Eastside Grasslands). Details on habitat types, subtypes, and categories can be found in Exhibit P of the Facility's ASC, especially Attachment P-1 which contains the biological survey reports. Details on potential disturbance to habitat from construction and operation of the Facility, as well as avoidance and minimization measures, can be found in the ASC Exhibits P and Q[3].

3.0 Description of Disturbance

Construction of the Facility will result in temporary and permanent disturbance (see Exhibits C[4] and P). Section 3.1.1 (below) details the acres of each habitat subtype that will be temporarily and permanently disturbed during construction and operation of the Facility. All areas within the solar array fence are considered a permanent disturbance and will be revegetated for the purposes of site stabilization to reduce erosion, dust pollution, and topsoil depletion, and to reduce potential for invasion by noxious and invasive plants. The entire solar array fence will occupy approximately 1,479 acres . As noted above, this area is considered permanently disturbed; however, vegetation within the solar array fence will be retained and/or revegetated and this area would be reclaimed upon retirement.

Temporary disturbance will occur in areas outside the solar array fence that will be disturbed during construction activities, but which will not be occupied by permanent facilities. Temporary disturbance will occur in association with the construction of aboveground and underground collector and transmission lines, new roads, and perimeter fence.

Prior to construction, a crosswalk of the final version of this Plan will be prepared for use by the construction contractor to facilitate Plan implementation and ensure ground disturbance is minimized to the extent practicable. A kick-off meeting with the Certificate Holder, their environmental contractor, construction contractor, and ODOE will be held at least 14 days prior to construction. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify that anticipated disturbance levels are followed to the extent possible and will document any variances and justifications for those variances for ODOE review.

3.1 Disturbance Levels

Revegetation needs will be determined by a combination of disturbance level and existing vegetative cover. Disturbance levels will primarily be determined by site conditions such as slope, gradient, and existing vegetation. Disturbance levels are defined as follows:

Level 1 - Mowing: Mowing is used to conserve vegetative resources within a facility while mitigating risk of fire and facilitating construction activities. Vegetation will be limited to a height of 12 inches and mowed to no less than 6 inches during construction. Mowing to no less than 6 inches protects perennial grass crowns and allows grasses to regenerate. Depending on facility objectives, vegetation

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[3] Complete Application for Site Certificate, Exhibit Q, May 16, 2024.
[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

can be allowed to reach a normal height or kept trimmed to a height between 6 inches and the plant's full height potential. Crushing of vegetation will be minimal and this disturbance level is designed to have a minimal impact on existing vegetation. This method is least likely to result in invasions of undesirable plant species.

Level 2 – Overland Drive and Crush: Disturbance caused by accessing a facility without significantly modifying the landscape. Vegetation is crushed to the ground, but no surface soil is removed so root structures are left intact. Even though vegetation may be damaged or destroyed, the surface soil and seed bank remain in place. Some crushed vegetation will likely sprout after disturbance ceases. These activities would result in minimal to moderate disturbance. This type of disturbance will result in a faster recovery time for vegetation compared to Levels 3 and 4. Soil seed banks remain largely in place, perennial vegetation can grow back, and minimal external efforts are necessary. This method is less likely to result in invasions of undesirable plant species compared to Levels 3 and 4.

Level 3 – Clear and Cut: Disturbance caused by accessing the facility including having to remove all vegetation in order to improve or provide suitable access for other equipment. All vegetation is removed, soils are compacted, and the root zone or soil A-horizon may be disturbed, but no sub-surface soil is removed. Clear and cut activities would result in moderate disturbance. This type of disturbance will result in moderate recovery times for vegetation. This method has a moderate risk for invasion of undesirable plant species. An example is imprinting to crush vegetation down into the soil or incidental grading and smoothing of surface soils.

Level 4 – Clear and Cut with Soil Removal: Disturbance is caused by removing all vegetation in the impact zone, soils are compacted, and surface soil and subsoil are displaced. These activities result in heavy disturbance. This type of disturbance results in an extensive recovery time for vegetation, and is most likely to lead to invasions of undesirable plant species, which can result in lengthy and expensive control efforts. Includes disc-and-roll construction, and other traditional construction methods where soils are disturbed and no vegetation is left intact. This category includes all work requiring the segregation and replacement of topsoils.

3.1.1 Facility Disturbance

To the maximum extent practicable, Level 1 and Level 2 disturbance will be used during Facility construction. Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable, although construction vehicles driving across the site may affect existing root systems by compacting soils. Grading within solar arrays will be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically, but not exclusively, 10 percent maximum on North slopes and 15 percent maximum in other directions). Areas where the slope and gradient are within panel and racking tolerances will only be graded in road, inverter, and energy storage footprints where possible. Preservation of existing root systems will minimize soil erosion, providing both improved compliance with stormwater and dust management requirements, facilitate revegetation success, and preserve soil productivity for future agricultural use. Construction will be coordinated and sequenced to the extent practicable with landowners to maintain land in current production and

weed control until just prior to construction. This will avoid land being left unmanaged and minimize weed issues that can complicate revegetation.

Prior to construction, the Certificate Holder will provide maps and shapefiles showing anticipated construction disturbance levels at the Facility, along with total acreage and major activities associated with each level. This will serve to demonstrate the Certificate Holder's avoidance and minimization of ground disturbing activities to the extent practicable.

Table 1 presents the estimated maximum acreage of temporary and permanent disturbance to habitat subtypes associated with Facility construction and operation based on the permitted layout. Table 1 will be updated prior to construction to reflect the final disturbance acreage by habitat subtype for the final layout. Figures depicting the location of Facility infrastructure are included in Exhibit C, and a figure depicting habitat subtypes within the site boundary is available in Exhibit P.

Table 1. Maximum Temporary and Permanent Disturbance by Habitat Subtype

ODFW Habitat Category	Habitat Subtype	Permanent Disturbance (Acres)[1, 2]	Temporary Disturbance (Acres) [1]
5	Eastside Grasslands	4.7	<0.1
	Category 5 Habitat Subtotal	**4.7**	**<0.1**
6	Orchards, Vineyards, Wheat Fields, Other Row Crops	1,474	13.4
	Urban and Mixed Environs	0.2	0.1
	Category 6 Habitat Subtotal	**1,474**	**13.5**
	Grand Total[1]	**1,479**	**13.5**

Note: Totals in this table may not appear to sum correctly due to rounding. <0.1 means greater than zero but less than 0.05 acre disturbance.

1. Additional details associated with temporary and permanent disturbance are provided in Exhibit C of the ASC. Disturbances were calculated based on the layout permitted in the ASC and will be updated prior to construction based on an updated layout.
2. Acres of permanent disturbance includes the entire area within the solar array area fence including the footprints of all solar components and supporting facilities, as well as the areas outside of the footprint of permanent components and facilities (e.g., areas underneath and between rows of solar panels).

4.0 Reclamation and Revegetation Methods

This plan addresses revegetation methods for temporary disturbances to agricultural lands and wildlife habitat, as well as revegetation and vegetation management of lands within the solar array fence. Revegetation of temporarily disturbed developed habitat (i.e., Urban and Mixed Environs habitat subtype) will be determined on a case-by-case basis and is not covered further in this plan. Temporary disturbances to agricultural habitat (i.e., Orchards, Vineyards, Wheat Fields, Other Row Crops habitat subtype) will be restored as described in Section 4.5.1. The Certificate Holder will restore temporarily disturbed areas by re-establishing slope, surface stability, and drainage features, as needed, followed by soil preparation and seeding. Soil preparation and seeding techniques are described below.

Revegetation will begin as soon as feasible after completion of each construction phase. Seeding and planting will be done in a timely manner and in the appropriate season to facilitate germination and establishment of seeded species.

Prior to construction, final revegetation methods will be developed for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department and will be incorporated as an amendment to this Plan upon ODOE approval.

4.1 Roles and Responsibilities

A construction contractor qualified to perform revegetation and seeding will be responsible for implementing measures in the National Pollutant Discharge Elimination System (NPDES) 1200-C permit, as well as revegetation activities discussed herein during and immediately after construction. A qualified botanist or revegetation specialist will be responsible for monitoring and reporting on revegetation success. Remedial revegetation actions, if needed during the operation phase, will be performed by a qualified contractor. The Certificate Holder will be responsible for ensuring that all contractors perform work in accordance with permit requirements and all agreed upon methods for revegetation.

The goal of this Plan is to increase the probability of revegetation success, reduce early weed establishment, reduce erosion and dust pollution, protect topsoil for future agricultural use in permanent disturbance areas, and ensure no loss of habitat quality for temporary disturbances to wildlife habitat. To ensure this goal is met, the Certificate Holder will ensure that the contractor selected for revegetation will be a qualified revegetation and seeding contractor with demonstrated experience in the Columbia Plateau. Options for contracting and managing this work include:

- Having the construction contractor subcontract revegetation work out to a qualified revegetation and seeding contractor. The contract will stipulate the Certificate Holder's right to dictate the timing, methods, and management of seeding.
- Contracting directly with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.
- Having the environmental contractor contract with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.

The revegetation and seeding contractor's qualifications and scope of work will be provided as a submittal to ODOE prior to construction. Additionally, a crosswalk of the final version of this Plan will be prepared for use by the revegetation and seeding contractor prior to initiation of revegetation to facilitate Plan implementation. A kick-off meeting with the Certificate Holder, their environmental contractor, revegetation and seeding contractor, and ODOE will be held at least 14 days prior to initiation of revegetation activities. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify seeding methods and timing requirements are followed appropriately and will document any variances and the justifications for those variances. Monitoring and follow-up will be provided as described in Section 6.0 to ensure oversight and increase the probability of revegetation success.

4.2 Soil Reclamation

Soil scientists use a soil penetrometer to field measure subsurface compaction in soil. This tool measures resistance (pressure) to the advance of a cone-tipped rod with a T-handle, vertically through the soil column. The metric intends to measure soil compaction that can inhibit the ability of plants to penetrate the soil. An operator pushes the penetrometer rod with a cone base into the ground with consistent force. A pressure gauge records pressure in pounds per square inch (psi), equaling levels of resistance at differing soil layers. Resistance is measured at 3-inch intervals until the meter goes above 300 psi, which is a level of soil compaction most roots cannot penetrate. For this test compaction would be measured at 3, 6, 9, and 12 inches if the soils allow. Soil compaction testing must be completed in spring or late fall when soils are at field capacity (approximately 24 hours after a soaking rain). Baseline soil compaction measurements will be taken prior to construction. Baseline soil compaction sample locations and baseline compaction results will be submitted to ODOE prior to construction.

1. Baseline and post-construction soil compaction measurements and testing must be done in conditions favorable to soil testing (e.g. non-saturated or frozen soils).
2. Baseline soil compaction measurements will be documented and established by using the above protocol, or other protocol as approved by ODOE, to establish baseline soil conditions within temporary disturbance areas.
3. Recordation of the baseline soil plots must be represented on a map based on final Facility design.
4. Post-construction soil compaction testing following the above protocols must be completed in spring or late fall when soil conditions are favorable to soil testing (non-saturated or frozen soils). Compaction testing will occur after soil stockpiles are replaced and grading is complete but prior to initiation of revegetation activities.
5. If soil monitoring demonstrates that soils are compacted more than 300 psi, then remediation activities must be completed prior to initiation of revegetation activities. See Section 4.3 below, the Facility NPDES 1200-C permit, and applicable Site Certificate Conditions.

In addition, in areas where soil is removed during construction, the following measures will be taken where appropriate:

- During construction, excavated topsoil will be stockpiled separately from subsoil and replaced in proper order with topsoil on the surface to maintain soil productivity. Stockpiled soil will be put back in place prior to revegetation activities.
- Soils will be stabilized during construction using the appropriate best management practices as determined by the onsite stormwater pollution prevention plan implementor.
- Soil preparation will involve standard, commonly used methods (i.e. tracking, decompaction, and tilling), and will consider all relevant site-specific factors, including slope, size of area, and erosion potential. Soils will be de-compacted if necessary to create a

uniform seedbed using an agricultural disc, soil ripper, or similar equipment. Additional details regarding soil preparation are in Section 4.3.

- Topsoil and other soils from noxious weed infested areas will not be moved outside of the infested areas and will be returned to their previous location during reclamation activities to eliminate the transport of weed seeds, roots, or rhizomes.
- Soils from weed-infested areas will be treated with a non-persistent, pre-emergent herbicide prior to initiation of revegetation efforts, depending on site-specific conditions.
- Prior to final regrade and revegetation efforts, any weeds that have grown during periods of construction dormancy should be treated as described in the Noxious Weed Control Plan.
- The construction contractor will use appropriate erosion and sediment control practices (i.e., seeded or unseeded hydromulch, tackifier, weed-free erosion control blankets, weed-free or locally sourced straw mulch) to maintain topsoil during construction in both temporary and permanent disturbance areas.

4.3 Site Preparation

Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable. Areas where the slope and gradient are within the solar panel and racking tolerances will receive minimal grading, with grading in those areas limited to the roads, inverter, and energy storage footprints. In areas where soil is removed during construction, the Certificate Holder will demonstrate adequate soil stabilization to prevent erosion and dust pollution. The following measures will be taken where appropriate:

- Site preparation will take into account all relevant site-specific factors, including slope, size of area, and erosion potential.
- Areas of severe machine or vehicle tracking that would hinder seeding success and are unnecessary for soil stabilization will be regraded.
- In the spring, fall or winter of the year prior to when construction would occur, areas of high erosion risk (e.g., slopes, areas with low vegetative cover) should be seeded with a non-invasive, non-persistent cover crop such as triticale to stabilize soils.
- If soils are not suitable for revegetation, soil amendments may be required. Any imported topsoil, if required, will be demonstrated to be suitable for vegetative success.
- Where soil compaction testing demonstrates that soils are compacted greater than 300 psi, soils will be mechanically scarified (e.g., tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction, to maintain soil productivity, and reduce the potential for erosion on compacted soils. Dry soils should be de-compacted using an agricultural disc, soil ripper, or similar equipment.
- Prior to seeding and/or planting of revegetation areas, soils will be prepared into a firm, fine-textured seedbed that is relatively free of debris. Shallow tilling with a disc, followed by a harrow or drag if necessary, can typically achieve this. If replaced soil is too soft, then

seeds may be buried too deep to properly germinate; a roller or culti-packer should be used to pack down the soil.

- In non-cropland temporary disturbance areas, site complexity will be considered during soil preparation. For instance, it may be desirable to purposely create an uneven, patchy site that allows for depressions and other microsites that result in small variations in aspect and moisture holding to promote complexity.
- Seeded areas will be temporarily stabilized to facilitate establishment. This can be accomplished by application of seedless, certified weed-free hydromulch containing a tackifier or straw mulch crimping. Alternate methods may be proposed by the revegetation and seeding contractor but will require prior written approval by ODOE and must provide demonstrated success in sites with similar wind and soil conditions.
- The Certificate Holder or a designated construction contractor will use mulching and other appropriate practices, as required by the anticipated NPDES 1200-C permit, to control erosion and sediment during construction and revegetation work.

4.4 Revegetation of Permanent Disturbance Areas

During construction, the Certificate Holder will implement site stabilization measures, including seeding of all disturbed areas according to the Certificate Holder’s anticipated NPDES 1200-C permit. Approximately 6 months prior to commercial operation of each phase of construction, the Certificate Holder will meet with ODFW, ODOE, and Morrow County Weed Department personnel to review the actual extent and conditions of disturbed areas and confirm the revegetation methods to be implemented.

As portions of the Facility are prepared for installation of Facility components (i.e., grading is complete), but prior to installation, all areas with less than 70 percent vegetative cover should be seeded with a non-invasive, non-persistent cover crop. The cover crop will be selected based on the time of year and site conditions; for example, winter wheat or sterile triticale can be seeded from fall to early spring, while peas should be seeded in spring. Tillage radish and sunflowers can be seeded in spring to break up compaction but are not suitable options for soil stability. A cover crop will stabilize soils and suppress noxious weed infestations to reduce erosion and facilitate revegetation of desired plant species.

Following the completion of each construction phase, permanent disturbance areas will be reseeded with a mix of native or non-invasive, non-native grasses and forbs as appropriate based on disturbance level and actual site conditions (see Section 4.4). All seeds will be obtained from a reputable supplier in compliance with the Oregon Seed Law (OAR 603-056). The final seed mix for permanent disturbance areas will include low growing grasses and pollinator-friendly forbs compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Table 3 in Section 4.7 includes an example of low-growing seed mix for permanent disturbance areas.

4.5 Revegetation of Temporary Disturbance Areas

4.5.1 Agricultural Lands

Temporarily disturbed agricultural lands will be reseeded with the appropriate crop or maintained as fallow in consultation with the landowner or farm operator. The Certificate Holder will consult with the landowner or farm operator to determine the seed mix, application methods, and rates for seed and fertilizer. Success of cropland revegetation will have been achieved when production of the revegetated area is comparable to that of adjacent, non-disturbed croplands of the same type.

Agricultural lands will be reseeded to match the timing of the crop rotation on adjacent cropland to facilitate easy harvest and re-establish the appropriate crop rotation. Agricultural lands that will be seeded in the year that construction is complete can be temporarily hydromulched or otherwise stabilized until seeding can occur in the fall; agricultural lands that will be fallow for a year (i.e., fallow rather than reseeded the year construction is complete) will be planted with a cover crop (dependent on timing of construction closeout) or have continued stabilization with hydromulch, straw mulch crimping, or other best management practices through the fallow year.

Soil compaction as a result of construction activity is a concern for restoring agricultural soils to their pre-construction productivity. Within temporary disturbance areas, the Certificate Holder will excavate and store topsoil separately from subsoil, so that topsoil is replaced and restored appropriately. During post-construction revegetation of temporary disturbance to agricultural lands, the Certificate Holder will loosen agricultural soil by mechanical scarification (tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction. Soil amendment, by addition of organic matter (e.g., compost), may also be necessary to alleviate compaction.

Success determination will involve consultation with the landowner or farm operator, and the Certificate Holder will report to ODOE on the success of agricultural land revegetation efforts. Noxious weed control is necessary for successful revegetation of agricultural lands and will be implemented per the methods described in the Draft Noxious Weed Control Plan (Exhibit P, Attachment P-3; updated for RFA 1, see Attachment 6).

4.5.2 Wildlife Habitat

During construction, the Certificate Holder will implement site stabilization measures, including seeding of temporarily disturbed areas according to the Certificate Holder's anticipated NPDES 1200-C permit. Approximately 6 months prior to commercial operation of each phase of construction, the Certificate Holder will meet with ODFW, ODOE, and Morrow County Weed Department personnel to review the actual extent and conditions of temporarily disturbed areas, confirm the revegetation methods to be implemented, and to revisit reference sites as necessary.

Following each construction phase, all areas, with the exception of temporarily disturbed agricultural lands, will be seeded with a mix of native or non-invasive, non-native grasses and forbs (see Section 4.7). All seeds will be obtained from a reputable supplier in compliance with the

Oregon Seed Law (OAR 603-056). The methods used and timing of planting will be appropriate to the seed mixes, weather conditions, and site conditions (including area size, slope, and erosion potential) based upon consultation with ODOE, ODFW, ODA, and the Morrow County Weed Department.

Seed mixes may include species selected to enhance soil health, such as nitrogen-fixing species, if determined to be appropriate based on coordination with ODOE, ODA, and ODFW. Including these species in the seed mix would help the other plant species thrive and increase long-term survival of desired species. Additionally, the seed mixes include species intended to provide broader ecosystem benefits, such as pollinator species, that will benefit the surrounding landscape. The seed mix for temporarily disturbed areas outside of the solar array fence will include taller native species of grasses and pollinator-friendly forbs to increase overall site biodiversity and increase benefits to wildlife and pollinators. Using native or non-invasive, non-native pollinator-friendly plants as ground cover under solar panels can also help recharge groundwater, reduce erosion, and improve soil carbon sequestration (Neal and Atre 2020).

4.6 Seeding Methods

The seeding method and timing of planting will be appropriate to the seed mixes (see Section 4.7), weather conditions (e.g., precipitation, wind speed, temperature, etc.), and site conditions (including area size, slope, and erosion potential) based upon consultation with ODOE, ODA, ODFW, the Morrow County Weed Department, and the seed supplier. Seeding from late September to March is typically recommended; however, the Certificate Holder will consult with ODOE, ODFW, ODA, Morrow County Weed Department, and/or the seed supplier to determine the optimal timing for seed application based on climatic conditions of the particular year when construction and revegetation efforts are implemented.

Common seed application methods that may be used for revegetation are broadcast seeding, drill seeding, imprint seeding, and hydroseeding; each of these are discussed further below. Other seeding methods may be proposed for review and approval prior to revegetation efforts.

4.6.1 Broadcast Seeding

Broadcast seeding is the application of seed directly to the ground surface. This method may be chosen for areas with shallow and rocky soils, and the type of broadcast spreader would depend on the size of the area to be seeded and the terrain. Broadcast seeding may be completed before or after panel and fence installation.

In this method, the seed mix is typically broadcast at a rate of 20 to 24 pounds pure live seed per acre, or twice the recommended rate for drill seeding; this rate may be adjusted depending on the recommendation of the actual seed supplier and agencies. When feasible, due to the seasonality of when planting can occur, the entire area will be seeded after grading is complete but before placement of Facility components, providing more flexibility in seed application. In those instances where seeding occurs prior to installation of components, follow-up seeding will occur in areas temporarily disturbed by installation and any areas that are deficient in vegetation from the first round of seeding. Immediately following seed application, hydromulch or certified weed-free straw would be applied. Broadcast seeding will not be employed if winds exceed 5 miles per hour. If certified weed-free straw is unavailable, the Certificate Holder or a designated construction contractor will identify a local source of straw. The local source of the straw will be approved by the county weed master and ODFW prior to purchase. This straw will either be crimped into the ground or applied with a tackifier.

4.6.2 Drill Seeding

Drill seeding can be used for larger areas with deeper soils and moderate to gentle terrain to accommodate mechanical equipment. This method provides the advantage of planting the seed at a uniform depth and may provide better soil to seed contact. Drill seeding plants seeds using an agricultural or range seed drill at a rate of 12 to 14 pounds pure live seed per acre, per discussions with a seed supplier and ODFW. The rate may be adjusted depending on the recommendations of the actual seed supplier. Drill seeding will be difficult after Facility components have been installed so it will primarily be used if seeding occurs after grading is complete but before components are installed or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.3 Imprint Seeding

Imprint seeding is a no-till drill seeding method used to restore grasslands in areas with low annual precipitation. Seeds will be sown at 20 to 24 pounds pure live seed per acre or according to application rates recommended by the seed supplier. The seeder consists of a heavy metal drum roller with V-shaped, angled teeth and a seed agitator box. The teeth create V-shaped troughs with a depth of 4-7 inches to collect rainwater. The rolling drum presses the seed into the soil, insuring good seed-to-soil contact. The troughs collect rainwater for seed germination and seedling growth. Imprint seeders can be used on steep slopes and generally do not require seed bed preparation before seeding. Seeding can occur on soils with light to moderate vegetative cover, with vegetation acting as a mulch to prevent soil erosion until seedlings are established. Imprint seeders do not work well in areas with shrubs or heavy vegetation cover. Heavily compacted soils may need to be ripped or de-compacted before seeding. Imprint seeding will be difficult after solar components have been installed, so it will primarily be used if seeding occurs after grading is complete but before components are installed, or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.4 Hydroseeding

Hydroseeding is a method of hydraulically applying seeds, stabilizers, and soil amendments to the surface of the soil. Hydroseeding is most applicable for areas where drill or broadcast seeding machinery cannot access; this usually includes steeper sloped or narrow terrain but can be used in all terrains. Hydroseeding is feasible after panel installation but before the Facility is fenced. Soil bed preparation is also crucial for growth success and frequently includes tracking perpendicular to the slope to create micro conditions for seed. Flat grading and compaction are not recommended. Seeding rates increase by 30 to 50 percent of broadcast seeding rates (i.e., 30 pounds pure live seed per acre) per consultation with the seed supplier and ODFW. Prior to hydroseeding the tackifier and fertilizer, if included, will be reviewed and approved in consultation with ODOE. Fertilizer should not be used when hydroseeding wildlife habitat.

4.7 Seed Mixes

Two seed mixes are proposed for revegetation efforts: one for revegetation of temporary disturbance areas outside the solar array fence, and one for revegetation of permanent disturbance areas within the solar array fence. Tables 2 and 3 present example seed mixes that would be considered for revegetation. However, the number of seed mixes and composition of final seed mixes will be determined in consultation with ODOE and ODFW and will be based on pre-construction conditions and availability of seed at the time of procurement.

Grassland Seed Mix #1 would be appropriate for revegetation of temporarily disturbed areas outside the solar array fence, with the exception of areas that would be returned to agricultural production following construction (as noted in Section 4.5.1). The example seed mix is presented in Table 2 and contains a mixture of native grasses and native, pollinator-friendly forbs. This seed mix includes a mixture of deep-rooted grasses and flowering plants as these types of species can capture and filter stormwater, build topsoil, and provide food sources and for native insects (Davis 2021). Forbs included in this seed mix were also chosen based on their bloom period. Including plants that flower throughout the growing season provides a continuous source of nectar and pollen and can attract a variety of pollinators (NRCS 2011).

Table 2. Example Grassland Seed Mix #1

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Bluebunch wheatgrass[1]	*Pseudoroegneria spicata*	35
	Sandberg's bluegrass[2]	*Poa secunda* ssp. *secunda*	15
	Bottlebrush squirreltail	*Elymus elymoides*	10
	Needle-and-thread grass[3]	*Hesperostipa comata*	10
Forbs	Low gumweed	*Grindelia nana*	5
	Hoary aster	*Dieteria* (*Machaeranthera*) *canescens*	5
	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Munro's globemallow[4]	*Sphaeralcea munroana*	5
	Western blue flax	*Linum lewisii*	5
	Yarrow	*Achillea millefolium*	5

1. An alternative to bluebunch wheatgrass is Snake River wheatgrass (*Elymus wawawaiensis*; also sold as "Secar" bluebunch wheatgrass).
2. An alternative to Sandberg's bluegrass is big bluegrass (*Poa secunda* subsp. *juncifolia*; also sold as *P. ampla*).
3. Alternatives to needle-and-thread grass include the non-native bunchgrasses crested wheatgrass (*Agropyron cristatum*) and sheep/hard fescue (*Festuca ovina/F. trachyphylla*).
4. An alternative to Munro's globemallow is blanketflower (*Gaillardia aristata*).

A second grassland seed mix, Grassland Seed Mix #2, is suggested for post-construction revegetation within the solar array fence, including areas that previously consisted of agricultural lands. The example seed mix presented in Table 3 contains a mixture of low-growing native and non-native grasses and native and non-native pollinator friendly forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Similar to Grassland Seed Mix #1, this seed mix includes a mixture of deep-rooted grasses and flowering plants that flower throughout the growing season.

Table 3. Example Grassland Seed Mix #2

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Sandberg's bluegrass	*Poa secunda* ssp. *secunda*	35
	Bottlebrush squirreltail, common squirreltail	*Elymus elymoides* ssp. *elymoides*	15
	Desert fescue[1]	*Vulpia microstachys*	10
	Thurber's needlegrass	*Eriocoma (Achnatherum) thurberianum*	10
Forbs	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Bigseed bisuitroot[2]	*Lomatium macrocarpum*	5
	Erigeron/fleabane	*Erigeron filifolius, E. linearis,* or *E. pumilus*	5
	Oregon sunshine	*Eriophyllum lanatum*	5
	Snow buckwheat	*Eriogonum niveum*	5
	Wollypod milkvetch	*Astragalus purshii*	5

1. Alternatives to desert fescue are sixweeks fescue (*Vulpia octoflora*) or sheep/hard fescue (*Festuca ovina*/*F. trachyphylla*).
2. An alternative to bigseed biscuitroot is longleaf phlox (*Phlox longifolia*).

4.8 Revegetation Methods by Disturbance Level

Revegetation methods for each disturbance level were developed to tailor revegetation to specific conditions (Table 4). Revegetation should follow soil reclamation, site preparation, and seeding methods described in Sections 4.2 through 4.7.

Table 4. Revegetation Methods by Disturbance Level

Disturbance Level	Soil Reclamation	Site Preparation	Seeding
1 – Mowing	Ensure vegetation remains intact.	Retain existing vegetation root systems to prevent erosion. Control weeds.	Seed if necessary to achieve success criteria
2 – Overland Drive and Crush	Measure soil compaction in areas of high vehicle traffic.	Retain existing vegetation root systems and/or mulch to prevent erosion. Decompact soil in areas of high vehicle traffic if necessary. Control weeds.	Seed if necessary to achieve success criteria
3 – Clear and Cut	Measure soil compaction.	Mulch to prevent erosion. Decompact soil if necessary. Control weeds	Required
4 – Clear and Cut with Soil Removal	Measure soil compaction. Stockpile topsoil separately from subsoil and stabilize during construction.	Mulch to prevent erosion. Decompact soil. Regrade and replace subsoil then topsoil prior to seeding. Control weeds.	Required

5.0 Revegetation Documentation

Records will be kept of revegetation efforts in all temporary and permanent disturbance areas. Records will include:

- Date construction phase was completed;
- Acreage of each disturbance level;
- Description and photos of the affected area;
- Date revegetation was initiated;
- Description of the revegetation effort, including methods and timing;
- Supporting figures representing the location, acres affected, and pre-disturbance condition of the revegetation area; and
- Confirmation from the landowner that temporary disturbances in cropland have been satisfactorily restored.

The Certificate Holder will meet with ODOE at least 14 days prior to initiation of revegetation efforts. The Certificate Holder will update ODOE with these records monthly as revegetation work occurs and will provide ODOE with copies of these records along with submission of the monitoring report that is required by the Site Certificate.

6.0 Monitoring

6.1 Monitoring of Permanent Disturbance Areas

In accordance with the Certificate Holder's anticipated NPDES 1200-C permit, all areas within the solar array fence must be revegetated to stabilize soils for the purposes of erosion and dust pollution control. Pursuant to OAR 345-022-0022, construction and operation of the Facility must not result in significant adverse impacts to soils, including but not limited to, erosion. Pursuant to MCZO 3.010.K.3.f.(3), construction or maintenance activities shall not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. Therefore, monitoring is required to demonstrate compliance with the above site stabilization and weed control requirements. The Certificate Holder will monitor permanent disturbance areas to assess the following:

- Dominant species composition;
- Relative cover of desirable and undesirable forbs and grasses;
- Percent cover of bare soil;
- Degree of erosion;
- Presence noxious weeds; and
- Qualitative assessment of overall vigor of vegetation within revegetated areas.

Monitoring will be conducted by a qualified botanist or revegetation specialist and will begin within 60 days of the completion of initial site revegetation. Permanent disturbance areas will be monitored using a meander survey. During the meander survey, the surveyor will walk within the solar array fence and document the assessment items listed above using photos and spatial data collection. Areas of erosion and significant patches of bare soil will be mapped and photographed. The surveyor will record dominant species, overall percent cover of forbs and grasses, and general notes about plant vigor.

Monitoring will be conducted at least once per season during the first year following construction. After the first complete year of monitoring, the Certificate Holder will consult with ODOE to determine if the monitoring cycle can be reduced based on revegetation progress. After five years of monitoring, the Certificate Holder will design a long-term monitoring plan in consultation with ODOE.

6.1.1 Success Criteria

Success criteria outlined below will demonstrate compliance with the soil protection standard (OAR 345-022-0022); NPDES 1200-C permit requirements; and the requirements of MCZO 3.010.K.3.f.(4):

- Establish uniform (i.e., evenly distributed, without large bare areas) perennial, non-invasive vegetation that provides 70 percent or more cover on all exposed areas.

Requirements of the soil protection standard and MCZO 3.010.K.3.f.(4) apply to the construction and operation of the Facility. Therefore, the Certificate Holder shall maintain compliance with revegetation success criteria for all areas within the solar array fence for the life of the Facility. In each monitoring report, the Certificate Holder will include an assessment of whether the area within the solar array fence is meeting or trending toward meeting the revegetation success criteria. Final determination of whether the Certificate Holder is in compliance with the revegetation obligations will be made by ODOE. Remedial actions and/or additional monitoring for areas may be required in areas that have been determined by ODOE not to have met the success criteria.

6.1.2 Reporting

Monitoring reports will be prepared and submitted to ODOE once per season during the first year following construction. After the first year of monitoring is complete, the reporting cycle will be modified to align with the new monitoring cycle determined in consultation with ODOE. The first monitoring report will include a detailed description and timeline of revegetation methods that were implemented including species, amounts, and locations of seed applications and dates revegetation work was performed.

Each monitoring report will include:

- GIS maps of revegetation areas and disturbance levels;
- Monitoring methods;
- Local climatic data (i.e., precipitation, temperature) for the monitoring month and year and percent deviation from the historical average;
- Results of monitoring efforts;
- The investigator’s assessment of whether the revegetated areas are trending toward meeting the success criteria;
- Assessments of factors impacting the ability of revegetated area to trend towards meeting the success criteria; and
- Recommendations for adaptive management, if any.

6.2 Monitoring of Temporary Disturbance Areas

Per ODFW recommendations on other projects, temporary disturbance monitoring is not required for temporary disturbance areas less than 0.5 acres or when the area is not sufficiently large to accommodate a monitoring site. Because there are no non-agricultural habitat types with temporary disturbance areas greater than 0.5 acres, no monitoring or reference sites will be established for this Facility.

6.3 Adaptive Management

After each revegetation monitoring visit in either temporary or permanent disturbance areas, the Certificate Holder's qualified investigator will report to the Certificate Holder regarding the revegetation progress of each revegetation area. If applicable, the investigator will make recommendations to the Certificate Holder for reseeding, weed control, or other remedial measures for areas that are not showing progress toward achieving revegetation success. The investigator will provide a description of factors that may be contributing to the lack of revegetation success. The Certificate Holder will include the investigator's recommendations for adaptive management and the measures taken in the next monitoring report. ODOE may require reseeding or other remedial measures in cases where success criteria have not been met.

If a revegetation area is damaged by wildfire during the first 5 years following initial seeding, the Certificate Holder will amend this Plan, subject to ODOE approval, to restore the damaged area. The Certificate Holder will continue to monitor and report on revegetation progress during the remainder of the 5-year period. The Certificate Holder will report to ODOE and ODFW the area impacted by the fire (with a map or figure) within 72 hours of discovery.

6.4 Soil Reclamation Monitoring

Soil measurements conducted per Section 4.2 shall be evaluated to determine whether soils within disturbance areas have compaction readings of greater than 300 psi. If results show soils have compaction readings of greater than 300 psi, then remediation activities must be completed before revegetation can begin. Prior to initiation of revegetation, the Certificate Holder will provide the results of soil compaction testing to ODOE.

7.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

8.0 References

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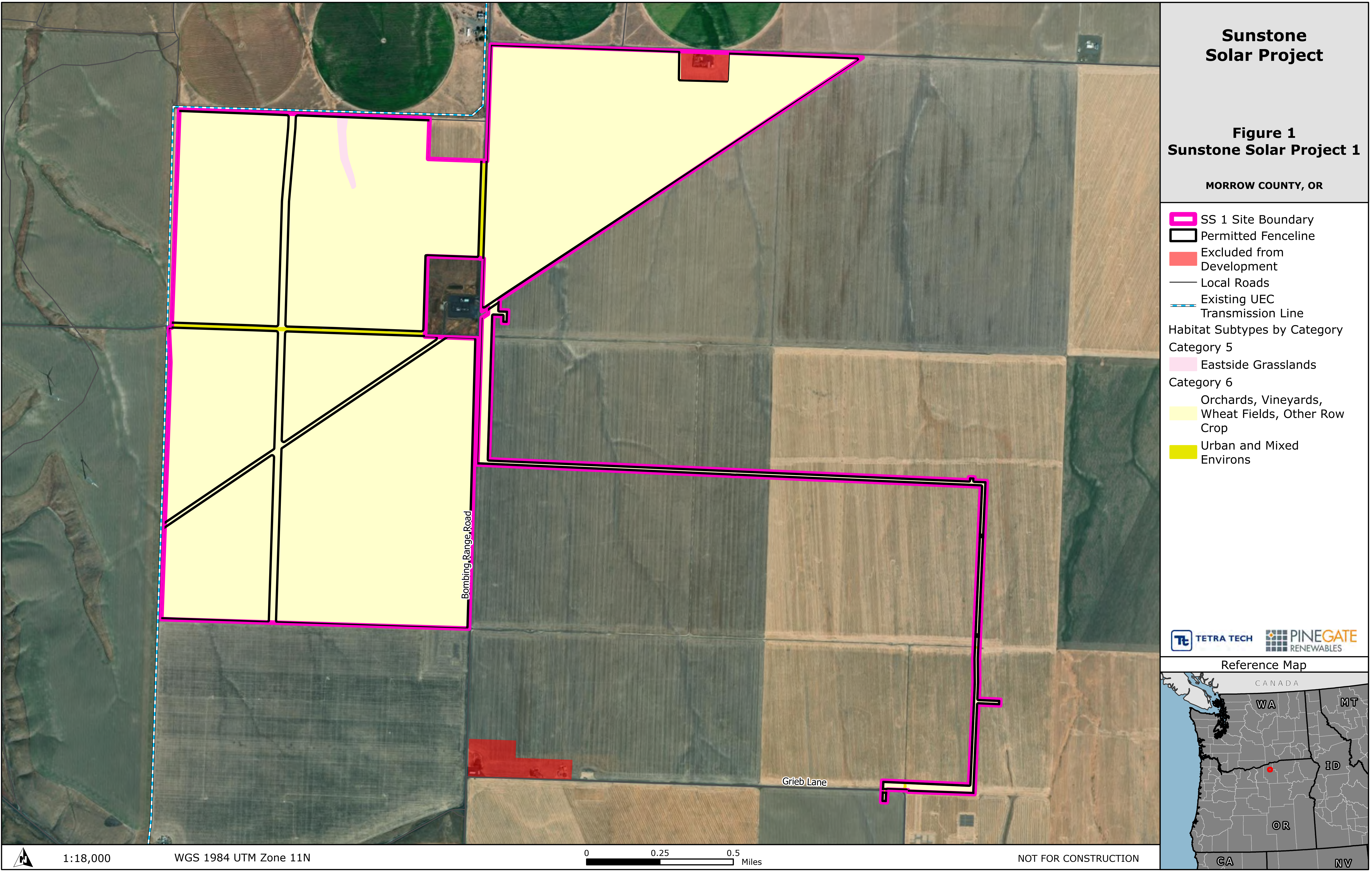
Sunstone Solar Project

Figure 1
Sunstone Solar Project 1

MORROW COUNTY, OR



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Sunstone Solar Project 1
Draft Wildlife Monitoring Plan

Prepared for

PINEGATE
RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 1, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

Table of Contents

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1.0 Introduction

Sunstone Solar 1, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 1 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities and the anticipated phasing of construction are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Wildlife Monitoring Plan (WMP) describes wildlife monitoring the Certificate Holder will conduct during operation of the Facility. This WMP has the following components:

1. Raptor nest surveys
2. Washington ground squirrel (WAGS; *Urocitellus washingtoni)* monitoring
3. Wildlife Reporting and Handling System (WRHS)
4. Data reporting

This WMP will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE) and the Oregon Department of Fish and Wildlife (ODFW) and will be updated as needed to reflect the final layout of the Facility.

2.0 Raptor Nest Surveys

The objectives of raptor nest surveys are: (1) to count raptor nests on the ground or above ground at the Facility; and (2) to determine whether there are noticeable changes in nesting activity in the local populations of raptor species, with particular focus on Swainson's hawks (*Buteo swainsoni*), the only state sensitive raptor species documented nesting during baseline surveys.

The Certificate Holder will conduct long-term ground-based monitoring of nests identified during the baseline raptor nest surveys, as well as any other nests identified subsequently. The ground-based surveys will be used to evaluate nest success by gathering data on nest occupancy. The Certificate Holder will employ qualified personnel to perform raptor nest surveys.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

2.1 Initial Monitoring

The first monitoring season will be in the first full raptor nesting season after the commercial operating date. During the first monitoring season, the surveyor will conduct one ground survey for raptor nests in late May or early June and additional surveys as described in this section. The ground surveys will be conducted within the site boundary to determine nest occupancy.

All nests discovered during the anticipated pre-construction surveys and any nests discovered during post-construction surveys, whether active or inactive, will be given identification numbers. Global Positioning System (GPS) coordinates will be recorded for each nest. Locations of inactive nests will be recorded because they could become occupied during future years.

After the first monitoring season, the surveyor will analyze this one year of data compared to the baseline data. The Certificate Holder will provide a summary of the first-year results in the monitoring report described in Section 5.0.

2.2 Long-Term Monitoring

The surveyor will conduct raptor nest surveys at 5-year intervals for the life of the Facility.[2] The surveyor will conduct long-term raptor nest surveys following the methods described in Section 2.3 every 5 years after the first monitoring season in years divisible by 5. This may result in a greater than 5-year period between the initial monitoring season and the first long-term monitoring season (e.g., if the initial monitoring season is 2028, the first long-term monitoring season would be 2035 rather than 2033). During each long-term monitoring event biologists will visit all previously identified nest locations in addition to searching the survey area for new nest sites.

In conducting long-term surveys, the surveyor will follow the same survey protocols as the initial survey (Section 2.3), unless the Certificate Holder proposes alternative protocols that are approved by ODOE. In developing an alternative protocol, the Certificate Holder will consult with ODFW and ODOE and will take into consideration other raptor nest monitoring conducted in adjacent or overlapping areas.

The Certificate Holder will analyze the data to identify any trends in the number of raptor breeding attempts the Facility supports and the success of those attempts. The Certificate Holder will submit a report after each year of long-term raptor nest surveys.

2.3 Monitoring Protocol

Qualifications of surveyors: Surveys and nest monitoring will be conducted by professional, qualified biologists with a relevant academic background and sufficient field experience pertaining to avian biology and species identification.

Survey period: Occupancy surveys will be conducted between March 1 and May 31. The survey period may be extended in consultation with ODFW and ODOE.

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[2] As used in this plan, "life of the Facility" means continuously until the Facility is restored and the site certificate is terminated in accordance with OAR 345-027-0110.

Survey area: The survey area will be limited to leased parcels within the Site Boundary, where surveyor access is granted. Surveys will be performed from public roads and project roads, or from participating landowner parcels only, as site conditions safely permit (e.g. snow, mud).

Survey protocol: Biologists will conduct a ground-based search for raptor nest activity using binoculars and/or spotting scopes to search potential nest sites. Previously identified nests will be surveyed to determine the occupancy status of nests. New nests that are discovered will also be surveyed and visited in future monitoring years. A log will be kept to track nest occupancy status on all nests. ArcGIS Online or similar GIS program will be used to locate and track the nests.

Data collection: Data collected during the survey will include, at a minimum, the location, occupancy status, occupying species, activity observed, and condition of each nest.

Nest Location: Nest/Burrow Identification Number: Existing IDs will be used where possible in addition to corresponding GPS waypoint numbers.

Occupying Species: Using four-letter American Ornithologists' Union codes (e.g., SWHA = Swainson's hawk).

Raptor Activity:

- Adult Present: Proximity of the adult to the nest (e.g., on nest, nearby, or unknown).
- Eggs or Young: Number of eggs or young observed.
- Nest Substrate: Structure in which nest was located (e.g., broadleaf tree, cut bank, transmission pole, etc.).
- Nest Height: Height relative to the structure it is on (e.g., on top of transmission pole, 3/4 of height of tree).

Nest Condition: To assess nest condition the following criteria will be used:

- No Longer Present: For nests that are no longer present.
- Unknown: The nest cannot be found, was not surveyed, or the nest is present, but because of its location a determination cannot be made.
- Excellent: Defined cup or nest bowl with a well-maintained rim; adult or young present.
- Good: Nest bowl intact and rim defined; minor repair needed for nest to be used; margins of nest in loose configuration, minor slumping occurring.
- Fair: Nest bowl intact and nest not dilapidated; but needs significant repair in order to be used; material is slumping or sliding.
- Poor: Loose structure of nest bowl still present; nest walls and side falling out; nest is in need of major repair to be used.
- Remnant: Nest bowl not defined; scant material remaining and not usable unless fully rebuilt.

Determination of active nests: Nest occupancy status will be determined using the definitions below.

Active: Defined by the presence of one or more eggs, dependent young, or adults on the nest in the past 10 days during the breeding season, including the period when adults are displaying courtship behaviors and are building or adding to the nest in preparation for egg-laying.

Potentially Active: There is not observable activity during the visit, but active status cannot be confirmed.

Inactive: The inactive status will only be determined if the nest is observed for at least one hour each time over the course of two consecutive visits separated by at least one day.

3.0 Washington Ground Squirrel Monitoring

No WAGS were detected during baseline surveys, but any new colonies that are detected incidentally during other surveys, such as raptor nest monitoring, will be documented and the extent of those colonies delineated and included in future WAGS monitoring and reporting activities.

If any incidental WAGS are detected, the Certificate Holder will employ qualified personnel to monitor these locations every 5 years thereafter in years divisible by five for the life of the Facility (i.e., on the same monitoring schedule as the raptor nest surveys). The survey area will include the colonies (i.e., groups of active burrows) and a buffer of 785 feet in suitable habitat, if accessible. The surveyors will walk linear transects spaced 165 to 230 feet (50 to 70 meters) apart two times between February 15 and May 31. Surveys of each location will be spaced at least 2 weeks apart. Surveyors will record locations of activity centers and colony boundaries using a sub-meter accuracy GPS unit; approximate number of burrows; and representative photographs of burrows and scat. Surveyors will describe habitat characteristics at each location and note any noticeable land use or habitat changes that may have occurred since detection.

After each survey, the Certificate Holder will report the results to ODFW and ODOE and will include maps of the areas surveyed and detection locations. WAGS surveys will not be conducted if there are barriers to WAGS dispersal (i.e., active agriculture fields, highways, perennial waterbodies) or no suitable habitat.

4.0 Wildlife Reporting and Handling System

The Certificate Holder will document fatalities found during routine maintenance activities and any other incidentally detected fatalities. However, systematic post-construction fatality monitoring studies are not likely to produce significant findings or provide meaningful data on impacts based on the attributes of this Facility (especially relative to the costs that they incur to implement) as described below, and therefore no systematic post-construction fatality monitoring study is proposed for the Facility nor is one needed to meet the standards under Oregon Administrative Rule (OAR) 345-022-0060. In a December 2023 meeting with the Certificate Holder and ODOE, ODFW stated they are not requesting a post-construction fatality monitoring study for the Facility. If evidence of significant fatality events is detected by operations and maintenance (O&M) staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring and adaptive management.

Although mortality at the Facility due to collision with infrastructure is possible, as it is with most human development (e.g., buildings), the available literature on avian mortality at utility-scale photovoltaic solar energy sites suggests that mortality at these facilities is comparatively low (Walston et al. 2016, Loss et al. 2014, Kosciuch et al. 2020, Smith et al. 2021). In Oregon, results of a fatality study at a 56-MW photovoltaic facility near Prineville detected only three bird fatalities, only two of which were native birds (i.e., a horned lark [*Eremophila alpestris*] and a dark-eyed junco [*Junco hyemalis*]), during 1 year of standardized searches (ODOE 2020). These results suggest that large fatality events are unlikely at photovoltaic solar facilities in the region but that low numbers of fatalities of common ground-dwelling bird species could be detected at the Facility (ODOE 2020), and may be similar to background mortality levels. Post-construction fatality monitoring studies conducted at utility-scale photovoltaic solar facilities to date have reported lower fatality rates compared to other human development types, with fatalities in general primarily composed of resident ground-nesting birds.

In contrast to wind energy development, impacts to wildlife from photovoltaic solar development are primarily associated with habitat loss rather than direct mortality from collisions. The Facility is located almost entirely on wheat fields, and impacts to wildlife habitat will be minimal, restricted primarily to small tracts of disturbed grasslands. This habitat will be mitigated in accordance with ODFW's Habitat Mitigation Policy (OAR 635-415-0025), as described in the Facility's Exhibit P and Habitat Mitigation Plan (Attachment P-2 to Exhibit P; updated for RFA 1, see Attachment 6). The Certificate Holder will adhere to standard best management practices including following Avian Powerline Interaction Committee guidelines for minimizing avian collisions and electrocutions (APLIC 2006, 2012), primarily burying the medium voltage collector line system, and implementing down-shield lighting for permanent lighting at the substations and O&M buildings, and identifying a licensed local wildlife rehabilitator capable of responding to the Facility in the event of injured wildlife. Based on coordination with ODFW, the Certificate Holder will additionally install flight diverters on the overhead collector line that crosses Sand Hollow. The Certificate Holder will use wildlife-friendly fencing that does not include a top strand. Thus, the Facility has already minimized the risk of avian collision fatalities, based on known risk factors such as lighting (Gehring et al. 2009; Kerlinger et al. 2010; USFWS 2012, 2013).

Additionally, post-construction fatality monitoring is not necessary for the Certificate Holder to meet the standards under OAR 345-022-0060 (i.e., that the design, construction and operation of the facility, taking into account mitigation, are consistent with the general fish and wildlife habitat mitigation goals and standards of OAR 635-415-0025, ODFW's Fish and Wildlife Habitat Mitigation Policy) because the mitigation goals and standards relate to fish and wildlife habitat quality and quantity rather than fatalities of fish and wildlife individuals. OAR 635-415-0025 goals and standards for impacts to Category 2, 3, 4, and 5 habitat (i.e., the habitat categories addressed in the Facility's Habitat Mitigation Plan) include avoidance and, where impacts are unavoidable, mitigation to achieve the goal of no net loss of either habitat quantity or quality (Category 2, 3 and 4 habitat) and/or a net benefit in habitat quantity or quality (Category 2 and 5 habitat). Fatality monitoring, in itself, does not improve or maintain habitat quantity or quality, nor would the results of monitoring affect the habitat mitigation ratios or the size of the mitigation need described in the

Facility's Habitat Mitigation Plan attached to Exhibit P and Attachment 6 for RFA 1. Therefore, a systematic post-construction fatality monitoring study is not necessary for the Energy Facility Siting Council (EFSC) to determine that the Facility is consistent with OAR 635-415-0025

Although standardized fatality searches will not be implemented, all incidentally detected fatalities will be reported in the WRHS. The WRHS is a program for O&M staff to report wildlife (including bird and bat) casualties found during operation of the Facility. O&M staff will be trained in the methods needed to carry out this program. This monitoring program includes the initial response, handling, and reporting of bird and bat carcasses discovered incidental to maintenance operations ("incidental finds"). Approximately 10 permanent O&M staff are anticipated to be on-site for Facility operations and be responsible for WRHS program implementation. If a battery energy storage system is installed, additional workers will be on-site, but they will likely be contract employees and will not be included in WRHS program implementation. As part of routine O&M activities, O&M staff will visit each inverter pad approximately every 6 months to visually inspect equipment. If evidence of significant fatality events is detected by O&M staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring.

All carcasses discovered by O&M staff will be photographed and recorded. If O&M staff find a carcass at the Facility, they will notify qualified personnel who will identify the carcass. If the qualified personnel determines that a carcass is a state or federally threatened or endangered or otherwise protected species, agency reporting procedures and timelines specified in Section 5.0 shall be followed. Information recorded for each carcass and reported to ODFW and ODOE will include the location, date of discovery, species if known, as well as any evidence that might assist in determination of cause of death, such as evidence of electrocution, vehicular strike, wire strike, predation, or disease. Based on coordination with ODFW, feather spots[3] will be documented if found as well, consistent with industry standards; however, feather spots will not necessarily be attributed to a Facility-caused fatality (personal communication with J. Thompson, ODFW, December 13, 2023). Fatalities documented by O&M staff will be reported to ODOE and ODFW annually, as described in Section 5.0.

Prior to construction, the Certificate Holder will develop and implement a protocol for handling injured birds. Any injured native birds found at the Facility may be carefully captured by trained qualified personnel and transported to a qualified rehabilitation specialist approved by ODOE. Alternatively, the Certificate Holder may contact a qualified rehabilitation specialist approved by ODOE to respond to injured wildlife. Blue Mountain Wildlife (https://bluemountainwildlife.org/, 541.278.0215), located in Pendleton, Oregon, has confirmed the ability to respond to injured native wildlife, especially migratory birds, at the Facility (Lynn Tompkins, personal communication, April 11, 2023). The Certificate Holder will pay costs, if any, charged for time and expenses related to care and rehabilitation of injured native birds found on the site, unless the cause of injury is clearly demonstrated to be unrelated to Facility operations.

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[3] Feather spots are defined as at least 5 tail feathers, or 2 primary feathers, or a total of at least 10 feathers with no attached bone or tissue, within 5 meters of each other (CEC and CDFG 2007).

5.0 Data Reporting

The Certificate Holder will report wildlife monitoring methods, data, and data analysis to ODOE for each calendar year in which wildlife monitoring occurs. Monitoring data include raptor nest survey data, WAGS monitoring data (if applicable), and WRHS data. The Certificate Holder may include the reporting of wildlife monitoring data and analysis in the annual report required under OAR 345-026-0080 or submit this information as a separate document at the same time the annual report is submitted. In addition, the Certificate Holder will provide to ODOE data or records generated in carrying out this WMP upon request by ODOE.

The Certificate Holder will notify the U.S. Fish and Wildlife Service and ODFW if any federal or state endangered or threatened species are killed or injured at the Facility within 24 hours of species identification.

6.0 Plan Amendment

This WMP may be amended from time to time by agreement of the Certificate Holder and EFSC. Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this WMP. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

7.0 References

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Inadvertent Discovery Plan

Sunstone Solar Project 1

Morrow County, Oregon

October 2025

Author:
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Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

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1.0 INTRODUCTION

Pine Gate Renewables (PGR) proposes to construct and operate the approved Sunstone Solar Project 1 (Facility), a solar energy generation facility with related or supporting facilities including an energy storage system on private lands in Morrow County, Oregon. PGR seeks a Site Certificate through the Oregon Department of Energy (ODOE), Oregon Energy Facility Siting Council (EFSC or Council) for the Facility. The Facility will include an up to 200-megawatt (MW) solar project, battery energy storage system, and related or supporting facilities in Morrow County, Oregon. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1). The approved solar facility siting area (Facility site boundary) is located on privately owned agricultural land with areas of sage brush near the drainages and along Sand Hollow Canyon.

To meet the requirements for site certification, PGR must develop an Inadvertent Discovery Plan (IDP) for monitoring construction activities and responding to the discovery of archaeological resources or buried human remains.

2.0 CULTURAL RESOURCES IN THE PROJECT AREA

The entirety of the Facility site boundary and a 2-mile viewshed was surveyed for cultural resources, including pedestrian surveys along with subsurface shovel probing within the Facility site boundary. Two Historic Properties of Religious or Cultural Significance to Indian Tribes (HPRCSITs), Sand Hollow Battleground and Sisupa, are identified in the Oregon State Historic Preservation Office's (SHPO) archaeological database as overlapping a portion of the Facility site boundary. The HPRCSITs are eligible for listing on the NRHP.

Due to the presence of two culturally important resource areas to the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) within the Facility site boundary and its viewshed, the CTUIR has recommended monitoring to protect potential HPRCSIT-associated subsurface resources. The CTUIR has recommended that monitoring occur in the following areas:

- Within the HPRCSIT boundaries and a 100-foot surrounding buffer area, monitoring should occur for all ground disturbing activities, except driving posts for the solar modules; and
- Monitoring should occur within the Facility site boundary for all excavation work related to the proposed 3-foot-deep collector cable system.

Prior to construction, PGR will develop a Monitoring Plan that incorporates this IDP and includes necessary staff, agency, and tribal contact information once determined. This plan should include monitoring protocols and staffing roles and incorporate input from the CTUIR.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

3.0 PROCEDURES FOR THE DISCOVERY OF ARCHAEOLOGICAL RESOURCES

If any staff, contractors, or subcontractors, including archaeological and/or tribal monitors, believe that they have encountered cultural or archaeological remains of any kind, all work at and adjacent to the discovery shall immediately cease. The area of work stoppage will be adequate to provide for the security, protection, and integrity of the archaeological discovery. A cultural resource discovery may be pre-contact period or historic period in age and consist of (but not limited to):

- Areas of charcoal or charcoal-stained soil and stones;
- Stone tools or waste flakes (i.e., an arrowhead or stone chips);
- Bone, burned rock, or shell, whether or not seen in association with stone tools or chips;
- Clusters of tin cans, ceramics, flat glass, or bottles; and
- Concentrations of brick, railway tracks, or logging or agricultural equipment.

In the event unrecorded archaeological resources are identified during the construction or operation of the Sunstone Solar Project 1, work within 100 feet of the find shall be halted and directed away from the discovery until a Qualified Archaeologist[2] assesses the resource and its significance for inclusion on the NRHP. This assessment will include coordination with the CTUIR. (A wider avoidance area will be required for human remains; see below.) The archaeologist, in coordination with ODOE, the SHPO, Facility personnel, CTUIR, and the landowner, shall make the necessary plans for treatment of the finds and for the evaluation and mitigation of impacts if the finds are found to be eligible for listing on the NRHP.

A Qualified Archaeologist will determine if the resources are archaeological and greater than 50 years old. If the archaeologist believes that the discovery is a cultural resource, he or she in coordination with the PGR Construction Manager will establish a 100-foot avoidance buffer to protect the discovery site where construction activities will be suspended until treatment of the discovery can be determined. Vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery site or avoidance area. Any newly discovered archaeological resource will be considered eligible to the NRHP until determined otherwise. Work in the immediate area will not resume until treatment of the discovery has been completed.

If archaeological artifacts are observed during construction, the Qualified Archaeologist will ensure proper documentation and assessment of any discovered cultural resources. All precontact and historic cultural material discovered during project construction will be recorded by the archaeologist in SHPO's online archaeological site form database. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/sediment descriptions will be prepared for subsurface exposure. Discovery locations will be documented on scaled site plans and site location maps.

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[2] *Qualified Archaeologist* - means a person with qualifications meeting the federal secretary of the interior's standards for a Professional Archaeologist . An individual who has: (A) A post-graduate degree in archaeology, anthropology, history, classics or other germane discipline with a specialization in archaeology, or a documented equivalency of such a degree; (B) Twelve weeks of supervised experience in basic archaeological field research, including both survey and excavation and four weeks of laboratory analysis or curating; and (C) Has designed and executed an archaeological study, as evidenced by a Master of Arts or Master of Science thesis, or report equivalent in scope and quality, dealing with archaeological field research.

If the Qualified Archaeologist in consultation with the SHPO and CTUIR determines that the discovery is an NRHP-eligible cultural resource, they will consult to determine appropriate treatment to be presented and agreed upon in a Memorandum of Agreement (MOA) or other appropriate documentation. Mitigation measures will be developed in consultation with PGR, ODOE, SHPO, CTUIR, and the landowner, and could include avoidance through redesign, conducting data recovery, and/or relocating materials. Treatment measures performed may include protecting in place or data recovery such as mapping, photography, limited probing, and sample collection, or other activity deemed appropriate through an MOA or other appropriate documentation.

If human remains are inadvertently discovered, ODOE, SHPO, the Legislative Commission on Indian Services (LCIS), and CTUIR will decide when construction may continue at the discovery location. Where cultural resources are encountered during construction, but additional project effects to the resources are not anticipated, Facility construction may continue while documentation and assessment of the cultural resources proceed. If continued construction is likely to cause additional impacts to such resources, Facility activities within a radius of 100 feet of the discovery will cease until the Qualified Archaeologist has documented the site, evaluated its significance in consultation with CTUIR, and assessed potential effects to the site.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the discovery of the cultural resource, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 100 foot buffer—work may continue outside of this buffer.
3) Notify PGR Project Manager and ODOE (see Attachment A).
4) Construction Manager will need to contact a Qualified Archaeologist to assess the find.
5) If archaeologist determines the find is an archaeological site or object, contact SHPO. If it is determined to *not* be archaeological, you may continue work.

4.0 PROCEDURES FOR THE DISCOVERY OF HUMAN REMAINS

If human remains and/or associated grave goods are inadvertently encountered during Project activities, the Oregon State legislature protocol[3] for inadvertent discovery of human remains will be followed (Oregon State Legislature 2025). All activity that may cause further disturbance to the remains shall cease and the area secured and protected from further disturbance. A 200-foot avoidance buffer will be utilized for human remains and associated grave goods until appropriate

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[3] https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

treatment is completed. The presence of skeletal remains will be immediately reported to the County Medical Examiner, Oregon State Police, SHPO, and LCIS. The remains will not be touched, moved, or further disturbed. The County Medical Examiner or LCIS State Physical Anthropologist will assume jurisdiction over the human skeletal remains and determine whether those remains are forensic or non-forensic. If the remains are non-forensic, then they will report that finding to SHPO and the State Physical Anthropologist with the LCIS, who will then take jurisdiction over the remains and will notify CTUIR.

Although excavation work in the immediate area of a human remains find will not resume until assessment has been completed, excavation work may continue in other parts of the Facility that have been surveyed for cultural resources. Due to the sensitive nature of such a find, human remains should never be left unattended. No work will resume in the area of a human remains discovery until written authorization has been received from the LCIS and SHPO.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the inadvertent discovery, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 60-meter/200-foot buffer, then work may continue outside of this buffer with caution.
3) Cover remains from view and protect them from damage or exposure, restrict access, and leave in place until directed otherwise. Do not take photographs. Do not speak to the media.
4) Notify (refer to Attachment A for contact information):
    - PGR Project Manager
    - ODOE
    - Oregon State Police **DO NOT CALL 911**
    - SHPO
    - LCIS State Physical Anthropologist
    - CTUIR and other appropriate Native American Tribes determined by LCIS

5) If the site is determined not to be a crime scene by the Oregon State Police, do not move anything! The remains will continue to be secured in place along with any associated funerary objects, and protected from weather, water runoff, and shielded from view.
6) Do not resume any work in the buffered area until a plan is developed and carried out between ODOE, SHPO, LCIS, and appropriate Native American Tribes and you are directed that work may proceed.

5.0 CONFIDENTIALITY

The Facility and employees shall make their best efforts, in accordance with federal and state law, to ensure that its personnel and contractors keep the discovery confidential. The media, or any third-party member or members of the public are not to be contacted or have information regarding the discovery, and any public or media inquiry is to be reported to ODOE. Prior to any release, the responsible agencies and Tribes shall concur on the amount of information, if any, to be released to the public.

To protect fragile, vulnerable, or threatened sites, the National Historic Preservation Act, as amended (Section 304 [16 U.S.C. 470s-3]), and Oregon State law (Oregon Revised Statute 192.501(11)) establishes that the location of archaeological sites, both on land and underwater, shall be confidential.

6.0 REFERENCES

Oregon State Legislature

2025 Electronic document accessed July 2025, https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

ATTACHMENT A: CONTACTS

1. Pine Gate Renewables

Project Manager	To be determined prior to construction

2. Cultural Resource Contacts

Qualified Archaeologist	Lara Rooke, Tetra Tech (425) 217 7625 (Cell)
Oregon SHPO State Archaeologist	John Pouley (503) 480-9164
State Physical Anthropologist, LCIS	Dr. Elissa Bullion (971) 707-1372 or (503) 986-1067

3. Agency Contacts

ODOE	Christopher Clark (503) 871-7254
Oregon State Police	Craig Heuberger (503) 731-0079 or (503) 731-3030 (dispatch)
Morrow County Medical Examiner	(541) 676-5421

4. Tribal Contacts

CTUIR	Teara Farrow Ferman (Human Remains) (541) 429-7230 or (541) 377-2959 (cell)
	Ashley Morton (Archaeological Resources) (541) 429-7214

Sunstone Solar Project 1

Draft Construction Wildfire Mitigation Plan

Sunstone Solar Project 1
October 2025

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 1, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

Table of Contents

List of Tables

Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 1, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
EMP	Emergency Management Plan
Facility	Sunstone Solar Project 1
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 1, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 1 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) is attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described in this plan, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final Construction WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During construction, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to construction of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115, if significantly different from Final Order on ASC and the Request for Amendment 1.

4.0 Inspection and Management

OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;

4.1 Vegetation Management

The Certificate Holder and contractor(s) will maintain vegetation within the Site Boundary and will also maintain a defensible space clearance along Facility features. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

The following best management practices to minimize fire risk from vehicle travel and fueling activities would be implemented at the site during construction:

- The movement of vehicles will be planned and managed to minimize fire risk.
- The contractor(s) will be responsible for identifying and marking paths for all off-road vehicle travel. All off-road vehicle travel will be required to stay on the identified paths. No off-road vehicle travel will be permitted while working alone. Travel off road or parking in vegetated areas will be restricted during fire season.
- Areas with grass that are as tall or taller than the exhaust system of a vehicle must be wetted before vehicles travel through it.
- Workers will be instructed to shut off the engine of any vehicle that gets stuck, and periodically inspect the area adjacent to the exhaust system for evidence of ignition of vegetation. Stuck vehicles will be pulled out rather than “rocked” free and the area will be inspected again after the vehicle has been moved.
- All combustion engines (including but not limited to off road vehicles, chainsaws, and generators) will be equipped with a spark arrester that meets U.S. Forest Service Standard 5100-1.
- The contractor(s) will designate a location for field fueling operations at the temporary construction yards. Any fueling of generators, pumps, etc. shall take place at this location only.
- Fuel containers, if used, shall remain in a vehicle or equipment trailer, parked at a designated location alongside a county right-of-way. No fuel containers shall be in the vehicles that exit the right-of-way except the five-gallon container that is required for the water truck pump.
- Smoking shall only be allowed in designated smoking areas at the Facility.

5.0 Preventative and Minimization Actions for Wildfire Risk

OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;

5.1 Preventative Actions

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads[3]. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present. See Exhibit U[4] for additional discussion of Project fire prevention measures and coordination with local emergency responders.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during construction of the Facility, as applicable.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

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[3] Complete Application for Site Certificate, Exhibit D, May 16, 2024.

[4] Complete Application for Site Certificate, Exhibit U, May 16, 2024.

5.2.2 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fore spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high risk locations, designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.3 Emergency Management Plan

The EMP will be prepared prior to construction by the Certificate Holder and construction contractor and will contain policies and procedures for preparing for and responding to a range of potential emergencies, including fires. Implementation of the EMP will ensure risks to public health and safety and risks to emergency responders are minimized. Any potential fires inside the solar array will be controlled by trained staff who will be able to access the Facility around the clock. These measures will help keep external fires out or internal fires in. The EMP will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The plan will also specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, a construction kickoff meeting to discuss emergency planning, and invitations to observe any emergency drill conducted at the Facility.

In addition to the emergency responses to be stipulated in the EMP, personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

Another safety mitigation measure is to have available on site during construction is a water truck, water buffalo, or tank with minimum 500 gallon capacity.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

The Certificate Holder will track the industry groups and applicable design standards outlined in Table 2 to identify future technologies or best practices that could be implemented at the Facility.

Table 2: Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the O&M building and the substation enclosure.	Remodeling to the O&M and enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

Reference	Description	Method
1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/. 2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf. 3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.		

7.0 References

Gilbertson-Day, J.W., R.D. Stratton, J.H. Scott, K.C. Vogler, and A. Brough. 2018. Pacific Northwest Quantitative Wildfire Risk Assessment: Methods and Results. Quantum Spatial, Pyrologix, and BLM and USFS Fire, Fuels and Aviation Management. Available online at: https://oe.oregonexplorer.info/externalcontent/wildfire/reports/20170428_PNW_Quantitative_Wildfire_Risk_Assessment_Report.pdf.

IEEE (Institute of Electrical and Electronics Engineers). 2012. Guide for Substation Fire Protection. IEEE Std 979-2012, November, 1–99. https://doi.org/10.1109/IEEESTD.2012.6365301.

IEEE. 2015. Guide for Safety in AC Substation Grounding. IEEE Std 80-2013 (Revision of IEEE Std 80-2000/ Incorporates IEEE Std 80-2013/Cor 1-2015), May, 1–226. https://doi.org/10.1109/IEEESTD.2015.7109078.

Jeevarajan, Judith A., Tapesh Joshi, Mohammad Parhizi, Taina Rauhala, and Daniel Juarez-Robles. 2022. Battery Hazards for Large Energy Storage Systems. *ACS Energy Letters* 7(8):2725-2733. Available online at: https://pubs.acs.org/doi/pdf/10.1021/acsenergylett.2c01400

NERC (North American Electric Reliability Corporation). 2009. Transmission Vegetation Management NERC Standard FAC-003-2 Technical Reference. NERC Standard FAC-003-2 Technical Reference Prepared by the North American Electric Reliability Corporation Vegetation Management Standard Drafting Team. Available online at: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-2.pdf

NFPA (National Fire Protection Association). 2021. NFPA 1, Fire Code - Chapter 52 Stationary Storage Battery Systems. 2021 Edition. Quincy, MA.

NFPA. 2023. NFPA 70, National Electrical Code (NEC). 2023 Edition. Quincy, MA. Available online at: https://catalog.nfpa.org/NFPA-70-National-Electrical-Code-NEC-Softbound-P1194.aspx?icid=D731.

ODF and USFS (Oregon Department of Forestry and U.S. Department of Agriculture Forest Service). 2018. Oregon CWPP Planning Tool. Available online at: https://tools.oregonexplorer.info/oe_htmlviewer/index.html?viewer=wildfireplanning (Accessed October 2022).

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Sunstone Solar Project 1
Draft Operational Wildfire Mitigation Plan

Sunstone Solar Project 1
October 2025

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 1, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

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Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 1, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
EMP	Emergency Management Plan
Facility	Sunstone Solar Project 1
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 1, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 1 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) was attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described above, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers, (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire, (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.
[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs, battery components, and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During operation, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires and how to safely respond to fires involving BESS components. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment Update

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to operation of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115.

4.0 Inspection and Management

> *OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;*

4.1 Facility Inspections

Facility components will be inspected quarterly. The supervisory, control, and data acquisition (SCADA) system collects operating and performance data from the Facility as a whole and allows remote operation. The Certificate Holder will monitor the Facility components, such as the substation and solar arrays, 24 hours a day, 7 days a week including shutdown capabilities. These operational monitoring and maintenance measures are also discussed in Section 4.0.

The battery energy storage system may consist of either zinc-based batteries or lithium-ion (Li-ion) batteries and will be stored in completely contained, leak-proof modules. The modules will be stored on a concrete pad to capture any leaks that may occur. Operations and maintenance (O&M) employees will conduct inspections of the battery energy storage systems according to the manufacturer's recommendations, which are assumed to be monthly inspections.

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Section 2.7.1 of Exhibit B summarizes the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected.

Table 2 below provides draft operational inspections for electrical facility components from similar types of facilities. As part of finalizing the final operational WMP, the Certificate Holder may update this table as applicable to facility equipment, standards, and inspections.

Table 2. Draft Operational Inspections for Electrical Components

Inspection	Procedure	Standard	Time frame
Solar Inverter	Visual inspection of inverter and surrounding area.	SPCC Plan[1] Manufacturer's maintenance recommendations	Monthly SPCC Bi-annual Preventative Maintenance
Substation	Visual inspection of MPT, Avian Power Line Interaction Committee (APLIC) measures, and surrounding area.	Manufacturer's maintenance recommendations APLIC[2]	Monthly Yearly (APLIC)
BESS	Visual inspection of BESS, PCS, and surrounding areas	SPCC Plan Manufacturer's maintenance recommendations	Monthly

Inspection	Procedure	Standard	Time frame
Overhead electrical lines	Visual inspection of components, grounding, APLIC measures, vertical clearance distance between conductor and vegetation.	National Energy reliability Corporation (NERC)3 APLIC	Bi-annual
1. The Operational Spill Prevention, Control, and Countermeasure Plan for the facility will require these components to be inspected monthly for spills. During these inspections, Operational Staff will also visually inspect the component and surrounding area. 2. The Certificate Holder will develop an inspection checklist and program of electrical equipment based on manufacturer's recommendations for individual components. 3. Vegetation maintenance standard FAC-003-0 .			

4.2 Vegetation Management

Vegetation within areas temporarily disturbed during construction of the Facility, as well as revegetation of areas within the solar array fence line area, will be revegetated as outlined in the Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4[3]; updated for RFA 1, see Attachment 6). As noted in the Revegetation and Reclamation Plan, areas within the solar array fence line area will be revegetated with a mixture of low-growing grasses and forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). In addition, vegetation within the solar array fence line area will be managed as needed to reduce fuels for fire. This would include mowing vegetation under solar panels periodically, if required. The Certificate Holder will also maintain a 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

A physical vegetation survey assessment of the fenced area will be completed at least twice a year to monitor for vegetation clearances, maintain fire breaks, as applicable, and monitor for wildfire hazards. One of the vegetation survey assessments will occur in May or June, prior to the start of the dry season, a time when wildfire risk begins to become heightened. The survey will be conducted by the Site Operations Manager and will be used to assess the frequency of any upcoming vegetation maintenance required and identify areas that may need additional attention. The Site Operations Manager will visually assess and document vegetation height, abundance, and areas where vegetation should not be present such as crushed rock bed around collector substations. The vegetation survey assessment will determine that clearances and fire breaks (vegetative clearance areas and areas determined to remain clear to act as permanent fire breaks or areas where temporary fire breaks may be deployed in the event of a fire) are satisfactory, and if not, the mitigation procedures will be implemented (e.g., vegetation management) to ensure clearances and fire breaks are satisfactory The vegetation survey will document::

- Location of observations

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[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

- Species
- Estimated growth rate
- Abundance
- Clearance / Setbacks
- Risk of fire hazard

Additional vegetation surveys may be required throughout the season based on seasonally heightened fire risk. Vegetation Maintenance procedures and BMPs will be followed during operation of the Facility to ensure that vegetation does not grow in a manner that blocks or reduces solar radiation reaching the solar panels and reduce the risk of starting a fire. Vegetation control will employ best management practices (BMPs) and techniques that are most appropriate for the local environment. BMPs may include physical vegetation control such as mowing. Noxious weeds within the site boundary will be controlled in accordance with the Noxious Weed Control Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). Efforts will be made to minimize the use of herbicides and only herbicides approved for use by the U.S. Environmental Protection Agency and Oregon Department of Agriculture will be used. Herbicides used for vegetation management of the site will be selected and used in a manner that fully complies with all applicable laws and regulations.

Vegetation within the fence line and below the solar arrays will be maintained to a height of 18 inches and provide a minimum of 24-inch clear distance to any exposed electrical cables. Exposed electrical wires should be running under the solar panels at the midpoint or higher than the center of the panel. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present.

Ongoing vegetation management to ensure that vegetation does not grow in these graveled areas is outlined in Table 3.

Table 3. Vegetation Management Procedures by Facility Component

Vegetation Management	Procedure	Standard	Time Frame
Solar Inverter	Herbicide application on gravel pad around inverter to prevent vegetation growth.	Institute of Electrical and Electronics Engineers (IEEE) 80[1] National Electrical Code (NEC) 70[2]	Yearly, depending on vegetation condition.
Substation	Herbicide application on substation gravel pad. Highly compacted gravel foundations of substation are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.

Vegetation Management	Procedure	Standard	Time Frame
Battery energy storage system	Herbicide application on gravel pad surrounding the battery energy storage system. Highly compacted gravel foundations of the battery energy storage system are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.
Overhead electrical lines	Mow vegetation to achieve clearance requirements between conductor and ground.	North American Electric Reliability Corporation (NERC)[3]	Yearly, depending on vegetation condition.
1. IEEE (2015) 2. NFPA (2023) 3. NERC (2009)			

5.0 Preventative and Minimization Actions for Wildfire Risk

> *OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;*

5.1 Preventative Actions and Design Features

The Certificate Holder will minimize risk of operation of the facility causing wildfire by implementing a number of systems and procedures. During O&M activities, these will include requirements to conduct welding or metal cutting only in areas cleared of vegetation, and maintaining emergency firefighting equipment on-site. Employees will keep vehicles on roads and off dry grassland when feasible during the dry months of the year, unless such activities are required for emergency purposes, in which case fire precautions will be observed. Fire extinguishers and shovels will be kept in all vehicles. On-site employees will also receive training on fire prevention and response and have on-site fire extinguishers to respond to small fires. In the event of a large fire, emergency responders will be dispatched.

The Certificate Holder will minimize risk of Facility components causing wildfire through preventative actions. In the design of the Facility, the Certificate Holder will implement the design considerations and best practices outlined in Table 4 to minimize electrical fire risk from facility components.

Table 4. Design Considerations for Fire Safety by Facility Component

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Electrical connections by qualified electricians	X	X	X	X
Inspections for mechanical integrity prior to energizations	X	X	X	X
Lighting protection	X	X	X	X
Corrosion protection	X	X	X	X
Strain relief of connecting cabling	X	X	X	X
Protection against moisture	X	X	X	X
Grounding systems	X	X	X	X
Safety setback from structures	X[1]	X[1]	X[1]	X[2]
Technology specific design standards	X[3]	X[4]	X[5]	X[3]

1. Graveled inside structure's perimeter fence with additional 3-foot gravel setback outside of structure's perimeter fence
2. Vertical and horizontal clearances from structures depends on voltage of conductor.
3. NFPA 70 (.NFPA 2023).
4. IEEE 979 (IEEE 2012).
5. NFPA 1, Chapter 52 (NFPA 2021).

During Facility operations, the areas within the site boundary that are subject to a heightened risk of wildfire include the solar array areas. The solar array areas will have low-growing vegetation maintained below the solar arrays during the operational period of the Facility. Measures for reducing the risk of fire ignition and reducing the risk of equipment damage were a wildfire to occur are discussed further in Section 3.0, including the Facility's vegetation management program (see Section 3.2), and through the emergency response procedures that will be described in the Emergency Management Plan (EMP). The EMP will be developed for the Facility and is outlined below in Section 4.2.5. The collector substation area, transformer pads, and the permanent, fenced parking and storage area will have reduced risk for fire due to the fact that these areas will have a gravel base with no vegetation within a 10-foot perimeter to reduce fire risk.

The Facility components will meet National Electrical Code and Institute of Electrical and Electronics Engineers standards and will not pose a significant fire risk. The solar array will have shielded electrical cabling, as required by applicable code, to prevent electrical fires. In addition, the collector system and substation will have redundant surge arrestors to deactivate the Facility during unusual operational events that could start fires. The collector substation will have also sufficient spacing between equipment to prevent the spread of fire.

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. A 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary will be maintained. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present. See Exhibit U for additional discussion of Project fire prevention measures and coordination with local emergency responders. Vegetation free areas such as gravel pads or base and facility perimeter and interior roads act as a permanent fire break which could minimize the spread of fires on site or impacts from an external wildfire.

Smoke/fire detectors will be placed around the site that will be tied to the SCADA system and will contact local firefighting services. This communication system allows each solar string, battery energy storage system, and substation to be monitored by a SCADA system, accessed through both the SCADA control room in the substations or remotely. This system monitors these components for variables such as meteorological conditions, critical operating parameters, and power output. The solar array is controlled and monitored via the SCADA system and can be controlled remotely. SCADA software is tuned specifically to the needs of each project by the solar module manufacturer or a third-party SCADA vendor. This system will be monitored 24/7 by a remote operations center.

The Certificate Holder proposes to construct either a direct current–coupled distributed battery energy storage system (located throughout the solar array fence line area at the inverter and transformer sites) or alternating current–coupled battery energy storage system (concentrated in a single location within the solar array fence). The system as a whole will use a series of self-contained containers located within the solar array fence line area. The containers may have their own additional fencing, to be determined prior to construction. Each container will be placed on a concrete foundation. Regardless of the battery technology selected, the containers are estimated to require up to 0.2 to 0.4 acre each with a total of 2,491 containers. Each container is rated for outdoor environments and holds the batteries and a battery management system.

The Facility will use either Li-ion batteries or zinc batteries to store up to 200 MW alternating current of power over a 6-hour discharge duration (1,200 megawatt-hours alternating current) (ASC Exhibit C, Figure C-2[4]).

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Additionally, zinc batteries will have fans and a heating unit for climate control.

The following paragraphs summarize the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected. The chemicals used in Li-ion batteries are generally nontoxic but do present a flammability hazard. Li-ion systems would also include a fire prevention system and cooling units placed either on top of the containers or along the side. Li-ion batteries are susceptible to overheating and typically require cooling systems dedicated to each battery energy storage system enclosure, especially at the utility scale (Jeevarajan et al. 2022). The

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[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

gas released by an overheating Li-ion cell is mainly carbon dioxide but may also include carbon monoxide, methane, ethylene, and propylene (Jeevarajan et al. 2022).

The Certificate Holder will implement the following fire prevention and control methods to minimize fire and safety risks for the Li-ion batteries proposed for the battery energy storage system:

- The batteries will be stored in completely contained, leak-proof modules.
- Ample working space will be provided around the battery energy storage system for maintenance and safety purposes.
- Off-site, 24-hour monitoring of the battery energy storage system will be implemented and will include shutdown capabilities.
- Transportation of Li-ion batteries is subject to 49 Code of Federal Regulations (CFR) 173.185 – Department of Transportation Pipeline and Hazardous Material Administration. This regulation contains requirements for prevention of a dangerous evolution of heat; prevention of short circuits; prevention of damage to the terminals; and prevention of batteries coming into contact with other batteries or conductive materials. Adherence to the requirements and regulations, personnel training, safe interim storage, and segregation from other potential waste streams will minimize any public hazard related to transport, use, or disposal of batteries.
- Design of the battery energy storage system will be in accordance with applicable Underwriters Laboratories (UL; specifically, 1642, 1741, 1973, 9540A), National Electric Code, and National Fire Protection Association (specifically 855) standards, which require rigorous industry testing and certification related to fire safety and/or other regulatory requirements applicable to battery storage at the time of construction.
- Additionally, the Certificate Holder will employ the following design practices, as applicable to the available technology and design at time of construction:
    - Use of Li-ion phosphate battery chemistry that does not release oxygen when it decomposes due to temperature;
    - Employment of an advanced and proven battery management system;
    - Qualification testing of battery systems in accordance with UL 9540A (UL Solutions 2025);
    - Employment of Fike fire control panels with 24-hour battery backup at every battery container;
    - Installation of fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems in every battery container;
    - Installation of doors that are equipped with a contact that will shut down the battery container if opened;

  - Installation of fire extinguishing and thermal insulation sheets between each individual battery cell;
  - Implementation of locks and fencing to prevent entry of unauthorized personnel;
  - Installation of remote power disconnect switches; and
  - Clear and visible signs to identify remote power disconnect switches.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during operations of the Facility.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

5.2.2 Electrical Safety Program

All operational workers will be trained in electrical safety and the specific hazards of the Facility. This training will address:

- Minimum experience requirements to work on different types of electrical components;
- Electrical equipment testing and troubleshooting;
- Switching system;
- Provisions for entering high voltage areas (e.g., substation);
- Minimum approach distances; and
- Required personal protective equipment.

5.2.3 Lock Out/Tag Out Program

During maintenance activities, electrical equipment will be de-energized and physically locked or tagged in the de-energized positions to inadvertent events that could result in arc flash.

5.2.4 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fire spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high-risk locations, as designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.5 Emergency Management Plan

Emergency Management will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The final WMP will specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, annual meetings to discuss emergency planning, protocols for how to respond to electrical fires and safely respond to a fire involving BESS components, and invitations to observe any emergency drill conducted at the Facility.

At the beginning of Facility operations, a copy of the site plan indicating the arrangement of the Facility structures, access points, and fire breaks will be provided to the local fire district.

Personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

During times of heightened wildfire risk, a water truck, water buffalo, or tank with minimum 500 gallon capacity will be stationed at the site during operations and maintenance activities.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the amended site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

This Plan will be updated by the Certificate Holder every 5 years. Updates to this Plan will account for changes in local fire protection agency personnel and changes in best practices for minimizing and mitigating fire risk. It is recommended to consult with Morrow County, the local fire department, and the Morrow County Emergency Manager.

After each 5-year review, a copy of the updated plans will be provided to the Oregon Department of Energy with the annual compliance report required under OAR 345-026-008(2).

Every 5 years, the Certificate Holder will review wildfire risk and update this Plan for the site boundary. Evaluation of wildfire risk will be consistent with the requirements of OAR 345-022-0115(1) using current data from reputable sources.

The Certificate Holder may consider revisions to this Plan at its sole discretion to incorporate future best practices or emerging technology depending on whether the new technology is cost effective and suitable for the site conditions. The Certificate Holder will track the industry groups and applicable design standards outlined in Table 5 to identify future technologies or best practices that could be implemented at the Facility.

Table 5. Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the O&M building and the substation enclosure.	Remodeling to the O&M and enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/.
2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf.
3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.

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Sunstone Solar Project 2

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Sunstone Solar Project 2
Draft Fugitive Dust Control Plan

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 2, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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Table of Contents

List of Attachments

1.0 Introduction

This Fugitive Dust Control Plan (Plan) has been developed by Sunstone Solar 2, LLC (Certificate Holder), a subsidiary of Pine Gate Renewables, LLC, for the approved Sunstone Solar Project 2 (Facility) in Morrow County, Oregon. The purpose of this Plan is to reduce fugitive dust emissions associated with construction-related activities of a photovoltaic energy generation facility with up to 200 megawatts (MW) alternating current and related or supporting facilities, as well as a 1,200 MW-hour distributed battery energy storage system. The majority of the site consists of a mix of fallow fields and fields in small grain production, primarily dryland wheat; no farmlands within the site boundary receive irrigation (the application of water to land for purposes of growing agricultural products; Sunstone Solar 2024). This Plan summarizes the sources of and regulatory issues that relate to fugitive dust emissions; identifies responsibilities, monitoring, and training; and provides reasonable available control methods for fugitive dust in a table for easy reference in the field (Attachment 1).

This is an owner-imposed Plan that is expected to be implemented, maintained, and adaptively managed by the selected contractor throughout all phases of construction. The performance criteria and suggested measures identified in this Plan are minimums, and the contractor is expected to identify and implement additional measures as needed to fully meet all regulatory and public safety performance criteria. As identified in this Plan, the contractor may propose alternative approaches for consideration by the owner.

1.1 Fugitive Dust Sources

The Natural Resources Conservation Service (NRCS) Web Soil Survey identified six major soil types within the project area (NRCS 2025). Approximately 98 percent of the site is composed of Warden silt loam, which is moderately or severely susceptible to erosion from ground disturbance, wind, and vehicle traffic on unpaved roads due to its composition of hemic organic soil materials and very fine sand (NRCS 2025, NRCS 2011). Due to their composition, the retention of moisture in these sediments is thus restricted. Furthermore, these sediment particles have a low resistance to dust propagation and would be transported or drift to adjacent lands due to the lack of water through irrigation; thus, these soils are considered at high risk for fugitive dust.

Fugitive dust can arise from a variety of construction and operational activities associated with solar development. The sources can be grouped into three general categories: dust created from ground-disturbing activities such as clearing and grading, dust created from wind action on bare soils and stockpiles such as those not fully stabilized post-construction with either vegetation or a tackifier, and dust created from traffic on unpaved roads. Sediment is the basis for fugitive dust, meaning that sediment particles can become fugitive dust if they are windborne. Therefore, the thresholds for treating sediment and erosion on the site will be similar if not the same as the thresholds for treating fugitive dust. Maintaining existing vegetation and root systems is the single most effective method for avoiding fugitive dust and sediment. Where existing vegetation and root systems are disturbed, quickly reestablishing vegetation is critical.

1.2 Regulatory Compliance

Fugitive dust is a source of particulate matter with a mean diameter less than 10 microns (PM_{10}) which is one of the seven air pollutants the U.S. Environmental Protection Agency (EPA) regulates under the National Ambient Air Quality Standards (NAAQS). To a lesser extent, fugitive dust is a source of particulate matter with a mean diameter less than 2.5 microns ($PM_{2.5}$), which has proposed regulations pending under NAAQS. These soil particles are very small, can remain suspended in the air for long periods of time, and are easily inhaled into the lungs. Increased risks of death and disease have been linked to periods of high outdoor PM_{10} and $PM_{2.5}$ concentrations. These fine particles can potentially be lifted thousands of feet into the atmosphere and transported across continents and oceans creating global health, ecological, and climate change impacts.

The EPA shares responsibility with the Oregon Department of Environmental Quality (ODEQ) for the implementation of Clean Air Act (CAA) criteria in Oregon. ODEQ implements the CAA rules under the EPA-approved Oregon Administrative Rules (Chapter 340, Division 21 General Emission Standards for Particulate Matter). Fugitive dust is the primary concern related to the CAA at the Project. Fugitive dust is defined by ODEQ as dust that visibly leaves the project site for a period of more than **18 seconds in a 6-minute period,** determined by the attached EPA Method 22 (ODEQ 2019) at the downwind property boundary (Oregon Administrative Rules [OAR] 340-208-0210 (2)-a and -b).

The ODEQ Rule 340-208-0210 contains the following requirements for fugitive dust:

- Reasonable precautions must be taken to prevent particulate matter from becoming airborne. This includes, but is not limited to, the use of water or other chemicals to control dust during construction, on unpaved roads, and during the transport of materials; enclosure of materials stockpiles and covering of open-body trucks; and prompt removal from paved streets of earth or other material.
- If fugitive dust is discovered, ODEQ may require the Facility to cease work until the fugitive dust emissions are controlled. Emissions are considered controlled when fugitive dust is no longer leaving the Facility site for more than 18 seconds in a 6-minute period.

Further, ODEQ Rule 340-208-0300 specifies that it is prohibited to cause or allow any air contaminants (e.g., fugitive dust) to create a nuisance. If ODEQ determines that a nuisance has been created, the agency may pursue informal or formal enforcement actions to abate the nuisance.

A National Pollutant Discharge Elimination System Construction Stormwater Discharge Permit (Oregon 1200-C Construction Stormwater Permit), pursuant to Oregon Revised Statutes 468.050 and Section 402 of the federal Clean Water Act, will be obtained from ODEQ. This permit requires the permit holder to "Prevent wind-blown soil and dust from areas with exposed soil through the appropriate application of water or other dust suppression techniques to control the generation of pollutants that could be discharged in stormwater from the site" (Section 2.2.9) and requires permit holders to implement measures including monitoring, record keeping, reporting of exceedances, and installation, maintenance, and adaptive management of best management practices (BMPs) to control both stormwater and fugitive dust discharges. Implementation of these measures is intended to reduce fugitive dust to a negligible impact and ensure compliance with applicable air quality regulations.

The Morrow County Code regulates nuisances through the Oregon State Statute Chapter 203. Controlling fugitive dust emissions is required to avoid creating a public nuisance, which is defined as "any thing, substance, or act that is a threat to the public health, safety or welfare" (Morrow County Code Enforcement Ordinance ORD-2021-4).

2.0 Fugitive Dust Control Plan

2.1 Responsibility

The expectation is that the Contractor will implement and adaptively manage this Plan, controlling fugitive dust emissions and meeting all regulatory and public safety performance criteria throughout construction. As described in Section 1.2 above, the holder of the Oregon 1200-C permit is required to control fugitive dust emissions, including ensuring compliance by all subcontractors and outside service providers.

If the Certificate Holder identifies that the regulatory and public safety performance criteria are not being met, the Certificate Holder will implement enforcement measures, including but not limited to:

- Issuance of a Non-Conformance and/or Non-Compliance Report.
- Contractor to prepare and submit a corrective action plan.
- Contractor to document corrective actions taken and performance criteria met.
- Partial or full stoppage of work on site through activation of shut-down clause in contract.
- At the Certificate Holder's sole discretion, an outside contractor may be contracted to implement corrective actions, to be reimbursed by the Contractor.

Additionally, the Certificate Holder may establish a Community Action Council to create an open and ongoing pathway for communication with stakeholders for the Project, including controlling fugitive dust emissions and avoiding the creation of nuisances. The Community Action Council could include representatives from the Morrow County Commissioners' Office, Morrow County Planning Department, Oregon Department of Transportation, and neighboring landowners. The Contractor will work with the Certificate Holder to determine whether this Community Action Council will be established, and if so, the details of its establishment.

2.2 Monitoring

As required by the 1200-C permit, the permit holder will perform visual monitoring and recordkeeping by a Certified Erosion and Sediment Control or Storm Water Quality Inspector (inspector). The Contractor's construction site manager and inspector will be responsible for ensuring that the measures in this Plan are implemented, monitored, and adaptively managed, and that any exceedances are immediately reported to the Certificate Holder.

The visual monitoring required by the 1200-C permit must occur at least once every 14 calendar days. However, because OAR 340-208-0210 restricts visible fugitive emissions on a continuous standard to a maximum of 18 seconds in a given 6-minute period, and because fugitive dust emissions may provide an immediate public safety concern in this location, this Plan requires that fugitive dust be monitored and controlled on an ongoing basis.

Monitoring for fugitive dust emissions shall include:

- Use of EPA Method 22 (ODEQ 2019; see Attachment 2) as specified in OAR 340-208-0210, at least once a day.
- The observation shall be performed during times of peak construction activity at the downwind property boundary.
- Recording of observations in a fugitive dust inspection log that is kept on site and shall be available digitally to the Certificate Holder. This log shall include all information required in EPA Method 22 and shall also include photos and/or video taken during the observation period to document conditions.
- Installation and operation of a weather station, recording (at a minimum) wind speed and direction.

Triggers for additional, more frequent monitoring will include:

- Observation of visible fugitive dust emissions by Contractor, agency, or the Certificate Holder staff.
- Request by a member of the Community Action Council established by the Certificate Holder.
- Wind speeds greater than 15 miles per hour.
- Receipt of complaints or concerns through the Project Dust Control Hotline.

2.3 Training

EPA Method 22 (ODEQ 2019) does not require a specific certification, but it is necessary that the person responsible for observations completed for this method be knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in the references cited in Method 22 (EPA 2019) or from the lecture portion of the EPA Method 9 certification course. The Contractor shall document in the inspection log how the person responsible for observations meets this requirement.

Construction workers will attend a Worker Environmental Awareness Program training prior to conducting construction activities. This training will include a summary of fugitive dust control measures included in this Plan and the responsibilities of personnel working on the Facility related to fugitive dust control.

2.4 Fugitive Dust Prevention and Management

This document and the attached table are intended to provide guidance to construction personnel on measures intended to minimize impacts and control fugitive dust emissions during construction. It is the responsibility of the Contractor to monitor and adaptively manage the site to maintain compliance with all local, state, and federal requirements. Additionally, this Plan is supplemental to the Contractor's Erosion and Sediment Control Plan and does not substitute for any requirements of ODEQ or other agencies.

This Plan is performance-based. As shown in the flow chart in Figure 1, if fugitive dust emissions in excess of the ODEQ criteria of **18 seconds in a 6-minute period** occur, the Contractor shall:

- Implement adaptive management actions, including altering work operations and/or pause work until the fugitive dust emissions are controlled.
- Document that fugitive dust emissions have been controlled, including monitoring with EPA Method 22.
- In addition to any reporting requirements required in the 1200-C permit, report noncompliance incidents and adaptive management actions taken by the Certificate Holder within 24 hours of occurrence.

The Contractor shall maintain and implement this Plan during all phases of construction. The table in Attachment 1 provides suggested Reasonable Available Control Measures (RACMs) for anticipated fugitive dust sources based on industry-standard BMPs and reasonable precautions specified in the Oregon 1200-C permit, ODEQ's Construction Stormwater Best Management Practices Manual (Manual) (ODEQ 2021), and OAR 340-208-0210. Supplemental RACMs are identified in the table in case initial RACMs are not effective in controlling fugitive dust or are not feasible to implement (Attachment 1).

The Contractor shall identify and implement additional RACMs as needed to control fugitive dust emissions. Additionally, the Contractor may propose alternative approaches and RACMs for controlling fugitive dust. This proposal shall be made in writing and is subject to the approval of the Certificate Holder.

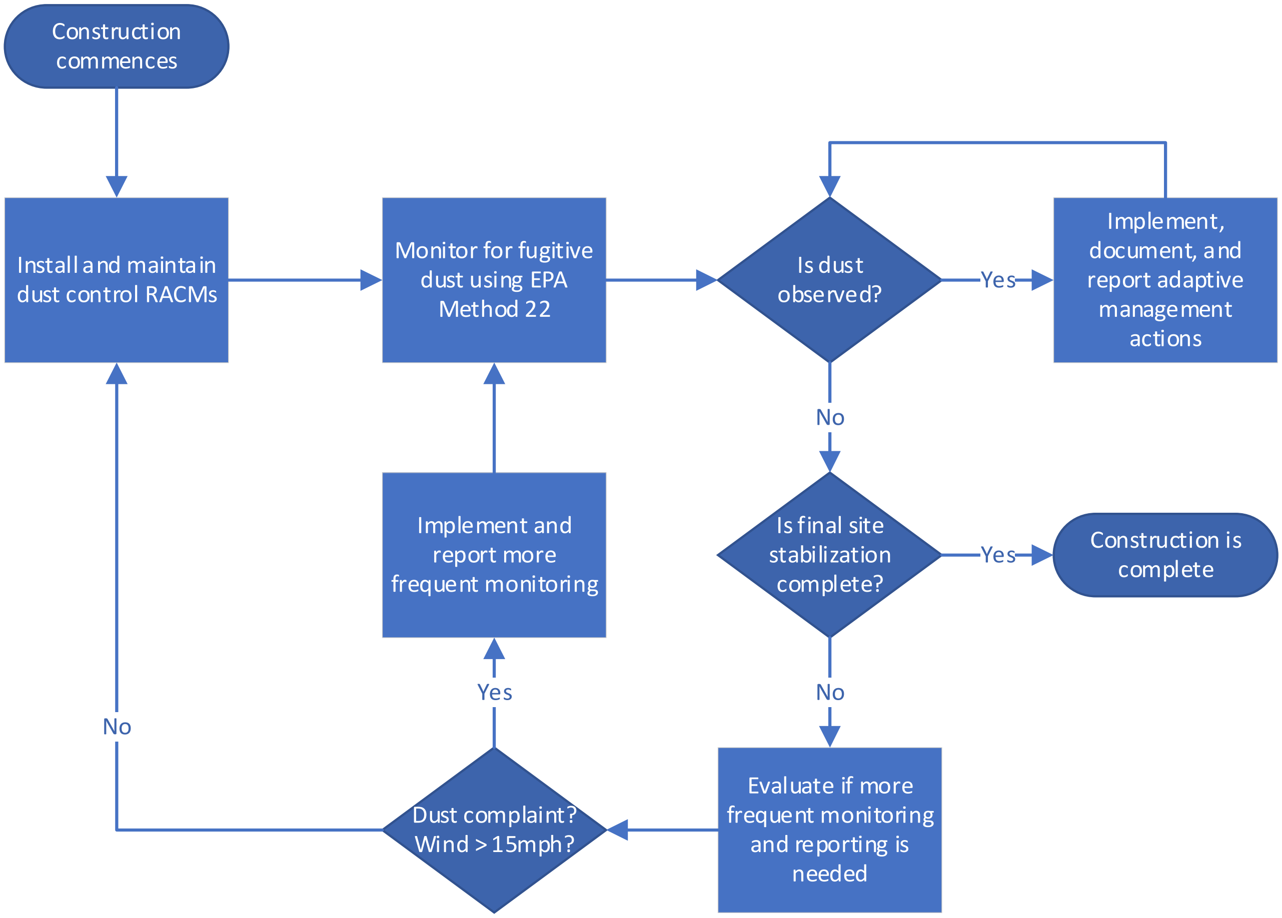

Figure 1. Dust Control Plan Flow Chart

3.0 References

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Attachment 1: Fugitive Dust Sources and Reasonable Available Control Measures

Fugitive Dust Sources and Reasonable Available Control Measures

Construction Phase	RACM(s)	Supplemental RACM(s)
All Phases of Construction	Daily fugitive dust monitoring and record keeping.	Increase frequency of monitoring.
	Prominent display of Dust Control Hotline signs, providing direct access to the Contractor's site manager or inspector.	If established, proactive engagement with Community Action Council.
	If established, Worker Environmental Awareness Program training for all construction employees.	Additional trainings and refreshers for employees.
	Maintain stockpile of BMPs on site, including sufficient palliatives for a single treatment of all site access roads and sufficient palliatives, mulch, and/or hydromulch for a minimum of 25 percent of the total disturbed area, and machinery for application.	Increase stockpile of palliatives, mulch, and/or hydromulch and add additional BMPs.
	Documentation and reporting of adaptive management actions.	Development and submittal of revised Fugitive Dust Control Plan.
Site Access	Install and maintain stabilized construction entrances at ingress/egress locations and restrict traffic to these locations.	Add additional construction entrance BMPs (e.g., wheel wash).
	Daily sweeping up of sediment from paved surfaces utilizing vacuum sweeper with HEPA filtration.	Increase sweeper frequency.
	Access roads shall be graveled.	Road maintenance and reapplication of gravel.
	Access roads will be stabilized with water or palliative sufficient to eliminate visible and sustained dust from vehicular travel and wind erosion. Reapply stabilization as necessary to maintain dust-free condition.	If water is unavailable or ineffective, or if water use is limited by any agency or regulation, access roads will be stabilized with longer-lasting palliatives.
	Restrict construction traffic to established and stabilized access routes.	Install fencing or barricades to prevent traffic outside of established routes.
	Limit traffic speeds to 15 miles per hour on stabilized unpaved roads within the site as long as such speeds do not create significant visible dust emissions. Traffic speed signs shall be displayed prominently at all site entrances and exits.	Limit traffic speeds within the site to 5 or 10 miles per hour.

Construction Phase	RACM(s)	Supplemental RACM(s)
Clearing, Grading, and Unstable Surfaces	Maintain the natural topography and vegetation of the site to the extent possible, including by limited grading and limited establishment of temporary access roads.	Reduce area being actively worked and stabilize unworked areas.
	Phase construction to expose the minimum amount of soil necessary.	Increase construction phasing to further minimize exposed soil.
	Leave existing vegetation intact to the extent possible.	Utilize mowing and rolling techniques to maintain plant root systems for soil stabilization.
	Minimize disturbance areas and soil exposure to the maximum extent feasible.	Limit work to a portion of the disturbed area until all disturbed areas receive temporary or final stabilization.
	When wind speeds exceed 15 miles per hour, minimize new disturbances to the extent possible and/or mobilize additional water trucks or palliatives to minimize fugitive dust from exposed surfaces.	Stop all ground disturbing activities and apply additional dust control measures until measures are effective or wind speeds slow and fugitive emissions stop.
	Separate and cover topsoil.	Increase maintenance frequency for topsoil cover. Combine methods, such as mulch plus tackifier.
	Stabilize exposed soils within the timeframes established in the 1200-C permit. Stabilize exposed soils in stages based on site conditions and weather.	Stabilize exposed soils more frequently, even if additional work is anticipated within the timeframe established in the 1200-C permit. Reapply stabilization measures following any additional disturbances.
	Temporarily stabilize exposed surfaces to prohibit significant and sustained visible fugitive dust from wind erosion. Utilize BMPs such as mulch, hydromulch with or without seeds, tackifier, spreading stone or gravel, and trackwalking.	Combine stabilization methods, such as mulch plus tackifier, or trackwalking plus hydromulch. Increase frequency of maintenance of stabilization.
	Seed exposed surfaces during the appropriate season with approved temporary or permanent seed mixes.	Reapply seed to newly disturbed areas or areas with poor germination. Use temporary seeding even if additional work is anticipated before final stabilization. Use irrigation to enhance seeding success.
	Gate seals should be tight on dump trucks. Soil load shall be kept below 6 inches of the freeboard of the truck. Drop heights shall be minimized when loaders dump soil into trucks.	Cover haul trucks with a tarp or other suitable cover.

Attachment 2: EPA Method 22

State of Oregon Department of Environmental Quality

OAR 340-208-0210
EPA Method 22

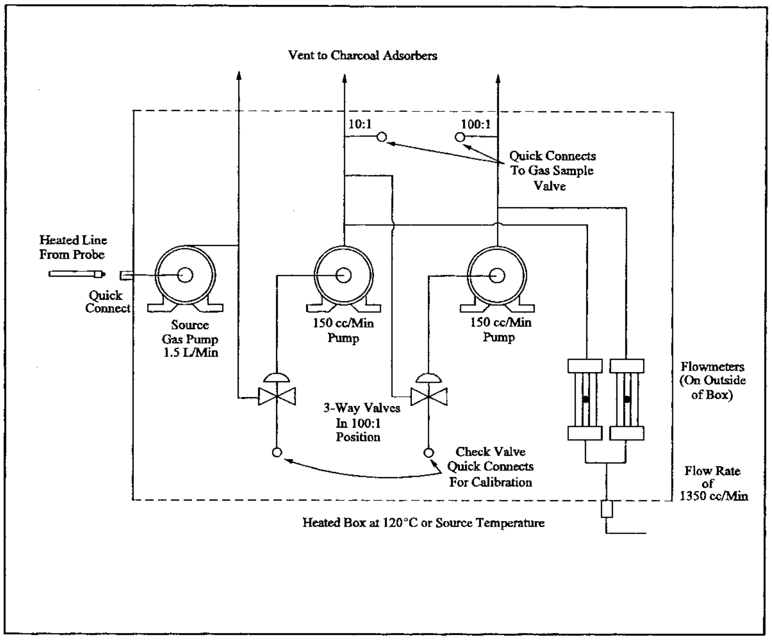


Figure 18-13. Schematic Diagram of the Heated Box Required for Dilution of Sample Gas.

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST

[Respond with initials or number as appropriate]

1. Presurvey data:		
A. Grab sample collected	☐	______
B. Grab sample analyzed for composition	☐	______
Method GC	☐	______
GC/MS	☐	______
Other	☐	______
C. GC-FID analysis performed	☐	______
2. Laboratory calibration data:		
A. Calibration curves prepared	☐	______
Number of components	☐	______
Number of concentrations/component (3 required).	☐	______
B. Audit samples (optional):		
Analysis completed	☐	______
Verified for concentration	☐	______
OK obtained for field work	☐	______
3. Sampling procedures:		
A. Method:		
Bag sample	☐	______
Direct interface	☐	______
Dilution interface	☐	______
B. Number of samples collected	☐	______
4. Field Analysis:		
A. Total hydrocarbon analysis performed	☐	______
B. Calibration curve prepared	☐	______
Number of components	☐	______
Number of concentrations per component (3 required).	☐	______

Gaseous Organic Sampling and Analysis Data

Plant ______________________

Date ______________________

Location ______________________

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST (RESPOND WITH INITIALS OR NUMBER AS APPROPRIATE)

	Date
1. Pre-survey data	
A. Grab sample collected	______
B. Grab sample analyzed for composition	______
Method GC	______
GC/MS	______
Other______________________	______
C. GC–FID analysis performed	______
2. Laboratory calibration curves prepared	______
A. Number of components	______
B. Number of concentrations per component (3 required)	______
C. OK obtained for field work	______
3. Sampling procedures.	
A. Method.	
Bag sample	______
Direct interface	______
Dilution interface	______
B. Number of samples collected	______
4. Field Analysis.	
A. Total hydrocarbon analysis performed	______
B. Calibration curve prepared	______
Number of components	______
Number of concentrations per component (3 required)	______

Figure 18–14. Sampling and Analysis Sheet

[36 FR 24877, Dec. 23, 1971]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting appendix A–6 to part 60, see the List of CFR sections Affected, which appears in the Finding Aids section of the printed volume and at *www.fdsys.gov*.

APPENDIX A–7 TO PART 60—TEST METHODS 19 THROUGH 25E

Method 19—Determination of sulfur dioxide removal efficiency and particulate, sulfur dioxide and nitrogen oxides emission rates

Method 20—Determination of nitrogen oxides, sulfur dioxide, and diluent emissions from stationary gas turbines

Method 21—Determination of volatile organic compound leaks

Method 22—Visual determination of fugitive emissions from material sources and smoke emissions from flares

Method 23—Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans From Stationary Sources

Method 24—Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

Method 24A—Determination of volatile matter content and density of printing inks and related coatings

Method 25—Determination of total gaseous nonmethane organic emissions as carbon

Method 25A—Determination of total gaseous organic concentration using a flame ionization analyzer

Method 25B—Determination of total gaseous organic concentration using a nondispersive infrared analyzer

Method 25C—Determination of nonmethane organic compounds (NMOC) in MSW landfill gases

Method 25D—Determination of the Volatile Organic Concentration of Waste Samples

Method 25E—Determination of Vapor Phase Organic Concentration in Waste Samples

The test methods in this appendix are referred to in §60.8 (Performance Tests) and §60.11 (Compliance With Standards and Maintenance Requirements) of 40 CFR part 60, subpart A (General Provisions). Specific uses of these test methods are described in the standards of performance contained in the subparts, beginning with Subpart D.

Within each standard of performance, a section title ''Test Methods and Procedures'' is provided to: (1) Identify the test methods to be used as reference methods to the facility subject to the respective standard and (2) identify any special instructions or conditions to be followed when applying a method to the respective facility. Such instructions (for example, establish sampling rates, volumes, or temperatures) are to be used either in addition to, or as a substitute for procedures in a test method. Similarly, for sources subject to emission monitoring requirements, specific instructions pertaining to any use of a test method as a reference method are provided in the subpart or in Appendix B.

Inclusion of methods in this appendix is not intended as an endorsement or denial of their applicability to sources that are not subject to standards of performance. The methods are potentially applicable to other sources; however, applicability should be confirmed by careful and appropriate evaluation of the conditions prevalent at such sources.

The approach followed in the formulation of the test methods involves specifications for equipment, procedures, and performance. In concept, a performance specification approach would be preferable in all methods because this allows the greatest flexibility to the user. In practice, however, this approach is impractical in most cases because performance specifications cannot be established. Most of the methods described herein, therefore, involve specific equipment specifications and procedures, and only a few methods in this appendix rely on performance criteria.

Minor changes in the test methods should not necessarily affect the validity of the results and it is recognized that alternative and equivalent methods exist. section 60.8 provides authority for the Administrator to specify or approve (1) equivalent methods, (2) alternative methods, and (3) minor changes in the methodology of the test methods. It should be clearly understood that unless otherwise identified all such methods and changes must have prior approval of the Administrator. An owner employing such methods or deviations from the test methods without obtaining prior approval does so at the risk of subsequent disapproval and retesting with approved methods.

Within the test methods, certain specific equipment or procedures are recognized as being acceptable or potentially acceptable and are specifically identified in the methods. The items identified as acceptable options may be used without approval but must be identified in the test report. The potentially approvable options are cited as ''subject to the approval of the Administrator'' or as ''or equivalent.'' Such potentially approvable techniques or alternatives may be used at the discretion of the owner without prior approval. However, detailed descriptions for applying these potentially approvable techniques or alternatives are not provided in the test methods. Also, the potentially approvable options are not necessarily acceptable in all applications. Therefore, an owner electing to use such potentially approvable techniques or alternatives is responsible for: (1) assuring that the techniques or alternatives are in fact applicable and are properly executed; (2) including a written description of the alternative method in the test report (the written method must be clear and must be capable of being performed without additional instruction, and the degree of detail should be similar to the detail contained in the test methods); and (3) providing any rationale or supporting data necessary to show the validity of the alternative in the particular application. Failure to meet these requirements can result in the Administrator's disapproval of the alternative.

METHOD 19—DETERMINATION OF SULFUR DIOXIDE REMOVAL EFFICIENCY AND PARTICULATE MATTER, SULFUR DIOXIDE, AND NITROGEN OXIDE EMISSION RATES

1.0 Scope and Application

1.1 Analytes. This method provides data reduction procedures relating to the following pollutants, but does not include any sample collection or analysis procedures.

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X), including:		
Nitric oxide (NO)	10102–43–9	N/A
Nitrogen dioxide (NO_2)	10102–44–0.	
Particulate matter (PM)	None assigned	N/A
Sulfur dioxide (SO_2)	7499–09–05	N/A

1.2 Applicability. Where specified by an applicable subpart of the regulations, this method is applicable for the determination of (a) PM, SO_2, and NO_X emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions.

2.0 Summary of Method

2.1 Emission Rates. Oxygen (O_2) or carbon dioxide (CO_2) concentrations and appropriate F factors (ratios of combustion gas volumes to heat inputs) are used to calculate pollutant emission rates from pollutant concentrations.

2.2 Sulfur Reduction Efficiency and SO_2 Removal Efficiency. An overall SO_2 emission reduction efficiency is computed from the efficiency of fuel pretreatment systems, where applicable, and the efficiency of SO_2 control devices.

2.2.1 The sulfur removal efficiency of a fuel pretreatment system is determined by fuel sampling and analysis of the sulfur and heat contents of the fuel before and after the pretreatment system.

2.2.2 The SO_2 removal efficiency of a control device is determined by measuring the SO_2 rates before and after the control device.

2.2.2.1 The inlet rates to SO_2 control systems (or, when SO_2 control systems are not used, SO_2 emission rates to the atmosphere) are determined by fuel sampling and analysis.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety [Reserved]

6.0 Equipment and Supplies [Reserved]

7.0 Reagents and Standards [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transport [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedures [Reserved]

12.0 Data Analysis and Calculations

12.1 Nomenclature

B_{wa} = Moisture fraction of ambient air, percent.

B_{ws} = Moisture fraction of effluent gas, percent.

%C = Concentration of carbon from an ultimate analysis of fuel, weight percent.

C_d = Pollutant concentration, dry basis, ng/scm (lb/scf)

$\%CO_{2d}$,$\%CO_{2w}$ = Concentration of carbon dioxide on a dry and wet basis, respectively, percent.

C_w = Pollutant concentration, wet basis, ng/scm (lb/scf).

D = Number of sampling periods during the performance test period.

E = Pollutant emission rate, ng/J (lb/million Btu).

E_a = Average pollutant rate for the specified performance test period, ng/J (lb/million Btu).

E_{ao}, E_{ai} = Average pollutant rate of the control device, outlet and inlet, respectively, for the performance test period, ng/J (lb/million Btu).

E_{bi} = Pollutant rate from the steam generating unit, ng/J (lb/million Btu)

E_{bo} = Pollutant emission rate from the steam generating unit, ng/J (lb/million Btu).

E_{ci} = Pollutant rate in combined effluent, ng/J (lb/million Btu).

E_{co} = Pollutant emission rate in combined effluent, ng/J (lb/million Btu).

E_d = Average pollutant rate for each sampling period (*e.g.*, 24-hr Method 6B sample or 24-hr fuel sample) or for each fuel lot (*e.g.*, amount of fuel bunkered), ng/J (lb/million Btu).

E_{di} = Average inlet SO_2 rate for each sampling period d, ng/J (lb/million Btu)

E_g = Pollutant rate from gas turbine, ng/J (lb/million Btu).

E_{ga} = Daily geometric average pollutant rate, ng/J (lbs/million Btu) or ppm corrected to 7 percent O_2.

E_{jo},E_{ji} = Matched pair hourly arithmetic average pollutant rate, outlet and inlet, respectively, ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

E_h = Hourly average pollutant, ng/J (lb/million Btu).

E_{hj} = Hourly arithmetic average pollutant rate for hour ''j,'' ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

EXP = Natural logarithmic base (2.718) raised to the value enclosed by brackets.

F_d, F_w, F_c = Volumes of combustion components per unit of heat content, scm/J (scf/million Btu).

GCV = Gross calorific value of the fuel consistent with the ultimate analysis, kJ/kg (Btu/lb).

GCV_p, GCV_r = Gross calorific value for the product and raw fuel lots, respectively, dry basis, kJ/kg (Btu/lb).

%H = Concentration of hydrogen from an ultimate analysis of fuel, weight percent.

H = Total number of operating hours for which pollutant rates are determined in the performance test period.

H_b = Heat input rate to the steam generating unit from fuels fired in the steam generating unit, J/hr (million Btu/hr).

H_g = Heat input rate to gas turbine from all fuels fired in the gas turbine, J/hr (million Btu/hr).

$\%H_2O$ = Concentration of water from an ultimate analysis of fuel, weight percent.

H_r = Total numbers of hours in the performance test period (*e.g.*, 720 hours for 30-day performance test period).

K = Conversion factor, 10^{-5} (kJ/J)/(%) [10^6 Btu/million Btu].

K_c = (9.57 scm/kg)/% [(1.53 scf/lb)/%].

K_{cc} = (2.0 scm/kg)/% [(0.321 scf/lb)/%].

K_{hd} = (22.7 scm/kg)/% [(3.64 scf/lb)/%].

K_{hw} = (34.74 scm/kg)/% [(5.57 scf/lb)/%].

K_n = (0.86 scm/kg)/% [(0.14 scf/lb)/%].

K_o = (2.85 scm/kg)/% [(0.46 scf/lb)/%].

K_s = (3.54 scm/kg)/% [(0.57 scf/lb)/%].

K_w = (1.30 scm/kg)/% [(0.21 scf/lb)/%].

ln = Natural log of indicated value.

L_p,L_r = Weight of the product and raw fuel lots, respectively, metric ton (ton).

%N = Concentration of nitrogen from an ultimate analysis of fuel, weight percent.

N = Number of fuel lots during the averaging period.

n = Number of fuels being burned in combination.

n_d = Number of operating hours of the affected facility within the performance test period for each E_d determined.

n_t = Total number of hourly averages for which paired inlet and outlet pollutant rates are available within the 24-hr midnight to midnight daily period.

%O = Concentration of oxygen from an ultimate analysis of fuel, weight percent.

$\%O_{2d}$, $\%O_{2w}$ = Concentration of oxygen on a dry and wet basis, respectively, percent.

P_s = Potential SO_2 emissions, percent.

$\%R_f$ = SO_2 removal efficiency from fuel pretreatment, percent.

$\%R_g$ = SO_2 removal efficiency of the control device, percent.

$\%R_{ga}$ = Daily geometric average percent reduction.

$\%R_o$ = Overall SO_2 reduction, percent.

%S = Sulfur content of as-fired fuel lot, dry basis, weight percent.

S_e = Standard deviation of the hourly average pollutant rates for each performance test period, ng/J (lb/million Btu).

$\%S_f$ = Concentration of sulfur from an ultimate analysis of fuel, weight percent.

S_i = Standard deviation of the hourly average inlet pollutant rates for each performance test period, ng/J (lb/million Btu).

S_o = Standard deviation of the hourly average emission rates for each performance test period, ng/J (lb/million Btu).

$\%S_p$, $\%S_r$ = Sulfur content of the product and raw fuel lots respectively, dry basis, weight percent.

$t_{0.95}$ = Values shown in Table 19–3 for the indicated number of data points n.

X_k = Fraction of total heat input from each type of fuel k.

12.2 Emission Rates of PM, SO_2, and NO_X. Select from the following sections the applicable procedure to compute the PM, S_{O2}, or NO_X emission rate (E) in ng/J (lb/million Btu). The pollutant concentration must be in ng/scm (lb/scf) and the F factor must be in scm/J (scf/million Btu). If the pollutant concentration (C) is not in the appropriate units, use Table 19–1 in section 17.0 to make the proper conversion. An F factor is the ratio of the gas volume of the products of combustion to the heat content of the fuel. The dry F factor (F_d) includes all components of combustion less water, the wet F factor (F_w) includes all components of combustion, and the carbon F factor (F_c) includes only carbon dioxide.

NOTE: Since F_w factors include water resulting only from the combustion of hydrogen in the fuel, the procedures using F_w factors are not applicable for computing E from steam generating units with wet scrubbers or with other processes that add water (*e.g.*, steam injection).

12.2.1 Oxygen-Based F Factor, Dry Basis. When measurements are on a dry basis for both O ($\%O_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_d \frac{20.9}{\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-1}$$

12.2.2 Oxygen-Based F Factor, Wet Basis. When measurements are on a wet basis for both O_2 ($\%O_{2w}$) and pollutant (C_w) concentrations, use either of the following:

12.2.2.1 If the moisture fraction of ambient air (B_{wa}) is measured:

$$E = C_w F_w \frac{20.9}{\left[20.9\left(1 - B_{wa}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-2}$$

Instead of actual measurement, B_{wa} may be estimated according to the procedure below.

NOTE: The estimates are selected to ensure that negative errors will not be larger than −1.5 percent. However, positive errors, or over-estimation of emissions by as much as 5 percent may be introduced depending upon the geographic location of the facility and the associated range of ambient moisture.

12.2.2.1.1 B_{wa} = 0.027. This value may be used at any location at all times.

12.2.2.1.2 B_{wa} = Highest monthly average of B_{wa} that occurred within the previous calendar year at the nearest Weather Service Station. This value shall be determined annually and may be used as an estimate for the entire current calendar year.

12.2.2.1.3 B_{wa} = Highest daily average of Bwa that occurred within a calendar month at the nearest Weather Service Station, calculated from the data from the past 3 years. This value shall be computed for each month and may be used as an estimate for the current respective calendar month.

12.2.2.2 If the moisture fraction (B_{ws}) of the effluent gas is measured:

$$E = C_w F_d \frac{20.9}{\left[20.9\left(1 - B_{ws}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-3}$$

12.2.3 Oxygen-Based F Factor, Dry/Wet Basis.

12.2.3.1 When the pollutant concentration is measured on a wet basis (C_w) and O_2 concentration is measured on a dry basis ($\%O_{2d}$), use the following equation:

$$E = \frac{\left(C_w F_d\right)(20.9)}{\left(1 - B_{ws}\right)\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-4}$$

12.2.3.2 When the pollutant concentration is measured on a dry basis (C_d) and the O_2 concentration is measured on a wet basis ($\%O_{2w}$), use the following equation:

$$E = \frac{C_d F_d \, 20.9}{\dfrac{\left(20.9 - \%O_{2w}\right)}{\left(1 - B_{ws}\right)}} \qquad \text{Eq. 19-5}$$

12.2.4 Carbon Dioxide-Based F Factor, Dry Basis. When measurements are on a dry basis for both CO_2 ($\%CO_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_c \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-6}$$

12.2.5 Carbon Dioxide-Based F Factor, Wet Basis. When measurements are on a wet basis for both CO_2 ($\%CO_{2w}$) and pollutant (C_w) concentrations, use the following equation:

$$E = C_w F_c \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-7}$$

12.2.6 Carbon Dioxide-Based F Factor, Dry/Wet Basis.

12.2.6.1 When the pollutant concentration is measured on a wet basis (C_w) and CO_2 concentration is measured on a dry basis ($\%CO_{2d}$), use the following equation:

$$E = \frac{C_w F_c}{\left(1 - B_{ws}\right)} \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-8}$$

12.2.6.2 When the pollutant concentration is measured on a dry basis (C_d) and CO_2 concentration is measured on a wet basis ($\%CO_{2w}$), use the following equation:

$$E = C_d F_c \left(1 - B_{ws}\right) \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-9}$$

12.2.7 Direct-Fired Reheat Fuel Burning. The effect of direct-fired reheat fuel burning (for the purpose of raising the temperature of the exhaust effluent from wet scrubbers to above the moisture dew-point) on emission rates will be less than 1.0 percent and, therefore, may be ignored.

12.2.8 Combined Cycle-Gas Turbine Systems. For gas turbine-steam generator combined cycle systems, determine the emissions from the steam generating unit or the percent reduction in potential SO_2 emissions as follows:

12.2.8.1 Compute the emission rate from the steam generating unit using the following equation:

$$E_{bo} = E_{co} + \frac{H_g}{H_b}\left(E_{co} - E_g\right) \qquad \text{Eq. 19-10}$$

12.2.8.1.1 Use the test methods and procedures section of 40 CFR Part 60, Subpart GG to obtain E_{co} and E_g. Do not use F_w factors for determining E_g or E_{co}. If an SO_2 control device is used, measure E_{co} after the control device.

12.2.8.1.2 Suitable methods shall be used to determine the heat input rates to the steam generating units (H_b) and the gas turbine (H_g).

12.2.8.2 If a control device is used, compute the percent of potential SO_2 emissions (P_s) using the following equations:

$$E_{bi} = E_{ci} - \frac{H_g}{H_b}\left(E_{ci} - E_g\right) \qquad \text{Eq. 19-11}$$

$$P_s = 100\left(1 - \frac{E_{bo}}{E_{bi}}\right) \qquad \text{Eq. 19-12}$$

NOTE: Use the test methods and procedures section of Subpart GG to obtain E_{ci} and E_g. Do not use F_w factors for determining E_g or E_{ci}.

12.3 F Factors. Use an average F factor according to section 12.3.1 or determine an applicable F factor according to section 12.3.2. If combined fuels are fired, prorate the applicable F factors using the procedure in section 12.3.3.

12.3.1 Average F Factors. Average F factors (F_d, F_w, or F_c) from Table 19–2 in section 17.0 may be used.

12.3.2 Determined F Factors. If the fuel burned is not listed in Table 19–2 or if the owner or operator chooses to determine an F factor rather than use the values in Table 19–2, use the procedure below:

12.3.2.1 Equations. Use the equations below, as appropriate, to compute the F factors:

$$F_d = \frac{K\left(K_{hd}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O\right)}{GCV} \qquad \text{Eq. 19-13}$$

$$F_w = \frac{K\left[K_{hw}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O + K_w\%H_2O\right]}{GCV_w} \qquad \text{Eq. 19-14}$$

$$F_c = \frac{K\left(K_{cc}\%C\right)}{GCV} \qquad \text{Eq. 19-15}$$

NOTE: Omit the $\%H_2O$ term in the equations for F_w if %H and %O include the unavailable hydrogen and oxygen in the form of H_2O.)

12.3.2.2 Use applicable sampling procedures in section 12.5.2.1 or 12.5.2.2 to obtain samples for analyses.

12.3.2.3 Use ASTM D 3176–74 or 89 (all cited ASTM standards are incorporated by reference—see §60.17) for ultimate analysis of the fuel.

12.3.2.4 Use applicable methods in section 12.5.2.1 or 12.5.2.2 to determine the heat content of solid or liquid fuels. For gaseous fuels, use ASTM D 1826–77 or 94 (incorporated by reference—see §60.17) to determine the heat content.

12.3.3 F Factors for Combination of Fuels. If combinations of fuels are burned, use the following equations, as applicable unless otherwise specified in an applicable subpart:

$$F_d = \sum_{k=1}^{n}\left(X_k F_{dk}\right) \qquad \text{Eq. 19-16}$$

$$F_w = \sum_{k=1}^{n}\left(X_k F_{wk}\right) \qquad \text{Eq. 19-17}$$

$$F_c = \sum_{k=1}^{n}\left(X_k F_{ck}\right) \qquad \text{Eq. 19-18}$$

12.4 Determination of Average Pollutant Rates.

12.4.1 Average Pollutant Rates from Hourly Values. When hourly average pollutant rates (E_h), inlet or outlet, are obtained (*e.g.*, CEMS values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{1}{H}\sum_{j=1}^{n} E_{hj} \qquad \text{Eq. 19-19}$$

12.4.2 Average Pollutant Rates from Other than Hourly Averages. When pollutant rates are determined from measured values representing longer than 1-hour periods (*e.g.*, daily fuel sampling and analyses or Method 6B values), or when pollutant rates are determined from combinations of 1-hour and longer than 1-hour periods (*e.g.*, CEMS and Method 6B values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{\sum_{j=1}^{D}\left(n_d E_d\right)_j}{\sum_{j=1}^{D} n_{dj}} \qquad \text{Eq. 19-20}$$

12.4.3 Daily Geometric Average Pollutant Rates from Hourly Values. The geometric average pollutant rate (E_{ga}) is computed using the following equation:

$$E_{ga} = \exp\left[\frac{1}{n_t}\sum_{j=1}^{n_t}\left[1n\left(E_{hj}\right)\right]\right] \qquad \text{Eq. 19-21}$$

12.5 Determination of Overall Reduction in Potential Sulfur Dioxide Emission.

12.5.1 Overall Percent Reduction. Compute the overall percent SO_2 reduction ($\%R_o$) using the following equation:

$$\%R_o = 100\left[1.0 - \left(1.0 - \frac{\%R_f}{100}\right)\left(1.0 - \frac{\%R_g}{100}\right)\right] \qquad \text{Eq. 19-22}$$

12.5.2 Pretreatment Removal Efficiency (Optional). Compute the SO_2 removal efficiency from fuel pretreatment ($\%R_f$) for the averaging period (*e.g.*, 90 days) as specified in the applicable regulation using the following equation:

$$\%R_f = 100\left[1.0 - \frac{\sum_{j=1}^{N}\left(\frac{\%S_{pj}}{GCV_{pj}}\right)L_{pj}}{\sum_{j=1}^{N}\left(\frac{\%S_{rj}}{GCV_{rj}}\right)L_{rj}}\right] \qquad \text{Eq. 19-23}$$

NOTE: In calculating $\%R_f$, include %S and GCV values for all fuel lots that are not pretreated and are used during the averaging period.

12.5.2.1 Solid Fossil (Including Waste) Fuel/Sampling and Analysis.

NOTE: For the purposes of this method, raw fuel (coal or oil) is the fuel delivered to the desulfurization (pretreatment) facility. For oil, the input oil to the oil desulfurization process (*e.g.*, hydrotreatment) is considered to be the raw fuel.

12.5.2.1.1 Sample Increment Collection. Use ASTM D 2234–76, 96, 97a, or 98 (incorporated by reference—see §60.17), Type I, Conditions A, B, or C, and systematic spacing. As used in this method, systematic spacing is intended to include evenly spaced increments in time or increments based on equal weights of coal passing the collection area. As a minimum, determine the number and weight of increments required per gross sample representing each coal lot according to Table 2 or Paragraph 7.1.5.2 of ASTM D 2234. Collect one gross sample for each lot of raw coal and one gross sample for each lot of product coal.

12.5.2.1.2 ASTM Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of product coal is the weight of product coal from one type of raw coal. The lot size of raw coal is the weight of raw coal used to produce one lot of product coal. Typically, the lot size is the weight of coal processed in a 1-day (24-hour) period. If more than one type of coal is treated and produced in 1 day, then gross samples must be collected and analyzed for each type of coal. A coal lot size equaling the 90-day quarterly fuel quantity for a steam generating unit may be used if representative sampling can be conducted for each raw coal and product coal.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.1.3 Gross Sample Analysis. Use ASTM D 2013–72 or 86 to prepare the sample, ASTM D 3177–75 or 89 or ASTM D 4239–85, 94, or 97 to determine sulfur content (%S), ASTM D 3173–73 or 87 to determine moisture content, and ASTM D 2015–77 (Reapproved 1978) or 96, D 3286–85 or 96, or D 5865–98 or 10 to determine gross calorific value (GCV) (all standards cited are incorporated by reference—see §60.17 for acceptable versions of the standards) on a dry basis for each gross sample.

12.5.2.2 Liquid Fossil Fuel-Sampling and Analysis. See Note under section 12.5.2.1.

12.5.2.2.1 Sample Collection. Follow the procedures for continuous sampling in ASTM D 270 or D 4177–95 (incorporated by reference—see §60.17) for each gross sample from each fuel lot.

12.5.2.2.2 Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of a product oil is the weight of product oil from one pretreatment facility and intended as one shipment (ship load, barge load, etc.). The lot size of raw oil is the weight of each crude liquid fuel type used to produce a lot of product oil.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.2.3 Sample Analysis. Use ASTM D 129–64, 78, or 95, ASTM D 1552–83 or 95, or ASTM D 4057–81 or 95 to determine the sulfur content (%S) and ASTM D 240–76 or 92 (all standards cited are incorporated by reference—see §60.17) to determine the GCV of each gross sample. These values may be assumed to be on a dry basis. The owner or operator of an affected facility may elect to determine the GCV by sampling the oil combusted on the first steam generating unit operating day of each calendar month and then using the lowest GCV value of the three GCV values per quarter for the GCV of all oil combusted in that calendar quarter.

12.5.2.3 Use appropriate procedures, subject to the approval of the Administrator, to determine the fraction of total mass input derived from each type of fuel.

12.5.3 Control Device Removal Efficiency. Compute the percent removal efficiency ($\%R_g$) of the control device using the following equation:

$$\%R_g = 100\left(1.0 - \frac{E_{ao}}{E_{ai}}\right) \qquad \text{Eq. 19-24}$$

12.5.3.1 Use continuous emission monitoring systems or test methods, as appropriate, to determine the outlet SO_2 rates and, if appropriate, the inlet SO_2 rates. The rates may be determined as hourly (E_h) or other sampling period averages (E_d). Then, compute the average pollutant rates for the performance test period (E_{ao} and E_{ai}) using the procedures in section 12.4.

12.5.3.2 As an alternative, as-fired fuel sampling and analysis may be used to determine inlet SO_2 rates as follows:

12.5.3.2.1 Compute the average inlet SO_2 rate (E_{di}) for each sampling period using the following equation:

$$E_{di} = K\frac{\%S}{GCV} \qquad \text{Eq. 19-25}$$

Where:

$$K = 2\times10^7\left(\frac{\text{ng } SO_2}{\%S}\right)\left(\frac{(\text{kJ})}{\text{J}}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^4\left(\frac{\text{lb } SO_2}{\%S}\right)\left(\frac{\text{Btu}}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4 to determine the average inlet SO_2 rate for the performance test period (E_{ai}).

12.5.3.2.2 Collect the fuel samples from a location in the fuel handling system that provides a sample representative of the fuel bunkered or consumed during a steam generating unit operating day. For the purpose of as-fired fuel sampling under section 12.5.3.2 or section 12.6, the lot size for coal is the weight of coal bunkered or consumed during each steam generating unit operating day. The lot size for oil is the weight of oil supplied to the ‘‘day’’ tank or consumed during each steam generating unit operating day. For reporting and calculation purposes, the gross sample shall be identified with the calendar day on which sampling began. For steam generating unit operating days when a coal-fired steam generating unit is operated without coal being added to the bunkers, the coal analysis from the previous ‘‘as bunkered’’ coal sample shall be used until coal is bunkered again. For steam generating unit operating days when an oil-fired steam generating unit is operated without oil being added to the oil ‘‘day’’ tank, the oil analysis from the previous day shall be used until the ‘‘day’’ tank is filled again. Alternative definitions of fuel lot size may be used, subject to prior approval of the Administrator.

12.5.3.2.3 Use ASTM procedures specified in section 12.5.2.1 or 12.5.2.2 to determine %S and GCV.

12.5.4 Daily Geometric Average Percent Reduction from Hourly Values. The geometric average percent reduction ($\%R_{ga}$) is computed using the following equation:

$$\%R_{ga} = 100\left[1 - \text{EXP}\left(\frac{1}{n_t}\sum_{j=1}^{n_t}\mathrm{1n}\frac{E_{jo}}{E_{ji}}\right)\right] \qquad \text{Eq. 19-26}$$

NOTE: The calculation includes only paired data sets (hourly average) for the inlet and outlet pollutant measurements.

12.6 Sulfur Retention Credit for Compliance Fuel. If fuel sampling and analysis procedures in section 12.5.2.1 are being used to determine average SO_2 emission rates (E_{as}) to the atmosphere from a coal-fired steam generating unit when there is no SO_2 control device, the following equation may be used to adjust the emission rate for sulfur retention credits (no credits are allowed for oil-fired systems) (E_{di}) for each sampling period using the following equation:

$$E_{di} = 0.97K\ \frac{\%S}{GDV} \qquad \text{Eq. 19-27}$$

Where:

$$K = 2\times10^{7}\left(\frac{\text{ng SO}_2}{\%S}\right)\left(\frac{\text{kJ}}{\text{J}}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^{4}\left(\frac{\text{lb SO}_2}{\%S}\right)\left(\frac{\text{Btu}}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4.2 to determine the average SO_2 emission rate to the atmosphere for the performance test period (E_{ao}).

12.7 Determination of Compliance When Minimum Data Requirement Is Not Met.

12.7.1 Adjusted Emission Rates and Control Device Removal Efficiency. When the minimum data requirement is not met, the Administrator may use the following adjusted emission rates or control device removal efficiencies to determine compliance with the applicable standards.

12.7.1.1 Emission Rate. Compliance with the emission rate standard may be determined by using the lower confidence limit of the emission rate (E_{ao}*) as follows:

$$E^{*}_{ao} = E_{ao} - t_{0.95}\,S_o \qquad \text{Eq. 19-28}$$

12.7.1.2 Control Device Removal Efficiency. Compliance with the overall emission reduction ($\%R_o$) may be determined by using the lower confidence limit of the emission rate (E_{ao}*) and the upper confidence limit of the inlet pollutant rate (E_{ai}*) in calculating the control device removal efficiency ($\%R_g$) as follows:

$$\%R_g = 100\left(1.0 - \frac{E^{*}_{ao}}{E^{*}_{ai}}\right) \qquad \text{Eq. 19-29}$$

$$E^{*}_{ai} = E_{ai} + t_{0.95}\,S_i \qquad \text{Eq. 19-30}$$

12.7.2 Standard Deviation of Hourly Average Pollutant Rates. Compute the standard deviation (S_e) of the hourly average pollutant rates using the following equation:

$$S_e = \sqrt{\frac{1}{H} - \frac{1}{H_r}}\ \sqrt{\frac{\sum_{j=1}^{H}\left(E_{hj} - E_a\right)^2}{H-1}} \qquad \text{Eq. 19-31}$$

Equation 19–19 through 19–31 may be used to compute the standard deviation for both the outlet (S_o) and, if applicable, inlet (S_i) pollutant rates.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References [Reserved]

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION

From	To	Multiply by
g/scm	ng/scm	10^9
mg/scm	ng/scm	10^6
lb/scf	ng/scm	1.602×10^{13}

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION—Continued

From	To	Multiply by
ppm SO_2	ng/scm	2.66×10^6
ppm NO_X	ng/scm	1.912×10^6
ppm SO_2	lb/scf	1.660×10^{-7}
ppm NO_X	lb/scf	1.194×10^{-7}

TABLE 19–2—F FACTORS FOR VARIOUS FUELS[1]

Fuel Type	F_d		F_w		F_c	
	dscm/J	dscf/10^6 Btu	wscm/J	wscf/10^6 Btu	scm/J	scf/10^6 Btu
Coal:						
Anthracite[2]	2.71×10^{-7}	10,100	2.83×10^{-7}	10,540	0.530×10^{-7}	1,970
Bituminus[2]	2.63×10^{-7}	9,780	2.86×10^{-7}	10,640	0.484×10^{-7}	1,800
Lignite	2.65×10^{-7}	9,860	3.21×10^{-7}	11,950	0.513×10^{-7}	1,910
Oil[3]	2.47×10^{-7}	9,190	2.77×10^{-7}	10,320	0.383×10^{-7}	1,420
Gas:.						
Natural	2.34×10^{-7}	8,710	2.85×10^{-7}	10,610	0.287×10^{-7}	1,040
Propane	2.34×10^{-7}	8,710	2.74×10^{-7}	10,200	0.321×10^{-7}	1,190
Butane	2.34×10^{-7}	8,710	2.79×10^{-7}	10,390	0.337×10^{-7}	1,250
Wood	2.48×10^{-7}	9,240			0.492×10^{-7}	1,830
Wood Bark	2.58×10^{-7}	9,600			0.516×10^{-7}	1,920
Municipal	2.57×10^{-7}	9,570			0.488×10^{-7}	1,820
Solid Waste						

[1] Determined at standard conditions: 20 °C (68 °F) and 760 mm Hg (29.92 in Hg)
[2] As classified according to ASTM D 388.
[3] Crude, residual, or distillate.

TABLE 19–3—VALUES FOR $T_{0.95*}$

n[1]	$t_{0.95}$	n[1]	$t_{0.95}$	n[1]	$t_{0.95}$
2	6.31	8	1.89	22–26	1.71
3	2.42	9	1.86	27–31	1.70
4	2.35	10	1.83	32–51	1.68
5	2.13	11	1.81	52–91	1.67
6	2.02	12–16	1.77	92–151	1.66
7	1.94	17–21	1.73	152 or more	1.65

[1] The values of this table are corrected for n-1 degrees of freedom. Use n equal to the number (H) of hourly average data points.

METHOD 20—DETERMINATION OF NITROGEN OXIDES, SULFUR DIOXIDE, AND DILUENT EMISSIONS FROM STATIONARY GAS TURBINES

1.0 Scope and Application

What is Method 20?

Method 20 contains the details you must follow when using an instrumental analyzer to determine concentrations of nitrogen oxides, oxygen, carbon dioxide, and sulfur dioxide in the emissions from stationary gas turbines. This method follows the specific instructions for equipment and performance requirements, supplies, sample collection and analysis, calculations, and data analysis in the methods listed in section 2.0.

1.1 Analytes. What does this method determine?

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X) as nitrogen dioxide:	10102–43–9	Typically <2% of Calibration Span.
Nitric oxide (NO)	10102–44–0	
Nitrogen dioxide NO_2.		
Diluent oxygen (O_2) or carbon dioxide (CO_2)		Typically <2% of Calibration Span.
Sulfur dioxide (SO_X)	7446–09–5	Typically <2% of Calibration Span.

1.2 Applicability. When is this method required? The use of Method 20 may be required by specific New Source Performance Standards, Clean Air Marketing rules, and State Implementation Plans and permits where

measuring SO_2, NO_X, CO_2, and/or O_2 concentrations in stationary gas turbines emissions are required. Other regulations may also require its use.

1.3 Data Quality Objectives. How good must my collected data be? Refer to section 1.3 of Method 7E.

2.0 Summary of Method

In this method, NO_X, O_2 (or CO_2), and SO_X are measured using the following methods found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 3A—Determination of Oxygen and Carbon Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(c) Method 6C—Determination of Sulfur Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(d) Method 7E—Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(e) Method 19—Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates.

3.0 Definitions

Refer to section 3.0 of Method 7E for the applicable definitions.

4.0 Interferences

Refer to section 4.0 of Methods 3A, 6C, and 7E as applicable.

5.0 Safety

Refer to section 5.0 of Method 7E.

6.0 Equipment and Supplies

The measurement system design is shown in Figure 7E–1 of Method 7E. Refer to the appropriate methods listed in section 2.0 for equipment and supplies.

7.0 Reagents and Standards

Refer to the appropriate methods listed in section 2.0 for reagents and standards.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling Site and Sampling Points. Follow the procedures of section 8.1 of Method 7E. For the stratification test in section 8.1.2, determine the diluent-corrected pollutant concentration at each traverse point.

8.2 Initial Measurement System Performance Tests. You must refer to the appropriate methods listed in section 2.0 for the measurement system performance tests as applicable.

8.3 Interference Check. You must follow the procedures in section 8.3 of Method 3A or 6C, or section 8.2.7 of Method 7E (as appropriate).

8.4 Sample Collection. You must follow the procedures of section 8.4 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

8.5 Post-Run System Bias Check, Drift Assessment, and Alternative Dynamic Spike Procedure. You must follow the procedures of sections 8.5 and 8.6 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

9.0 Quality Control

Follow quality control procedures in section 9.0 of Method 7E.

10.0 Calibration and Standardization

Follow the procedures for calibration and standardization in section 10.0 of Method 7E.

11.0 Analytical Procedures

Because sample collection and analysis are performed together (see section 8), additional discussion of the analytical procedure is not necessary.

12.0 Calculations and Data Analysis

You must follow the procedures for calculations and data analysis in section 12.0 of the appropriate method listed in section 2.0. Follow the procedures in section 12.0 of Method 19 for calculating fuel-specific F factors, diluent-corrected pollutant concentrations, and emission rates.

13.0 Method Performance

The specifications for the applicable performance checks are the same as in section 13.0 of Method 7E.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures

Refer to section 16.0 of the appropriate method listed in section 2.0 for alternative procedures.

17.0 References

Refer to section 17.0 of the appropriate method listed in section 2.0 for references.

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Refer to section 18.0 of the appropriate method listed in section 2.0 for tables, diagrams, flowcharts, and validation data.

METHOD 21—DETERMINATION OF VOLATILE ORGANIC COMPOUND LEAKS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile Organic Compounds (VOC).	No CAS number assigned.

1.2 Scope. This method is applicable for the determination of VOC leaks from process equipment. These sources include, but are not limited to, valves, flanges and other connections, pumps and compressors, pressure relief devices, process drains, open-ended valves, pump and compressor seal system degassing vents, accumulator vessel vents, agitator seals, and access door seals.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A portable instrument is used to detect VOC leaks from individual sources. The instrument detector type is not specified, but it must meet the specifications and performance criteria contained in section 6.0. A leak definition concentration based on a reference compound is specified in each applicable regulation. This method is intended to locate and classify leaks only, and is not to be used as a direct measure of mass emission rate from individual sources.

3.0 Definitions

3.1 *Calibration gas* means the VOC compound used to adjust the instrument meter reading to a known value. The calibration gas is usually the reference compound at a known concentration approximately equal to the leak definition concentration.

3.2 *Calibration precision* means the degree of agreement between measurements of the same known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration.

3.3 *Leak definition concentration* means the local VOC concentration at the surface of a leak source that indicates that a VOC emission (leak) is present. The leak definition is an instrument meter reading based on a reference compound.

3.4 *No detectable emission* means a local VOC concentration at the surface of a leak source, adjusted for local VOC ambient concentration, that is less than 2.5 percent of the specified leak definition concentration. that indicates that a VOC emission (leak) is not present.

3.5 *Reference compound* means the VOC species selected as the instrument calibration basis for specification of the leak definition concentration. (For example, if a leak definition concentration is 10,000 ppm as methane, then any source emission that results in a local concentration that yields a meter reading of 10,000 on an instrument meter calibrated with methane would be classified as a leak. In this example, the leak definition concentration is 10,000 ppm and the reference compound is methane.)

3.6 *Response factor* means the ratio of the known concentration of a VOC compound to the observed meter reading when measured using an instrument calibrated with the reference compound specified in the applicable regulation.

3.7 *Response time* means the time interval from a step change in VOC concentration at the input of the sampling system to the time at which 90 percent of the corresponding final value is reached as displayed on the instrument readout meter.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Pollutants. Several of the compounds, leaks of which may be determined by this method, may be irritating or corrosive to tissues (*e.g.*, heptane) or may be toxic (*e.g.*, benzene, methyl alcohol). Nearly all are fire hazards. Compounds in emissions should be determined through familiarity with the source. Appropriate precautions can be found in reference documents, such as reference No. 4 in section 16.0.

6.0 Equipment and Supplies

A VOC monitoring instrument meeting the following specifications is required:

6.1 The VOC instrument detector shall respond to the compounds being processed. Detector types that may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption, and photoionization.

6.2 The instrument shall be capable of measuring the leak definition concentration specified in the regulation.

6.3 The scale of the instrument meter shall be readable to ±2.5 percent of the specified leak definition concentration.

6.4 The instrument shall be equipped with an electrically driven pump to ensure that a sample is provided to the detector at a constant flow rate. The nominal sample flow rate, as measured at the sample probe tip, shall be 0.10 to 3.0 l/min (0.004 to 0.1 ft^3/min) when the probe is fitted with a glass wool plug or filter that may be used to prevent plugging of the instrument.

6.5 The instrument shall be equipped with a probe or probe extension or sampling not to exceed 6.4 mm (¼ in) in outside diameter,

with a single end opening for admission of sample.

6.6 The instrument shall be intrinsically safe for operation in explosive atmospheres as defined by the National Electrical Code by the National Fire Prevention Association or other applicable regulatory code for operation in any explosive atmospheres that may be encountered in its use. The instrument shall, at a minimum, be intrinsically safe for Class 1, Division 1 conditions, and/or Class 2, Division 1 conditions, as appropriate, as defined by the example code. The instrument shall not be operated with any safety device, such as an exhaust flame arrestor, removed.

7.0 Reagents and Standards

7.1 Two gas mixtures are required for instrument calibration and performance evaluation:

7.1.1 Zero Gas. Air, less than 10 parts per million by volume (ppmv) VOC.

7.1.2 Calibration Gas. For each organic species that is to be measured during individual source surveys, obtain or prepare a known standard in air at a concentration approximately equal to the applicable leak definition specified in the regulation.

7.2 Cylinder Gases. If cylinder calibration gas mixtures are used, they must be analyzed and certified by the manufacturer to be within 2 percent accuracy, and a shelf life must be specified. Cylinder standards must be either reanalyzed or replaced at the end of the specified shelf life.

7.3 Prepared Gases. Calibration gases may be prepared by the user according to any accepted gaseous preparation procedure that will yield a mixture accurate to within 2 percent. Prepared standards must be replaced each day of use unless it is demonstrated that degradation does not occur during storage.

7.4 Mixtures with non-Reference Compound Gases. Calibrations may be performed using a compound other than the reference compound. In this case, a conversion factor must be determined for the alternative compound such that the resulting meter readings during source surveys can be converted to reference compound results.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Instrument Performance Evaluation. Assemble and start up the instrument according to the manufacturer's instructions for recommended warmup period and preliminary adjustments.

8.1.1 Response Factor. A response factor must be determined for each compound that is to be measured, either by testing or from reference sources. The response factor tests are required before placing the analyzer into service, but do not have to be repeated at subsequent intervals.

8.1.1.1 Calibrate the instrument with the reference compound as specified in the applicable regulation. Introduce the calibration gas mixture to the analyzer and record the observed meter reading. Introduce zero gas until a stable reading is obtained. Make a total of three measurements by alternating between the calibration gas and zero gas. Calculate the response factor for each repetition and the average response factor.

8.1.1.2 The instrument response factors for each of the individual VOC to be measured shall be less than 10 unless otherwise specified in the applicable regulation. When no instrument is available that meets this specification when calibrated with the reference VOC specified in the applicable regulation, the available instrument may be calibrated with one of the VOC to be measured, or any other VOC, so long as the instrument then has a response factor of less than 10 for each of the individual VOC to be measured.

8.1.1.3 Alternatively, if response factors have been published for the compounds of interest for the instrument or detector type, the response factor determination is not required, and existing results may be referenced. Examples of published response factors for flame ionization and catalytic oxidation detectors are included in References 1–3 of section 17.0.

8.1.2 Calibration Precision. The calibration precision test must be completed prior to placing the analyzer into service and at subsequent 3-month intervals or at the next use, whichever is later.

8.1.2.1 Make a total of three measurements by alternately using zero gas and the specified calibration gas. Record the meter readings. Calculate the average algebraic difference between the meter readings and the known value. Divide this average difference by the known calibration value and multiply by 100 to express the resulting calibration precision as a percentage.

8.1.2.2 The calibration precision shall be equal to or less than 10 percent of the calibration gas value.

8.1.3 Response Time. The response time test is required before placing the instrument into service. If a modification to the sample pumping system or flow configuration is made that would change the response time, a new test is required before further use.

8.1.3.1 Introduce zero gas into the instrument sample probe. When the meter reading has stabilized, switch quickly to the specified calibration gas. After switching, measure the time required to attain 90 percent of the final stable reading. Perform this test sequence three times and record the results. Calculate the average response time.

8.1.3.2 The instrument response time shall be equal to or less than 30 seconds. The instrument pump, dilution probe (if any), sample probe, and probe filter that will be used

during testing shall all be in place during the response time determination.

8.2 Instrument Calibration. Calibrate the VOC monitoring instrument according to section 10.0.

8.3 Individual Source Surveys.

8.3.1 Type I—Leak Definition Based on Concentration. Place the probe inlet at the surface of the component interface where leakage could occur. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained. Leave the probe inlet at this maximum reading location for approximately two times the instrument response time. If the maximum observed meter reading is greater than the leak definition in the applicable regulation, record and report the results as specified in the regulation reporting requirements. Examples of the application of this general technique to specific equipment types are:

8.3.1.1 Valves. The most common source of leaks from valves is the seal between the stem and housing. Place the probe at the interface where the stem exits the packing gland and sample the stem circumference. Also, place the probe at the interface of the packing gland take-up flange seat and sample the periphery. In addition, survey valve housings of multipart assembly at the surface of all interfaces where a leak could occur.

8.3.1.2 Flanges and Other Connections. For welded flanges, place the probe at the outer edge of the flange-gasket interface and sample the circumference of the flange. Sample other types of nonpermanent joints (such as threaded connections) with a similar traverse.

8.3.1.3 Pumps and Compressors. Conduct a circumferential traverse at the outer surface of the pump or compressor shaft and seal interface. If the source is a rotating shaft, position the probe inlet within 1 cm of the shaft-seal interface for the survey. If the housing configuration prevents a complete traverse of the shaft periphery, sample all accessible portions. Sample all other joints on the pump or compressor housing where leakage could occur.

8.3.1.4 Pressure Relief Devices. The configuration of most pressure relief devices prevents sampling at the sealing seat interface. For those devices equipped with an enclosed extension, or horn, place the probe inlet at approximately the center of the exhaust area to the atmosphere.

8.3.1.5 Process Drains. For open drains, place the probe inlet at approximately the center of the area open to the atmosphere. For covered drains, place the probe at the surface of the cover interface and conduct a peripheral traverse.

8.3.1.6 Open-ended Lines or Valves. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.7 Seal System Degassing Vents and Accumulator Vents. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.8 Access door seals. Place the probe inlet at the surface of the door seal interface and conduct a peripheral traverse.

8.3.2 Type II—''No Detectable Emission''. Determine the local ambient VOC concentration around the source by moving the probe randomly upwind and downwind at a distance of one to two meters from the source. If an interference exists with this determination due to a nearby emission or leak, the local ambient concentration may be determined at distances closer to the source, but in no case shall the distance be less than 25 centimeters. Then move the probe inlet to the surface of the source and determine the concentration as outlined in section 8.3.1. The difference between these concentrations determines whether there are no detectable emissions. Record and report the results as specified by the regulation. For those cases where the regulation requires a specific device installation, or that specified vents be ducted or piped to a control device, the existence of these conditions shall be visually confirmed. When the regulation also requires that no detectable emissions exist, visual observations and sampling surveys are required. Examples of this technique are:

8.3.2.1 Pump or Compressor Seals. If applicable, determine the type of shaft seal. Perform a survey of the local area ambient VOC concentration and determine if detectable emissions exist as described in section 8.3.2.

8.3.2.2 Seal System Degassing Vents, Accumulator Vessel Vents, Pressure Relief Devices. If applicable, observe whether or not the applicable ducting or piping exists. Also, determine if any sources exist in the ducting or piping where emissions could occur upstream of the control device. If the required ducting or piping exists and there are no sources where the emissions could be vented to the atmosphere upstream of the control device, then it is presumed that no detectable emissions are present. If there are sources in the ducting or piping where emissions could be vented or sources where leaks could occur, the sampling surveys described in section 8.3.2 shall be used to determine if detectable emissions exist.

8.3.3 Alternative Screening Procedure.

8.3.3.1 A screening procedure based on the formation of bubbles in a soap solution that is sprayed on a potential leak source may be used for those sources that do not have continuously moving parts, that do not have surface temperatures greater than the boiling point or less than the freezing point of the soap solution, that do not have open

areas to the atmosphere that the soap solution cannot bridge, or that do not exhibit evidence of liquid leakage. Sources that have these conditions present must be surveyed using the instrument technique of section 8.3.1 or 8.3.2.

8.3.3.2 Spray a soap solution over all potential leak sources. The soap solution may be a commercially available leak detection solution or may be prepared using concentrated detergent and water. A pressure sprayer or squeeze bottle may be used to dispense the solution. Observe the potential leak sites to determine if any bubbles are formed. If no bubbles are observed, the source is presumed to have no detectable emissions or leaks as applicable. If any bubbles are observed, the instrument techniques of section 8.3.1 or 8.3.2 shall be used to determine if a leak exists, or if the source has detectable emissions, as applicable.

9.0 Quality Control

Section	Quality control measure	Effect
8.1.2	Instrument calibration precision check	Ensure precision and accuracy, respectively, of instrument response to standard.
10.0	Instrument calibration.	

10.0 Calibration and Standardization

10.1 Calibrate the VOC monitoring instrument as follows. After the appropriate warmup period and zero internal calibration procedure, introduce the calibration gas into the instrument sample probe. Adjust the instrument meter readout to correspond to the calibration gas value.

NOTE: If the meter readout cannot be adjusted to the proper value, a malfunction of the analyzer is indicated and corrective actions are necessary before use.

11.0 Analytical Procedures [Reserved]

12.0 Data Analyses and Calculations [Reserved]

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Dubose, D.A., and G.E. Harris. Response Factors of VOC Analyzers at a Meter Reading of 10,000 ppmv for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81051. September 1981.

2. Brown, G.E., *et al.* Response Factors of VOC Analyzers Calibrated with Methane for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–022. May 1981.

3. DuBose, D.A. *et al.* Response of Portable VOC Analyzers to Chemical Mixtures. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–110. September 1981.

4. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 22—VISUAL DETERMINATION OF FUGITIVE EMISSIONS FROM MATERIAL SOURCES AND SMOKE EMISSIONS FROM FLARES

NOTE: This method is not inclusive with respect to observer certification. Some material is incorporated by reference from Method 9.

1.0 Scope and Application

This method is applicable for the determination of the frequency of fugitive emissions from stationary sources, only as specified in an applicable subpart of the regulations. This method also is applicable for the determination of the frequency of visible smoke emissions from flares.

2.0 Summary of Method

2.1 Fugitive emissions produced during material processing, handling, and transfer operations or smoke emissions from flares are visually determined by an observer without the aid of instruments.

2.2 This method is used also to determine visible smoke emissions from flares used for combustion of waste process materials.

2.3 This method determines the amount of time that visible emissions occur during the observation period (*i.e.*, the accumulated emission time). This method does not require that the opacity of emissions be determined. Since this procedure requires only the determination of whether visible emissions occur and does not require the determination of opacity levels, observer certification according to the procedures of Method 9 is not required. However, it is necessary that the observer is knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative

to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in References 1 and 2 or from the lecture portion of the Method 9 certification course.

3.0 Definitions

3.1 *Emission frequency* means the percentage of time that emissions are visible during the observation period.

3.2 *Emission time* means the accumulated amount of time that emissions are visible during the observation period.

3.3 *Fugitive emissions* means emissions generated by an affected facility which is not collected by a capture system and is released to the atmosphere. This includes emissions that (1) escape capture by process equipment exhaust hoods; (2) are emitted during material transfer; (3) are emitted from buildings housing material processing or handling equipment; or (4) are emitted directly from process equipment.

3.4 *Observation period* means the accumulated time period during which observations are conducted, not to be less than the period specified in the applicable regulation.

3.5 *Smoke emissions* means a pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission.

4.0 Interferences

4.1 Occasionally, fugitive emissions from sources other than the affected facility (*e.g.*, road dust) may prevent a clear view of the affected facility. This may particularly be a problem during periods of high wind. If the view of the potential emission points is obscured to such a degree that the observer questions the validity of continuing observations, then the observations shall be terminated, and the observer shall clearly note this fact on the data form.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment

6.1 Stopwatches (two). Accumulative type with unit divisions of at least 0.5 seconds.

6.2 Light Meter. Light meter capable of measuring illuminance in the 50 to 200 lux range, required for indoor observations only.

7.0 Reagents and Supplies [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transfer [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

11.1 Selection of Observation Location. Survey the affected facility, or the building or structure housing the process to be observed, and determine the locations of potential emissions. If the affected facility is located inside a building, determine an observation location that is consistent with the requirements of the applicable regulation (*i.e.*, outside observation of emissions escaping the building/structure or inside observation of emissions directly emitted from the affected facility process unit). Then select a position that enables a clear view of the potential emission point(s) of the affected facility or of the building or structure housing the affected facility, as appropriate for the applicable subpart. A position at least 4.6 m (15 feet), but not more than 400 m (0.25 miles), from the emission source is recommended. For outdoor locations, select a position where the sunlight is not shining directly in the observer's eyes.

11.2 Field Records.

11.2.1 Outdoor Location. Record the following information on the field data sheet (Figure 22–1): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record also the estimated wind speed, wind direction, and sky condition. Sketch the process unit being observed, and note the observer location relative to the source and the sun. Indicate the potential and actual emission points on the sketch.

11.2.2 Indoor Location. Record the following information on the field data sheet (Figure 22–2): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record as appropriate the type, location, and intensity of lighting on the data sheet. Sketch the process unit being observed, and note the observer location relative to the source. Indicate the potential and actual fugitive emission points on the sketch.

11.3 Indoor Lighting Requirements. For indoor locations, use a light meter to measure the level of illumination at a location as close to the emission source(s) as is feasible. An illumination of greater than 100 lux (10 foot candles) is considered necessary for proper application of this method.

11.4 Observations.

11.4.1 Procedure. Record the clock time when observations begin. Use one stopwatch to monitor the duration of the observation

period. Start this stopwatch when the observation period begins. If the observation period is divided into two or more segments by process shutdowns or observer rest breaks (see section 11.4.3), stop the stopwatch when a break begins and restart the stopwatch without resetting it when the break ends. Stop the stopwatch at the end of the observation period. The accumulated time indicated by this stopwatch is the duration of observation period. When the observation period is completed, record the clock time. During the observation period, continuously watch the emission source. Upon observing an emission (condensed water vapor is not considered an emission), start the second accumulative stopwatch; stop the watch when the emission stops. Continue this procedure for the entire observation period. The accumulated elapsed time on this stopwatch is the total time emissions were visible during the observation period (*i.e.,* the emission time.)

11.4.2 Observation Period. Choose an observation period of sufficient length to meet the requirements for determining compliance with the emission standard in the applicable subpart of the regulations. When the length of the observation period is specifically stated in the applicable subpart, it may not be necessary to observe the source for this entire period if the emission time required to indicate noncompliance (based on the specified observation period) is observed in a shorter time period. In other words, if the regulation prohibits emissions for more than 6 minutes in any hour, then observations may (optional) be stopped after an emission time of 6 minutes is exceeded. Similarly, when the regulation is expressed as an emission frequency and the regulation prohibits emissions for greater than 10 percent of the time in any hour, then observations may (optional) be terminated after 6 minutes of emission are observed since 6 minutes is 10 percent of an hour. In any case, the observation period shall not be less than 6 minutes in duration. In some cases, the process operation may be intermittent or cyclic. In such cases, it may be convenient for the observation period to coincide with the length of the process cycle.

11.4.3 Observer Rest Breaks. Do not observe emissions continuously for a period of more than 15 to 20 minutes without taking a rest break. For sources requiring observation periods of greater than 20 minutes, the observer shall take a break of not less than 5 minutes and not more than 10 minutes after every 15 to 20 minutes of observation. If continuous observations are desired for extended time periods, two observers can alternate between making observations and taking breaks.

11.5 Recording Observations. Record the accumulated time of the observation period on the data sheet as the observation period duration. Record the accumulated time emissions were observed on the data sheet as the emission time. Record the clock time the observation period began and ended, as well as the clock time any observer breaks began and ended.

12.0 Data Analysis and Calculations

If the applicable subpart requires that the emission rate be expressed as an emission frequency (in percent), determine this value as follows: Divide the accumulated emission time (in seconds) by the duration of the observation period (in seconds) or by any minimum observation period required in the applicable subpart, if the actual observation period is less than the required period, and multiply this quotient by 100.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

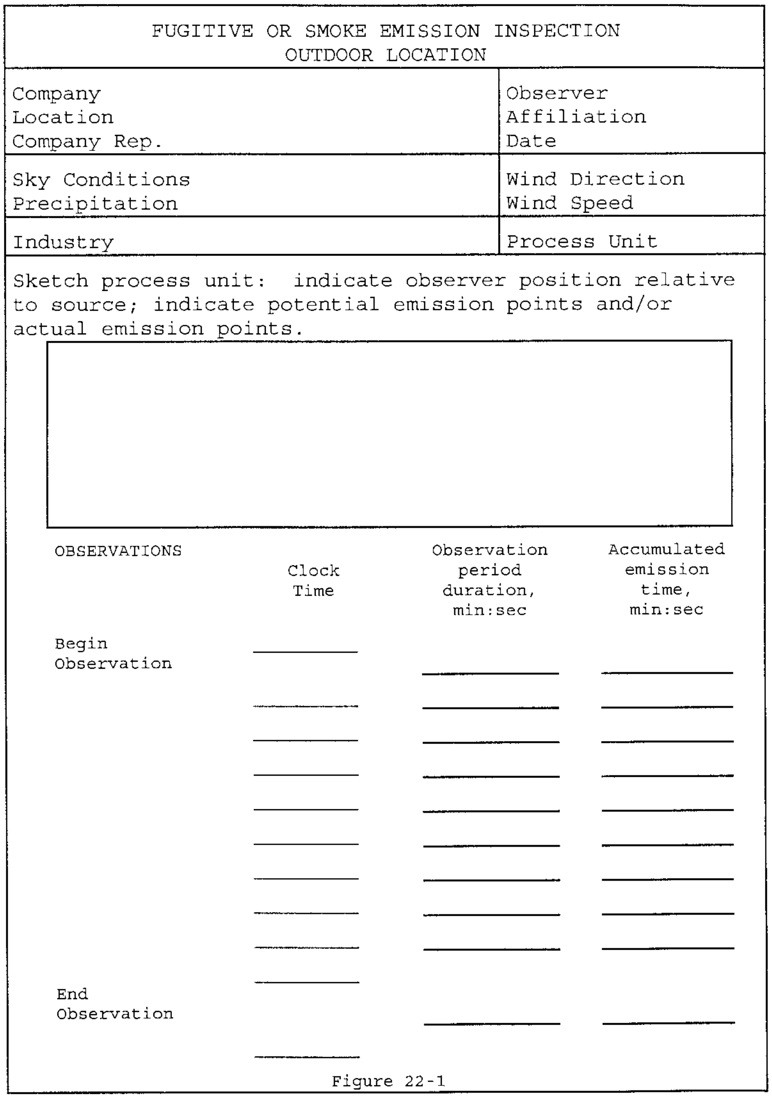
15.0 Waste Management [Reserved]

16.0 References

1. Missan, R., and A. Stein. Guidelines for Evaluation of Visible Emissions Certification, Field Procedures, Legal Aspects, and Background Material. EPA Publication No. EPA–340/1–75–007. April 1975.

2. Wohlschlegel, P., and D.E. Wagoner. Guideline for Development of a Quality Assurance Program: Volume IX—Visual Determination of Opacity Emissions from Stationary Sources. EPA Publication No. EPA–650/4–74–005i. November 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data



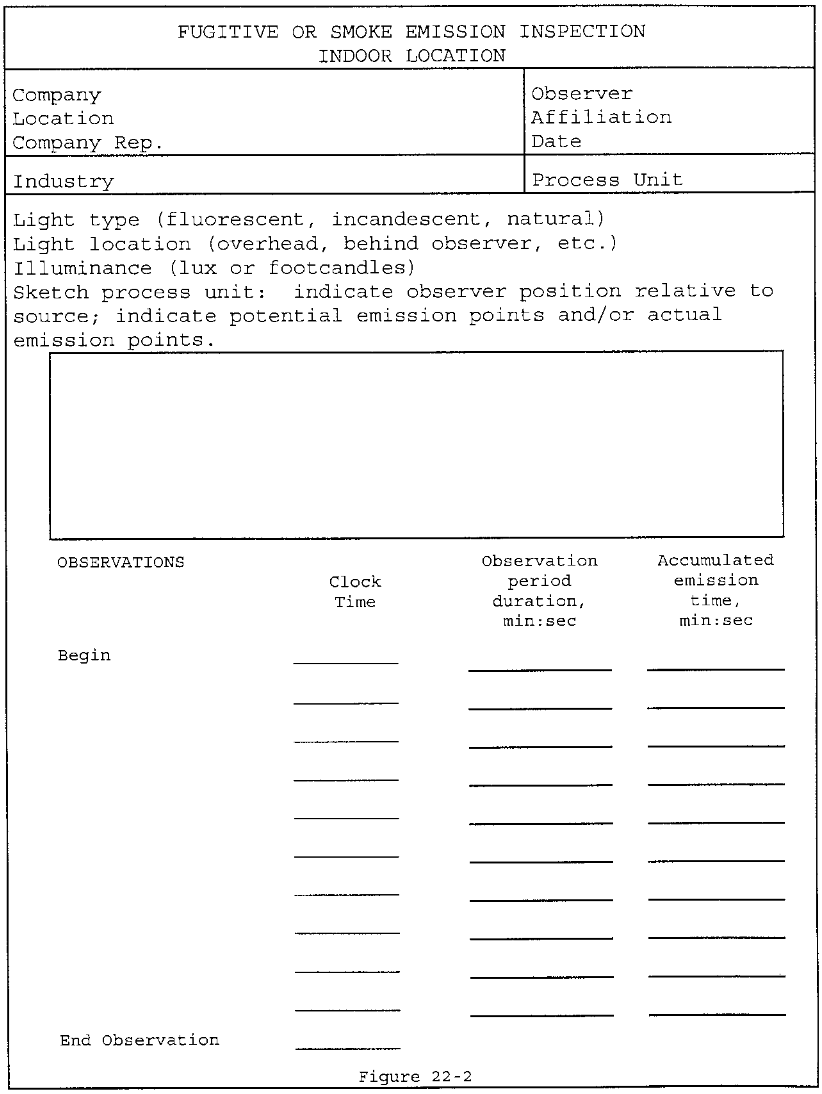
FUGITIVE OR SMOKE EMISSION INSPECTION
OUTDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Sky Conditions Precipitation	Wind Direction Wind Speed
Industry	Process Unit

Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin Observation			
End Observation			

Figure 22-1



FUGITIVE OR SMOKE EMISSION INSPECTION
INDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Industry	Process Unit

Light type (fluorescent, incandescent, natural)
Light location (overhead, behind observer, etc.)
Illuminance (lux or footcandles)
Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
End Observation	________		

Figure 22-2

METHOD 23—DETERMINATION OF POLYCHLORINATED DIBENZO-P-DIOXINS AND POLYCHLORINATED DIBENZOFURANS FROM STATIONARY SOURCES

1. Applicability and Principle

1.1 Applicability. This method is applicable to the determination of polychlorinated dibenzo-p-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) from stationary sources.

1.2 Principle. A sample is withdrawn from the gas stream isokinetically and collected in the sample probe, on a glass fiber filter, and on a packed column of adsorbent material. The sample cannot be separated into a particle vapor fraction. The PCDD's and

PCDF's are extracted from the sample, separated by high resolution gas chromatography, and measured by high resolution mass spectrometry.

2. Apparatus

2.1 Sampling. A schematic of the sampling train used in this method is shown in Figure 23–1. Sealing greases may not be used in assembling the train. The train is identical to that described in section 2.1 of Method 5 of this appendix with the following additions:

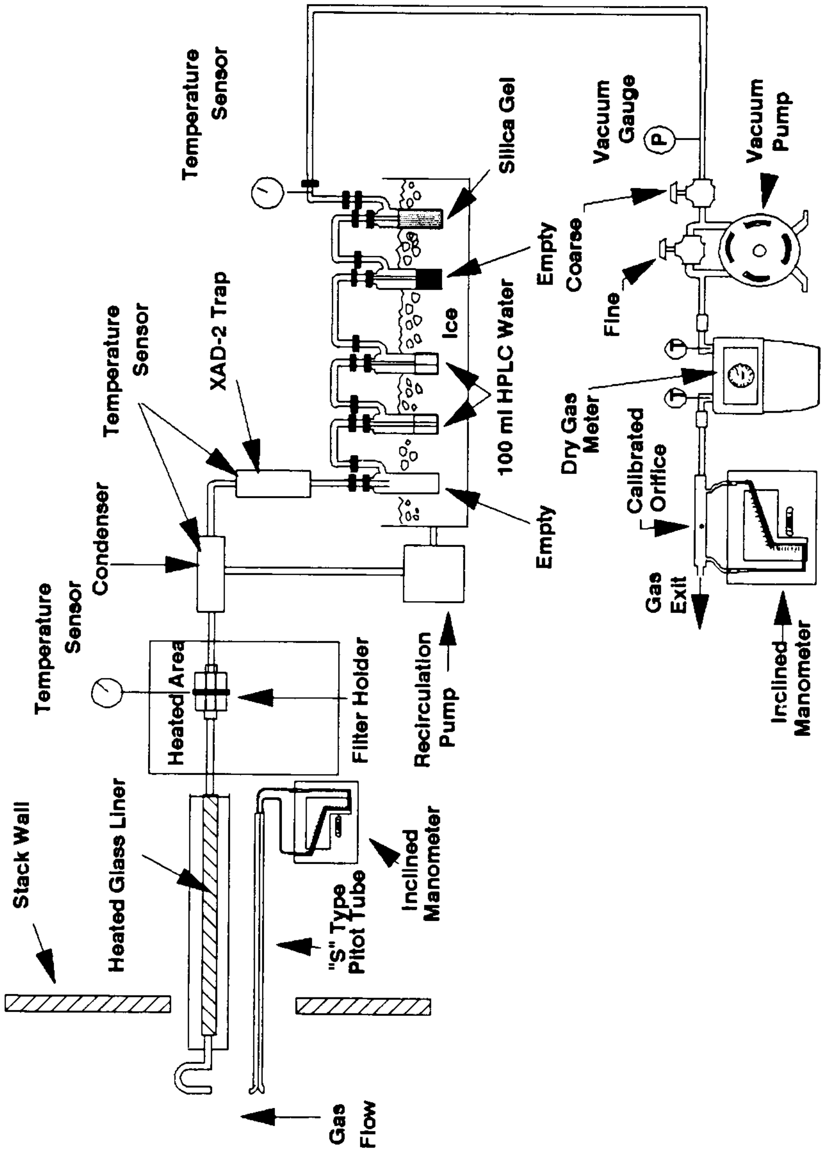


Figure 23.1 Sampling train

2.1.1 Nozzle. The nozzle shall be made of nickel, nickel-plated stainless steel, quartz, or borosilicate glass.

2.1.2 Sample Transfer Lines. The sample transfer lines, if needed, shall be heat traced, heavy walled TFE (½ in. OD with ⅛ in. wall) with connecting fittings that are capable of forming leak-free, vacuum-tight connections without using sealing greases. The line shall be as short as possible and must be maintained at 120 °C.

2.1.1 Filter Support. Teflon or Teflon-coated wire.

2.1.2 Condenser. Glass, coil type with compatible fittings. A schematic diagram is shown in Figure 23–2.

2.1.3 Water Bath. Thermostatically controlled to maintain the gas temperature exiting the condenser at <20 °C (68 °F).

2.1.4 Adsorbent Module. Glass container to hold the solid adsorbent. A shematic diagram is shown in Figure 23–2. Other physical configurations of the resin trap/condenser assembly are acceptable. The connecting fittings shall form leak-free, vacuum tight seals. No sealant greases shall be used in the sampling train. A coarse glass frit is included to retain the adsorbent.

2.2 Sample Recovery.

2.2.1 Fitting Caps. Ground glass, Teflon tape, or aluminum foil (Section 2.2.6) to cap off the sample exposed sections of the train.

2.2.2 Wash Bottles. Teflon, 500-ml.

2.2.3 Probe-Liner Probe-Nozzle, and Filter-Holder Brushes. Inert bristle brushes with precleaned stainless steel or Teflon handles. The probe brush shall have extensions of stainless steel or Teflon, at least as long as the probe. The brushes shall be properly sized and shaped to brush out the nozzle, probe liner, and transfer line, if used.

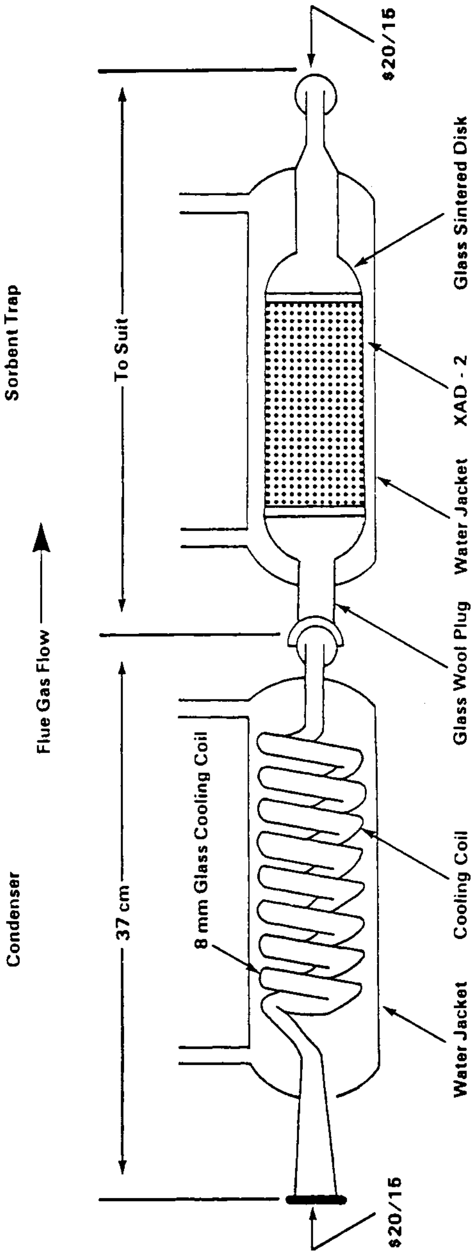


Figure 23.2. Condenser and adsorbent trap

2.2.4 Filter Storage Container. Sealed filter holder, wide-mouth amber glass jar with Teflon-lined cap, or glass petri dish.

2.2.5 Balance. Triple beam.

2.2.6 Aluminum Foil. Heavy duty, hexane-rinsed.

2.2.7 Storage Container. Air-tight container to store silica gel.

2.2.8 Graduated Cylinder. Glass, 250-ml with 2-ml graduation.

2.2.9 Glass Sample Storage Container. Amber glass bottle for sample glassware washes, 500- or 1000-ml, with leak free Teflon-lined caps.

2.3 Analysis.

2.3.1 Sample Container. 125- and 250-ml flint glass bottles with Teflon-lined caps.

2.3.2 Test Tube. Glass.

2.3.3 Soxhlet Extraction Apparatus. Capable of holding 43 × 123 mm extraction thimbles.

2.3.4 Extraction Thimble. Glass, precleaned cellulosic, or glass fiber.

2.3.5 Pasteur Pipettes. For preparing liquid chromatographic columns.

2.3.6 Reacti-vials. Amber glass, 2-ml, silanized prior to use.

2.3.7 Rotary Evaporator. Buchi/Brinkman RF–121 or equivalent.

2.3.8 Nitrogen Evaporative Concentrator. N-Evap Analytical Evaporator Model III or equivalent.

2.3.9 Separatory Funnels. Glass, 2-liter.

2.3.10 Gas Chromatograph. Consisting of the following components:

2.3.10.1 Oven. Capable of maintaining the separation column at the proper operating temperature ±°C and performing programmed increases in temperature at rates of at least 40 °C/min.

2.3.10.2 Temperature Gauge. To monitor column oven, detector, and exhaust temperatures ±1 °C.

2.3.10.3 Flow System. Gas metering system to measure sample, fuel, combustion gas, and carrier gas flows.

2.3.10.4 Capillary Columns. A fused silica column, 60 × 0.25 mm inside diameter (ID), coated with DB–5 and a fused silica column, 30 m × 0.25 mm ID coated with DB–225. Other column systems may be used provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

2.3.11 Mass Spectrometer. Capable of routine operation at a resolution of 1:10000 with a stability of ±5 ppm.

2.3.12 Data System. Compatible with the mass spectrometer and capable of monitoring at least five groups of 25 ions.

2.3.13 Analytical Balance. To measure within 0.1 mg.

3. Reagents

3.1 Sampling.

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Standard Method D 2986–71 (Reapproved 1978) (incorporated by reference—see §60.17).

3.1.1.1 Precleaning. All filters shall be cleaned before their initial use. Place a glass extraction thimble and 1 g of silica gel and a plug of glass wool into a Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Place no more than 50 filters in the thimble onto the silica gel bed and top with the cleaned glass wool. Charge the Soxhlet with toluene and reflux for 16 hours. After extraction, allow the Soxhlet to cool, remove the filters, and dry them under a clean N_2 stream. Store the filters in a glass petri dish sealed with Teflon tape.

3.1.2 Adsorbent Resin. Amberlite XAD–2 resin. Thoroughly cleaned before initial use.

3.1.2.1 Cleaning Procedure. This procedure may be carried out in a giant Soxhlet extractor. An all-glass filter thimble containing an extra-course frit is used for extraction of XAD–2. The frit is recessed 10–15 mm above a crenelated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass wool plug and a stainless steel ring because it floats on methylene chloride. This process involves sequential extraction in the following order.

Solvent	Procedure
Water	Initial rinse: Place resin in a beaker, rinse once with water, and discard. Fill with water a second time, let stand overnight, and discard.
Water	Extract with water for 8 hours.
Methanol	Extract for 22 hours.
Methylene Chloride	Extract for 22 hours.
Toluene	Extract for 22 hours.

3.1.2.2 Drying.

3.1.2.2.1 Drying Column. Pyrex pipe, 10.2 cm ID by 0.6 m long, with suitable retainers.

3.1.2.2.2 Procedure. The adsorbent must be dried with clean inert gas. Liquid nitrogen from a standard commercial liquid nitrogen cylinder has proven to be a reliable source of large volumes of gas free from organic contaminants. Connect the liquid nitrogen cylinder to the column by a length of cleaned copper tubing, 0.95 cm ID, coiled to pass through a heat source. A convenient heat source is a water-bath heated from a steam line. The final nitrogen temperature should only be warm to the touch and not over 40 °C. Continue flowing nitrogen through the adsorbent until all the residual solvent is removed. The flow rate should be sufficient to gently agitate the particles but not so excessive as the cause the particles to fracture.

3.1.2.3 Quality Control Check. The adsorbent must be checked for residual toluene.

3.1.2.3.1 Extraction. Weigh 1.0 g sample of dried resin into a small vial, add 3 ml of toluene, cap the vial, and shake it well.

3.1.2.3.2 Analysis. Inject a 2 µl sample of the extract into a gas chromatograph operated under the following conditions:

Column: 6 ft × ⅛ in stainless steel containing 10 percent OV–101 on 100/120 Supelcoport.
Carrier Gas: Helium at a rate of 30 ml/min.
Detector: Flame ionization detector operated at a sensitivity of 4×10^{-11} A/mV.
Injection Port Temperature: 250 °C.
Detector Temperature: 305 °C.
Oven Temperature: 30 °C for 4 min; programmed to rise at 40 °C/min until it reaches 250 °C; return to 30 °C after 17 minutes.

Compare the results of the analysis to the results from the reference solution. Prepare the reference solution by injection 2.5 µl of methylene chloride into 100 ml of toluene. This corresponds to 100 µg of methylene chloride per g of adsorbent. The maximum acceptable concentration is 1000 µg/g of adsorbent. If the adsorbent exceeds this level, drying must be continued until the excess methylene chloride is removed.

3.1.2.4 Storage. The adsorbent must be used within 4 weeks of cleaning. After cleaning, it may be stored in a wide mouth amber glass container with a Teflon-lined cap or placed in one of the glass adsorbent modules tightly sealed with glass stoppers. If precleaned adsorbent is purchased in sealed containers, it must be used within 4 weeks after the seal is broken.

3.1.3 Glass Wool. Cleaned by sequential immersion in three aliquots of methylene chloride, dried in a 110 °C oven, and stored in a methylene chloride-washed glass jar with a Teflon-lined screw cap.

3.1.4 Water. Deionized distilled and stored in a methylene chloride-rinsed glass container with a Teflon-lined screw cap.

3.1.5 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175 °C (350 °F) for two hours. New silica gel may be used as received. Alternately other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.6 Chromic Acid Cleaning Solution. Dissolve 20 g of sodium dichromate in 15 ml of water, and then carefully add 400 ml of concentrated sulfuric acid.

3.2 Sample Recovery.

3.2.2 Acetone. Pesticide quality.

3.2.2 Methylene Chloride. Pesticide qualtity.

3.2.3 Toluene. Pesticide quality.

3.3 Analysis.

3.3.1 Potassium Hydroxide. ACS grade, 2-percent (weight/volume) in water.

3.3.2 Sodium Sulfate. Granulated, reagent grade. Purify prior to use by rinsing with methylene chloride and oven drying. Store the cleaned material in a glass container with a Teflon-lined screw cap.

3.3.3 Sulfuric Acid. Reagent grade.

3.3.4 Sodium Hydroxide. 1.0 N. Weigh 40 g of sodium hydroxide into a 1-liter volumetric flask. Dilute to 1 liter with water.

3.3.5 Hexane. Pesticide grade.

3.3.6 Methylene Chloride. Pesticide grade.

3.3.7 Benzene. Pesticide Grade.

3.3.8 Ethyl Acetate.

3.3.9 Methanol. Pesticide Grade.

3.3.10 Toluene. Pesticide Grade.

3.3.11 Nonane. Pesticide Grade.

3.3.12 Cyclohexane. Pesticide Grade.

3.3.13 Basic Alumina. Activity grade 1, 100–200 mesh. Prior to use, activate the alumina by heating for 16 hours at 130 °C before use. Store in a desiccator. Pre-activated alumina may be purchased from a supplier and may be used as received.

3.3.14 Silica Gel. Bio-Sil A, 100–200 mesh. Prior to use, activate the silica gel by heating for at least 30 minutes at 180 °C. After cooling, rinse the silica gel sequentially with methanol and methylene chloride. Heat the rinsed silica gel at 50 °C for 10 minutes, then increase the temperature gradually to 180 °C over 25 minutes and maintain it at this temperature for 90 minutes. Cool at room temperature and store in a glass container with a Teflon-lined screw cap.

3.3.15 Silica Gel Impregnated with Sulfuric Acid. Combine 100 g of silica gel with 44 g of concentrated sulfuric acid in a screw capped glass bottle and agitate thoroughly. Disperse the solids with a stirring rod until a uniform mixture is obtained. Store the mixture in a glass container with a Teflon-lined screw cap.

3.3.16 Silica Gel Impregnated with Sodium Hydroxide. Combine 39 g of 1 N sodium hydroxide with 100 g of silica gel in a screw capped glass bottle and agitate thoroughly. Disperse solids with a stirring rod until a uniform mixture is obtained. Store the mixture in glass container with a Teflon-lined screw cap.

3.3.17 Carbon/Celite. Combine 10.7 g of AX–21 carbon with 124 g of Celite 545 in a 250-ml glass bottle with a Teflon-lined screw cap. Agitate the mixture thoroughly until a uniform mixture is obtained. Store in the glass container.

3.3.18 Nitrogen. Ultra high purity.

3.3.19 Hydrogen. Ultra high purity.

3.3.20 Internal Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading "Internal Standards" in 10 ml of nonane.

3.3.21 Surrogate Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading "Surrogate Standards" in 10 ml of nonane.

3.3.22 Recovery Standard Solution. Prepare a stock standard solution containing the

isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Recovery Standards'' in 10 ml of nonane.

4. Procedure

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation.

4.1.1.1 Cleaning Glassware. All glass components of the train upstream of and including the adsorbent module, shall be cleaned as described in section 3A of the ''Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.'' Special care shall be devoted to the removal of residual silicone grease sealants on ground glass connections of used glassware. Any residue shall be removed by soaking the glassware for several hours in a chromic acid cleaning solution prior to cleaning as described above.

4.1.1.2 Adsorbent Trap. The traps must be loaded in a clean area to avoid contamination. They may not be loaded in the field. Fill a trap with 20 to 40 g of XAD–2. Follow the XAD–2 with glass wool and tightly cap both ends of the trap. Add 100 µl of the surrogate standard solution (section 3.3.21) to each trap.

4.1.1.3 Sample Train. It is suggested that all components be maintained according to the procedure described in APTD–0576. Alternative mercury-free thermometers may be used if the thermometers are, at a minimum, equivalent in terms of performance or suitably effective for the specific temperature measurement application.

4.1.1.4 Silica Gel. Weigh several 200 to 300 g portions of silica gel in an air tight container to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel may be weighed directly in its impinger or sampling holder just prior to sampling.

4.1.1.5 Filter. Check each filter against light for irregularities and flaws or pinhole leaks. Pack the filters flat in a clean glass container.

4.1.2 Preliminary Determinations. Same as section 4.1.2 of Method 5.

4.1.3 Preparation of Collection Train.

4.1.3.1 During preparation and assembly of the sampling train, keep all train openings where contamination can enter, sealed until just prior to assembly or until sampling is about to begin.

NOTE: Do not use sealant grease in assembling the train.

4.1.3.2 Place approximately 100 ml of water in the second and third impingers, leave the first and fourth impingers empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fifth impinger.

4.1.3.3 Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

4.1.3.4 Assemble the train as shown in Figure 23–1.

4.1.3.5 Turn on the adsorbent module and condenser coil recirculating pump and begin monitoring the adsorbent module gas entry temperature. Ensure proper sorbent temperature gas entry temperature before proceeding and before sampling is initiated. It is extremely important that the XAD–2 adsorbent resin temperature never exceed 50 °C because thermal decomposition will occur. During testing, the XAD–2 temperature must not exceed 20 °C for efficient capture of the PCDD's and PCDF's.

4.1.4 Leak-Check Procedure. Same as Method 5, section 4.1.4.

4.1.5 Sample Train Operation. Same as Method 5, section 4.1.5.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Seal the nozzle end of the sampling probe with Teflon tape or aluminum foil.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe. Remove the probe from the train and close off both ends with aluminum foil. Seal off the inlet to the train with Teflon tape, a ground glass cap, or aluminum foil.

Transfer the probe and impinger assembly to the cleanup area. This area shall be clean and enclosed so that the chances of losing or contaminating the sample are minimized. Smoking, which could contaminate the sample, shall not be allowed in the cleanup area.

Inspect the train prior to and during disassembly and note any abnormal conditions, e.g., broken filters, colored impinger liquid, etc. Treat the samples as follows:

4.2.1 Container No. 1. Either seal the filter holder or carefully remove the filter from the filter holder and place it in its identified container. Use a pair of cleaned tweezers to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the container any particulate matter and filter fibers which adhere to the filter holder gasket, by using a dry inert bristle brush and a sharp-edged blade. Seal the container.

4.2.2 Adsorbent Module. Remove the module from the train, tightly cap both ends, label it, cover with aluminum foil, and store it on ice for transport to the laboratory.

4.2.3 Container No. 2. Quantitatively recover material deposited in the nozzle, probe transfer lines, the front half of the filter holder, and the cyclone, if used, first, by

brushing while rinsing three times each with acetone and then, by rinsing the probe three times with methylene chloride. Collect all the rinses in Container No. 2.

Rinse the back half of the filter holder three times with acetone. Rinse the connecting line between the filter and the condenser three times with acetone. Soak the connecting line with three separate portions of methylene chloride for 5 minutes each. If using a separate condenser and adsorbent trap, rinse the condenser in the same manner as the connecting line. Collect all the rinses in Container No. 2 and mark the level of the liquid on the container.

4.2.4 Container No. 3. Repeat the methylene chloride-rinsing described in section 4.2.3 using toluene as the rinse solvent. Collect the rinses in Container No. 3 and mark the level of the liquid on the container.

4.2.5 Impinger Water. Measure the liquid in the first three impingers to within ±1 ml by using a graduated cylinder or by weighing it to within ±0.5 g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

Discard the liquid after measuring and recording the volume or weight.

4.2.7 Silica Gel. Note the color of the indicating silica gel to determine if it has been completely spent and make a mention of its condition. Transfer the silica gel from the fifth impinger to its original container and seal. If a moisture determination is made, follow the applicable procedures in sections 8.7.6.3 and 11.2.3 of Method 5 to handle and weigh the silica gel. If moisture is not measured, the silica gel may be disposed.

5. Analysis

All glassware shall be cleaned as described in section 3A of the ''Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.'' All samples must be extracted within 30 days of collection and analyzed within 45 days of extraction.

5.1 Sample Extraction.

5.1.1 Extraction System. Place an extraction thimble (section 2.3.4), 1 g of silica gel, and a plug of glass wool into the Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Remove the extraction thimble from the extraction system and place it in a glass beaker to catch the solvent rinses.

5.1.2 Container No. 1 (Filter). Transfer the contents directly to the glass thimble of the extraction system and extract them simultaneously with the XAD–2 resin.

5.1.3 Adsorbent Cartridge. Suspend the adsorbent module directly over the extraction thimble in the beaker (See section 5.1.1). The glass frit of the module should be in the up position. Using a Teflon squeeze bottle containing toluene, flush the XAD–2 into the thimble onto the bed of cleaned silica gel. Thoroughly rinse the glass module catching the rinsings in the beaker containing the thimble. If the resin is wet, effective extraction can be accomplished by loosely packing the resin in the thimble. Add the XAD–2 glass wool plug into the thimble.

5.1.4 Container No. 2 (Acetone and Methylene Chloride). Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus, at a temperature of less than 37 °C. Rinse the sample container three times with small portions of methylene chloride and add these to the concentrated solution and concentrate further to near dryness. This residue contains particulate matter removed in the rinse of the train probe and nozzle. Add the concentrate to the filter and the XAD–2 resin in the Soxhlet apparatus described in section 5.1.1.

5.1.5 Extraction. Add 100 µl of the internal standard solution (Section 3.3.20) to the extraction thimble containing the contents of the adsorbent cartridge, the contents of Container No. 1, and the concentrate from section 5.1.4. Cover the contents of the extraction thimble with the cleaned glass wool plug to prevent the XAD–2 resin from floating into the solvent reservoir of the extractor. Place the thimble in the extractor, and add the toluene contained in the beaker to the solvent reservoir. Pour additional toluene to fill the reservoir approximately ⅔ full. Add Teflon boiling chips and assemble the apparatus. Adjust the heat source to cause the extractor to cycle three times per hour. Extract the sample for 16 hours. After extraction, allow the Soxhlet to cool. Transfer the toluene extract and three 10-ml rinses to the rotary evaporator. Concentrate the extract to approximately 10 ml. At this point the analyst may choose to split the sample in half. If so, split the sample, store one half for future use, and analyze the other according to the procedures in sections 5.2 and 5.3. In either case, use a nitrogen evaporative concentrator to reduce the volume of the sample being analyzed to near dryness. Dissolve the residue in 5 ml of hexane.

5.1.6 Container No. 3 (Toluene Rinse). Add 100 µl of the Internal Standard solution (section 3.3.2) to the contents of the container. Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus at a temperature of less than 37 °C. Rinse the sample container apparatus at a temperature of less than 37 °C. Rinse the sample container three times with small portions of toluene and add these to the concentrated solution and concentrate further to near dryness. Analyze the extract separately according to the procedures in sections 5.2 and 5.3, but concentrate the solution in a rotary evaporator apparatus rather than a nitrogen evaporative concentrator.

5.2 Sample Cleanup and Fractionation.

5.2.1 Silica Gel Column. Pack one end of a glass column, 20 mm × 230 mm, with glass wool. Add in sequence, 1 g silica gel, 2 g of sodium hydroxide impregnated silica gel, 1 g silica gel, 4 g of acid-modified silica gel, and 1 g of silica gel. Wash the column with 30 ml of hexane and discard it. Add the sample extract, dissolved in 5 ml of hexane to the column with two additional 5-ml rinses. Elute the column with an additional 90 ml of hexane and retain the entire eluate. Concentrate this solution to a volume of about 1 ml using the nitrogen evaporative concentrator (section 2.3.7).

5.2.2 Basic Alumina Column. Shorten a 25-ml disposable Pasteur pipette to about 16 ml. Pack the lower section with glass wool and 12 g of basic alumina. Transfer the concentrated extract from the silica gel column to the top of the basic alumina column and elute the column sequentially with 120 ml of 0.5 percent methylene chloride in hexane followed by 120 ml of 35 percent methylene chloride in hexane. Discard the first 120 ml of eluate. Collect the second 120 ml of eluate and concentrate it to about 0.5 ml using the nitrogen evaporative concentrator.

5.2.3 AX–21 Carbon/Celite 545 Column. Remove the botton 0.5 in. from the tip of a 9-ml disposable Pasteur pipette. Insert a glass fiber filter disk in the top of the pipette 2.5 cm from the constriction. Add sufficient carbon/celite mixture to form a 2 cm column. Top with a glass wool plug. In some cases AX–21 carbon fines may wash through the glass wool plug and enter the sample. This may be prevented by adding a celite plug to the exit end of the column. Rinse the column in sequence with 2 ml of 50 percent benzene in ethyl acetate, 1 ml of 50 percent methylene chloride in cyclohexane, and 2 ml of hexane. Discard these rinses. Transfer the concentrate in 1 ml of hexane from the basic alumina column to the carbon/celite column along with 1 ml of hexane rinse. Elute the column sequentially with 2 ml of 50 percent methylene chloride in hexane and 2 ml of 50 percent benzene in ethyl acetate and discard these eluates. Invert the column and elute in the reverse direction with 13 ml of toluene. Collect this eluate. Concentrate the eluate in a rotary evaporator at 50 °C to about 1 ml. Transfer the concentrate to a Reacti-vial using a toluene rinse and concentrate to a volume of 200 µl using a stream of N_2. Store extracts at room temperature, shielded from light, until the analysis is performed.

5.3 Analysis. Analyze the sample with a gas chromatograph coupled to a mass spectrometer (GC/MS) using the instrumental parameters in sections 5.3.1 and 5.3.2. Immediately prior to analysis, add a 20 µl aliquot of the Recovery Standard solution from Table 1 to each sample. A 2 µl aliquot of the extract is injected into the GC. Sample extracts are first analyzed using the DB–5 capillary column to determine the concentration of each isomer of PCDD's and PCDF's (tetra-through octa-). If tetra-chlorinated dibenzofurans are detected in this analysis, then analyze another aliquot of the sample in a separate run, using the DB–225 column to measure the 2,3,7,8 tetra-chloro dibenzofuran isomer. Other column systems may be used, provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

5.3.1 Gas Chromatograph Operating Conditions.

5.3.1.1 Injector. Configured for capillary column, splitless, 250 °C.

5.3.1.2 Carrier Gas. Helium, 1–2 ml/min.

5.3.1.3 Oven. Initially at 150 °C. Raise by at least 40 °C/min to 190 °C and then at 3 °C/min up to 300 °C.

5.3.2 High Resolution Mass Spectrometer.

5.3.2.1 Resolution. 10000 m/e.

5.3.2.2 Ionization Mode. Electron impact.

5.3.2.3 Source Temperature 250 °C.

5.3.2.4 Monitoring Mode. Selected ion monitoring. A list of the various ions to be monitored is summarized in Table 3.

5.3.2.5 Identification Criteria. The following identification criteria shall be used for the characterization of polychlorinated dibenzodioxins and dibenzofurans.

1. The integrated ion-abundance ratio (M/M + 2 or M + 2/M + 4) shall be within 15 percent of the theoretical value. The acceptable ion-abundance ratio ranges for the identification of chlorine-containing compounds are given in Table 4.
2. The retention time for the analytes must be within 3 seconds of the corresponding ^{13}C-labeled internal standard, surrogate or alternate standard.
3. The monitored ions, shown in Table 3 for a given analyte, shall reach their maximum within 2 seconds of each other.
4. The identification of specific isomers that do not have corresponding ^{13}C-labeled standards is done by comparison of the relative retention time (RRT) of the analyte to the nearest internal standard retention time with reference (i.e., within 0.005 RRT units) to the comparable RRT's found in the continuing calibration.
5. The signal to noise ratio for all monitored ions must be greater than 2.5.
6. The confirmation of 2, 3, 7, 8–TCDD and 2, 3, 7, 8–TCDF shall satisfy all of the above identification criteria.
7. For the identification of PCDF's, no signal may be found in the corresponding PCDPE channels.

5.3.2.6 Quantification. The peak areas for the two ions monitored for each analyte are summed to yield the total response for each analyte. Each internal standard is used to quantify the indigenous PCDD's or PCDF's in its homologous series. For example, the $^{13}C_{12}$–2,3,7,8-tetra chlorinated dibenzodioxin is used to calculate the concentrations of all

other tetra chlorinated isomers. Recoveries of the tetra- and penta- internal standards are calculated using the $^{13}C_{12}$–1,2,3,4–TCDD. Recoveries of the hexa- through octa- internal standards are calculated using $^{13}C_{12}$–1,2,3,7,8,9–HxCDD. Recoveries of the surrogate standards are calculated using the corresponding homolog from the internal standard.

6. Calibration

Same as Method 5 with the following additions.

6.1 GC/MS System.

6.1.1 Initial Calibration. Calibrate the GC/MS system using the set of five standards shown in Table 2. The relative standard deviation for the mean response factor from each of the unlabeled analytes (Table 2) and of the internal, surrogate, and alternate standards shall be less than or equal to the values in Table 5. The signal to noise ratio for the GC signal present in every selected ion current profile shall be greater than or equal to 2.5. The ion abundance ratios shall be within the control limits in Table 4.

6.1.2 Daily Performance Check.

6.1.2.1 Calibration Check. Inject on µl of solution Number 3 from Table 2. Calculate the relative response factor (RRF) for each compound and compare each RRF to the corresponding mean RRF obtained during the initial calibration. The analyzer performance is acceptable if the measured RRF's for the labeled and unlabeled compounds for the daily run are within the limits of the mean values shown in Table 5. In addition, the ion-abundance ratios shall be within the allowable control limits shown in Table 4.

6.1.2.2 Column Separation Check. Inject a solution of a mixture of PCDD's and PCDF's that documents resolution between 2,3,7,8–TCDD and other TCDD isomers. Resolution is defined as a valley between peaks that is less than 25 percent of the lower of the two peaks. Identify and record the retention time windows for each homologous series.

Perform a similar resolution check on the confirmation column to document the resolution between 2,3,7,8 TCDF and other TCDF isomers.

6.2 Lock Channels. Set mass spectrometer lock channels as specified in Table 3. Monitor the quality control check channels specified in Table 3 to verify instrument stability during the analysis.

7. Quality Control

7.1 Sampling Train Collection Efficiency Check. Add 100 µl of the surrogate standards in Table 1 to the absorbent cartridge of each train before collecting the field samples.

7.2 Internal Standard Percent Recoveries. A group of nine carbon labeled PCDD's and PCDF's representing, the tetra-through octachlorinated homologues, is added to every sample prior to extraction. The role of the internal standards is to quantify the native PCDD's and PCDF's present in the sample as well as to determine the overall method efficiency. Recoveries of the internal standards must be between 40 to 130 percent for the tetra-through hexachlorinated compounds while the range is 25 to 130 percent for the higher hepta- and octachlorinated homologues.

7.3 Surrogate Recoveries. The five surrogate compounds in Table 2 are added to the resin in the adsorbent sampling cartridge before the sample is collected. The surrogate recoveries are measured relative to the internal standards and are a measure of collection efficiency. They are not used to measure native PCDD's and PCDF's. All recoveries shall be between 70 and 130 percent. Poor recoveries for all the surrogates may be an indication of breakthrough in the sampling train. If the recovery of all standards is below 70 percent, the sampling runs must be repeated. As an alternative, the sampling runs do not have to be repeated if the final results are divided by the fraction of surrogate recovery. Poor recoveries of isolated surrogate compounds should not be grounds for rejecting an entire set of the samples.

7.4 Toluene QA Rinse. Report the results of the toluene QA rinse separately from the total sample catch. Do not add it to the total sample.

8.0 [Reserved]

9. Calculations

Same as Method 5, section 6 with the following additions.

9.1 Nomenclature.

A_{ai} = Integrated ion current of the noise at the retention time of the analyte.

A^*_{ci} = Integrated ion current of the two ions characteristic of the internal standard i in the calibration standard.

A_{cij} = Integrated ion current of the two ions characteristic of compound i in the jth calibration standard.

A^*_{cij} = Integrated ion current of the two ions characteristic of the internal standard i in the jth calibration standard.

A_{csi} = Integrated ion current of the two ions characteristic of surrogate compound i in the calibration standard.

A_i = Integrated ion current of the two ions characteristic of compound i in the sample.

A^*_i = Integrated ion current of the two ions characteristic of internal standard i in the sample.

A_{rs} = Integrated ion current of the two ions characteristic of the recovery standard.

A_{si} = Integrated ion current of the two ions characteristic of surrogate compound i in the sample.

C_i = Concentration of PCDD or PCDF i in the sample, pg/M^3.

C_T = Total concentration of PCDD's or PCDF's in the sample, pg/M^3.

m_{ci} = Mass of compound i in the calibration standard injected into the analyzer, pg.

m_{rs} = Mass of recovery standard in the calibration standard injected into the analyzer, pg.

m_{si} = Mass of surrogate compound in the calibration standard, pg.

RRF_i = Relative response factor.

RRF_{rs} = Recovery standard response factor.

RRF_s = Surrogate compound response factor.

9.2 Average Relative Response Factor.

$$RRF_i = \frac{1}{n}\sum_{j=1}^{n}\frac{A_{cij}\, m^*_{ci}}{A^*_{cij}\, m_{ci}} \qquad \text{Eq. 23-1}$$

9.3 Concentration of the PCDD's and PCDF's.

$$C_i = \frac{m_i * A_i}{A_i * RRF_i V_{mstd}} \qquad \text{Eq. 23-2}$$

9.4 Recovery Standard Response Factor.

$$RRF_{rs} = \frac{A_{ci} * m_{rs}}{A_{rs} m_{ci} *} \qquad \text{Eq. 23-3}$$

9.5 Recovery of Internal Standards (R*).

$$R* = \frac{A_i * m_{rs}}{A_{rs} RF_{rs} m_i *} \times 100\% \qquad \text{Eq. 23-4}$$

9.6 Surrogate Compound Response Factor.

$$RRF_s = \frac{A_{ci} * m_s}{A_{cis} m_{ci} *} \qquad \text{Eq. 23-5}$$

9.7 Recovery of Surrogate Compounds (R_s).

$$R_s = \frac{A_s m_i *}{A_i * RRF_s m_s} \times 100\% \qquad \text{Eq. 23-6}$$

9.8 Minimum Detectable Limit (MDL).

$$MDL = \frac{2.5\ A_{ai} m_i *}{A_{ci} * RRF_i} \qquad \text{Eq. 23-7}$$

9.9 Total Concentration of PCDD's and PCDF's in the Sample.

$$C_{Tr} = \sum_{i=1}^{n} C_i \qquad \text{Eq. 23-8}$$

Any PCDD's or PCDF's that are reported as nondetected (below the MDL) shall be counted as zero for the purpose of calculating the total concentration of PCDD's and PCDF's in the sample.

10. Bibliography

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TABLE 1—COMPOSITION OF THE SAMPLE FORTIFICATION AND RECOVERY STANDARDS SOLUTIONS

Analyte	Concentration (pg/µl)
Internal Standards:	
$^{13}C_{12}$-2,3,7,8-TCDD	100
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100
$^{13}C_{12}$-OCDD	100
$^{13}C_{12}$-2,3,7,8-TCDF	100
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100
Surrogate Standards:	
$^{37}Cl_4$-2,3,7,8-TCDD	100
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	100
$^{13}C_{12}$-2,3,4,7,8-PeCDF	100
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	100
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	100
Recovery Standards:	
$^{13}C_{12}$-1,2,3,4-TCDD	500
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS

Compound	Concentrations (pg/µL)				
	Solution No.				
	1	2	3	4	5
Alternate Standard:					
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	2.5	5	25	250	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS—Continued

Compound	Concentrations (pg/µL)				
	Solution No.				
	1	2	3	4	5
Recovery Standards:					
${}^{13}C_{12}$-1,2,3,4-TCDD ..	100	100	100	100	100
${}^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100

TABLE 3—ELEMENTAL COMPOSITIONS AND EXACT MASSES OF THE IONS MONITORED BY HIGH RESOLUTION MASS SPECTROMETRY FOR PCDD'S AND PCDF'S

Descriptor No.	Accurate mass	Ion type	Elemental composition	Analyte
2	292.9825	LOCK	C_7F_{11}	PFK
	303.9016	M	$C_{12}H_4{}^{35}Cl_4O$	TCDF
	305.8987	M + 2	$C_{12}H_4{}^{35}Cl^{37}O$	TCDF
	315.9419	M	${}^{13}C_{12}H_4{}^{35}Cl_4O$	TCDF (S)
	317.9389	M + 2	${}^{13}C_{12}H_4{}^{35}Cl_3{}^{37}ClO$	TCDF (S)
	319.8965	M	$C_{12}H_4{}^{35}ClO_2$	TCDD
	321.8936	M + 2	$C_{12}H_4{}^{35}Cl_3{}^{37}ClO_2$	TCDD
	327.8847	M	$C_{12}H_4{}^{37}Cl_4O_2$	TCDD (S)
	330.9792	QC	C_7F_{13}	PFK
	331.9368	M	${}^{13}C_{12}H_4{}^{35}Cl_4O_2$	TCDD (S)
	333.9339	M + 2	${}^{13}C_{12}H_4{}^{35}Cl^{37}ClO_2$	TCDD (S)
	339.8597	M + 2	$C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PECDF
	341.8567	M + 4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O$	PeCDF
	351.9000	M + 2	${}^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF (S)
	353.8970	M + 4	${}^{13}C_{12}H_3{}^{35}Cl^{3537}Cl_2O$	PeCDF (S)
	355.8546	M + 2	$C_{12}H_3{}^{35}Cl_337ClO_2$	PeCDD
	357.8516	M + 4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O_2$	PeCDD
	367.8949	M + 2	${}^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO_2$	PeCDD (S)
	369.8919	M + 4	${}^{13}C_{12}H_3{}^{35}Cl_3{}^{37}\ Cl_2O_2$	PeCDD (S)
	375.8364	M + 2	$C_{12}H_4{}^{35}Cl_5{}^{37}ClO$	HxCDPE
	409.7974	M + 2	$C_{12}H_3{}^{35}Cl_6{}^{37}ClO$	HpCPDE
3	373.8208	M + 2	$C_{12}H_235Cl_5{}^{37}ClO$	HxCDF
	375.8178	M + 4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDF
	383.8639	M	${}^{13}C_{12}H_2{}^{35}Cl_6O$	HxCDF (S)
	385.8610	M + 2	${}^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO$	HxCDF (S)
	389.8157	M + 2	$C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD
	391.8127	M + 4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O_2$	HxCDD
	392.9760	LOCK	C_9F_{15}	PFK
	401.8559	M + 2	${}^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD (S)
	403.8529	M + 4	${}^{13}C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDD (S)
	445.7555	M + 4	$C_{12}H_2{}^{35}Cl_6{}^{37}Cl_2O$	OCDPE
	430.9729	QC	C_9F_{17}	PFK
4	407.7818	M + 2	$C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF
	409.7789	M + 4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O$	HpCDF
	417.8253	M	${}^{13}C_{12}H^{35}Cl_7O$	HpCDF (S)
	419.8220	M + 2	${}^{13}C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF (S)
	423.7766	M + 2	$C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD
	425.7737	M + 4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD
	435.8169	M + 2	${}^{13}C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD (S)
	437.8140	M + 4	${}^{13}C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD (S)
	479.7165	M + 4	$C_{12}H^{35}Cl_7{}^{37}Cl_2O$	NCPDE
	430.9729	LOCK	C_9F_{17}	PFK
	441.7428	M + 2	$C_{12}{}^{35}Cl_7{}^{37}ClO$	OCDF
	443.7399	M + 4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O$	OCDF
	457.7377	M + 2	$C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD
	459.7348	M + 4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD
	469.7779	M + 2	${}^{13}C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD (S)
	471.7750	M + 4	${}^{13}C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD (S)
	513.6775	M + 4	$C_{12}{}^{35}Cl_8{}^{37}Cl_2O_2$	DCDPE
	442.9728	QC	$C_{10}F_{17}$	PFK

(a) The following nuclidic masses were used:
H = 1.007825
C = 12.000000
${}^{13}C$ = 13.003355
F = 18.9984
O = 15.994915
${}^{35}Cl$ = 34.968853
${}^{37}Cl$ = 36.965903

S = Labeled Standard
QC = Ion selected for monitoring instrument stability during the GC/MS analysis.

TABLE 4—ACCEPTABLE RANGES FOR ION-ABUNDANCE RATIOS OF PCDD'S AND PCDF'S

No. of chlorine atoms	Ion type	Theoretical ratio	Control limits	
			Lower	Upper
4	M/M + 2	0.77	0.65	0.89
5	M + 2/M + 4	1.55	1.32	1.78
6	M + 2/M + 4	1.24	1.05	1.43
6[a]	M/M + 2	0.51	0.43	0.59
7[b]	M/M + 2	0.44	0.37	0.51
7	M + 2/M + 4	1.04	0.88	1.20
8	M + 2/M + 4	0.89	0.76	1.02

[a] Used only for ^{13}C-HxCDF.
[b] Used only for ^{13}C-HpCDF.

TABLE 5—MINIMUM REQUIREMENTS FOR INITIAL AND DAILY CALIBRATION RESPONSE FACTORS

Compound	Relative response factors	
	Initial calibration RSD	Daily calibration % difference
Unlabeled Analytes:		
2,3,7,8-TCDD	25	25
2,3,7,8-TCDF	25	25
1,2,3,7,8-PeCDD	25	25
1,2,3,7,8-PeCDF	25	25
2,3,4,7,8-PeCDF	25	25
1,2,4,5,7,8-HxCDD	25	25
1,2,3,6,7,8-HxCDD	25	25
1,2,3,7,8,9-HxCDD	25	25
1,2,3,4,7,8-HxCDF	25	25
1,2,3,6,7,8-HxCDF	25	25
1,2,3,7,8,9-HxCDF	25	25
2,3,4,6,7,8-HxCDF	25	25
1,2,3,4,6,7,8-HpCDD	25	25
1,2,3,4,6,7,8-HpCDF	25	25
OCDD	25	25
OCDF	30	30
Internal Standards:		
^{13}C$_{12}$-2,3,7,8-TCDD	25	25
^{13}C$_{12}$-1,2,3,7,8-PeCDD	30	30
^{13}C$_{12}$-1,2,3,6,7,8-HxCDD	25	25
^{13}C$_{12}$-1,2,3,4,6,7,8-HpCDD	30	30
^{13}C$_{12}$-OCDD	30	30
^{13}C$_{12}$-2,3,7,8-TCDF	30	30
^{13}C$_{12}$-1,2,3,7,8-PeCDF	30	30
^{13}C$_{12}$-1,2,3,6,7,8-HxCDF	30	30
^{13}C$_{12}$-1,2,3,4,6,7,8-HpCDF	30	30
Surrogate Standards:		
^{37}Cl$_4$-2,3,7,8-TCDD	25	25
^{13}C$_{12}$-2,3,4,7,8-PeCDF	25	25
^{13}C$_{12}$-1,2,3,4,7,8-HxCDD	25	25
^{13}C$_{12}$-1,2,3,4,7,8-HxCDF	25	25
^{13}C$_{12}$-1,2,3,4,7,8,9-HpCDF	25	25
Alternate Standard:		
^{13}C$_{12}$-1,2,3,7,8,9-HxCDF	25	25

METHOD 24—DETERMINATION OF VOLATILE MATTER CONTENT, WATER CONTENT, DENSITY, VOLUME SOLIDS, AND WEIGHT SOLIDS OF SURFACE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds	No CAS Number assigned
Water.	7732–18–5

1.2 Applicability. This method is applicable for the determination of volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

1.3 Precision and Bias. Intra-and inter-laboratory analytical precision statements are presented in section 13.1. No bias has been identified.

2.0 Summary of Method

2.1 Standard methods are used to determine the volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

3.0 Definitions

3.1 *Waterborne coating* means any coating which contains more than 5 percent water by weight in its volatile fraction.

3.2 *Multicomponent coatings* are coatings that are packaged in two or more parts, which are combined before application. Upon combination a coreactant from one part of the coating chemically reacts, at ambient conditions, with a coreactant from another part of the coating.

3.3 *Ultraviolet (UV) radiation-cured coatings* are coatings which contain unreacted monomers that are polymerized by exposure to ultraviolet light.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Several of the compounds that may be contained in the coatings analyzed by this method may be irritating or corrosive to tissues (e.g., heptane) or may be toxic (e.g., benzene, methyl alcohol). Nearly all are fire hazards.

Appropriate precautions can be found in reference documents, such as Reference 3 of section 16.0.

6.0 Equipment and Supplies

The equipment and supplies specified in the ASTM methods listed in sections 6.1 through 6.6 (incorporated by reference—see § 60.17 for acceptable versions of the methods) are required:

6.1 ASTM D 1475–60, 80, or 90, Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products.

6.2 ASTM D 2369–81, 87, 90, 92, 93, or 95, Standard Test Method for Volatile Content of Coatings.

6.3 ASTM D 3792–79 or 91, Standard Test Method for Water Content of Water Reducible Paints by Direct Injection into a Gas Chromatograph.

6.4 ASTM D 4017–81, 90, or 96a, Standard Test Method for Water in Paints and Paint Materials by the Karl Fischer Titration Method.

6.5 ASTM 4457–85 91, Standard Test Method for Determination of Dichloromethane and 1,1,1-Trichloroethane in Paints and Coatings by Direct Injection into a Gas Chromatograph.

6.6 ASTM D 5403–93, Standard Test Methods for Volatile Content of Radiation Curable Materials.

6.7 ASTM D 6419–00, Test Method for Volatile Content of Sheet-Fed and Coldset Web Offset Printing Inks.

7.0 Reagents and Standards

7.1 The reagents and standards specified in the ASTM methods listed in sections 6.1 through 6.6 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 1 of section 16.0.

9.0 Quality Control

9.1 Reproducibility

NOTE: Not applicable to UV radiation-cured coatings). The variety of coatings that may be subject to analysis makes it necessary to verify the ability of the analyst and the analytical procedures to obtain reproducible results for the coatings tested. Verification is accomplished by running duplicate analyses on each sample tested (Sections 11.2 through 11.4) and comparing the results with the intra-laboratory precision statements (Section 13.1) for each parameter.

9.2 Confidence Limits for Waterborne Coatings. Because of the inherent increased imprecision in the determination of the VOC content of waterborne coatings as the weight percent of water increases, measured parameters for waterborne coatings are replaced with appropriate confidence limits (Section 12.6). These confidence limits are based on measured parameters and inter-laboratory precision statements.

10.0 Calibration and Standardization

10.1 Perform the calibration and standardization procedures specified in the ASTM methods listed in sections 6.1 through 6.6.

11.0 Analytical Procedure

Additional guidance can be found in Reference 2 of section 16.0.

11.1 Non Thin-film Ultraviolet Radiation-cured (UV radiation-cured) Coatings.

11.1.1 Volatile Content. Use the procedure in ASTM D 5403 to determine the volatile matter content of the coating except the curing test described in NOTE 2 of ASTM D 5403 is required.

11.1.2 Water Content. To determine water content, follow section 11.3.2.

11.1.3 Coating Density. To determine coating density, follow section 11.3.3.

11.1.4 Solids Content. To determine solids content, follow section 11.3.4.

11.1.5 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the equation in section 12.2. If C is less than 0.2 g and A is greater than or equal to 225 cm^2 (35 in^2) then the coating or ink is considered a thin-film UV radiation-cured coating and ASTM D 5403 is not applicable.

NOTE: As noted in section 1.4 of ASTM D 5403, this method may not be applicable to radiation curable materials wherein the volatile material is water.

11.2 Multi-component Coatings.

11.2.1 Sample Preparation.

11.2.1.1 Prepare about 100 ml of sample by mixing the components in a storage container, such as a glass jar with a screw top or a metal can with a cap. The storage container should be just large enough to hold the mixture. Combine the components (by weight or volume) in the ratio recommended by the manufacturer. Tightly close the container between additions and during mixing to prevent loss of volatile materials. However, most manufacturers mixing instructions are by volume. Because of possible error caused by expansion of the liquid when measuring the volume, it is recommended that the components be combined by weight. When weight is used to combine the components and the manufacturer's recommended ratio is by volume, the density must be determined by section 11.3.3.

11.2.1.2 Immediately after mixing, take aliquots from this 100 ml sample for determination of the total volatile content, water content, and density.

11.2.2 Volatile Content. To determine total volatile content, use the apparatus and

reagents described in ASTM D2369 (incorporated by reference; see §60.17 for the approved versions of the standard), respectively, and use the following procedures:

11.2.2.1 Weigh and record the weight of an aluminum foil weighing dish. Add 3 ±1 ml of suitable solvent as specified in ASTM D2369 to the weighing dish. Using a syringe as specified in ASTM D2369, weigh to 1 mg, by difference, a sample of coating into the weighing dish. For coatings believed to have a volatile content less than 40 weight percent, a suitable size is 0.3 + 0.10 g, but for coatings believed to have a volatile content greater than 40 weight percent, a suitable size is 0.5 ±0.1 g.

NOTE: If the volatile content determined pursuant to section 12.4 is not in the range corresponding to the sample size chosen repeat the test with the appropriate sample size. Add the specimen dropwise, shaking (swirling) the dish to disperse the specimen completely in the solvent. If the material forms a lump that cannot be dispersed, discard the specimen and prepare a new one. Similarly, prepare a duplicate. The sample shall stand for a minimum of 1 hour, but no more than 24 hours prior to being oven cured at 110 ±5 °C (230 ±9 °F) for 1 hour.

11.2.2.2 Heat the aluminum foil dishes containing the dispersed specimens in the forced draft oven for 60 min at 110 ±5 °C (230 ±9 °F). Caution—provide adequate ventilation, consistent with accepted laboratory practice, to prevent solvent vapors from accumulating to a dangerous level.

11.2.2.3 Remove the dishes from the oven, place immediately in a desiccator, cool to ambient temperature, and weigh to within 1 mg.

11.2.2.4 Run analyses in pairs (duplicate sets) for each coating mixture until the criterion in section 11.4 is met. Calculate W_V following Equation 24–2 and record the arithmetic average.

11.2.3 Water Content. To determine water content, follow section 11.3.2.

11.2.4 Coating Density. To determine coating density, follow section 11.3.3.

11.2.5 Solids Content. To determine solids content, follow section 11.3.4.

11.2.6 Exempt Solvent Content. To determine the exempt solvent content, follow section 11.3.5.

NOTE: For all other coatings (*i.e.*, water-or solvent-borne coatings) not covered by multicomponent or UV radiation-cured coatings, analyze as shown below:

11.3 Water-or Solvent-borne coatings.

11.3.1 Volatile Content. Use the procedure in ASTM D 2369 to determine the volatile matter content (may include water) of the coating.

11.3.1.1 Record the following information:

W_1 = weight of dish and sample before heating, g

W_2 = weight of dish and sample after heating, g

W_3 = sample weight, g.

11.3.1.2 Calculate the weight fraction of the volatile matter (W_v) for each analysis as shown in section 12.3.

11.3.1.3 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.1.4 Record the arithmetic average (W_v).

11.3.2 Water Content. For waterborne coatings only, determine the weight fraction of water (W_w) using either ASTM D 3792 or ASTM D 4017.

11.3.2.1 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.2.2 Record the arithmetic average (w_w).

11.3.3 Coating Density. Determine the density (Dc, kg/l) of the surface coating using the procedure in ASTM D 1475.

11.3.3.1 Run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement in section 13.1.

11.3.3.2 Record the arithmetic average (D_c).

11.3.4 Solids Content. Determine the volume fraction (V_s) solids of the coating by calculation using the manufacturer's formulation.

11.3.5 Exempt Solvent Content. Determine the weight fraction of exempt solvents (W_E) by using ASTM Method D4457. Run a duplicate set of determinations and record the arithmetic average (W_E).

11.4 Sample Analysis Criteria. For W_v and W_w, run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement for that parameter. For D_c, run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement. If, after several attempts, it is concluded that the ASTM procedures cannot be used for the specific coating with the established intra-laboratory precision (excluding UV radiation-cured coatings), the U.S. Environmental Protection Agency (EPA) will assume responsibility for providing the necessary procedures for revising the method or precision statements upon written request to: Director, Emissions, Monitoring, and Analysis Division, MD–14, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

12.0 Calculations and Data Analysis

12.1 Nomenclature.

A = Area of substrate, cm^2, (in^2).

C = Amount of coating or ink added to the substrate, g.

D_c = Density of coating or ink, g/cm^3 (g/in^3).

F = Manufacturer's recommended film thickness, cm (in).

W_o = Weight fraction of nonaqueous volatile matter, g/g.

W_s = Weight fraction of solids, g/g.

W_v = Weight fraction of the volatile matter, g/g.

W_w = Weight fraction of the water, g/g.

12.2 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the following equation:

$$C = F\,A\,D_c \qquad \text{Eq. 24-1}$$

12.3 Calculate W_v for each analysis as shown below:

$$W_v = \frac{W_1 - W_2}{W_3} \qquad \text{Eq. 24-2}$$

12.4 Nonaqueous Volatile Matter.

12.4.1 Solvent-borne Coatings.

$$W_o = W_v \qquad \text{Eq. 24-3}$$

12.4.2 Waterborne Coatings.

$$W_o = W_v - W_w \qquad \text{Eq. 24-4}$$

12.4.3 Coatings Containing Exempt Solvents.

$$W_o = W_v - W_E - W_w \qquad \text{Eq. 24-5}$$

12.5 Weight Fraction Solids.

$$W_s = 1 - W_v \qquad \text{Eq. 24-6}$$

12.6 Confidence Limit Calculations for Waterborne Coatings. To calculate the lower confidence limit, subtract the appropriate inter-laboratory precision value from the measured mean value for that parameter. To calculate the upper confidence limit, add the appropriate inter-laboratory precision value to the measured mean value for that parameter. For W_v and D_c, use the lower confidence limits; for W_w, use the upper confidence limit. Because W_s is calculated, there is no adjustment for this parameter.

13.0 Method Performance

13.1 Analytical Precision Statements. The intra-and inter-laboratory precision statements are given in Table 24–1 in section 17.0.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as specified in section 6.0, with the addition of the following:

1. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.
2. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A.

EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

3. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 24–1—ANALYTICAL PRECISION STATEMENTS

	Intra-laboratory	Inter-laboratory
Volatile matter content, W_v	±0.015 $\overline{W}_v$	±0.047 $\overline{\overline{W}}_v$
Water content, W_w	±0.029 $\overline{W}_w$	±0.075 $\overline{W}_w$
Density, D_c	±0.001 kg/l	±0.002 kg/l

METHOD 24A—DETERMINATION OF VOLATILE MATTER CONTENT AND DENSITY OF PUBLICATION ROTOGRAVURE INKS AND RELATED PUBLICATION ROTOGRAVURE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds (VOC).	No CAS number assigned.

1.2 Applicability. This method is applicable for the determination of the VOC content and density of solvent-borne (solvent-reducible) publication rotogravure inks and related publication rotogravure coatings.

2.0 Summary of Method

2.1 Separate procedures are used to determine the VOC weight fraction and density of the ink or related coating and the density of the solvent in the ink or related coating. The VOC weight fraction is determined by measuring the weight loss of a known sample quantity which has been heated for a specified length of time at a specified temperature. The density of both the ink or related coating and solvent are measured by a standard procedure. From this information, the VOC volume fraction is calculated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Some of the compounds that may be contained in the inks or related coatings analyzed by this method may be irritating or corrosive to tissues or may be toxic. Nearly all are fire hazards. Appropriate precautions can be found in reference documents, such as Reference 6 of section 16.0.

6.0 Equipment and Supplies

The following equipment and supplies are required for sample analysis:

6.1 Weighing Dishes. Aluminum foil, 58 mm (2.3 in.) in diameter by 18 mm (0.7 in.) high, with a flat bottom. There must be at least three weighing dishes per sample.

6.2 Disposable Syringe. 5 ml.

6.3 Analytical Balance. To measure to within 0.1 mg.

6.4 Oven. Vacuum oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) and an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) for 4 hours. Alternatively, a forced draft oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) for 24 hours.

6.5 The equipment and supplies specified in ASTM D 1475–60, 80, or 90 (incorporated by reference—see § 60.17).

7.0 Reagents and Standards

7.1 The reagents and standards specified in ASTM D 1475–60, 80, or 90 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 4 of section 16.0.

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

Additional guidance can be found in Reference 5 of section 16.0.

11.1 VOC Weight Fraction. Shake or mix the ink or related coating sample thoroughly to assure that all the solids are completely suspended. Label and weigh to the nearest 0.1 mg a weighing dish and record this weight (M_{x1}). Using a 5 ml syringe, without a needle, extract an aliquot from the ink or related coating sample. Weigh the syringe and aliquot to the nearest 0.1 mg and record this weight (M_{cy1}). Transfer 1 to 3 g of the aliquot to the tared weighing dish. Reweigh the syringe and remaining aliquot to the nearest 0.1 mg and record this weight (M_{cy2}). Heat the weighing dish with the transferred aliquot in a vacuum oven at an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) and a temperature of 120 ±2 °C (248 ±4 °F) for 4 hours. Alternatively, heat the weighing dish with the transferred aliquot in a forced draft oven at a temperature of 120 ±2 °C for 24 hours. After the weighing dish has cooled, reweigh it to the nearest 0.1 mg and record the weight (M_{x2}). Repeat this procedure two times for each ink or related coating sample, for a total of three samples.

11.2 Ink or Related Coating Density. Determine the density of the ink or related coating (D_c) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the ink or related coating density as the arithmetic average (D_c) of the three determinations.

11.3 Solvent Density. Determine the density of the solvent (D_o) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the solvent density as the arithmetic average (D_o) of the three determinations.

12.0 Calculations and Data Analysis

12.1 VOC Weight Fraction. For each determination, calculate the volatile organic content weight fraction (W_o) using the following equation:

$$W_o = \frac{M_{x1} + M_{cy1} - M_{cy2} - M_{x2}}{M_{cy1} - M_{cy2}} \qquad \text{Eq. 24A-1}$$

Make a total of three determinations. Report the VOC weight fraction as the arithmetic average ($\bar{W}_o$) of the three determinations.

12.2 VOC Volume Fraction. Calculate the volume fraction volatile organic content (V_o) using the following equation:

$$V_o = \frac{\overline{W}_o \overline{D}_c}{\overline{D}_o} \qquad \text{Eq. 24A-2}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. ASTM Designation D 1475.

2. Teleconversation. Wright, Chuck, Inmont Corporation with Reich, R., A., Radian Corporation. September 25, 1979, Gravure Ink Analysis.

3. Teleconversation. Oppenheimer, Robert, Gravure Research Institute with Burt, Rick, Radian Corporation, November 5, 1979, Gravure Ink Analysis.

4. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

5. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A. EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

6. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25—DETERMINATION OF TOTAL GASEOUS NONMETHANE ORGANIC EMISSIONS AS CARBON

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total gaseous nonmethane organic compounds (TGNMO)	N/A	Dependent upon analytical equipment.

1.2 Applicability.

1.2.1 This method is applicable for the determination of volatile organic compounds (VOC) (measured as total gaseous nonmethane organics (TGNMO) and reported as carbon) in stationary source emissions. This method is not applicable for the determination of organic particulate matter.

1.2.2 This method is not the only method that applies to the measurement of VOC. Costs, logistics, and other practicalities of source testing may make other test methods more desirable for measuring VOC contents of certain effluent streams. Proper judgment is required in determining the most applicable VOC test method. For example, depending upon the molecular composition of the organics in the effluent stream, a totally automated semicontinuous nonmethane organics (NMO) analyzer interfaced directly to the source may yield accurate results. This approach has the advantage of providing emission data semicontinuously over an extended time period.

1.2.3 Direct measurement of an effluent with a flame ionization detector (FID) analyzer may be appropriate with prior characterization of the gas stream and knowledge that the detector responds predictably to the organic compounds in the stream. If present, methane (CH_4) will, of course, also be measured. The FID can be used under any of the following limited conditions: (1) Where only one compound is known to exist; (2) when the organic compounds consist of only hydrogen and carbon; (3) where the relative percentages of the compounds are known or can be determined, and the FID responses to the compounds are known; (4) where a consistent mixture of the compounds exists before and after emission control and only the relative concentrations are to be assessed; or (5) where the FID can be calibrated against mass standards of the compounds emitted (solvent emissions, for example).

1.2.4 Another example of the use of a direct FID is as a screening method. If there is enough information available to provide a rough estimate of the analyzer accuracy, the FID analyzer can be used to determine the VOC content of an uncharacterized gas stream. With a sufficient buffer to account for possible inaccuracies, the direct FID can be a useful tool to obtain the desired results without costly exact determination.

1.2.5 In situations where a qualitative/quantitative analysis of an effluent stream is desired or required, a gas chromatographic FID system may apply. However, for sources emitting numerous organics, the time and expense of this approach will be formidable.

2.0 Summary of Method

2.1 An emission sample is withdrawn from the stack at a constant rate through a heated filter and a chilled condensate trap by means of an evacuated sample tank. After sampling is completed, the TGNMO are determined by independently analyzing the condensate trap and sample tank fractions and combining the analytical results. The organic content of the condensate trap fraction is determined by oxidizing the NMO to carbon dioxide (CO_2) and quantitatively collecting in the effluent in an evacuated vessel; then a portion of the CO_2 is reduced to CH_4 and measured by an FID. The organic content of the sample tank fraction is measured by injecting a portion of the sample into a gas chromatographic column to separate the NMO from carbon monoxide (CO), CO_2, and CH_4; the NMO are oxidized to CO_2, reduced to CH_4, and measured by an FID. In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 Carbon Dioxide and Water Vapor. When carbon dioxide (CO_2) and water vapor are present together in the stack, they can produce a positive bias in the sample. The magnitude of the bias depends on the concentrations of CO_2 and water vapor. As a guideline, multiply the CO_2 concentration, expressed as volume percent, times the water vapor concentration. If this product does not exceed 100, the bias can be considered insignificant. For example, the bias is not significant for a source having 10 percent CO_2 and 10 percent water vapor, but it might be significant for a source having 10 percent CO_2 and 20 percent water vapor.

4.2. Particulate Matter. Collection of organic particulate matter in the condensate trap would produce a positive bias. A filter is included in the sampling equipment to minimize this bias.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

6.1 Sample Collection. The sampling system consists of a heated probe, heated filter, condensate trap, flow control system, and sample tank (see Figure 25–1). The TGNMO sampling equipment can be constructed from commercially available components and components fabricated in a machine shop. The following equipment is required:

6.1.1 Heated Probe. 6.4-mm (¼-in.) OD stainless steel tubing with a heating system capable of maintaining a gas temperature at the exit end of at least 129 °C (265 °F). The probe shall be equipped with a temperature sensor at the exit end to monitor the gas temperature. A suitable probe is shown in Figure 25–1. The nozzle is an elbow fitting attached to the front end of the probe while the temperature sensor is inserted in the side arm of a tee fitting attached to the rear of the probe. The probe is wrapped with a suitable length of high temperature heating tape, and then covered with two layers of glass cloth insulation and one layer of aluminum foil or an equivalent wrapping.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.2 Filter Holder. 25-mm (¹⁵⁄₁₆-in.) ID Gelman filter holder with 303 stainless steel body and 316 stainless steel support screen with the Viton O-ring replaced by a Teflon O-ring.

6.1.3 Filter Heating System.

6.1.3.1 A metal box consisting of an inner and an outer shell separated by insulating material with a heating element in the inner shell capable of maintaining a gas temperature at the filter of 121 ±3 °C (250 ±5 °F). The heating box shall include temperature sensors to monitor the gas temperature immediately upstream and immediately downstream of the filter.

6.1.3.2 A suitable heating box is shown in Figure 25–2. The outer shell is a metal box that measures 102 mm × 280 mm × 292 mm (4 in. × 11 in. × 11½ in.), while the inner shell is a metal box measuring 76 mm × 229 mm × 241 mm (3 in. × 9 in. × 9½ in.). The inner box is supported by 13-mm (½-in.) phenolic rods. The void space between the boxes is filled with ceramic fiber insulation which is sealed in place by means of a silicon rubber bead around the upper sides of the box. A removable lid made in a similar manner, with a 25-mm (1-in.) gap between the parts is used to cover the heating chamber. The inner box is heated with a 250-watt cartridge heater, shielded by a stainless steel shroud. The heater is regulated by a thermostatic temperature controller which is set to maintain a gas temperature of 121 °C (250 °F) as measured by the temperature sensor upstream of the filter.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.4 Condensate Trap. 9.5-mm (⅜-in.) OD 316 stainless steel tubing bent into a U-shape. Exact dimensions are shown in Figure

25–3. The tubing shall be packed with coarse quartz wool, to a density of approximately 0.11 g/cm^3 before bending. While the condensate trap is packed with dry ice in the Dewar, an ice bridge may form between the arms of the condensate trap making it difficult to remove the condensate trap. This problem can be prevented by attaching a steel plate between the arms of the condensate trap in the same plane as the arms to completely fill the intervening space.

6.1.5 Valve. Stainless steel control valve for starting and stopping sample flow.

6.1.6 Metering Valve. Stainless steel valve for regulating the sample flow rate through the sample train.

6.1.7 Rate Meter. Rotameter, or equivalent, capable of measuring sample flow in the range of 60 to 100 cm^3/min (0.13 to 0.21 ft^3/hr).

6.1.8 Sample Tank. Stainless steel or aluminum tank with a minimum volume of 4 liters (0.14 ft^3).

NOTE: Sample volumes greater than 4 liters may be required for sources with low organic concentrations.

6.1.9 Mercury Manometer. U-tube manometer or absolute pressure gauge capable of measuring pressure to within 1 mm Hg in the range of 0 to 900 mm.

6.1.10 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

6.2 Condensate Recovery. The system for the recovery of the organics captured in the condensate trap consists of a heat source, an oxidation catalyst, a nondispersive infrared (NDIR) analyzer, and an intermediate collection vessel (ICV). Figure 25–4 is a schematic of a typical system. The system shall be capable of proper oxidation and recovery, as specified in section 10.1.1. The following major components are required:

6.2.1 Heat Source. Sufficient to heat the condensate trap (including probe) to a temperature of 200 °C (390 °F). A system using both a heat gun and an electric tube furnace is recommended.

6.2.2 Heat Tape. Sufficient to heat the connecting tubing between the water trap and the oxidation catalyst to 100 °C (212 °F).

6.2.3 Oxidation Catalyst. A suitable length of 9.5 mm (⅜-in.) OD Inconel 600 tubing packed with 15 cm (6 in.) of 3.2 mm (⅜-in.) diameter 19 percent chromia on alumina pellets. The catalyst material is packed in the center of the catalyst tube with quartz wool packed on either end to hold it in place.

6.2.4 Water Trap. Leak-proof, capable of removing moisture from the gas stream.

6.2.5 Syringe Port. A 6.4-mm (¼-in.) OD stainless steel tee fitting with a rubber septum placed in the side arm.

6.2.6 NDIR Detector. Capable of indicating CO_2 concentration in the range of zero to 5 percent, to monitor the progress of combustion of the organic compounds from the condensate trap.

6.2.7 Flow-Control Valve. Stainless steel, to maintain the trap conditioning system near atmospheric pressure.

6.2.8 Intermediate Collection Vessel. Stainless steel or aluminum, equipped with a female quick connect. Tanks with nominal volumes of at least 6 liters (0.2 ft^3) are recommended.

6.2.9 Mercury Manometer. Same as described in section 6.1.9.

6.2.10 Syringe. 10-ml gas-tight glass syringe equipped with an appropriate needle.

6.2.11 Syringes. 10-μl and 50-μl liquid injection syringes.

6.2.12 Liquid Sample Injection Unit. 316 Stainless steel U-tube fitted with an injection septum (see Figure 25–7).

6.3 Analysis.

6.3.1 NMO Analyzer. The NMO analyzer is a gas chromatograph (GC) with backflush capability for NMO analysis and is equipped with an oxidation catalyst, reduction catalyst, and FID. Figures 25–5 and 25–6 are schematics of a typical NMO analyzer. This semicontinuous GC/FID analyzer shall be capable of: (1) Separating CO, CO_2, and CH_4 from NMO, (2) reducing the CO_2 to CH_4 and quantifying as CH_4, and (3) oxidizing the NMO to CO_2, reducing the CO_2 to CH_4 and quantifying as CH_4, according to section 10.1.2. The analyzer consists of the following major components:

6.3.1.1 Oxidation Catalyst. A suitable length of 9.5-mm (⅜-in.) OD Inconel 600 tubing packed with 5.1 cm (2 in.) of 19 percent chromia on 3.2-mm (⅛-in.) alumina pellets. The catalyst material is packed in the center of the tube supported on either side by quartz wool. The catalyst tube must be mounted vertically in a 650 °C (1200 °F) furnace. Longer catalysts mounted horizontally may be used, provided they can meet the specifications of section 10.1.2.1.

6.3.1.2 Reduction Catalyst. A 7.6-cm (3-in.) length of 6.4-mm (¼-in.) OD Inconel tubing fully packed with 100-mesh pure nickel powder. The catalyst tube must be mounted vertically in a 400 °C (750 °F) furnace.

6.3.1.3 Separation Column(s). A 30-cm (1-ft) length of 3.2-mm (⅛-in.) OD stainless steel tubing packed with 60/80 mesh Unibeads 1S followed by a 61-cm (2-ft) length of 3.2-mm (⅛-in.) OD stainless steel tubing packed with 60/80 mesh Carbosieve G. The Carbosieve and Unibeads columns must be baked separately at 200 °C (390 °F) with carrier gas flowing through them for 24 hours before initial use.

6.3.1.4 Sample Injection System. A single 10-port GC sample injection valve or a group of valves with sufficient ports fitted with a sample loop properly sized to interface with the NMO analyzer (1-cc loop recommended).

6.3.1.5 FID. An FID meeting the following specifications is required:

6.3.1.5.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.2.3.

6.3.1.5.2 Range. A full scale range of 10 to 50,000 ppm CH_4. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.3.1.6 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the analytical results.

6.3.2 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 1 mm Hg.

6.3.3 Temperature Sensor. Capable of measuring the laboratory temperature within 1 °C (2 °F).

6.3.4 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

7.0 Reagents and Standards

7.1 Sample Collection. The following reagents are required for sample collection:

7.1.1 Dry Ice. Solid CO2, crushed.

7.1.2 Coarse Quartz Wool. 8 to 15 um.

7.1.3 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Method D2986–71, 78, or 95a (incorporated by reference—see § 60.17). Test data from the supplier's quality control program are sufficient for this purpose.

7.2 NMO Analysis. The following gases are required for NMO analysis:

7.2.1 Carrier Gases. Helium (He) and oxygen (O_2) containing less than 1 ppm CO_2 and less than 0.1 ppm hydrocarbon.

7.2.2 Fuel Gas. Hydrogen (H_2), at least 99.999 percent pure.

7.2.3 Combustion Gas. Either air (less than 0.1 ppm total hydrocarbon content) or O_2 (purity 99.99 percent or greater), as required by the detector.

7.3 Condensate Analysis. The following are required for condensate analysis:

7.3.1 Gases. Containing less than 1 ppm carbon.

7.3.1.1 Air.

7.3.1.2 Oxygen.

7.3.2 Liquids. To conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society.

7.3.2.1 Hexane.

7.3.2.2 Decane.

7.4 Calibration. For all calibration gases, the manufacturer must recommend a maximum shelf life for each cylinder (i.e., the length of time the gas concentration is not expected to change more than ±5 percent from its certified value). The date of gas cylinder preparation, certified organic concentration, and recommended maximum shelf life must be affixed to each cylinder before shipment from the gas manufacturer to the buyer. The following calibration gases are required:

7.4.1 Oxidation Catalyst Efficiency Check Calibration Gas. Gas mixture standard with nominal concentration of 1 percent methane in air.

7.4.2 FID Linearity and NMO Calibration Gases. Three gas mixture standards with nominal propane concentrations of 20 ppm, 200 ppm, and 3000 ppm, in air.

7.4.3 CO_2 Calibration Gases. Three gas mixture standards with nominal CO_2 concentrations of 50 ppm, 500 ppm, and 1 percent, in air.

NOTE: Total NMO less than 1 ppm required for 1 percent mixture.

7.4.4 NMO Analyzer System Check Calibration Gases. Four calibration gases are needed as follows:

7.4.4.1 Propane Mixture. Gas mixture standard containing (nominal) 50 ppm CO, 50 ppm CH_4, 1 percent CO_2, and 20 ppm C_3H_8, prepared in air.

7.4.4.2 Hexane. Gas mixture standard containing (nominal) 50 ppm hexane in air.

7.4.4.3 Toluene. Gas mixture standard containing (nominal) 20 ppm toluene in air.

7.4.4.4 Methanol. Gas mixture standard containing (nominal) 100 ppm methanol in air.

8.0 Sample Collection, Preservation, Transport, and Storage

8.1 Sampling Equipment Preparation.

8.1.1 Condensate Trap Cleaning. Before its initial use and after each use, a condensate trap should be thoroughly cleaned and checked to ensure that it is not contaminated. Both cleaning and checking can be accomplished by installing the trap in the condensate recovery system and treating it as if it were a sample. The trap should be heated as described in section 11.1.3. A trap may be considered clean when the CO_2 concentration in its effluent gas drops below 10 ppm. This check is optional for traps that most recently have been used to collect samples which were then recovered according to the procedure in section 11.1.3.

8.1.2 Sample Tank Evacuation and Leak-Check. Evacuate the sample tank to 10 mm Hg absolute pressure or less. Then close the sample tank valve, and allow the tank to sit for 60 minutes. The tank is acceptable if a change in tank vacuum of less than 1 mm Hg is noted. The evacuation and leak-check may be conducted either in the laboratory or the field.

8.1.3 Sampling Train Assembly. Just before assembly, measure the tank vacuum using a mercury manometer. Record this vacuum, the ambient temperature, and the barometric pressure at this time. Close the sample tank valve and assemble the sampling

system as shown in Figure 25–1. Immerse the condensate trap body in dry ice at least 30 minutes before commencing sampling to improve collection efficiency. The point where the inlet tube joins the trap body should be 2.5 to 5 cm (1 to 2 in.) above the top of the dry ice.

8.1.4 Pretest Leak-Check. A pretest leak-check is required. Calculate or measure the approximate volume of the sampling train from the probe tip to the sample tank valve. After assembling the sampling train, plug the probe tip, and make certain that the sample tank valve is closed. Turn on the vacuum pump, and evacuate the sampling system from the probe tip to the sample tank valve to an absolute pressure of 10 mm Hg or less. Close the purge valve, turn off the pump, wait a minimum period of 10 minutes, and recheck the indicated vacuum. Calculate the maximum allowable pressure change based on a leak rate of 1 percent of the sampling rate using Equation 25–1, section 12.2. If the measured pressure change exceeds the allowable, correct the problem and repeat the leak-check before beginning sampling.

8.2 Sample Collection.

8.2.1 Unplug the probe tip, and place the probe into the stack such that the probe is perpendicular to the duct or stack axis; locate the probe tip at a single preselected point of average velocity facing away from the direction of gas flow. For stacks having a negative static pressure, seal the sample port sufficiently to prevent air in-leakage around the probe. Set the probe temperature controller to 129 °C (265 °F) and the filter temperature controller to 121 °C (250 °F). Allow the probe and filter to heat for about 30 minutes before purging the sample train.

8.2.2 Close the sample valve, open the purge valve, and start the vacuum pump. Set the flow rate between 60 and 100 cm^3/min (0.13 and 0.21 ft^3/hr), and purge the train with stack gas for at least 10 minutes.

8.2.3 When the temperatures at the exit ends of the probe and filter are within the corresponding specified ranges, check the dry ice level around the condensate trap, and add dry ice if necessary. Record the clock time. To begin sampling, close the purge valve and stop the pump. Open the sample valve and the sample tank valve. Using the flow control valve, set the flow through the sample train to the proper rate. Adjust the flow rate as necessary to maintain a constant rate (±10 percent) throughout the duration of the sampling period. Record the sample tank vacuum and flowmeter setting at 5-minute intervals. (See Figure 25–8.) Select a total sample time greater than or equal to the minimum sampling time specified in the applicable subpart of the regulations; end the sampling when this time period is reached or when a constant flow rate can no longer be maintained because of reduced sample tank vacuum.

NOTE: If sampling had to be stopped before obtaining the minimum sampling time (specified in the applicable subpart) because a constant flow rate could not be maintained, proceed as follows: After closing the sample tank valve, remove the used sample tank from the sampling train (without disconnecting other portions of the sampling train). Take another evacuated and leak-checked sample tank, measure and record the tank vacuum, and attach the new tank to the sampling train. After the new tank is attached to the sample train, proceed with the sampling until the required minimum sampling time has been exceeded.

8.3 Sample Recovery. After sampling is completed, close the flow control valve, and record the final tank vacuum; then record the tank temperature and barometric pressure. Close the sample tank valve, and disconnect the sample tank from the sample system. Disconnect the condensate trap at the inlet to the rate meter, and tightly seal both ends of the condensate trap. Do not include the probe from the stack to the filter as part of the condensate sample.

8.4 Sample Storage and Transport. Keep the trap packed in dry ice until the samples are returned to the laboratory for analysis. Ensure that run numbers are identified on the condensate trap and the sample tank(s).

9.0 Quality Control

Section	Quality control measure	Effect
10.1.1	Initial performance check of condensate recovery apparatus.	Ensure acceptable condensate recovery efficiency.
10.1.2, 10.2	NMO analyzer initial and daily performance checks.	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial Performance Checks.

10.1.1 Condensate Recovery Apparatus. Perform these tests before the system is first placed in operation, after any shutdown of 6 months or more, and after any major modification of the system, or at the frequency recommended by the manufacturer.

10.1.1.1 Carrier Gas and Auxiliary O_2 Blank Check. Analyze each new tank of carrier gas or auxiliary O_2 with the NMO analyzer to

check for contamination. Treat the gas cylinders as noncondensible gas samples, and analyze according to the procedure in section 11.2.3. Add together any measured CH_4, CO, CO_2, or NMO. The total concentration must be less than 5 ppm.

10.1.1.2 Oxidation Catalyst Efficiency Check.

10.1.1.2.1 With a clean condensate trap installed in the recovery system or a ⅛″ stainless steel connector tube, replace the carrier gas cylinder with the high level methane standard gas cylinder (Section 7.4.1). Set the four-port valve to the recovery position, and attach an ICV to the recovery system. With the sample recovery valve in vent position and the flow-control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

10.1.1.2.2 After the NDIR response has stabilized, switch the sample recovery valve from vent to collect. When the manometer or pressure gauge begins to register a slight positive pressure, open the flow-control valve. Keep the flow adjusted such that the pressure in the system is maintained within 10 percent of atmospheric pressure. Continue collecting the sample in a normal manner until the ICV is filled to a nominal gauge pressure of 300 mm Hg. Close the ICV valve, and remove the ICV from the system. Place the sample recovery valve in the vent position, and return the recovery system to its normal carrier gas and normal operating conditions. Analyze the ICV for CO_2 using the NMO analyzer; the catalyst efficiency is acceptable if the CO_2 concentration is within 2 percent of the methane standard concentration.

10.1.1.3 System Performance Check. Construct a liquid sample injection unit similar in design to the unit shown in Figure 25–7. Insert this unit into the condensate recovery and conditioning system in place of a condensate trap, and set the carrier gas and auxiliary O_2 flow rates to normal operating levels. Attach an evacuated ICV to the system, and switch from system vent to collect. With the carrier gas routed through the injection unit and the oxidation catalyst, inject a liquid sample (see sections 10.1.1.3.1 to 10.1.1.3.4) into the injection port. Operate the trap recovery system as described in section 11.1.3. Measure the final ICV pressure, and then analyze the vessel to determine the CO_2 concentration. For each injection, calculate the percent recovery according to section 12.7. Calculate the relative standard deviation for each set of triplicate injections according to section 12.8. The performance test is acceptable if the average percent recovery is 100 ±5 percent and the relative standard deviation is less than 2 percent for each set of triplicate injections.

10.1.1.3.1 50 µl hexane.

10.1.1.3.2 10 µl hexane.

10.1.1.3.3 50 µl decane.

10.1.1.3.4 10 µl decane.

10.1.2 NMO Analyzer. Perform these tests before the system is first placed in operation, after any shutdown longer than 6 months, and after any major modification of the system.

10.1.2.1 Oxidation Catalyst Efficiency Check. Turn off or bypass the NMO analyzer reduction catalyst. Make triplicate injections of the high level methane standard (Section 7.4.1). The oxidation catalyst operation is acceptable if the FID response is less than 1 percent of the injected methane concentration.

10.1.2.2 Reduction Catalyst Efficiency Check. With the oxidation catalyst unheated or bypassed and the heated reduction catalyst bypassed, make triplicate injections of the high level methane standard (Section 7.4.1). Repeat this procedure with both catalysts operative. The reduction catalyst operation is acceptable if the responses under both conditions agree within 5 percent of their average.

10.1.2.3 NMO Analyzer Linearity Check Calibration. While operating both the oxidation and reduction catalysts, conduct a linearity check of the analyzer using the propane standards specified in section 7.4.2. Make triplicate injections of each calibration gas. For each gas (*i.e.*, each set of triplicate injections), calculate the average response factor (area/ppm C) for each gas, as well as and the relative standard deviation (according to section 12.8). Then calculate the overall mean of the response factor values. The instrument linearity is acceptable if the average response factor of each calibration gas is within 2.5 percent of the overall mean value and if the relative standard deviation gas is less than 2 percent of the overall mean value. Record the overall mean of the propane response factor values as the NMO calibration response factor (RF_{NMO}). Repeat the linearity check using the CO_2 standards specified in section 7.4.3. Make triplicate injections of each gas, and then calculate the average response factor (area/ppm C) for each gas, as well as the overall mean of the response factor values. Record the overall mean of the response factor values as the CO_2 calibration response factor (RF_{CO2}). The RF_{CO2} must be within 10 percent of the RF_{NMO}.

10.1.2.4 System Performance Check. Check the column separation and overall performance of the analyzer by making triplicate injections of the calibration gases listed in section 7.4.4. The analyzer performance is acceptable if the measured NMO value for each gas (average of triplicate injections) is within 5 percent of the expected value.

10.2 NMO Analyzer Daily Calibration. The following calibration procedures shall be performed before and immediately after the

analysis of each set of samples, or on a daily basis, whichever is more stringent:

10.2.1 CO_2 Response Factor. Inject triplicate samples of the high level CO_2 calibration gas (Section 7.4.3), and calculate the average response factor. The system operation is adequate if the calculated response factor is within 5 percent of the RF_{CO2} calculated during the initial performance test (Section 10.1.2.3). Use the daily response factor (DRF_{CO2}) for analyzer calibration and the calculation of measured CO_2 concentrations in the ICV samples.

10.2.2 NMO Response Factors. Inject triplicate samples of the mixed propane calibration cylinder gas (Section 7.4.4.1), and calculate the average NMO response factor. The system operation is adequate if the calculated response factor is within 10 percent of the RF_{NMO} calculated during the initial performance test (Section 10.1.2.4). Use the daily response factor (DRF_{NMO}) for analyzer calibration and calculation of NMO concentrations in the sample tanks.

10.3 Sample Tank and ICV Volume. The volume of the gas sampling tanks used must be determined. Determine the tank and ICV volumes by weighing them empty and then filled with deionized distilled water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedure

11.1 Condensate Recovery. See Figure 25–9. Set the carrier gas flow rate, and heat the catalyst to its operating temperature to condition the apparatus.

11.1.1 Daily Performance Checks. Each day before analyzing any samples, perform the following tests:

11.1.1.1 Leak-Check. With the carrier gas inlets and the sample recovery valve closed, install a clean condensate trap in the system, and evacuate the system to 10 mm Hg absolute pressure or less. Monitor the system pressure for 10 minutes. The system is acceptable if the pressure change is less than 2 mm Hg.

11.1.1.2 System Background Test. Adjust the carrier gas and auxiliary oxygen flow rate to their normal values of 100 cc/min and 150 cc/min, respectively, with the sample recovery valve in vent position. Using a 10-ml syringe, withdraw a sample from the system effluent through the syringe port. Inject this sample into the NMO analyzer, and measure the CO_2 content. The system background is acceptable if the CO_2 concentration is less than 10 ppm.

11.1.1.3 Oxidation Catalyst Efficiency Check. Conduct a catalyst efficiency test as specified in section 10.1.1.2. If the criterion of this test cannot be met, make the necessary repairs to the system before proceeding.

11.1.2 Condensate Trap CO_2 Purge and Sample Tank Pressurization.

11.1.2.1 After sampling is completed, the condensate trap will contain condensed water and organics and a small volume of sampled gas. This gas from the stack may contain a significant amount of CO_2 which must be removed from the condensate trap before the sample is recovered. This is accomplished by purging the condensate trap with zero air and collecting the purged gas in the original sample tank.

11.1.2.2 Begin with the sample tank and condensate trap from the test run to be analyzed. Set the four-port valve of the condensate recovery system in the CO_2 purge position as shown in Figure 25–9. With the sample tank valve closed, attach the sample tank to the sample recovery system. With the sample recovery valve in the vent position and the flow control valve fully open, evacuate the manometer or pressure gauge to the vacuum of the sample tank. Next, close the vacuum pump valve, open the sample tank valve, and record the tank pressure.

11.1.2.3 Attach the dry ice-cooled condensate trap to the recovery system, and initiate the purge by switching the sample recovery valve from vent to collect position. Adjust the flow control valve to maintain atmospheric pressure in the recovery system. Continue the purge until the CO_2 concentration of the trap effluent is less than 5 ppm. CO_2 concentration in the trap effluent should be measured by extracting syringe samples from the recovery system and analyzing the samples with the NMO analyzer. This procedure should be used only after the NDIR response has reached a minimum level. Using a 10-ml syringe, extract a sample from the syringe port prior to the NDIR, and inject this sample into the NMO analyzer.

11.1.2.4 After the completion of the CO_2 purge, use the carrier gas bypass valve to pressurize the sample tank to approximately 1,060 mm Hg absolute pressure with zero air.

11.1.3 Recovery of the Condensate Trap Sample (See Figure 25–10).

11.1.3.1 Attach the ICV to the sample recovery system. With the sample recovery valve in a closed position, between vent and collect, and the flow control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

11.1.3.2 Begin auxiliary oxygen flow to the oxidation catalyst at a rate of 150 cc/min, then switch the four-way valve to the trap recovery position and the sample recovery valve to collect position. The system should now be set up to operate as indicated in Figure 25–10. After the manometer or pressure gauge begins to register a slight positive pressure, open the flow control valve. Adjust the flow-control valve to maintain atmospheric pressure in the system within 10 percent.

11.1.3.3 Remove the condensate trap from the dry ice, and allow it to warm to ambient temperature while monitoring the NDIR response. If, after 5 minutes, the CO_2 concentration of the catalyst effluent is below 10,000 ppm, discontinue the auxiliary oxygen flow to the oxidation catalyst. Begin heating the trap by placing it in a furnace preheated to 200 °C (390 °F). Once heating has begun, carefully monitor the NDIR response to ensure that the catalyst effluent concentration does not exceed 50,000 ppm. Whenever the CO_2 concentration exceeds 50,000 ppm, supply auxiliary oxygen to the catalyst at the rate of 150 cc/min. Begin heating the tubing that connected the heated sample box to the condensate trap only after the CO_2 concentration falls below 10,000 ppm. This tubing may be heated in the same oven as the condensate trap or with an auxiliary heat source such as a heat gun. Heating temperature must not exceed 200 °C (390 °F). If a heat gun is used, heat the tubing slowly along its entire length from the upstream end to the downstream end, and repeat the pattern for a total of three times. Continue the recovery until the CO_2 concentration drops to less than 10 ppm as determined by syringe injection as described under the condensate trap CO_2 purge procedure (Section 11.1.2).

11.1.3.4 After the sample recovery is completed, use the carrier gas bypass valve to pressurize the ICV to approximately 1060 mm Hg absolute pressure with zero air.

11.2 Analysis. Once the initial performance test of the NMO analyzer has been successfully completed (see section 10.1.2) and the daily CO_2 and NMO response factors have been determined (see section 10.2), proceed with sample analysis as follows:

11.2.1 Operating Conditions. The carrier gas flow rate is 29.5 cc/min He and 2.2 cc/min O_2. The column oven is heated to 85 °C (185 °F). The order of elution for the sample from the column is CO, CH_4, CO_2, and NMO.

11.2.2 Analysis of Recovered Condensate Sample. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (380 °F) as rapidly as possible. A rate of 30 °C/min (90 °F) has been shown to be adequate. Record the value obtained for the condensible organic material (C_{cm}) measured as CO_2 and any measured NMO. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average C_{cm}.

11.2.3 Analysis of Sample Tank. Perform the analysis as described in section 11.2.2, but record only the value measured for NMO (C_{tm}).

12.0 Data Analysis and Calculations

Carry out the calculations, retaining at least one extra significant figure beyond that of the acquired data. Round off figures after final calculations. All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature.

C = TGNMO concentration of the effluent, ppm C equivalent.

C_c = Calculated condensible organic (condensate trap) concentration of the effluent, ppm C equivalent.

C_{cm} = Measured concentration (NMO analyzer) for the condensate trap ICV, ppm CO_2.

C_t = Calculated noncondensible organic concentration (sample tank) of the effluent, ppm C equivalent.

C_{tm} = Measured concentration (NMO analyzer) for the sample tank, ppm NMO.

F = Sampling flow rate, cc/min.

L = Volume of liquid injected, μl.

M = Molecular weight of the liquid injected, g/g-mole.

M_c = TGNMO mass concentration of the effluent, mg C/dsm^3.

N = Carbon number of the liquid compound injected (N = 12 for decane, N = 6 for hexane).

n = Number of data points.

P_f = Final pressure of the intermediate collection vessel, mm Hg absolute.

P_b = Barometric pressure, cm Hg.

P_{ti} = Gas sample tank pressure before sampling, mm Hg absolute.

P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.

q = Total number of analyzer injections of intermediate collection vessel during analysis (where k = injection number, 1 * * * q).

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 * * * r).

r = Density of liquid injected, g/cc.

T_f = Final temperature of intermediate collection vessel, °K.

T_{ti} = Sample tank temperature before sampling, °K.

T_t = Sample tank temperature at completion of sampling, °K.

T_{tf} = Sample tank temperature after pressurizing, °K.

V = Sample tank volume, m^3.

V_t = Sample train volume, cc.

V_v = Intermediate collection vessel volume, m^3.

V_s = Gas volume sampled, dsm^3.

x_i = Individual measurements.

$\bar{x}$ = Mean value.

ΔP = Allowable pressure change, cm Hg.
Θ = Leak-check period, min.

12.2 Allowable Pressure Change. For the pretest leak-check, calculate the allowable pressure change using Equation 25–1:

$$\Delta P = 0.01 \frac{F P_b \Theta}{V_t} \qquad \text{Eq. 25-1}$$

12.3 Sample Volume. For each test run, calculate the gas volume sampled using Equation 25–2:

$$V_s = 0.3857\, V \left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}} \right) \qquad \text{Eq. 25-2}$$

12.4 Noncondensible Organics. For each sample tank, determine the concentration of nonmethane organics (ppm C) using Equation 25–3:

$$C_t = \left(\frac{\dfrac{P_{tf}}{T_{tf}}}{\dfrac{P_t}{T_t} - \dfrac{P_{ti}}{T_{ti}}} \right) \left(\frac{1}{r} \sum_{j=1}^{r} C_{tm_j} \right) \qquad \text{Eq. 25-3}$$

12.5 Condensible Organics. For each condensate trap determine the concentration of organics (ppm C) using Equation 25–4:

$$C_c = 0.3857 \frac{V_v P_f}{V_s T_f} \left(\frac{1}{q} \sum_{k=1}^{q} C_{cm_k} \right) \qquad \text{Eq. 25-4}$$

12.6 TGNMO Mass Concentration. Determine the TGNMO mass concentration as carbon for each test run, using Equation 25–5:

$$M_c = 0.4993 \left(C_t + C_c \right) \qquad \text{Eq. 25-5}$$

12.7 Percent Recovery. Calculate the percent recovery for the liquid injections to the condensate recovery and conditioning system using Equation 25–6:

$$\text{Percent Recovery} = K \frac{M\, V_v P_t C_{cm}}{L\, P\, T_f N} \qquad \text{Eq. 25-6}$$

where K = 1.604 (°K)(g-mole)(%)/(mm Hg)(ml)(m^3)(ppm).

12.8 Relative Standard Deviation. Use Equation 25–7 to calculate the relative standard deviation (RSD) of percent recovery and analyzer linearity.

$$RSD = \frac{100}{\bar{x}} \left[\frac{\sum_{i=1}^{n} \left(x_i - \bar{x} \right)^2}{n-1} \right]^{\frac{1}{2}} \qquad \text{Eq. 25-7}$$

13.0 Method Performance

13.1 Range. The minimum detectable limit of the method has been determined to be 50 parts per million by volume (ppm). No upper limit has been established.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, A.E., S. Witz, and R.D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, MA. June 15–20, 1975.) 14 p.

2. Salo, A.E., W.L. Oaks, and R.D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, CO. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

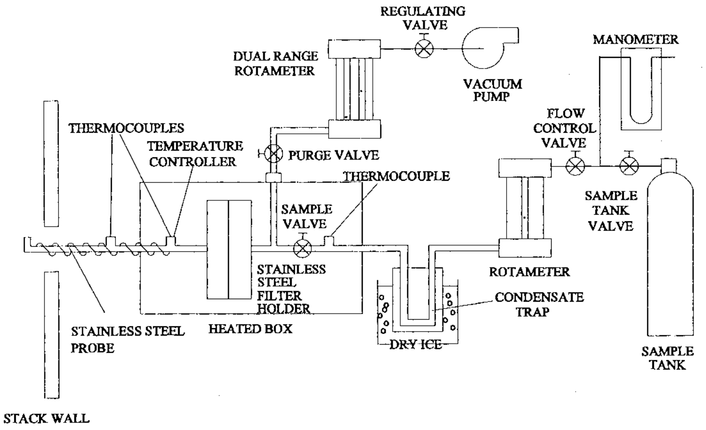


Figure 25-1. Sampling Train

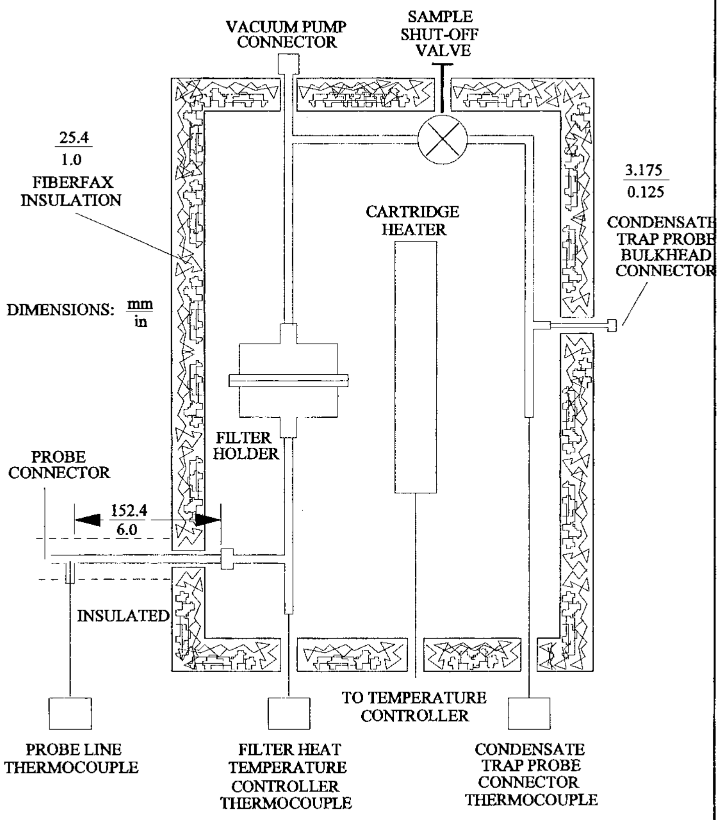


Figure 25-2. Out-of-stack Filter Box

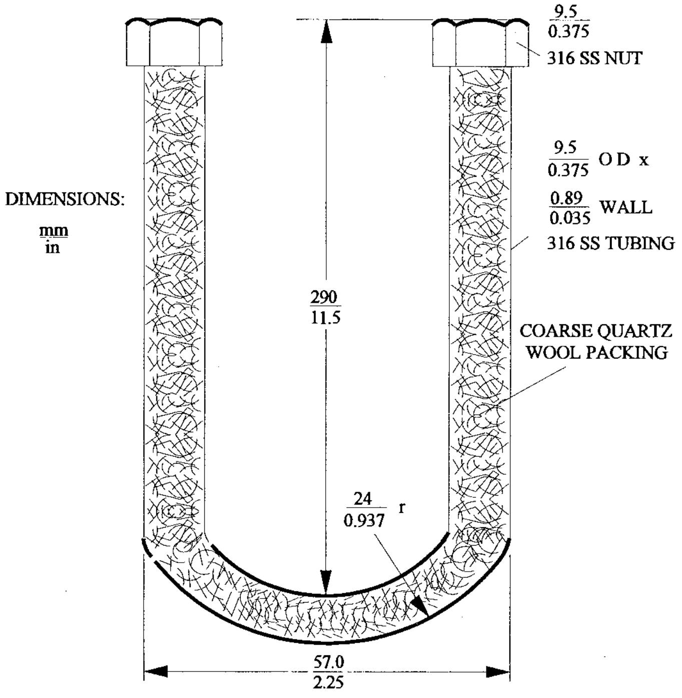


Figure 25-3. Condensate Trap

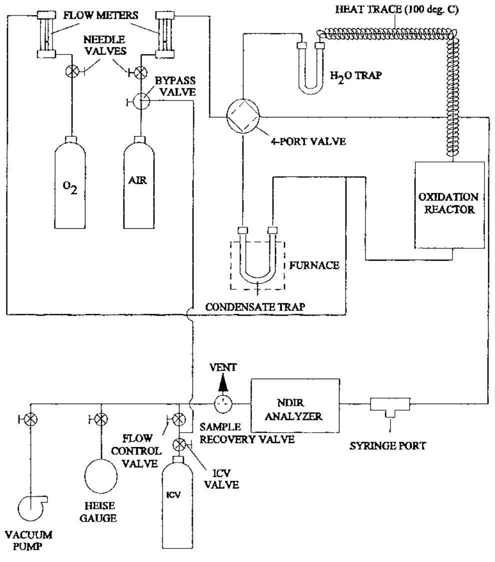


Figure 25-4. Condensate Recovery System

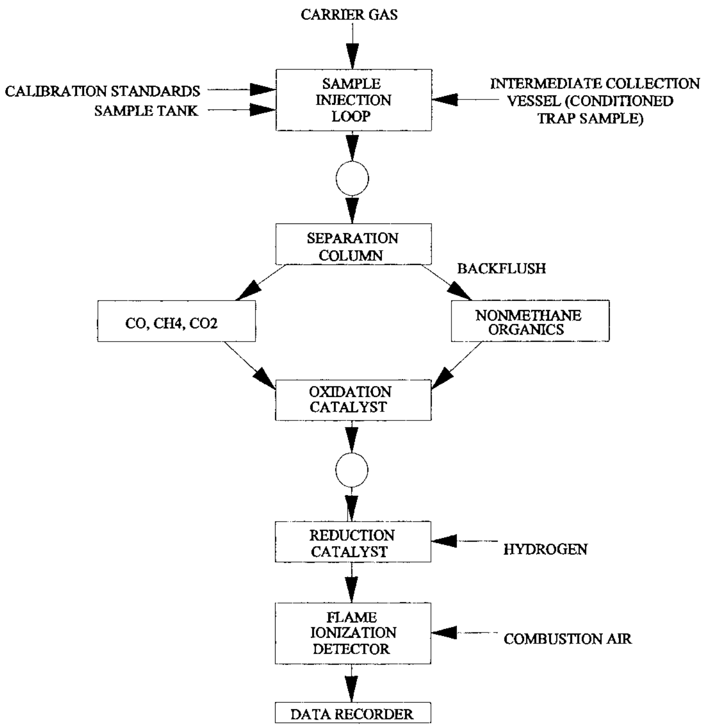


Figure 25-5. Simplified Schematic of Nonmethane Organic (NMO) Analyzer

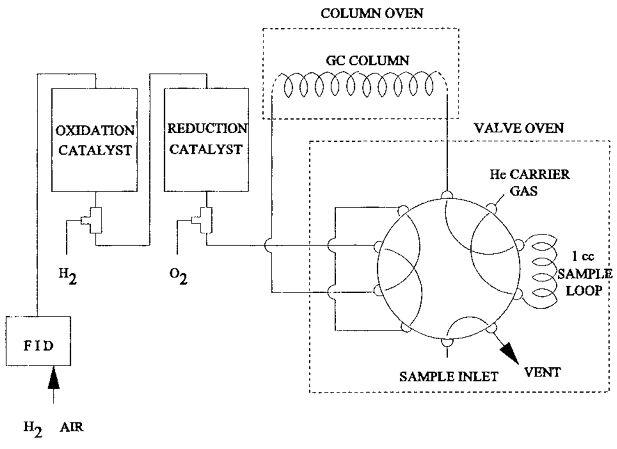


Figure 25-6. Nonmethane Organic Analyzer (NMO)

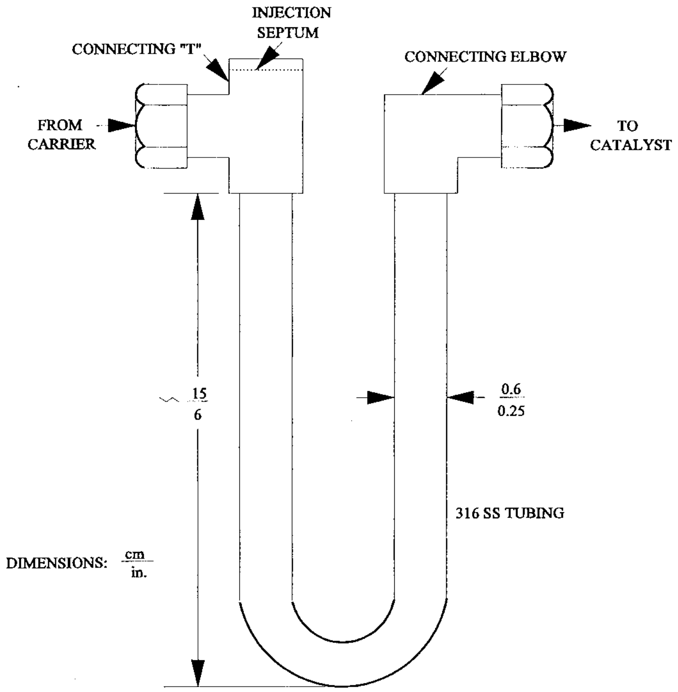
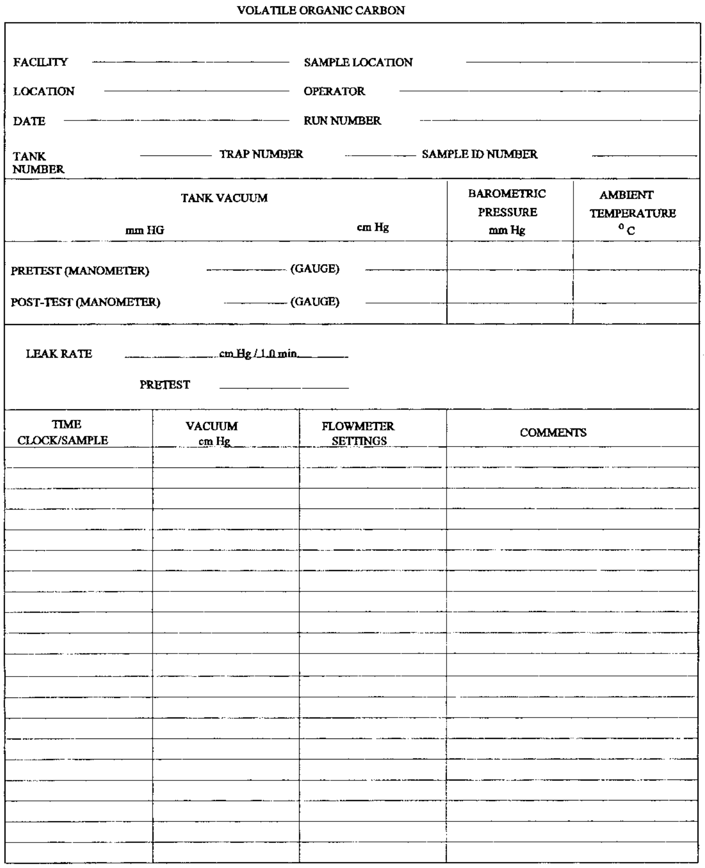


Figure 25-7. Liquid Sample Injection Unit



VOLATILE ORGANIC CARBON

FACILITY ______ SAMPLE LOCATION ______

LOCATION ______ OPERATOR ______

DATE ______ RUN NUMBER ______

TANK NUMBER ______ TRAP NUMBER ______ SAMPLE ID NUMBER ______

TANK VACUUM				BAROMETRIC PRESSURE mm Hg	AMBIENT TEMPERATURE °C
	mm HG		cm Hg		
PRETEST (MANOMETER)		(GAUGE)			
POST-TEST (MANOMETER)		(GAUGE)			

LEAK RATE ______ cm Hg / 1.0 min ______

PRETEST ______

TIME CLOCK/SAMPLE	VACUUM cm Hg	FLOWMETER SETTINGS	COMMENTS

Figure 25-8. Example Field Data Form

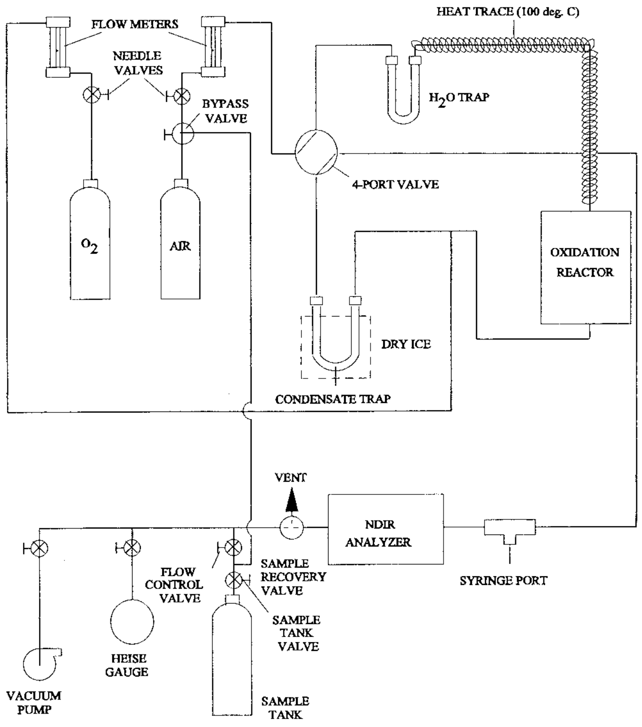


Figure 25-9. Condensate Recovery System, CO2 Purge

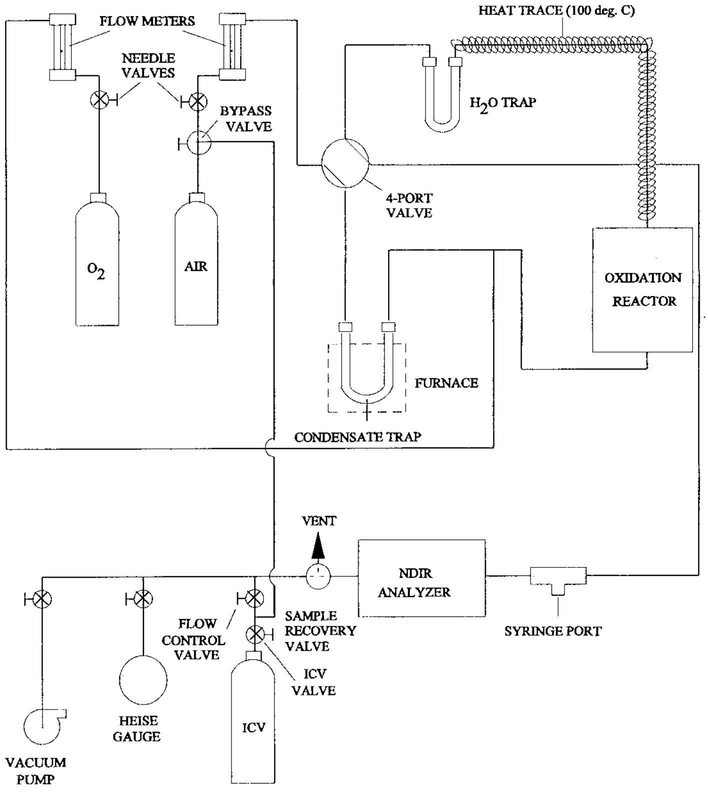


Figure 25-10. Condensate Recovery System, Collection of Trap Organics

METHOD 25A—DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A FLAME IONIZATION ANALYZER

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A gas sample is extracted from the source through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

3.1 *Calibration drift* means the difference in the measurement system response to a midlevel calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

3.2 *Calibration error* means the difference between the gas concentration indicated by the measurement system and the know concentration of the calibration gas.

3.3 *Calibration gas* means a known concentration of a gas in an appropriate diluent gas.

3.4 *Measurement system* means the total equipment required for the determination of the gas concentration. The system consists of the following major subsystems:

3.4.1 *Sample interface* means that portion of a system used for one or more of the following: sample acquisition, sample transportation, sample conditioning, or protection of the analyzer(s) from the effects of the stack effluent.

3.4.2 *Organic analyzer* means that portion of the measurement system that senses the gas to be measured and generates an output proportional to its concentration.

3.5 *Response time* means the time interval from a step change in pollutant concentration at the inlet to the emission measurement system to the time at which 95 percent of the corresponding final value is reached as displayed on the recorder.

3.6 *Span Value* means the upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the applicable emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected concentration. For convenience, the span value should correspond to 100 percent of the recorder scale.

3.7 *Zero drift* means the difference in the measurement system response to a zero level calibration gas before or after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

6.1 Measurement System. Any measurement system for total organic concentration that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 25A–1. All sampling components leading to the analyzer shall be heated ≥110 °C (220 °F) throughout the sampling period, unless safety reasons are cited (Section 5.2) The essential components of the measurement system are described below:

6.1.1 Organic Concentration Analyzer. A flame ionization analyzer (FIA) capable of meeting or exceeding the specifications of this method. The flame ionization detector block shall be heated >120 °C (250 °F).

6.1.2 Sample Probe. Stainless steel, or equivalent, three-hole rake type. Sample holes shall be 4 mm (0.16-in.) in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

6.1.3 Heated Sample Line. Stainless steel or Teflon'' tubing to transport the sample gas

to the analyzer. The sample line should be heated (≥110 °C) to prevent any condensation.

6.1.4 Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are applicable.

6.1.5 Particulate Filter. An in-stack or an out-of-stack glass fiber filter is recommended if exhaust gas particulate loading is significant. An out-of-stack filter should be heated to prevent any condensation.

6.1.6 Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

7.0 Reagents and Standards

7.1 Calibration Gases. The calibration gases for the gas analyzer shall be propane in air or propane in nitrogen. Alternatively, organic compounds other than propane can be used; the appropriate corrections for response factor must be made. Calibration gases shall be prepared in accordance with the procedure listed in Citation 2 of section 16. Additionally, the manufacturer of the cylinder should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change more than ±2 percent from the certified value. For calibration gas values not generally available (*i.e.*, organics between 1 and 10 percent by volume), alternative methods for preparing calibration gas mixtures, such as dilution systems (Test Method 205, 40 CFR Part 51, Appendix M), may be used with prior approval of the Administrator.

7.1.1 Fuel. A 40 percent H_2/60 percent N_2 gas mixture is recommended to avoid an oxygen synergism effect that reportedly occurs when oxygen concentration varies significantly from a mean value.

7.1.2 Zero Gas. High purity air with less than 0.1 part per million by volume (ppmv) of organic material (propane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

7.1.3 Low-level Calibration Gas. An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value.

7.1.4 Mid-level Calibration Gas. An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value.

7.1.5 High-level Calibration Gas. An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Selection of Sampling Site. The location of the sampling site is generally specified by the applicable regulation or purpose of the test (*i.e.*, exhaust stack, inlet line, etc.). The sample port shall be located to meet the testing requirements of Method 1.

8.2 Location of Sample Probe. Install the sample probe so that the probe is centrally located in the stack, pipe, or duct and is sealed tightly at the stack port connection.

8.3 Measurement System Preparation. Prior to the emission test, assemble the measurement system by following the manufacturer's written instructions for preparing sample interface and the organic analyzer. Make the system operable (Section 10.1).

8.4 Calibration Error Test. Immediately prior to the test series (within 2 hours of the start of the test), introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then introduce low-level and mid-level calibration gases successively to the measurement system. Record the analyzer responses for low-level and mid-level calibration gases and determine the differences between the measurement system responses and the predicted responses. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and must be replaced or repaired prior to testing. No adjustments to the measurement system shall be conducted after the calibration and before the drift check (Section 8.6.2). If adjustments are necessary before the completion of the test series, perform the drift checks prior to the required adjustments and repeat the calibration following the adjustments. If multiple electronic ranges are to be used, each additional range must be checked with a mid-level calibration gas to verify the multiplication factor.

8.5 Response Time Test. Introduce zero gas into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. Record the time from the concentration change to the measurement system response equivalent to 95 percent of the step change. Repeat the test three times and average the results.

8.6 Emission Measurement Test Procedure.

8.6.1 Organic Measurement. Begin sampling at the start of the test period, recording time and any required process information as appropriate. In particulate, note on the recording chart, periods of process interruption or cyclic operation.

8.6.2 Drift Determination. Immediately following the completion of the test period and hourly during the test period, reintroduce the zero and mid-level calibration gases, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until both the zero and calibration drift checks are made.) Record the analyzer response. If the drift values exceed the specified limits, invalidate the test results preceding the check and repeat the test following corrections to the measurement system. Alternatively, recalibrate the test measurement system as in section 8.4 and report the results using both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

NOTE: Note on the recording chart periods of process interruption or cyclic operation.

9.0 Quality Control

Method section	Quality control measure	Effect
8.4	Zero and calibration drift tests	Ensures that bias introduced by drift in the measurement system output during the run is no greater than 3 percent of span.

10.0 Calibration and Standardization

10.1 FIA equipment can be calibrated for almost any range of total organic concentrations. For high concentrations of organics (>1.0 percent by volume as propane), modifications to most commonly available analyzers are necessary. One accepted method of equipment modification is to decrease the size of the sample to the analyzer through the use of a smaller diameter sample capillary. Direct and continuous measurement of organic concentration is a necessary consideration when determining any modification design.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

12.1 Determine the average organic concentration in terms of ppmv as propane or other calibration gas. The average shall be determined by integration of the output recording over the period specified in the applicable regulation. If results are required in terms of ppmv as carbon, adjust measured concentrations using Equation 25A–1.

$$C_c = K C_{meas} \qquad \text{Eq. 25A-1}$$

Where:

C_c = Organic concentration as carbon, ppmv.

C_{meas} = Organic concentration as measured, ppmv.

K = Carbon equivalent correction factor.

= 2 for ethane.

= 3 for propane.

= 4 for butane.

= Appropriate response factor for other organic calibration gases.

13.0 Method Performance

13.1 Measurement System Performance Specifications.

13.1.1 Zero Drift. Less than ±3 percent of the span value.

13.1.2 Calibration Drift. Less than ±3 percent of span value.

13.1.3 Calibration Error. Less than ±5 percent of the calibration gas value.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Measurement of Volatile Organic Compounds—Guideline Series. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA–450/2–78–041. June 1978. p. 46–54.

2. EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards. U.S. Environmental Protection Agency, Quality Assurance and Technical Support Division. Research Triangle Park, N.C. September 1993.

3. Gasoline Vapor Emission Laboratory Evaluation—Part 2. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. EMB Report No. 75–GAS–6. August 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

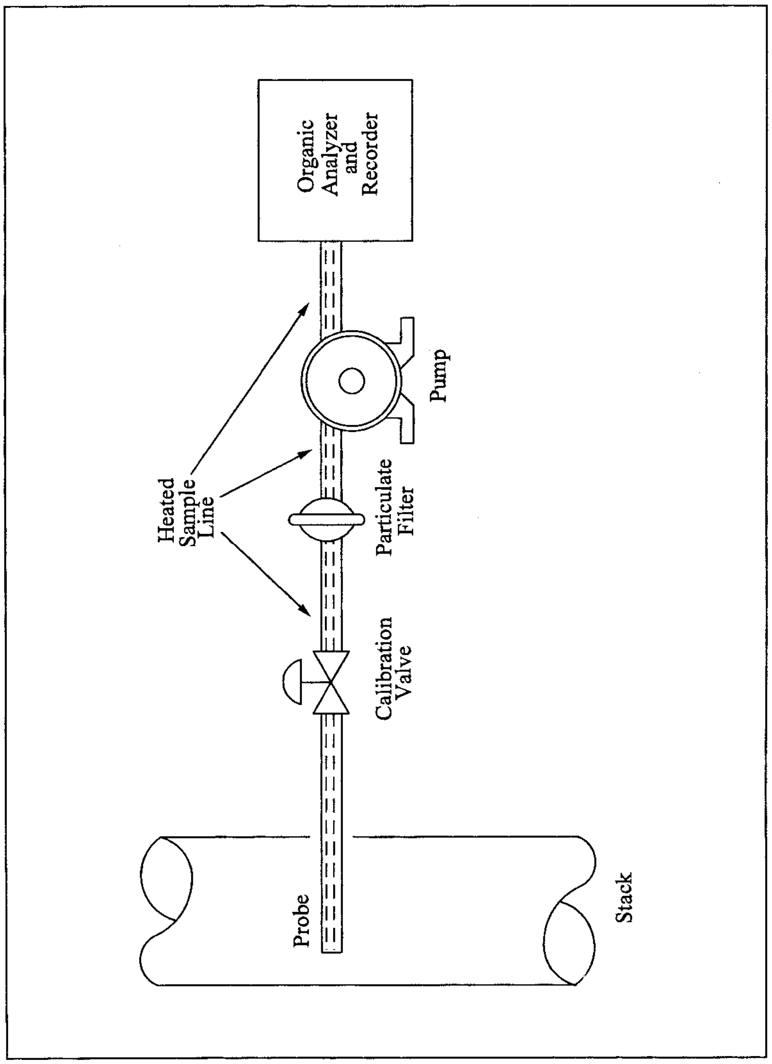


Figure 25A-1. Organic Concentration Measurement System.

METHOD 25B—DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A NONDISPERSIVE INFRARED ANALYZER

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 1, Method 6C, and Method 25A.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes. Other organic materials may be measured using the general procedure in this method, the appropriate calibration gas, and an analyzer set to the appropriate absorption band.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a nondispersive infrared analyzer (NDIR). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

Same as Method 25A, section 3.0.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

Same as Method 25A, section 6.0, with the exception of the following:

6.1 Organic Concentration Analyzer. A nondispersive infrared analyzer designed to measure alkane organics and capable of meeting or exceeding the specifications in this method.

7.0 Reagents and Standards

Same as Method 25A, section 7.1. No fuel gas is required for an NDIR.

8.0 Sample Collection, Preservation, Storage, and Transport

Same as Method 25A, section 8.0.

9.0 Quality Control

Same as Method 25A, section 9.0.

10.0 Calibration and Standardization

Same as Method 25A, section 10.0.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

Same as Method 25A, section 12.0.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as Method 25A, section 16.0.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25C—DETERMINATION OF NONMETHANE ORGANIC COMPOUNDS (NMOC) IN LANDFILL GASES

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling and analytical) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should also have a thorough knowledge of EPA Method 25.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Nonmethane organic compounds (NMOC).	No CAS number assigned.

1.2 Applicability. This method is applicable to the sampling and measurement of NMOC as carbon in landfill gases (LFG).

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A sample probe that has been perforated at one end is driven or augured to a depth of 0.9 m (3 ft) below the bottom of the landfill cover. A sample of the landfill gas is extracted with an evacuated cylinder. The NMOC content of the gas is determined by

injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4); the NMOC are oxidized to CO_2, reduced to CH_4, and measured by a flame ionization detector (FID). In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Since this method is complex, only experienced personnel should perform this test. LFG contains methane, therefore explosive mixtures may exist on or near the landfill. It is advisable to take appropriate safety precautions when testing landfills, such as refraining from smoking and installing explosion-proof equipment.

6.0 Equipment and Supplies

6.1 Sample Probe. Stainless steel, with the bottom third perforated. Teflon probe liners and sampling lines are also allowed. Non-perforated probes are allowed as long as they are withdrawn to create a gap equivalent to having the bottom third perforated. The sample probe must be capped at the bottom and must have a threaded cap with a sampling attachment at the top. The sample probe must be long enough to go through and extend no less than 0.9 m (3 ft) below the landfill cover. If the sample probe is to be driven into the landfill, the bottom cap should be designed to facilitate driving the probe into the landfill.

6.2 Sampling Train.

6.2.1 Rotameter with Flow Control Valve. Capable of measuring a sample flow rate of 100 ±10 ml/min. The control valve must be made of stainless steel.

6.2.2 Sampling Valve. Stainless steel.

6.2.3 Pressure Gauge. U-tube mercury manometer, or equivalent, capable of measuring pressure to within 1 mm Hg (0.5 in H_2O) in the range of 0 to 1,100 mm Hg (0 to 590 in H_2O).

6.2.4 Sample Tank. Stainless steel or aluminum cylinder, equipped with a stainless steel sample tank valve.

6.3 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg (5.4 in H_2O).

6.4 Purging Pump. Portable, explosion proof, and suitable for sampling NMOC.

6.5 Pilot Probe Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.1.

6.5.1 Pilot Probe. Tubing of sufficient strength to withstand being driven into the landfill by a post driver and an outside diameter of at least 6 mm (0.25 in.) smaller than the sample probe. The pilot probe shall be capped on both ends and long enough to go through the landfill cover and extend no less than 0.9 m (3 ft) into the landfill.

6.5.2 Post Driver and Compressor. Capable of driving the pilot probe and the sampling probe into the landfill. The Kitty Hawk portable post driver has been found to be acceptable.

6.6 Auger Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.2.

6.6.1 Auger. Capable of drilling through the landfill cover and to a depth of no less than 0.9 m (3 ft) into the landfill.

6.6.2 Pea Gravel.

6.6.3 Bentonite.

6.7 NMOC Analyzer, Barometer, Thermometer, and Syringes. Same as in sections 6.3.1, 6.3.2, 6.33, and 6.2.10, respectively, of Method 25.

7.0 Reagents and Standards

7.1 NMOC Analysis. Same as in Method 25, section 7.2.

7.2 Calibration. Same as in Method 25, section 7.4, except omit section 7.4.3.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sample Tank Evacuation and Leak-Check. Conduct the sample tank evacuation and leak-check either in the laboratory or the field. Connect the pressure gauge and sampling valve to the sample tank. Evacuate the sample tank to 10 mm Hg (5.4 in H_2O) absolute pressure or less. Close the sampling valve, and allow the tank to sit for 30 minutes. The tank is acceptable if no change more than ±2 mm is noted. Include the results of the leak-check in the test report.

8.2 Sample Probe Installation. The tester may use the procedure in section 8.2.1 or 8.2.2.

8.2.1 Pilot Probe Procedure. Use the post driver to drive the pilot probe at least 0.9 m (3 ft) below the landfill cover. Alternative procedures to drive the probe into the landfill may be used subject to the approval of the Administrator's designated representative.

8.2.1.1 Remove the pilot probe and drive the sample probe into the hole left by the pilot probe. The sample probe shall extend at least 0.9 m (3 ft) below the landfill cover and shall protrude about 0.3 m (1 ft) above the landfill cover. Seal around the sampling probe with bentonite and cap the sampling probe with the sampling probe cap.

8.2.2 Auger Procedure. Use an auger to drill a hole to at least 0.9 m (3 ft) below the landfill cover. Place the sample probe in the hole and backfill with pea gravel to a level 0.6 m (2 ft) from the surface. The sample probe shall protrude at least 0.3 m (1 ft) above the landfill cover. Seal the remaining area around the probe with bentonite. Allow 24

hours for the landfill gases to equilibrate inside the augured probe before sampling.

8.2.3 Driven Probes. Closed-point probes may be driven directly into the landfill in a single step. This method may not require backfilling if the probe is adequately sealed by its insertion. Unperforated probes that are inserted in this manner and withdrawn at a distance from a detachable tip to create an open space are also acceptable.

8.3 Sample Train Assembly. Just before assembling the sample train, measure the sample tank vacuum using the pressure gauge. Record the vacuum, the ambient temperature, and the barometric pressure at this time. Assemble the sampling probe purging system as shown in Figure 25C–1.

8.4 Sampling Procedure. Open the sampling valve and use the purge pump and the flow control valve to evacuate at least two sample probe volumes from the system at a flow rate of 500 ml/min or less. Close the sampling valve and replace the purge pump with the sample tank apparatus as shown in Figure 25C–2. Open the sampling valve and the sample tank valve and, using the flow control valve, sample at a flow rate of 500 ml/min or less until either a constant flow rate can no longer be maintained because of reduced sample tank vacuum or the appropriate composite volume is attained. Disconnect the sampling tank apparatus and pressurize the sample cylinder to approximately 1,060 mm Hg (567 in. H_2O) absolute pressure with helium, and record the final pressure. Alternatively, the sample tank may be pressurized in the lab.

8.4.1 The following restrictions apply to compositing samples from different probe sites into a single cylinder: (1) Individual composite samples per cylinder must be of equal volume; this must be verified by recording the flow rate, sampling time, vacuum readings, or other appropriate volume measuring data, (2) individual composite samples must have a minimum volume of 1 liter unless data is provided showing smaller volumes can be accurately measured, and (3) composite samples must not be collected using the final cylinder vacuum as it diminishes to ambient pressure.

8.4.2 Use Method 3C to determine the percent N_2 in each cylinder. The presence of N_2 indicates either infiltration of ambient air into the landfill gas sample or an inappropriate testing site has been chosen where anaerobic decomposition has not begun. The landfill gas sample is acceptable if the concentration of N_2 is less than 20 percent. Alternatively, Method 3C may be used to determine the oxygen content of each cylinder as an air infiltration test. With this option, the oxygen content of each cylinder must be less than 5 percent.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
8.4.2	Verify that landfill gas sample contains less than 20 percent N_2 or 5 percent O_2.	Ensures that ambient air was not drawn into the landfill gas sample and gas was sampled from an appropriate location.
10.1, 10.2	NMOC analyzer initial and daily performance checks.	Ensures precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial NMOC Analyzer Performance Test. Same as in Method 25, section 10.1, except omit the linearity checks for CO_2 standards.

10.2 NMOC Analyzer Daily Calibration.

10.2.1 NMOC Response Factors. Same as in Method 25, section 10.2.2.

10.3 Sample Tank Volume. The volume of the gas sampling tanks must be determined. Determine the tank volumes by weighing them empty and then filled with deionized water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedures

11.1 The oxidation, reduction, and measurement of NMOC's is similar to Method 25. Before putting the NMOC analyzer into routine operation, conduct an initial performance test. Start the analyzer, and perform all the necessary functions in order to put the analyzer into proper working order. Conduct the performance test according to the procedures established in section 10.1. Once the performance test has been successfully completed and the NMOC calibration response factor has been determined, proceed with sample analysis as follows:

11.1.1 Daily Operations and Calibration Checks. Before and immediately after the analysis of each set of samples or on a daily basis (whichever occurs first), conduct a calibration test according to the procedures established in section 10.2. If the criteria of the daily calibration test cannot be met, repeat

the NMOC analyzer performance test (Section 10.1) before proceeding.

11.1.2 Operating Conditions. Same as in Method 25, section 11.2.1.

11.1.3 Analysis of Sample Tank. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (383 °F) as rapidly as possible. A rate of 30 °C/min (54 °F/min) has been shown to be adequate. Record the value obtained for any measured NMOC. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average as C_{tm}.

12.0 Data Analysis and Calculations

NOTE: All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature

B_w = Moisture content in the sample, fraction.

C_{N2} = N_2 concentration in the diluted sample gas.

C_{mN2} = Measured N_2 concentration, fraction in landfill gas.

C_{mOx} = Measured Oxygen concentration, fraction in landfill gas.

C_{Ox} = Oxygen concentration in the diluted sample gas.

C_t = Calculated NMOC concentration, ppmv C equivalent.

C_{tm} = Measured NMOC concentration, ppmv C equivalent.

P_b = Barometric pressure, mm Hg.

P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.

P_{ti} = Gas sample tank pressure after evacuation, mm Hg absolute.

P_w = Vapor pressure of H_2O (from Table 25C–1), mm Hg.

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 . . . r).

T_t = Sample tank temperature at completion of sampling, °K.

T_{ti} = Sample tank temperature before sampling, °K.

T_{tf} = Sample tank temperature after pressuring, °K.

12.2 Water Correction. Use Table 25C–1 (Section 17.0), the LFG temperature, and barometric pressure at the sampling site to calculate B_w.

$$B_w = \frac{P_w}{P_b} \qquad \text{Eq. 25C-1}$$

12.3 Nitrogen Concentration in the landfill gas. Use equation 25C–2 to calculate the measured concentration of nitrogen in the original landfill gas.

$$C_{N2} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right] C_{mN2} \qquad \text{Eq.25C-2}$$

12.4 Oxygen Concentration in the landfill gas. Use equation 25C–3 to calculate the measured concentration of oxygen in the original landfill gas.

$$C_{Ox} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right] C_{mOx} \qquad \text{Eq.25C-3}$$

12.5 You must correct the NMOC Concentration for the concentration of nitrogen or oxygen based on which gas or gases passes the requirements in section 9.1.

12.5.1 NMOC Concentration with nitrogen correction. Use Equation 25C-4 to calculate the concentration of NMOC for each sample tank when the nitrogen concentration is less than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}\right)\left(1 - \frac{99}{78} C_{N2}\right) - B_w} \frac{1}{r} \sum_{j=1}^{r} C_{tm(j)} \qquad \text{Eq.25C-4}$$

12.5.2 NMOC Concentration with oxygen correction. Use Equation 25C-5 to calculate the concentration of NMOC for each sample tank if the landfill gas oxygen is less than 5 percent and the landfill gas nitrogen concentration is greater than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}\right)\left(1 - \frac{99}{21} C_{Ox}\right) - B_w} \frac{1}{r} \sum_{j=1}^{r} C_{tm(j)} \qquad \text{Eq.25C-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75-33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts. June 15-20, 1975.) 14 p.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74-190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9-13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

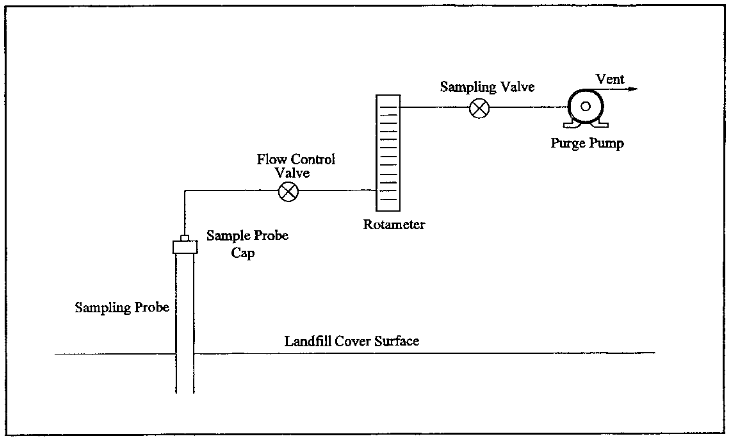


Figure 25C-1. Schematic of Sampling Probe Purging System

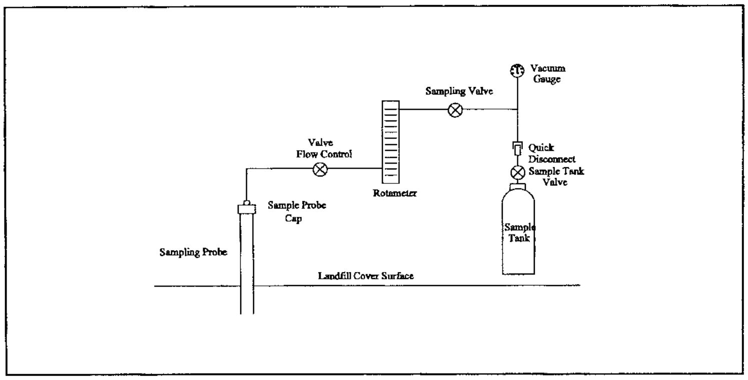


Figure 25C-2. Schematic of Sampling Train.

TABLE 25C–1—MOISTURE CORRECTION

Temperature, °C	Vapor Pressure of H_2O, mm Hg	Temperature, °C	Vapor Pressure of H_2O, mm Hg
4	6.1	18	15.5
6	7.0	20	17.5
8	8.0	22	19.8
10	9.2	24	22.4
12	10.5	26	25.2
14	12.0	28	28.3
16	13.6	30	31.8

METHOD 25D—DETERMINATION OF THE VOLATILE ORGANIC CONCENTRATION OF WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) or an electrolytic conductivity detector (ELCD) because knowledge beyond the scope of this presentation is required.

1.0 Scope and Application

1.1 Analyte. Volatile Organic Compounds. No CAS No. assigned.

1.2 Applicability. This method is applicable for determining the volatile organic (VO) concentration of a waste sample.

2.0 Summary of Method

2.1 Principle. A sample of waste is obtained at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). The sample is suspended in an organic/aqueous matrix, then heated and purged with nitrogen for 30 min. in order to separate certain organic compounds. Part of the sample is analyzed for carbon concentration, as methane, with an FID, and part of the sample is analyzed for chlorine concentration, as chloride, with an ELCD. The VO concentration is the sum of the carbon and chlorine content of the sample.

3.0 Definitions

3.1 *Well-mixed* in the context of this method refers to turbulent flow which results in multiple-phase waste in effect behaving as single-phase waste due to good mixing.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1 Sampling. The following equipment is required:

6.1.1 Sampling Tube. Flexible Teflon, 0.25 in. ID (6.35 mm).

6.1.2 Sample Container. Borosilicate glass, 40-mL, and a Teflon-lined screw cap capable of forming an air tight seal.

6.1.3 Cooling Coil. Fabricated from 0.25 in (6.35 mm). ID 304 stainless steel tubing with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Purging Apparatus. For separating the VO from the waste sample. A schematic of the system is shown in Figure 25D–1. The purging apparatus consists of the following major components.

6.2.1.1 Purging Flask. A glass container to hold the sample while it is heated and purged with dry nitrogen. The cap of the purging flask is equipped with three fittings: one for a purging lance (fitting with the #7 Ace-thread), one for the Teflon exit tubing (side fitting, also a #7 Ace-thread), and a third (a 50-mm Ace-thread) to attach the base of the purging flask as shown in Figure 25D–2. The base of the purging flask is a 50-mm ID (2 in) cylindrical glass tube. One end of the tube is open while the other end is sealed. Exact dimensions are shown in Figure 25D–2.

6.2.1.2 Purging Lance. Glass tube, 6-mm OD (0.2 in) by 30 cm (12 in) long. The purging end of the tube is fitted with a four-arm bubbler with each tip drawn to an opening 1 mm (0.04 in) in diameter. Details and exact dimensions are shown in Figure 25D–2.

6.2.1.3 Coalescing Filter. Porous fritted disc incorporated into a container with the same dimensions as the purging flask. The details of the design are shown in Figure 25D–3.

6.2.1.4 Constant Temperature Chamber. A forced draft oven capable of maintaining a uniform temperature around the purging flask and coalescing filter of 75 ±2 °C (167 ±3.6 °F).

6.2.1.5 Three-way Valve. Manually operated, stainless steel. To introduce calibration gas into system.

6.2.1.6 Flow Controllers. Two, adjustable. One capable of maintaining a purge gas flow rate of 6 ±0.06 L/min (0.2 ±0.002 ft^3/min) The other capable of maintaining a calibration gas flow rate of 1–100 mL/min (0.00004–0.004 ft^3/min).

6.2.1.7 Rotameter. For monitoring the air flow through the purging system (0–10 L/min)(0–0.4 ft^3/min).

6.2.1.8 Sample Splitters. Two heated flow restrictors (placed inside oven or heated to 120 ±10 °C (248 ±18 °F)). At a purge rate of 6 L/min (0.2 ft^3/min), one will supply a constant flow to the first detector (the rest of the flow will be directed to the second sample splitter). The second splitter will split the analytical flow between the second detector and the flow restrictor. The approximate flow to the FID will be 40 mL/min (0.0014 ft^3/min) and to the ELCD will be 15 mL/min (0.0005 ft^3/min), but the exact flow must be adjusted to be compatible with the individual detector and to meet its linearity requirement. The two sample splitters will be connected to each other by 1/8′ OD (3.175 mm) stainless steel tubing.

6.2.1.9 Flow Restrictor. Stainless steel tubing, 1/8′ OD (3.175 mm), connecting the second sample splitter to the ice bath. Length is determined by the resulting pressure in the purging flask (as measured by the pressure gauge). The resulting pressure from the use of the flow restrictor shall be 6–7 psig.

6.2.1.10 Filter Flask. With one-hole stopper. Used to hold ice bath. Excess purge gas is vented through the flask to prevent condensation in the flowmeter and to trap volatile organic compounds.

6.2.1.11 Four-way Valve. Manually operated, stainless steel. Placed inside oven, used to bypass purging flask.

6.2.1.12 On/Off Valves. Two, stainless steel. One heat resistant up to 130 °C (266 °F) and placed between oven and ELCD. The other a toggle valve used to control purge gas flow.

6.2.1.13 Pressure Gauge. Range 0–40 psi. To monitor pressure in purging flask and coalescing filter.

6.2.1.14 Sample Lines. Teflon, 1/4′ OD (6.35 mm), used inside the oven to carry purge gas to and from purging chamber and to and from coalescing filter to four-way valve. Also used to carry sample from four-way valve to first sample splitter.

6.2.1.15 Detector Tubing. Stainless steel, 1/8′ OD (3.175 mm), heated to 120 ±10 °C (248 ±18 °F) . Used to carry sample gas from each sample splitter to a detector. Each piece of tubing must be wrapped with heat tape and insulating tape in order to insure that no cold spots exist. The tubing leading to the ELCD will also contain a heat-resistant on-off valve (Section 6.2.1.12) which shall also be wrapped with heat-tape and insulation.

6.2.2 Volatile Organic Measurement System. Consisting of an FID to measure the carbon concentration of the sample and an ELCD to measure the chlorine concentration.

6.2.2.1 FID. A heated FID meeting the following specifications is required.

6.2.2.1.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.1.

6.2.2.1.2 Range. A full scale range of 50 pg carbon/sec to 50 μg carbon/sec. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.1.3 Data Recording System. A digital integration system compatible with the FID for permanently recording the output of the detector. The recorder shall have the capability to start and stop integration at points selected by the operator or it shall be capable of the ‘‘integration by slices’’ technique (this technique involves breaking down the chromatogram into smaller increments, integrating the area under the curve for each portion, subtracting the background for each portion, and then adding all of the areas together for the final area count).

6.2.2.2 ELCD. An ELCD meeting the following specifications is required. 1-propanol must be used as the electrolyte. The electrolyte flow through the conductivity cell shall be 1 to 2 mL/min (0.00004 to 0.00007 ft^3/min).

NOTE: A ¼-in. ID (6.35 mm) quartz reactor tube is strongly recommended to reduce carbon buildup and the resulting detector maintenance.

6.2.2.2.1 Linearity. A linear response (±10 percent) over the response range as demonstrated by the procedures in section 10.1.2.

6.2.2.2.2 Range. A full scale range of 5.0 pg/sec to 500 ng/sec chloride. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.2.3 Data Recording System. A digital integration system compatible with the output voltage range of the ELCD. The recorder must have the capability to start and stop integration at points selected by the operator or it shall be capable of performing the ‘‘integration by slices’’ technique.

7.0 Reagents and Standards

7.1 Sampling.

7.1.1 Polyethylene Glycol (PEG). Ninety-eight percent pure with an average molecular weight of 400. Before using the PEG, remove any organic compounds that might be detected as volatile organics by heating it to 120 °C (248 °F) and purging it with nitrogen at a flow rate of 1 to 2 L/min (0.04 to 0.07 ft^3/min) for 2 hours. The cleaned PEG must be stored under a 1 to 2 L/min (0.04 to 0.07 ft^3/min) nitrogen purge until use. The purge apparatus is shown in Figure 25D–4.

7.2 Analysis.

7.2.1 Sample Separation. The following are required for the sample purging step.

7.2.1.1 PEG. Same as section 7.1.1.

7.2.1.2 Purge Gas. Zero grade nitrogen (N_2), containing less than 1 ppm carbon.

7.2.2 Volatile Organics Measurement. The following are required for measuring the VO concentration.

7.2.2.1 Hydrogen (H_2). Zero grade H_2, 99.999 percent pure.

7.2.2.2 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2.2.3 Calibration Gas. Pressurized gas cylinder containing 10 percent propane and 1 percent 1,1-dichloroethylene by volume in nitrogen.

7.2.2.4 Water. Deionized distilled water that conforms to American Society for Testing and Materials Specification D 1193–74, Type 3, is required for analysis. At the option of the analyst, the $KMnO_4$ test for oxidizable organic matter may be omitted when high concentrations are not expected to be present.

7.2.2.5 1-Propanol. ACS grade or better. Electrolyte Solution. For use in the ELCD.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling.

8.1.1 Sampling Plan Design and Development. Use the procedures in chapter nine of Reference 1 in section 16 as guidance in developing a sampling plan.

8.1.2 Single Phase or Well-mixed Waste.

8.1.2.1 Install a sampling tap to obtain the sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). Assemble the sampling apparatus as shown in Figure 25D–5.

8.1.2.2 Prepare the sampling containers as follows: Pour 30 mL of clean PEG into the container. PEG will reduce but not eliminate the loss of organics during sample collection. Weigh the sample container with the screw cap, the PEG, and any labels to the nearest 0.01 g and record the weight (m_{st}). Store the containers in an ice bath until 1 hour before sampling (PEG will solidify at ice bath temperatures; allow the containers to reach room temperature before sampling).

8.1.2.3 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.1.2.4 After purging, stop the sample flow and direct the sampling tube to a preweighed sample container, prepared as described in section 8.1.2.2. Keep the tip of the tube below the surface of the PEG during sampling to minimize contact with the atmosphere. Sample at a flow rate such that the temperature of the waste is less than 10 °C (50 °F). Fill the sample container and immediately cap it (within 5 seconds) so that a minimum headspace exists in the container. Store immediately in a cooler and cover with ice.

8.1.3 Multiple-phase Waste. Collect a 10 g sample of each phase of waste generated using the procedures described in section 8.1.2 or 8.1.5. Each phase of the waste shall be analyzed as a separate sample. Calculate the weighted average VO concentration of the waste using Equation 25D–13 (Section 12.14).

8.1.4 Solid waste. Add approximately 10 g of the solid waste to a container prepared in the manner described in section 8.1.2.2, minimizing headspace. Cap and chill immediately.

8.1.5 Alternative to Tap Installation. If tap installation is impractical or impossible, fill a large, clean, empty container by submerging the container into the waste below the surface of the waste. Immediately fill a container prepared in the manner described in section 8.1.2.2 with approximately 10 g of the waste collected in the large container. Minimize headspace, cap and chill immediately.

8.1.6 Alternative sampling techniques may be used upon the approval of the Administrator.

8.2 Sample Recovery.

8.2.1 Assemble the purging apparatus as shown in Figures 25D–1 and 25D–2. The oven shall be heated to 75 ±2 °C (167 ±3.6 °F). The sampling lines leading from the oven to the detectors shall be heated to 120 ±10 °C (248 ±18 °F) with no cold spots. The flame ionization detector shall be operated with a heated block. Adjust the purging lance so that it reaches the bottom of the chamber.

8.2.2 Remove the sample container from the cooler, and wipe the exterior of the container to remove any extraneous ice, water, or other debris. Reweigh the sample container to the nearest 0.01 g, and record the weight (m_{sf}). Pour the contents of the sample container into the purging flask, rinse the sample container three times with a total of 20 mL of PEG (since the sample container originally held 30 mL of PEG, the total volume of PEG added to the purging flask will be 50 mL), transferring the rinsings to the purging flask after each rinse. Cap purging flask between rinses. The total volume of PEG in the purging flask shall be 50 mL. Add 50 mL of water to the purging flask.

9.0 Quality Control

9.1 Quality Control Samples. If audit samples are not available, prepare and analyze the two types of quality control samples (QCS) listed in Sections 9.1.1 and 9.1.2. Before placing the system in operation, after a shutdown of greater than six months, and after any major modifications, analyze each QCS in triplicate. For each detector, calculate the percent recovery by dividing measured concentration by theoretical concentration and multiplying by 100. Determine the mean percent recovery for each detector for each QCS triplicate analysis. The RSD for any triplicate analysis shall be ≤10 percent. For QCS 1 (methylene chloride), the percent recovery shall be ≥90 percent for carbon as methane, and ≥55 percent for chlorine as chloride. For QCS 2 (1,3-dichloro-2-propanol), the percent recovery shall be ≤15 percent for carbon as methane, and ≤6 percent for chlorine as chloride. If the analytical system does not meet the above-mentioned criteria for both detectors, check the system parameters (temperature, system pressure, purge rate, etc.), correct the problem, and repeat the triplicate analysis of each QCS.

9.1.1 QCS 1, Methylene Chloride. Prepare a stock solution by weighing, to the nearest 0.1 mg, 55 µL of HPLC grade methylene chloride in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 µL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze

the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 3.777×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 1.670×10^{-2}.

9.1.2 QCS 2, 1,3-dichloro-2-propanol. Prepare a stock solution by weighing, to the nearest 0.1 mg, 60 µL of high purity grade 1,3-dichloro-2-propanol in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 µL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 7.461×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 1.099×10^{-2}.

9.1.3 Routine QCS Analysis. For each set of compliance samples (in this context, set is per facility, per compliance test), analyze one QCS 1 and one QCS 2 sample. The percent recovery for each sample for each detector shall be ±13 percent of the mean recovery established for the most recent set of QCS triplicate analysis (Section 9.4). If the sample does not meet this criteria, check the system components and analyze another QCS 1 and 2 until a single set of QCS meet the ±13 percent criteria.

10.0 Calibration and Standardization

10.1 Initial Performance Check of Purging System. Before placing the system in operation, after a shutdown of greater than six months, after any major modifications, and at least once per month during continuous operation, conduct the linearity checks described in sections 10.1.1 and 10.1.2. Install calibration gas at the three-way calibration gas valve. See Figure 25D–1.

10.1.1 Linearity Check Procedure. Using the calibration standard described in section 7.2.2.3 and by varying the injection time, it is possible to calibrate at multiple concentration levels. Use Equation 25D–3 to calculate three sets of calibration gas flow rates and run times needed to introduce a total mass of carbon, as methane, (m_c) of 1, 5, and 10 mg into the system (low, medium and high FID calibration, respectively). Use Equation 25D–4 to calculate three sets of calibration gas flow rates and run times needed to introduce a total chloride mass (m_{ch}) of 1, 5, and 10 mg into the system (low, medium and high ELCD calibration, respectively). With the system operating in standby mode, allow the FID and the ELCD to establish a stable baseline. Set the secondary pressure regulator of the calibration gas cylinder to the same pressure as the purge gas cylinder and set the proper flow rate with the calibration flow controller (see Figure 25D–1). The calibration gas flow rate can be measured with a flowmeter attached to the vent position of the calibration gas valve. Set the four-way bypass valve to standby position so that the calibration gas flows through the coalescing filter only. Inject the calibration gas by turning the calibration gas valve from vent position to inject position. Continue the calibration gas flow for the appropriate period of time before switching the calibration valve to vent position. Continue recording the response of the FID and the ELCD for 5 min after switching off calibration gas flow. Make triplicate injections of all six levels of calibration.

10.1.2 Linearity Criteria. Calculate the average response factor (Equations 25D–5 and 25D–6) and the relative standard deviation (RSD) (Equation 25D–10) at each level of the calibration curve for both detectors. Calculate the overall mean of the three response factor averages for each detector. The FID linearity is acceptable if each response factor is within 5 percent of the overall mean and if the RSD for each set of triplicate injections is less than 5 percent. The ELCD linearity is acceptable if each response factor is within 10 percent of the overall mean and if the RSD for each set of triplicate injections is less than 10 percent. Record the overall mean value of the response factors for the FID and the ELCD. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2 Daily Calibrations.

10.2.1 Daily Linearity Check. Follow the procedures outlined in section 10.1.1 to analyze the medium level calibration for both the FID and the ELCD in duplicate at the start of the day. Calculate the response factors and the RSDs for each detector. For the FID, the calibration is acceptable if the average response factor is within 5 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 5 percent. For the ELCD, the calibration is acceptable if the average response factor is within 10 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 10 percent. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2.2 Calibration Range Check.

10.2.2.1 If the waste concentration for either detector falls below the range of calibration for that detector, use the procedure outlined in section 10.1.1 to choose two calibration points that bracket the new target

concentration. Analyze each of these points in triplicate (as outlined in section 10.1.1) and use the criteria in section 10.1.2 to determine the linearity of the detector in this ''mini-calibration'' range.

10.2.2.2 After the initial linearity check of the mini-calibration curve, it is only necessary to test one of the points in duplicate for the daily calibration check (in addition to the points specified in section 10.2.1). The average daily mini-calibration point should fit the linearity criteria specified in section 10.2.1. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat the calibration procedure mentioned in the first paragraph of section 10.2.2. A mini-calibration curve for waste concentrations above the calibration curve for either detector is optional.

10.3 Analytical Balance. Calibrate against standard weights.

11.0 Analysis

11.1 Sample Analysis.

11.1.1 Turn on the constant temperature chamber and allow the temperature to equilibrate at 75 ±2 °C (167 ±3.6 °F). Turn the four-way valve so that the purge gas bypasses the purging flask, the purge gas flowing through the coalescing filter and to the detectors (standby mode). Turn on the purge gas. Allow both the FID and the ELCD to warm up until a stable baseline is achieved on each detector. Pack the filter flask with ice. Replace ice after each run and dispose of the waste water properly. When the temperature of the oven reaches 75 ±2 °C (167 ±3.6 °F), start both integrators and record baseline. After 1 min, turn the four-way valve so that the purge gas flows through the purging flask, to the coalescing filter and to the sample splitters (purge mode). Continue recording the response of the FID and the ELCD. Monitor the readings of the pressure gauge and the rotameter. If the readings fall below established setpoints, stop the purging, determine the source of the leak, and resolve the problem before resuming. Leaks detected during a sampling period invalidate that sample.

11.1.2 As the purging continues, monitor the output of the detectors to make certain that the analysis is proceeding correctly and that the results are being properly recorded. Every 10 minutes read and record the purge flow rate, the pressure and the chamber temperature. Continue the purging for 30 minutes.

11.1.3 For each detector output, integrate over the entire area of the peak starting at 1 minute and continuing until the end of the run. Subtract the established baseline area from the peak area. Record the corrected area of the peak. See Figure 25D–6 for an example integration.

11.2 Water Blank. A water blank shall be analyzed for each batch of cleaned PEG prepared. Transfer about 60 mL of water into the purging flask. Add 50 mL of the cleaned PEG to the purging flask. Treat the blank as described in sections 8.2 and 8.3, excluding section 8.2.2. Calculate the concentration of carbon and chlorine in the blank sample (assume 10 g of waste as the mass). A VO concentration equivalent to ≤10 percent of the applicable standard may be subtracted from the measured VO concentration of the waste samples. Include all blank results and documentation in the test report.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A_b = Area under the water blank response curve, counts.

A_c = Area under the calibration response curve, counts.

A_s = Area under the sample response curve, counts.

C = Concentration of volatile organics in the sample, ppmw.

C_c = Concentration of carbon, as methane, in the calibration gas, mg/L.

C_{ch} = Concentration of chloride in the calibration gas, mg/L.

C_j = VO concentration of phase j, ppmw.

DR_t = Average daily response factor of the FID, mg CH_4/counts.

Dr_{th} = Average daily response factor of the ELCD, mg Cl^-/counts.

F_j = Weight fraction of phase j present in the waste.

m_c = Mass of carbon, as methane, in a calibration run, mg.

m_{ch} = Mass of chloride in a calibration run, mg.

m_s = Mass of the waste sample, g.

m_{sc} = Mass of carbon, as methane, in the sample, mg.

m_{sf} = Mass of sample container and waste sample, g.

m_{sh} = Mass of chloride in the sample, mg.

m_{st} = Mass of sample container prior to sampling, g.

m_{VO} = Mass of volatile organics in the sample, mg.

n = Total number of phases present in the waste.

P_p = Percent propane in calibration gas (L/L).

P_{vc} = Percent 1,1-dichloroethylene in calibration gas (L/L).

Q_c = Flow rate of calibration gas, L/min.

t_c = Length of time standard gas is delivered to the analyzer, min.

W = Weighted average VO concentration, ppmw.

12.2 Concentration of Carbon, as Methane, in the Calibration Gas.

$$C_c = \left(19.681 \times P_p\right) + \left(13.121 \times P_{vc}\right) \qquad \text{Eq. 25D-1}$$

12.3 Concentration of Chloride in the Calibration Gas.

$$C_{ch} = 28.998 \times P_{vc} \qquad \text{Eq. 25D-2}$$

12.4 Mass of Carbon, as Methane, in a Calibration Run.

$$M_c = C_c \times Q_c \times t_c \qquad \text{Eq. 25D-3}$$

12.5 Mass of Chloride in a Calibration Run.

$$m_{ch} = C_{ch} \times Q_c \times t_c \qquad \text{Eq. 25D-4}$$

12.6 FID Response Factor, mg/counts.

$$DR_t = \frac{m_c}{A_c} \qquad \text{Eq. 25D-5}$$

12.7 ELCD Response Factor, mg/counts.

$$DR_{th} = \frac{m_{ch}}{A_c} \qquad \text{Eq. 25D-6}$$

12.8 Mass of Carbon in the Sample.

$$m_{sc} = DR_t\left(A_s - A_b\right) \qquad \text{Eq. 25D-7}$$

12.9 Mass of Chloride in the Sample.

$$m_{sh} = DR_{th}\left(A_s - A_b\right) \qquad \text{Eq. 25D-8}$$

12.10 Mass of Volatile Organics in the Sample.

$$m_{vo} = m_{sc} + m_{sh} \qquad \text{Eq. 25D-9}$$

12.11 Relative Standard Deviation.

$$RSD = \frac{100}{\bar{x}} \sqrt{\frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}{n-1}} \qquad \text{Eq. 25D-10}$$

12.12 Mass of Sample.

$$m_s = m_{sf} - m_{st} \qquad \text{Eq. 25D-11}$$

12.13 Concentration of Volatile Organics in Waste.

$$C = \frac{\left(m_{vo} \times 1000\right)}{m_s} \qquad \text{Eq. 25D-12}$$

12.14 Weighted Average VO Concentration of Multi-phase Waste.

$$W = \sum_{j=1}^{n} F_j \, x \, \overline{C}_j \qquad \text{Eq. 25D-13}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. "Test Methods for Evaluating Solid Waste, Physical/Chemistry Methods", U.S. Environmental Protection Agency. Publication SW–846, 3rd Edition, November 1986 as amended by Update I, November 1990.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

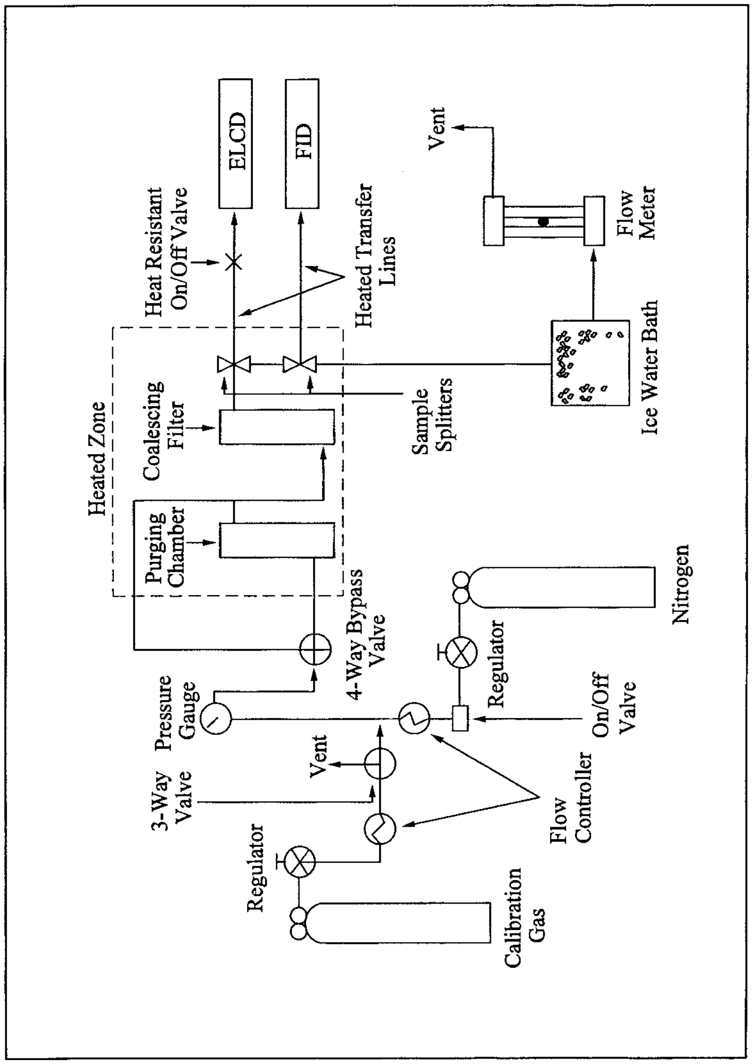


Figure 25D-1. Schematic of Purging Apparatus.

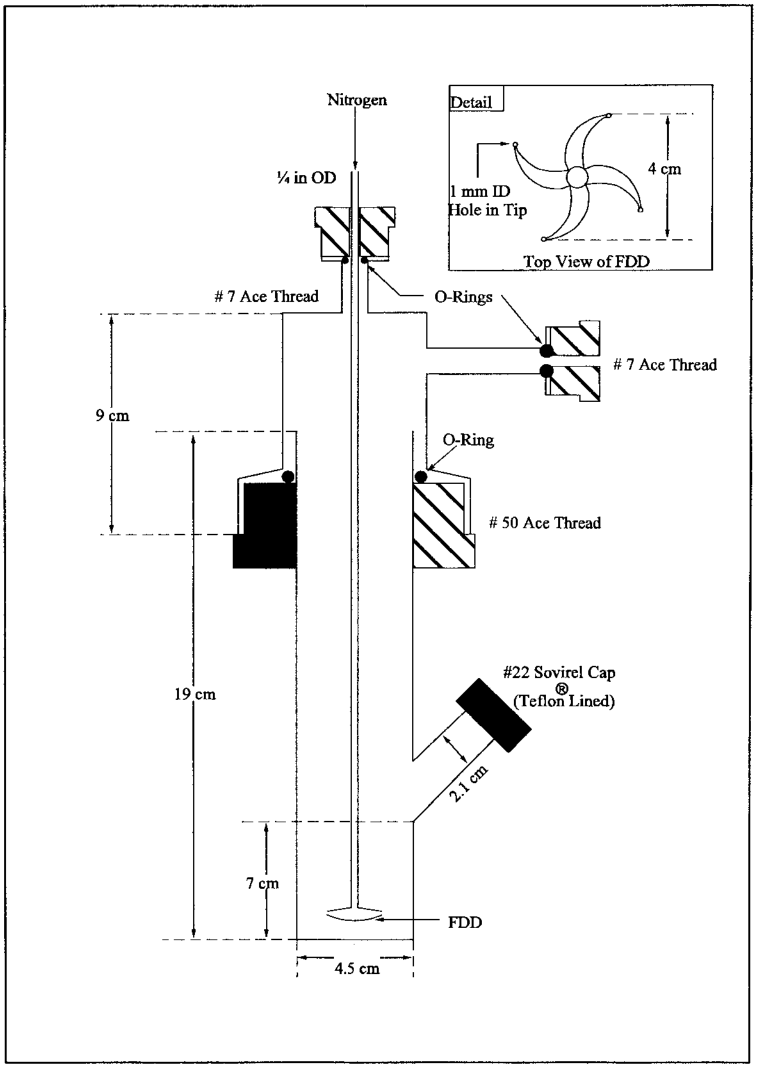
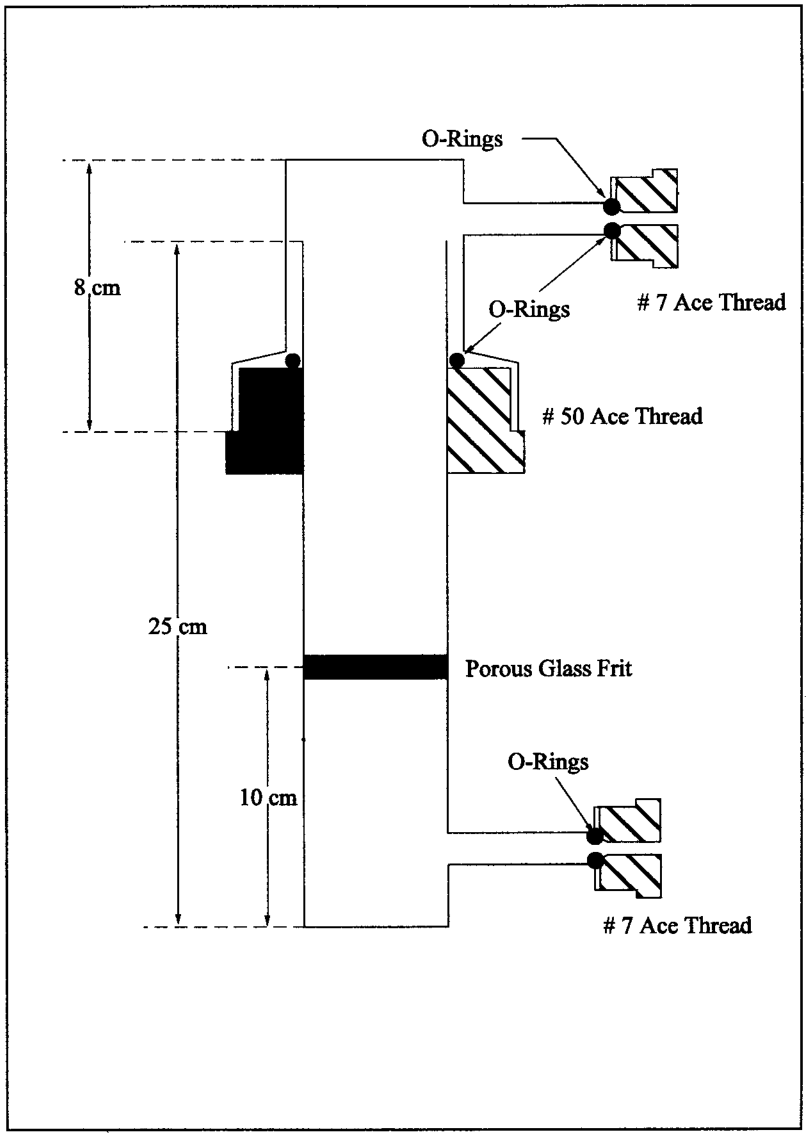


Figure 25D-2. Purging Lance.


O-Rings
O-Rings
7 Ace Thread
50 Ace Thread
8 cm
25 cm
Porous Glass Frit
O-Rings
10 cm
7 Ace Thread

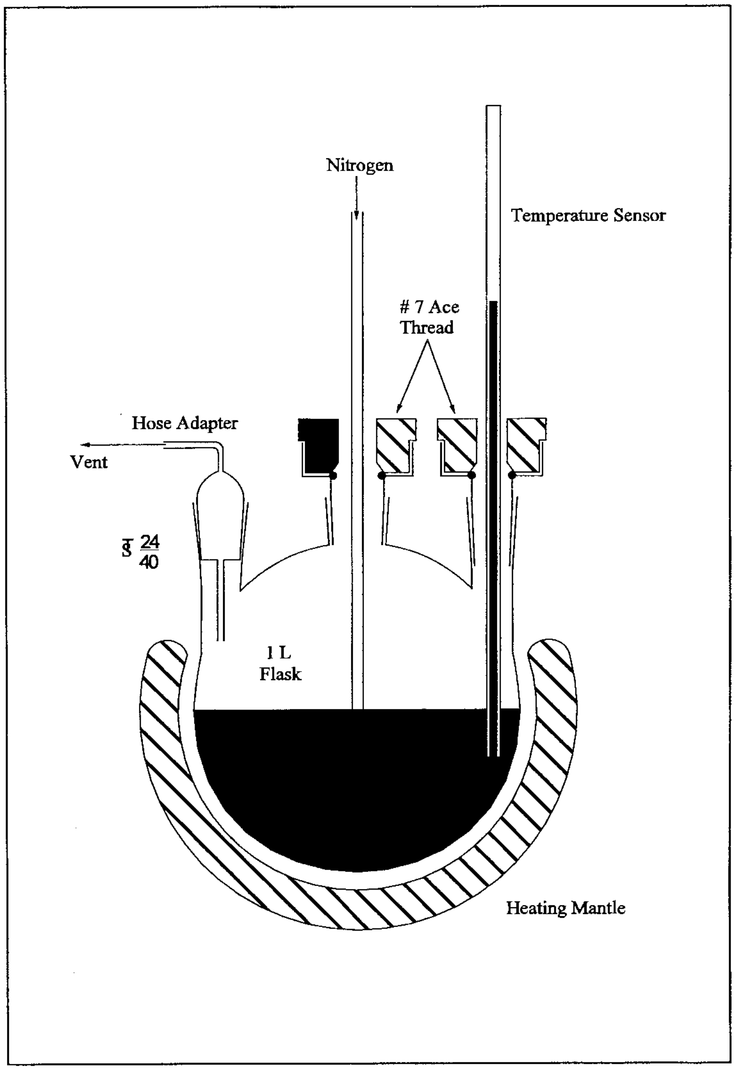


Figure 25D-4. Schematic of PEG Cleaning System.

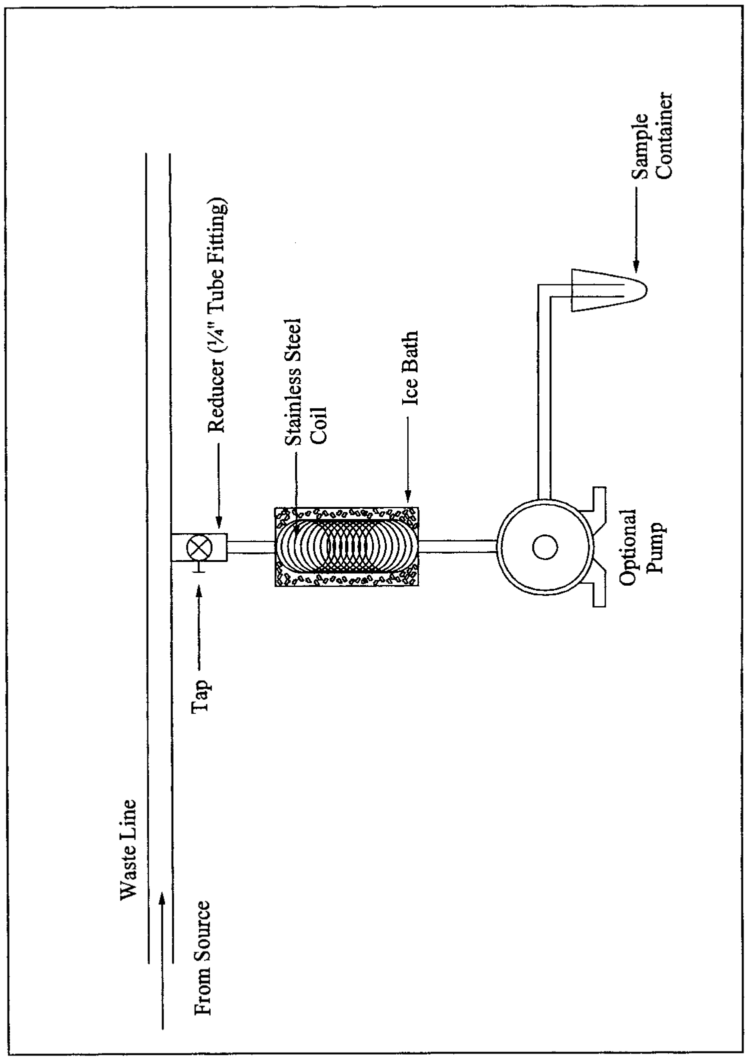


Figure 25D-5. Schematic of Sampling Apparatus.

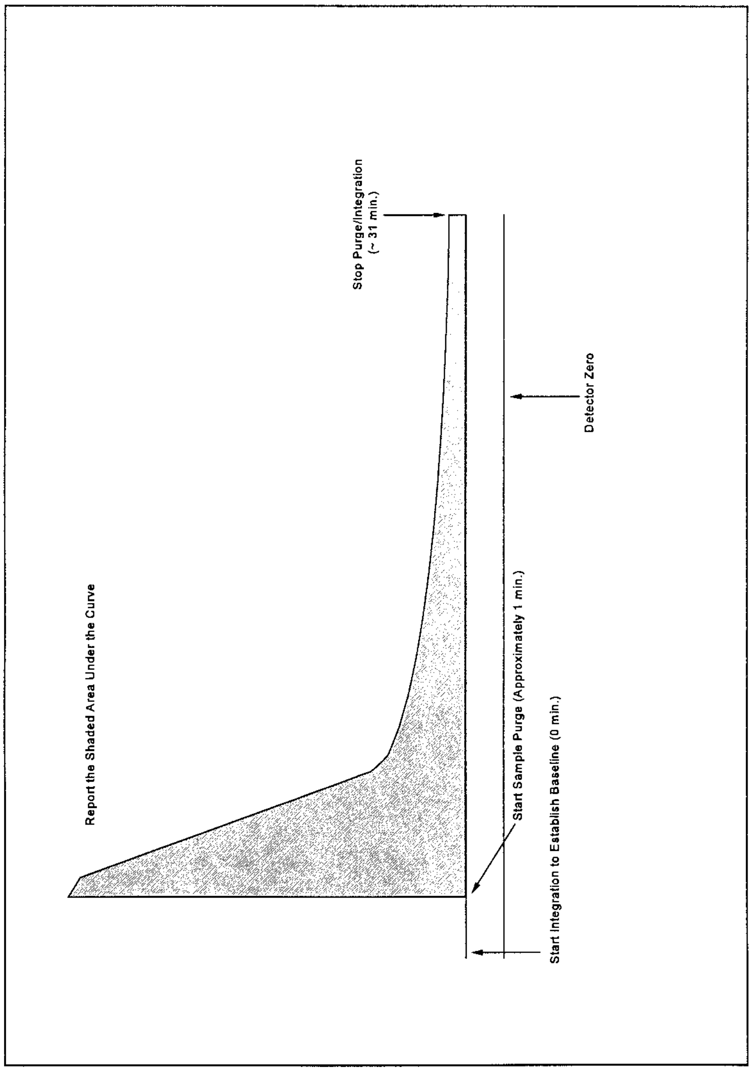


Figure 25D-6. Example Integration of Either Detector.

METHOD 25E—DETERMINATION OF VAPOR PHASE ORGANIC CONCENTRATION IN WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) nor by those who are unfamiliar with source sampling because knowledge beyond the scope of this presentation is required. This method is not inclusive with respect to specifications (*e.g.*, reagents and standards) and calibration procedures. Some material is incorporated by reference from other methods. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 106, part 61, Appendix B, and Method 18, part 60, Appendix A.

1.0 Scope and Application

1.1 Applicability. This method is applicable for determining the vapor pressure of waste cited by an applicable regulation.

1.2 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 The headspace vapor of the sample is analyzed for carbon content by a headspace analyzer, which uses an FID.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 The analyst shall select the operating parameters best suited to the requirements for a particular analysis. The analyst shall produce confirming data through an adequate supplemental analytical technique and have the data available for review by the Administrator.

5.0 Safety [Reserved]

6.0 Equipment and Supplies

6.1 Sampling. The following equipment is required:

6.1.1 Sample Containers. Vials, glass, with butyl rubber septa, Perkin-Elmer Corporation Numbers 0105–0129 (glass vials), B001–0728 (gray butyl rubber septum, plug style), 0105–0131 (butyl rubber septa), or equivalent. The seal must be made from butyl rubber. Silicone rubber seals are not acceptable.

6.1.2 Vial Sealer. Perkin-Elmer Number 105–0106, or equivalent.

6.1.3 Gas-Tight Syringe. Perkin-Elmer Number 00230117, or equivalent.

6.1.4 The following equipment is required for sampling.

6.1.4.1 Tap.

6.1.4.2 Tubing. Teflon, 0.25-in. ID.

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1.4.3 Cooling Coil. Stainless steel (304), 0.25 in.-ID, equipped with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Balanced Pressure Headspace Sampler. Perkin-Elmer HS–6, HS–100, or equivalent, equipped with a glass bead column instead of a chromatographic column.

6.2.2 FID. An FID meeting the following specifications is required.

6.2.2.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.2.

6.2.2.2 Range. A full scale range of 1 to 10,000 parts per million (ppm) propane (C_3H_8). Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.3 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the output of the detector.

6.2.4 Temperature Sensor. Capable of reading temperatures in the range of 30 to 60 °C (86 to 140 °F) with an accuracy of ±0.1 °C (±0.2 °F).

7.0 Reagents and Standards

7.1 Analysis. The following items are required for analysis.

7.1.1 Hydrogen (H_2). Zero grade hydrogen, as required by the FID.

7.1.2 Carrier Gas. Zero grade nitrogen, containing less than 1 ppm carbon (C) and less than 1 ppm carbon dioxide.

7.1.3 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2 Calibration and Linearity Check.

7.2.1 Stock Cylinder Gas Standard. 100 percent propane. The manufacturer shall: (a) Certify the gas composition to be accurate to ±3 percent or better (see section 7.2.1.1); (b) recommend a maximum shelf life over which the gas concentration does not change by greater than ±5 percent from the certified value; and (c) affix the date of gas cylinder preparation, certified propane concentration, and recommended maximum shelf life to the cylinder before shipment to the buyer.

7.2.1.1 Cylinder Standards Certification. The manufacturer shall certify the concentration of the calibration gas in the cylinder by (a) directly analyzing the cylinder and (b) calibrating his analytical procedure on the day of cylinder analysis. To calibrate his analytical procedure, the manufacturer shall use, as a minimum, a three-point calibration curve.

7.2.1.2 Verification of Manufacturer's Calibration Standards. Before using, the manufacturer shall verify each calibration standard by (a) comparing it to gas mixtures prepared in accordance with the procedure described in section 7.1 of Method 106 of Part 61, Appendix B, or by (b) calibrating it against Standard Reference Materials (SRM's) prepared by the National Bureau of Standards, if such SRM's are available. The agreement between the initially determined concentration value and the verification concentration value must be within ±5 percent. The manufacturer must reverify all calibration standards on a time interval consistent with the shelf life of the cylinder standards sold.

8.0 Sampling Collection, Preservation, Storage, and Transport

8.1 Install a sampling tap to obtain a sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to

the atmosphere). Assemble the sampling apparatus as shown in Figure 25E–1.

8.2 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.3 After purging, stop the sample flow and transfer the Teflon sampling tube to a sample container. Sample at a flow rate such that the temperature of the waste is <10 °C (<50 °F). Fill the sample container halfway (±5 percent) and cap it within 5 seconds. Store immediately in a cooler and cover with ice.

8.4 Alternative sampling techniques may be used upon the approval of the Administrator.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
10.2, 10.3	FID calibration and response check	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Use the procedures in sections 10.2 to calibrate the headspace analyzer and FID and check for linearity before the system is first placed in operation, after any shutdown longer than 6 months, and after any modification of the system.

10.2 Calibration and Linearity. Use the procedures in section 10 of Method 18 of Part 60, Appendix A, to prepare the standards and calibrate the flowmeters, using propane as the standard gas. Fill the calibration standard vials halfway (±5 percent) with deionized water. Purge and fill the airspace with calibration standard. Prepare a minimum of three concentrations of calibration standards in triplicate at concentrations that will bracket the applicable cutoff. For a cutoff of 5.2 kPa (0.75 psi), prepare nominal concentrations of 30,000, 50,000, and 70,000 ppm as propane. For a cutoff of 27.6 kPa (4.0 psi), prepare nominal concentrations of 200,000, 300,000, and 400,000 ppm as propane.

10.2.1 Use the procedures in section 11.3 to measure the FID response of each standard. Use a linear regression analysis to calculate the values for the slope (k) and the y-intercept (b). Use the procedures in sections 12.3 and 12.2 to test the calibration and the linearity.

10.3 Daily FID Calibration Check. Check the calibration at the beginning and at the end of the daily runs by using the following procedures. Prepare 2 calibration standards at the nominal cutoff concentration using the procedures in section 10.2. Place one at the beginning and one at the end of the daily run. Measure the FID response of the daily calibration standard and use the values for k and b from the most recent calibration to calculate the concentration of the daily standard. Use an equation similar to 25E–2 to calculate the percent difference between the daily standard and C_s. If the difference is within 5 percent, then the previous values for k and b can be used. Otherwise, use the procedures in section 10.2 to recalibrate the FID.

11.0 Analytical Procedures

11.1 Allow one hour for the headspace vials to equilibrate at the temperature specified in the regulation. Allow the FID to warm up until a stable baseline is achieved on the detector.

11.2 Check the calibration of the FID daily using the procedures in section 10.3.

11.3 Follow the manufacturer's recommended procedures for the normal operation of the headspace sampler and FID.

11.4 Use the procedures in sections 12.4 and 12.5 to calculate the vapor phase organic vapor pressure in the samples.

11.5 Monitor the output of the detector to make certain that the results are being properly recorded.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A = Measurement of the area under the response curve, counts.
b = y-intercept of the linear regression line.
C_a = Measured vapor phase organic concentration of sample, ppm as propane.
C_{ma} = Average measured vapor phase organic concentration of standard, ppm as propane.
C_m = Measured vapor phase organic concentration of standard, ppm as propane.
C_s = Calculated standard concentration, ppm as propane.
k = Slope of the linear regression line.
P_{bar} = Atmospheric pressure at analysis conditions, mm Hg (in. Hg).
P* = Organic vapor pressure in the sample, kPa (psi).
PD = Percent difference between the average measured vapor phase organic concentration (C_m) and the calculated standard concentration (C_s).
RSD = Relative standard deviation.
$\beta = 1.333 \times 10^{-7}$ kPa/[(mm Hg)(ppm)], (4.91×10^{-7} psi/[(in. Hg)(ppm)])

12.2 Linearity. Use the following equation to calculate the measured standard concentration for each standard vial.

$$C_m = kA + b \qquad \text{Eq. 25E-1}$$

12.2.1 Calculate the average measured standard concentration (C_{ma}) for each set of triplicate standards and use the following equation to calculate PD between C_{ma} and C_s. The instrument linearity is acceptable if the PD is within five for each standard.

$$PD = \frac{C_s - C_{ma}}{C_s} \times 100 \qquad \text{Eq. 25E-2}$$

12.3. Relative Standard Deviation (RSD). Use the following equation to calculate the RSD for each triplicate set of standards.

$$RSD = \frac{100}{C_{ma}} \sqrt{\frac{\sum (C_m - C_{ma})^2}{2}} \qquad \text{Eq. 25E-3}$$

The calibration is acceptable if the RSD is within five for each standard concentration.

12.4 Concentration of organics in the headspace. Use the following equation to calculate the concentration of vapor phase organics in each sample.

$$C_a = kA + b \qquad \text{Eq. 25E-4}$$

12.5 Vapor Pressure of Organics in the Headspace Sample. Use the following equation to calculate the vapor pressure of organics in the sample.

$$P^* = \beta P_{bar} C_a \qquad \text{Eq. 25E-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. ‘‘Determination of Solvent Vapor Concentrations by Total Combustion Analysis: a Comparison of Infared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. ‘‘Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) p. 25.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

Sunstone Solar Project 2
Draft Noxious Weed Control Plan

Prepared for

PINEGATE RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 2, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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Appendices

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1.0 Introduction

Sunstone Solar 2, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 2 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Noxious Weed Control Plan has been prepared to comply with Oregon Administrative Rule 660-033-0130 (38)(h)(D), which states, in regard to photovoltaic solar power generation facilities, that:

> "C*onstruction or maintenance activities will not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. This provision may be satisfied by the submittal and county approval of a weed control plan prepared by an adequately qualified individual that includes a long-term maintenance agreement. The approved plan shall be attached to the decision as a condition of approval*."

Noxious weeds are non-native, aggressive plants with the potential to cause significant damage to native ecosystems and/or cause significant economic losses. Noxious weeds are opportunistic plant species that readily flourish in disturbed areas, are difficult to control, and thereby can compete with and/or prevent native plant species from re-establishing. Notably, the likelihood of introduction or explosion of noxious weeds is correlated with new disturbances in a region, such as large-scale construction projects. In addition, noxious weed species can adversely affect the structure, composition, and success of revegetation efforts associated with construction-related temporary disturbances.

The intent of this Plan is to provide clear methods to prevent the introduction and spread of designated noxious weeds from the construction and operation of the Facility, control existing populations of noxious weeds within construction areas, and monitor the success of efforts to prevent and control noxious weeds. The Certificate Holder and its contractors will be responsible for implementing the methods detailed in this Plan.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

Prior to construction, the Certificate Holder shall finalize this plan by completing the following:

- Conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform pre-construction weed treatment.
- Develop final noxious weed monitoring methods in consultation with ODOE and incorporate as an amendment to this plan upon ODOE approval.
- Update Table 2 in consultation with ODOE and the Morrow County Weed Department.
- Provide records demonstrating all personnel have been trained on noxious weed control.
- Provide evidence that existing noxious weed infestations have been identified and treated in a manner consistent with Morrow County recommendations.
- Consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern.

2.0 Regulatory Framework

2.1 State of Oregon

In Oregon, a noxious weed is defined under Oregon Revised Statutes (ORS) 569.175 as "a terrestrial, aquatic, or marine plant designated by the State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.". Noxious weeds have been declared by ORS 569.350 as a menace to public welfare, and control of these plants is the responsibility of private landowners and operators, as well as county, state, and federal governments.

The Oregon State Weed Board (OSWB) was created by the Oregon Department of Agriculture (ODA) under ORS 569.600. OSWB provides recommendations for noxious weed control at the state-level and is responsible for updating the State Noxious Weed List. The OSWB and the ODA classify noxious weeds in Oregon in accordance with the ODA Noxious Weed Policy and Classification System (ODA 2024). There are three designations under the State's system:

- **A Listed Weed:** A weed of known economic importance that occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent.
    - **Recommended Action:** Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed:** A weed of economic importance that is regionally abundant but may have limited distribution in some counties.

  - **Recommended Action:** Limited to intensive control at the state, county, or regional level as determined on a site-specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.
- **T-Designated Weed:** A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

2.2 Morrow County

The Morrow County Code Enforcement Ordinance establishes procedures for enforcing Morrow County Code through the authority granted to general law counties by ORS Chapter 203. Section 11 of the county Code Enforcement Ordinance, updated on July 5, 2021, establishes Morrow County as a weed control district, defines what is considered a noxious weed or weed of economic importance, identifies the responsibility of private landowners to control weeds, and outlines the authority of the weed control district and Morrow County Weed Program Manager/Inspector to administer and enforce weed control in the ordinance (Morrow County 2021).

Morrow County has its own weed classification system that differs from the state. Morrow County defines two classifications of weeds (Morrow County 2025):

- **Noxious Weeds - “A List”:** Any plant that is determined by the weed advisory board and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land, or property under provisions of Oregon State Statute and thus mandated for control.
- **Weeds of Economic Importance - “B List”:** Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

2.3 State and County Weed Lists

The ODA lists 46 Class A species and 88 Class B species for the state of Oregon, 19 of which are T-designated (ODA 2024; Appendix A). Morrow County specifically recognizes 36 species of noxious weeds (Appendix B; Morrow County 2025). Although not all the Morrow County listed noxious weeds noted in Appendix B occur in the vicinity of the Facility, the Certificate Holder and its contractors should be aware of the entire list while monitoring and controlling weeds. Noxious weeds known to occur in the vicinity of the site boundary are discussed in Section 3.0.

3.0 Noxious Weeds Identified at the Facility

In June, 2022 Tetra Tech completed rare plant and habitat categorization surveys within and adjacent to the original Sunstone Solar Project site boundary[2]. During those surveys, four listed noxious weed species were documented, including three ODA-listed noxious weed species and four Morrow County listed species noxious weed species. Table 1 lists the noxious weed species observed, their noxious weed designation (i.e., status), and the frequency of observations. Locations of these noxious weeds documented during surveys are included in Exhibit P, Attachment P-1 of the ASC[3]. Three of the four noxious weed species observed were state and/or County "B" listed weeds (Table 1; Morrow County 2025, ODA 2024). One species, rush skeletonweed (*Chondrilla juncea*), is an "A" List Weed in Morrow County and a state "T"-designated weed, meaning that ODA has targeted this species for prevention and control (Morrow County 2025; ODA 2024). Note that none of these noxious weed species observations are located within the Sunstone Solar Project 2/Facility site boundary, however, due to the likelihood that these species could be found at the Facility in the future, they are retained for awareness and noxious weed prevention purposes.

Cereal rye (*Secale cereale*) was abundant in the previously disturbed areas outside of active crop fields and was generally found in previously disturbed ground. Rush skeletonweed was found in isolated small populations or single individuals on the hillside between active cropland and a gravel county road. Puncturevine (*Tribulus terrestris*) and jointed goatgrass (*Aegilops cylindrica*) were found in the highly disturbed border in between active cropland and roads. The Certificate Holder will conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform management actions. The Certificate Holder may coordinate with landowners regarding noxious weed presence. Identified noxious weed infestations will be treated prior to construction.

Table 1. Noxious Weeds Observed during Surveys in 2022

Scientific Name	Common Name	Oregon State Status[1]	Morrow County Status[1]	Frequency
Aegilops cylindrica	Jointed goatgrass	B	B	Few small patches.
Chondrilla juncea	Rush skeletonweed	B*, T	A	Occasional single plants.
Secale cereale	Cereal rye	Not listed	B	Scattered large-sized patches.
Tribulus terrestris	Puncturevine	B*	B	Few small to large-sized patches.
1. Definitions for state and county noxious weed status are provided in Sections 2.1 and 2.2, respectively. Species marked with a (*) are targeted for biocontrol (ODA 2024).				

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[2] Site Certificate for the Sunstone Solar Project, November 18, 2024.

[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

In addition to noxious weeds, cheatgrass, an invasive annual grass, was identified in grassland habitats within the site boundary. While this species is not listed as a noxious weed by the state or county, it and other invasive annual grasses can adversely impact habitat and can increase fire risk. To address these issues and maintain compliance with the requirements of the Revegetation Plan required under Condition PRE-FW-01, the certificate holder will monitor the spread of these species as explained in Section 4.3 and 4.4.

4.0 Noxious Weed Management

This section of this Plan describes the steps the Certificate Holder will take to prevent and control the establishment and spread of noxious weed species during both construction and operation of the Facility. Noxious weed control methods for the Facility described in this Plan have been developed utilizing information from the ODA Noxious Weed Control Program and the Morrow County Weed Department.

The management of noxious weeds will be considered throughout all stages of construction and operation of the Facility and will include:

- **Prevention:** Implementing measures to prevent the spread of noxious weeds during construction, operation, and maintenance activities.
- **Treatment:** Treating noxious weed populations with their appropriate control methods, at appropriate time intervals.
- **Monitoring:** Assessing noxious weed changes within the Facility site boundary over time and ensuring that legacy as well as new weed populations are not increasing their distributions.

The Certificate Holder's objective is to prevent the introduction of new noxious weed populations and the spread of existing noxious weed populations. The methods described below will be implemented to minimize the spread of noxious weeds during construction activities. New noxious weeds detected during post-construction revegetation will be considered a result of construction activities and will be controlled accordingly.

4.1 Prevention

Prior to the start of construction, all personnel will be trained on the importance of noxious weed control. As part of start-up activities, and to help facilitate the avoidance of existing infestations and identification of new infestations, the Certificate Holder or their construction contractor will provide information and training to all construction personnel regarding noxious weed identification and prevention strategies. Operations and maintenance personnel will be similarly informed. The importance of preventing the spread of noxious weeds in areas not currently infested and controlling the proliferation of noxious weeds already present within or near the Facility will be emphasized.

The Certificate Holder will implement the following best management practices to minimize the spread of noxious weeds during construction activities, revegetation efforts, and operation and maintenance activities. The following practices center around ensuring that noxious weed seeds or reproductive plant fragments are not unintentionally dispersed within or outside of the Facility boundaries by personnel or their vehicles. These practices allow for responsible movement around sites with noxious weeds already present, and ensure that new populations or species are not accidentally introduced into the Facility boundaries.

- Flagging and treating areas of noxious weed infestations prior to construction to alert construction personnel;
- Limiting vehicle access to designated routes, whether existing roads or newly constructed roads, and the outer limits of construction disturbances per the final design for the Facility;
- Limiting vehicle traffic in noxious weed-infested areas;
- Cleaning construction vehicles each time they enter or exit the Facility at a wash station located inside the Facility at vehicle ingress/egress points;
- Cleaning vehicles and equipment associated with ground disturbance and movement of topsoil utilizing a mobile wash station after performing work in noxious weed-infested areas and prior to performing work in non-infested areas;
- Where feasible, not moving topsoil and other soils from noxious weed infested areas outside of the infested areas and returning them to their previous location during reclamation activities;
- Treating soils from infested areas with a pre-emergent herbicide prior to initiation of revegetation efforts;
- Providing information regarding target noxious weed species at the operations and maintenance buildings;
- Treating noxious weeds via biological, mechanical or chemical control (see Section 4.2);
- Preventing conditions favorable for noxious weed germination and spread by revegetating temporarily disturbed areas as soon as practicable;
- Monitoring areas of disturbance for noxious weeds after construction (see Section 4.3), during the normal course of revegetation maintenance of temporary workspaces, and implementing control measures as appropriate;
- Revegetating the site with appropriate, local native seed or native plants; when these are not available, non-invasive, and non-persistent non-native species may be used; and
- Ensuring that seed and straw mulch used for site rehabilitation and revegetation are certified free of noxious weed seed and propagules.

4.2 Treatment

Control of noxious weeds and other invasive weed species will be implemented through biological, mechanical, chemical, or biological control measures. The control method used will depend on the

weed species and size of infestation, time of year, proximity to intact native habitats, and resources available (Tu et al. 2003). Generally, mechanical control is best suited for small infestations of tap-rooted weeds that can be hand pulled or large occurrences in areas where mowing or soil disturbance is acceptable. Chemical control is used for most occurrences of perennial weeds with rhizomes or stolons and large occurrences of any weed in areas where mowing or soil disturbance are not recommended. Successful noxious weed control programs typically combine mechanical and chemical treatment strategies (USEPA 2008).

The Certificate Holder will be responsible for hiring a qualified contractor to implement the treatment of noxious weeds. The Certificate Holder will ensure that noxious weed management actions will be conducted by specialists with the following qualifications:

- Experience in native plant, non-native and invasive plants, and noxious weed identification;
- Experience in noxious weed mapping;
- If chemical control is used, specialists must possess a Commercial or Public Pesticide Applicator License from the ODA or possess an Immediately Supervised Pesticide Trainee License and be supervised by a licensed applicator;
- Training in noxious weed management or Integrated Pest Management with an emphasis in noxious weeds;
- Experience in coordination with agencies and private landowners; and
- No recent (within one year) violations on the contractor’s record.

Existing noxious weed populations will be prevented from expanding in size and density and will not be spread to new sites. Existing populations of A listed noxious weeds will be eliminated. If it is determined that noxious weeds have invaded areas immediately adjacent to the Facility (e.g., areas visible just beyond the outer limits of construction disturbances associated with the Facility or along access roads) as a result of construction, the Certificate Holder will contact the landowner and seek approval to treat those noxious weed populations.

Long-term weed control methods will be described in a long-term monitoring plan as described in Section 4.3. The main factor in long-term weed control is successful revegetation with non-weedy species as described in the Draft Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). If feasible, long-term management of vegetation within the Facility solar array fence line may include prescriptive sheep and goat grazing by an authorized contractor, if approved by Morrow County, ODFW and ODOE. As noted above, short-term noxious weed control will be done through mechanical or chemical treatment. However, it will be important to ensure that the short-term treatment does not affect the establishment of the native perennial cover that will help provide the long-term control. Additionally, early detection and control of small noxious weed populations before they can expand into larger populations is extremely important for successful weed control efforts.

Noxious weed control will continue for the life of the Facility to meet the identified success criteria described in Section 4.3. Supplemental seeding of desirable species may be needed to meet and/or

maintain compliance with success criteria. Fertilizer application will be limited in areas treated for noxious weeds, as fertilizer can stimulate the growth of noxious weeds, and the timing of revegetation activities will need to be coordinated with noxious weed treatments.

4.2.1 Biological

Biological control involves the use of prescribed insects, fungi and livestock to control noxious weeds to achieve management objectives. Biological control methods are typically targeted to a specific species or plant to control its persistence. They are also used for maintenance in targeted areas for vegetation management control in height and density that includes mitigating fire risk and erosion. Biological control is environmentally friendly and should be the first consideration when applicable.

4.2.2 Mechanical Treatment

Mechanical treatment will be the preferred method of treatment for existing noxious weed populations where appropriate within the boundaries of the Facility. Mechanical control methods rely on removal of plants, seed heads, and/or cutting roots with a shovel or other hand tools or equipment that can be used to remove, mow, or disc noxious weed populations. Hand removal of plants is also included under this treatment method. Mechanical methods are useful for smaller, isolated populations of noxious weeds in areas of sensitive habitats. Additionally, hand removal of small infestations can minimize soil disturbance, allowing desirable species to remain and limiting conditions favorable for noxious weeds.

For some large noxious weed occurrences, mowing, tilling, discing, or other mechanical techniques may be used to reduce thatch prior to chemical application so that herbicide can more effectively make contact with the target species. However, some rhizomatous plants can spread by discing or tillage. In addition, rush skeletonweed, which was identified near the Facility (Section 3.0), can reproduce vegetatively from small segments of root, and discing or tilling can facilitate the spread of this species. As such, implementation of discing will be species-specific and avoided in areas where rush skeletonweed individuals have been found.

If tilling or discing is employed in areas that will be revegetated following construction, subsequent seeding will be conducted to re-establish desirable vegetative cover that will stabilize the soils and slow the potential re-invasion of noxious weeds. Discing, tilling, or other mechanical treatments that disturb the soil surface within native habitats will also be avoided in favor of herbicide application, which is an effective means of reducing the size of noxious weed populations as well as preventing the establishment of new infestations. Previously unbroken ground or fallow areas should not be tilled or rod-weeded to maintain native biocrusts and prevent exposing weed seeds.

4.2.3 Chemical Treatment

Chemical control can effectively remove noxious weeds through use of selective herbicide when mechanical control is not feasible. The specific herbicide used and the timing of application will be

chosen based on the specific noxious weed being treated, as appropriate herbicides differ between species and types of plants (i.e., dicots such as rush skeletonweed versus monocots such as jointed goatgrass). Example treatment methods, as well as the recommended timing of treatments for the four target noxious weeds identified within the Facility, are summarized in Table 2. The status of herbicide approval (e.g., confirming herbicides are approved for use by the U.S. Environmental Protection Agency [EPA] and ODA) will be checked annually.

Prior to construction and every fall season during facility operation, the Certificate Holder or its contractor will consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern, to allow for adaptive weed management given changes in weed control effectiveness from noxious weed species tolerance to herbicide treatment over time. Results of the consultation shall be reported in the Certificate Holder's annual monitoring report. Any alternative control methods can be proposed by the Certificate Holder or its contractors after consulting with the Morrow County Weed Department and included in the Certificate Holder's annual monitoring report.

Herbicides will be applied on identified, treatable, noxious weed infestations. The Certificate Holder or their contractors will coordinate with the Morrow County Weed Department to determine which populations are treatable and will notify landowners of proposed herbicide use on their lands prior to application. If a noxious weed population is deemed to be untreatable (e.g., too widespread and established in an area to successfully control), the Certificate Holder will implement the applicable prevention measures discussed in Section 4.1, except for treatment with herbicides.

Table 2. Example Treatment for Target Noxious Weed Species

Scientific Name	Common Name	Treatment Method and Timing
Aegilops cylindrica	Jointed goatgrass	**Glyphosate** – Apply to actively growing plants emerged before bolt stage (i.e., stage of growth where growth is focused on seed development versus leaf development). • Rate: 0.38 to 0.75 lb ae/a[1] **Imazapic –** Apply pre-emergence in fall. Due to the residual effect of this herbicide, it will not be used in areas to be revegetated. • Rate: 0.063 to 0.188 lb/a[1] **Sulfometuron** – Apply in fall or in late winter before jointed goatgrass is 3 inches tall. • Rate: 1 to 1.5 oz ai/a (1.33 to 2 oz/a)[1]
Chondrilla juncea	Rush skeletonweed	**2,4-D or MCPA –** Apply to rosettes in the spring immediately before or during bolting. • Rate: 2 lb ae/a[1] **Aminopyralid (Milestone) –** Spring or fall when rosettes are present. • Rate: 1.75 oz ae/a (7 fluid oz/a Milestone)[1] **Clopyralid –** Apply to rosettes in fall or up to early bolting in spring. • Rate: 0.25 to 0.375 lb ae/a (0.66 to 1 pint/a)[1]

Scientific Name	Common Name	Treatment Method and Timing
		Picloram – Apply from late fall to early spring. For best results, apply just before or during bolting. - Rate: 1 lb ae/a[1]
Secale cereale	Cereal rye	Postemergence, non-selective herbicides such as glyphosate can control cereal rye. Glyphosate does not provide residual weed control, so any plants that emerge after treatment will not be controlled. Other herbicides that have found to provide control include Clethodim, Hexazinone, Rimsulfuron, Sethoxydim, and Sulfometuron.
Tribulus terrestris	Puncturevine	**2,4-D amine or 2,4-D LV ester–** Apply every 3 weeks during growing season or when new seedlings appear. - Rate: 1 to 2 lb ae in 10 to 20 gal water for spot treatments **Bentazon (Basagran) + imazamox (Raptor)–** Apply to small, actively growing puncture vine - Rate: 0.75 to 1 lb ai/A bentazon + 0.031 lb ai/a imazamox (4 oz/A Raptor) **Bromacil + diuron–** Apply before weeds emerge. - Rate: 8 lb ai/A (10 lb/a)[1] **Chlorsulfuron–** Apply late fall or late winter preemergence to growth. Needs moisture to activate. - Rate: 1 oz ai/a (1.5 oz/a)[1] **Fomesafen –** Apply pre- and postemergence, depending on crop. - Rate: 1 to 2 pints/A (0.25 to 0.5 lb ai/a)[1] **Imazapic –** Apply early postemergence when plants are cracking. - Rate: 0.125 to 0.188 lb ai/a[1] **Indaziflam –** Apply at least several weeks prior to expected germination of puncture vine. Apply to dry soils when rain is not expected for at least 48 hours. Can be successfully applied several months in advance of weed germination. - Rate: Grazed areas 0.046 to 0.065 lb ai/a (3.5 to 5 oz/a Rejuvra); areas not grazed or cut for hay 0.046 to 0.09 lb ai/A (3.5 to 7 oz/a Rejuvra). Use lower rates only where weed pressure is light and shorter period of residual activity is desired. **Norflurazon –** Apply in fall to spring, before puncture vine emerges. - Rate: Refer to label. Adjust rates depending on soil texture and organic matter **Paraquat –** Apply as a postemergence spray to puncture vine foliage - Rate: 0.38 to 0.49 lb ai/a[1] -

Sources: DiTomaso e al. 2013; LCNWCB 2022; Prather and Peachey 2022.

[1] a = acre; ae = acid equivalent; ai = active ingredient; lb= pound; oz = ounces

4.2.3.1 Herbicide Application and Handling

Herbicide application will occur within the appropriate season and during the appropriate timeframe to achieve desired results, as approved by ODOE and the county weed departments. Herbicide application will adhere to EPA and ODA standards. Only those herbicides that are approved by the EPA and ODA will be used. In general, application of herbicides will not occur when the following conditions exists:

- Wind velocity exceeds 15 miles per hour for granular application, or exceeds 10 miles per hour for liquid applications;
- Snow or ice covers the foliage of target species; or
- Adverse weather conditions are forecasted within the next few days.

Hand application methods (e.g., backpack spraying) may be used in roadless areas or in rough terrain. Vehicle-mounted sprayers (e.g., handgun, boom, and injector) will be used mainly in open areas that are readily accessible by vehicle. Calibration checks of equipment will be conducted prior to spraying activities, as well as periodically throughout use, to ensure that appropriate application rates are achieved.

Herbicides will be transported to the Facility daily with the following stipulations:

- Only the quantity needed for that day's work will be transported.
- Concentrate will be transported in approved containers only, and in a manner that will prevent spilling, stored separately from food, clothing, and safety equipment.
- Mixing will be done off-site and at a distance greater than 200 feet from open or flowing water, wetlands, or other sensitive species' habitat. No herbicides will be applied at these areas unless authorized by the appropriate regulatory agencies.
- All herbicide equipment and containers will be inspected daily for leaks.
- Herbicides use will be in accordance with all manufacture's label recommendations and warnings.

4.2.3.2 Herbicide Spills and Cleanups

All appropriate precautions will be taken to avoid herbicide spills. In the event of a spill, cleanup will be immediate. Contractors will keep spill kits in their vehicles and in an appropriate storage shed to allow for quick and effective response to spills. Items included in the spill kit will be:

- Protective clothing and gloves;
- Adsorptive clay, "kitty litter," or other commercial adsorbent;
- Plastic bags and a bucket;
- A shovel;
- A fiber brush and screw-in handle;
- A dustpan;

- Caution tape;
- Highway flares (use on existing hard-top roads only); and
- Detergent.

Response to an herbicide spill will vary with the size and location of the spill, but general procedures include:

- Stopping the leak;
- Containing the spilled material;
- Traffic control;
- Dressing the clean-up team in protective clothing;
- Cleaning up and removing the spilled herbicide, as well as the contaminated adsorptive material and soil; and
- Transporting the spilled herbicide and contaminated material to an authorized disposal site.

4.2.3.3 Herbicide Spill Reporting

All herbicide contractors will have readily available copies of the appropriate material safety data sheets for the herbicides used at their disposal and will keep copies of the material safety data sheets in the application vehicle. If an herbicide spill of any size occurs, the appropriate agency and spill coordinators will be notified promptly. In case of a spill into wetlands and waterbodies, the appropriate federal, state, and county agencies will be notified immediately. All herbicide spills equal to or greater than 200 pounds or 25 gallons of pesticide residue will be reported to the Oregon Emergency Response System in accordance with applicable laws and requirements (OAR 340-142-0050; ODEQ 2024). The Certificate Holder will report all herbicide spills to ODOE by phone or email within 24 hours with follow up reporting as appropriate.

4.3 Monitoring

Weed inspections will occur across the entire Facility through visual inspection of the site while driving and/or walking. Final monitoring methods will be determined in consultation with ODOE prior to construction and will be incorporated as an amendment to this plan upon ODOE approval. Monitoring will be conducted by a qualified botanist or weed specialist and will begin in the first growing season after seeding. Monitoring for noxious weeds and other undesirable weed species will occur at least five times per year including in the spring, June, July, and August for summer annuals and in the fall during the first two years following construction to capture the different life cycles of noxious weed species. This will allow real-time assessment of weed growth and inform proactive weed control measures to prevent large scale infestations. Frequent checks during early revegetation efforts will enable the Certificate Holder to respond to new weed infestations in a timely manner and ensure the success of the site’s revegetation. These inspections will be used to inform ongoing weed control efforts.

The initial monitoring survey will be scheduled slightly before herbicide application, as applicable, to identify any noxious weed species within the areas to be treated, with a focus on target noxious weed species observed prior to construction (Table 1), or other populations of target noxious weeds not previously observed.

Monitoring will assess the success of noxious weed treatments and will document any new noxious weed infestations observed. During the first two years following construction, the Certificate Holder will meet with ODOE and the Morrow County Weed Department at least once per season to provide updates on weed infestations and control measures at the Facility. These results will also be summarized in annual monitoring reports that describe the treatments performed, treatment success, make recommendations to improve treatment success (if necessary), and note any new target noxious weed species or emergence. Reports will be submitted to the Oregon Department of Energy (ODOE), Oregon Department of Fish and Wildlife (ODFW), and Morrow County annually.

Based on the success of control efforts after the second year of monitoring, the Certificate Holder will consult with ODOE and ODFW to determine if the monitoring cycle can be reduced for years three to five. After five years of monitoring, the Certificate Holder will design a long-term weed control plan in consultation with ODOE and the Morrow County Weed Department. The Certificate Holder will maintain ongoing communication with individual landowners, the Morrow County Weed Department, and ODOE regarding noxious weeds within the Facility. Landowners may also contact the Certificate Holder directly to report the presence of noxious weeds related to Facility activity. The Certificate Holder will control the noxious weeds on a case-by-case basis and prepare a summary of measures taken for that landowner. During the operational period of the Facility, the Certificate Holder will control noxious weeds as described in the long-term weed control plan. The Certificate Holder will report the investigator's findings and recommendations regarding weed control in the Facility's annual report required per OAR 345-026-0080.

The following contact information for the Morrow County Weed Program Manager will be used and updated as needed:

Corey Sweeney, Weed Program Manager
Morrow County Public Works
365 West Highway 74
Lexington, OR 97839
(541) 989-9502
mcweed@co.morrow.or.us

4.4 Success Criteria

Success criteria outlined below are designed to demonstrate compliance with OAR 660-033-0130(38)(D) to prevent the introduction and spread of noxious weed species. In each annual monitoring report, the Certificate Holder will include an assessment of whether the Facility is meeting or trending toward meeting the noxious weed control success criteria. Compliance with the Facility Site Certificate will be demonstrated through documentation of meeting these success criteria for the life of the Facility.

- Class A and Class B noxious weed presence within the solar array fence line will not exceed 15 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Class T noxious weed presence within the solar array fence line will not exceed 5 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Invasive Annual Grasses and other Undesirable Species will not exceed more then 50 percent cover within any 1 acre area or more than 30 percent cover within the solar array fence line.
- During revegetation of temporary disturbance areas outside of the solar array fence line presence and cover of noxious weeds is 75 percent or less than that of the reference site.

5.0 Roles and Responsibilities

The Certificate Holder is the overall responsible party for construction and operation of the Facility and implementation of the noxious weed management activities described in this Plan. However, the Certificate Holder may use contractors to complete tasks associated with noxious weed management and monitoring. Example responsible parties and their roles may include:

Monitoring Contractor

- Perform site visits to document noxious weed occurrences.
- Provide summary memo after each visit to Certificate Holder's operations manager outlining findings and treatment recommendations.
- Communicate directly with Weed Management Contractor and provide maps, and photos of noxious weed species locations to Weed Management Contractor.
- Communicate with Morrow County Weed Program Manager, and ODA about noxious weed survey findings and treatment plans.
- Prepare annual report for the Facility describing noxious weed monitoring findings and treatments.
- Organize and attend quarterly calls with the Certificate Holder and Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Certificate Holder Site Manager

- Communicate findings and recommendations from Monitoring Contractor to the Weed Management Contractor.
- Document the work performed by the Weed Management Contractor and provide documentation to Monitoring Contractor. Documentation should include type and quantity

of herbicides applied, dates applied, and any associated EPA/U.S. Department of Environmental Quality licensing/documentation of chemicals used.

- Reviews annual reports to ensure all treatments performed by the Weed Management Contractor are documented.
- Maintain landowner communications, providing guidance to the Monitoring Contractor and Weed Management Contractor regarding landowner restrictions/requests for performing noxious weed monitoring/treatment on their properties.
- Attend quarterly calls with Monitoring Contractor and the Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Weed Management Contractor

- Review Monitoring Contractor memos describing noxious weed occurrences and recommendations and plan appropriate treatment to address those issues.
- Communicate treatment plan to the Certificate Holder.
- Maintain records of when, where, and what type of noxious weed treatments are being performed.
- Maintain all appropriate documentation of chemicals applied. Shares documentation during the quarterly calls with the Certificate Holder and Monitoring Contractor, and prior to Annual Report preparation.
- Attend quarterly calls with Monitoring Contractor and Certificate Holder.

Morrow County

- Review Monitoring Contractor memos describing weed occurrences and recommendations.
- Attend quarterly calls and provide recommendations.

6.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE. This Plan may also be amended periodically as the Certificate Holder continues to evaluate and modify, as needed, agricultural dual use activities at the Facility.

7.0 References

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Appendix A: Oregon State Noxious Weed List

OREGON
DEPARTMENT OF
AGRICULTURE

Noxious Weed Policy and Classification System
2024

Noxious Weed Control Program

Address: 635 Capitol Street NE, Salem, Oregon 97301
Phone: (503) 986-4625 **Fax:** (503) 986-4786
www.oregon.gov/ODA/programs/Weeds/Pages/AboutWeeds.aspx

Mission Statement

To protect Oregon’s natural resources and agricultural economy from the invasion and proliferation of invasive noxious weeds.

Program Overview

The Oregon Department of Agriculture (ODA) Noxious Weed Control Program provides statewide leadership for coordination and management of state listed noxious weeds. The state program focuses on noxious weed control efforts by implementing early detection and rapid response projects for new invasive noxious weeds, implementing biological control, implementing statewide inventory and survey, assisting the public and cooperators through technology transfer and noxious weed education, maintaining noxious weed data and maps for priority listed noxious weeds, and assisting land managers and cooperators with integrated weed management projects. The Noxious Weed Control Program also supports the Oregon State Weed Board (OSWB) with administration of the OSWB Grant Program, developing statewide management objectives, developing weed risk assessments, and maintaining the state noxious weed list.

Troy Abercrombie
Program Manager
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Noxious Weed Control Policy and Classification System

Definition

"Noxious weed" means a terrestrial, aquatic or marine plant designated by the Oregon State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.

Noxious weeds have become so thoroughly established and are spreading so rapidly on private, state, county, and federally owned lands, that they have been declared by ORS 569.350 to be a menace to public welfare. Steps leading to eradication, where possible, and intensive control are necessary. It is further recognized that the responsibility for eradication and intensive control rests not only on the private landowner and operator, but also on the county, state, and federal governments.

Weed Control Policy

Therefore, it shall be the policy of ODA to:

1. Assess non-native plants through risk assessment processes and make recommendations to the Oregon State Weed Board for potential listing.
2. Rate and classify weeds at the state level.
3. Prevent the establishment and spread of listed noxious weeds.
4. Encourage and implement the control or containment of infestations of listed noxious weed species and, if possible, eradicate them.
5. Develop and manage a biological weed control program.
6. Increase awareness of potential economic losses and other undesirable effects of existing and newly invading noxious weeds, and to act as a resource center for the dissemination of information.
7. Encourage and assist in the organization and operation of noxious weed control programs with government agencies and other weed management entities.
8. Develop partnerships with county weed control districts, universities, and other cooperators in the development of control methods.
9. Conduct statewide noxious weed surveys and weed control efficacy studies.

Weed Classification System

The purpose of this Classification System is to:

1. Act as the ODA's official guideline for prioritizing and implementing noxious weed control projects.
2. Assist the ODA in the distribution of available funds through the Oregon State Weed Board to assist county weed programs, cooperative weed management groups, private landowners, and other weed management entities.
3. Serve as a model for private and public sectors in developing noxious weed classification systems that aid in setting effective noxious weed control strategies.

Criteria for Determining Economic and Environmental Significance

Detrimental Effects

1. A plant species that causes or has the potential to cause severe negative impacts to Oregon’s agricultural economy and natural resources.
2. A plant species that has the potential to or does endanger native flora and fauna by its encroachment into forest, range, aquatic and conservation areas.
3. A plant species that has the potential or does hamper the full utilization and enjoyment of recreational areas.
4. A plant species that is poisonous, injurious, or otherwise harmful to humans and/or animals.

Plant Reproduction

1. A plant that reproduces by seed capable of being dispersed over wide areas or that is long-lived, or produced in large numbers.
2. A plant species that reproduces and spreads by tubers, creeping roots, stolons, rhizomes, or other natural vegetative means.

Distribution

1. A weed of known economic importance which occurs in Oregon in small enough infestations to make eradication/containment possible; or not known to occur, but its presence in neighboring states makes future occurrence seem imminent.
2. A weed of economic or ecological importance and of limited distribution in Oregon.
3. A weed that has not infested the full extent of its potential habitat in Oregon.

Difficulty of Control

A plant species that is not easily controlled with current management practices such as chemical, cultural, biological, and physical methods.

Noxious Weed Control Classification Definitions

Noxious weeds, for the purpose of this system, shall be listed as either A or B, and may also be designated as T, which are priority targets for control, as directed by the Oregon State Weed Board.

- **A Listed Weed**:
  A weed of known economic importance which occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent (Table I).
  Recommended action: Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed**:
  A weed of economic importance which is regionally abundant, but which may have limited distribution in some counties (Table II).
  Recommended action: Limited to intensive control at the state, county or regional level as determined on a site specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.
- **T-Designated Weed (T)**:
  A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

Weed Biological Control

Oregon implements biological control, or “biocontrol” as part of its integrated pest management approach to managing noxious weeds. This is the practice of using host-specific natural enemies such as insects or pathogens to control noxious weeds. The Oregon Department of Agriculture Noxious Weed Program has adopted the International Code of Best Practices for biological control of weeds. Only safe, effective, and federally-approved natural enemies will be used for biocontrol.

Table I: A Listed Weeds

Common Name	Scientific Name
African rue	*Peganum harmala*
Camelthorn	*Alhagi pseudalhagi*
Cape-ivy	*Delairea odorata*
Coltsfoot	*Tussilago farfara*
Common frogbit	*Hydrocharis morsus-ranae*
Cordgrass	
Common	*Spartina anglica*
Dense-flowered	*Spartina densiflora*
Saltmeadow	*Spartina patens*
Smooth	*Spartina alterniflora*
Delta arrowhead	*Sagittaria platyphyla*
European water chestnut	*Trapa natans*
Flowering rush	*Butomus umbellatus*
Garden yellow loosestrife	*Lysimachia vulgaris*
Giant hogweed	*Heracleum mantegazzianum*
Goatgrass	
Barbed	*Aegilops triuncialis*
Ovate	*Aegilops ovata*
Goatsrue	*Galega officinalis*
Hawkweed	
King-devil	*Hieracium piloselloides*
Mouse-ear	*Hieracium pilosella*
Orange	*Hieracium aurantiacum*
Yellow	*Hieracium floribundum*
Hoary alyssum	*Berteroa incana*
Hydrilla	*Hydrilla verticillata*
Japanese dodder	*Cuscuta japonica*
Kudzu	*Pueraria lobata*
Matgrass	*Nardus stricta*
Oblong spurge	*Euphorbia oblongata*
Palmer amaranth	*Amaranthus palmeri*
Paterson’s curse	*Echium plantagineum*
Purple nutsedge	*Cyperus rotundus*
Ravennagrass	*Saccharum ravennae*
Squarrose knapweed	*Centaurea virgata*

(Continued) Table I: A Listed Weeds

Common Name	Scientific Name
Starthistle	
Iberian	*Centaurea iberica*
Purple	*Centaurea calcitrapa*
Thistle	
Plumeless	*Carduus acanthoides*
Smooth distaff	*Carthamus baeticus*
Taurian	*Onopordum tauricum*
Turkish	*Carduus cinereus*
Welted (curly plumeless)	*Carduus crispus*
Woolly distaff	*Carthamus lanatus*
Water soldiers	*Stratiotes aloides*
West Indian spongeplant	*Limnobium laevigatum*
White bryonia	*Bryonia alba*
Yellow floating heart	*Nymphoides peltata*
Yellowtuft	*Alyssum murale, A. corsicum*

Table II: B Listed Weeds

Common Name	Scientific Name
Armenian (Himalayan) blackberry	*Rubus armeniacus (R. procerus, R. discolor)*
Biddy-biddy	*Acaena novae-zelandiae*
Broom	
French*****	*Genista monspessulana*
Portuguese (T)	*Cytisus striatus*
Scotch*****	*Cytisus scoparius*
Spanish	*Spartium junceum*
Butterfly bush	*Buddleja davidii (B. variabilis)*
Common bugloss (T)	*Anchusa officinalis*
Common crupina **(T)**	*Crupina vulgaris*
Common reed	*Phragmities australis ssp. australis*
Common viper’s bugloss (T)	*Echium vulgare*
Cutleaf teasel	*Dipsacus laciniatus*
Dyer’s woad (T)	*Isatis tinctoria*
English hawthorn	*Crataegus monogyna*
Eurasian watermilfoil	*Myriophyllum spicatum*
False brome	*Brachypodium sylvaticum*
Field bindweed	*Convolvulus arvensis*
Garlic mustard (T)	*Alliaria petiolata*
Geranium	
Herb Robert	*Geranium robertianum*
Shiny leaf	*Geranium lucidum*
Giant reed (T)	*Arundo donax*
Gorse***** (T)	*Ulex europaeus*
Halogeton	*Halogeton glomeratus*
Houndstongue	*Cynoglossum officinale*

* Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Indigo bush	*Amorpha fruticosa*
Ivy	
Atlantic	*Hedera hibernica*
English	*Hedera helix*
Jointed goatgrass	*Aegilops cylindrica*
Jubata grass	*Cortaderia jubata*
Knapweed	
Diffuse*****	*Centaurea diffusa*
Meadow*****	*Centaurea pratensis*
Russian*****	*Acroptilon repens*
Spotted*****	*Centaurea stoebe (C. maculosa)*
Knotweed	
Bohemian*****	*Fallopia x bohemica*
Giant*****	*Fallopia sachalinensis (Polygonum)*
Himalayan	*Polygonum polystachyum*
Japanese*****	*Fallopia japonica (Polygonum)*
Kochia	*Kochia scoparia*
Lesser celandine	*Ranunculus ficaria*
Meadow hawkweed (T)	*Pilosella caespitosum (Hieracium)*
Mediterranean sage*	*Salvia aethiopis*
Medusahead rye	*Taeniatherum caput-medusae*
Old man’s beard	*Clematis vitalba*
Parrot feather	*Myriophyllum aquaticum*
Perennial peavine	*Lathyrus latifolius*
Perennial pepperweed (T)	*Lepidium latifolium*
Pheasant’s eye	*Adonis aestivalis*
Pine echium (T)	*Echium pininana*
Poison hemlock*****	*Conium maculatum*
Policeman’s helmet	*Impatiens glandulifera*
Primrose-willow	
Large-flower (T)	*Ludwigia grandiflora*
Water primrose (T)	*Ludwigia hexapetala*
Floating (T)	*Ludwigia peploides*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Puncturevine*****	*Tribulus terrestris*
Purple loosestrife*****	*Lythrum salicaria*
Ribbongrass (T)	*Phalaris arundinacea var. Picta*
Rose	
Dog	*Rosa canina*
Sweetbriar	*Rosa rubiginosa*
Rush skeletonweed***** (T)	*Chondrilla juncea*
Saltcedar***** (T)	*Tamarix ramosissima*
Small broomrape	*Orabanche minor*
South American waterweed	*Egeria densa (Elodea)*
Spanish heath	*Erica lusitanica*
Spurge laurel	*Daphne laureola*
Spurge	
Leafy***** (T)	*Euphorbia esula*
Myrtle	*Euphorbia myrsinites*
St. Johnswort	*Hypericum perforatum*
Sulfur cinquefoil	*Potentilla recta*
Swainsonpea	*Sphaerophysa salsula*
Tansy ragwort***** (T)	*Senecio jacobaea (Jacobaea vulgaris)*
Thistle	
Bull	*Cirsium vulgare*
Canada*****	*Cirsium arvense*
Italian	*Carduus pycnocephalus*
Milk	*Silybum marianum*
Musk	*Carduus nutans*
Scotch	*Onopordum acanthium*
Slender-flowered	*Carduus tenuiflorus*
Toadflax	
Dalmatian*****	*Linaria dalmatica*
Yellow*****	*Linaria vulgaris*
Tree of heaven	*Ailanthus altissima*

*Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Ventenata grass	*Ventenata dubia*
Whitetop Hairy Lens-podded Whitetop (hoary cress)*****	 *Lepidium pubescens* *Lepidium chalepensis* *Lepidium draba*
Yellow archangel	*Lamiastrum galeobdolon*
Yellow flag iris	*Iris pseudacorus*
Yellow nutsedge	*Cyperus esculentus*
Yellow starthistle*	*Centaurea solstitialis*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

Appendix B: Morrow County Noxious Weed List

Morrow County Weed List:

NOXIOUS WEEDS

Noxious Weeds – "A" List" – Any plant that is determined by the weed advisory board, and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land or property under provisions of Oregon State Statute and thus mandated for control.

Rush Skeletonweed

Yellow Starthistle

Tansy Ragwort

Yellow Toadflax

Dalmatian Toadflax

Mediterranean Sage

Leafy Spurge

Spikeweed

Musk Thistle

Scotch Thistle

Purple Loosestrife

Common Crupina

Whitetop (Hoary Cress)

Houndstongue

Flowering Rush

Yellow Flag Iris

Plumeless Thistle

WEEDS OF ECONOMIC IMPORTANCE

Weeds of Economic Importance – “B” List – Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

Poison Hemlock

Canada Thistle

Jointed Goatgrass

St. Johnswort

Perennial Sowthistle

Field Bindweed

Cereal Rye

Johnsongrass

Russian Knapweed

Diffuse Knapweed

Spotted Knapweed

Field Dodder

Water Hemlock

Medusahead Rye

Puncturevine

Kochia

Perennial Pepperweed

Myrtle Spurge

Ventenata

Morrow County Weed Advisory Board

The Morrow Soil and Water Conservation District Board also serves as the Weed Advisory Board

Sunstone Solar Project 2
Draft Revegetation and Reclamation Plan

Prepared for

PINEGATE
RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 2, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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1.0 Introduction

Sunstone Solar 2, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 2 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon (Figure 1). The proposed Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 200 MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Revegetation and Reclamation Plan (Plan) has been prepared to guide revegetation of areas temporarily disturbed during construction of the Facility, as well as revegetation within the solar array fence in compliance with Site Certificate Conditions PRE-FW-01 and PRE-SP-01. This Plan will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE), the Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Agriculture (ODA), and Morrow County Weed Department to reflect the final layout of the Facility.

Prior to construction, this Plan shall be finalized based on the following:

1. Certificate Holder shall finalize the Plan based on disturbance associated with the final design/layout by disturbance level and habitat type and category.
2. Certificate Holder shall develop and incorporate maps showing anticipated construction disturbance levels along with the total acreage and major activities associated with each level.
3. Certificate Holder shall update Table 1 prior to construction to reflect the disturbance acreage by habitat subtype for the final layout.
4. Certificate Holder shall develop and incorporate revegetation methods for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department.

Prior to construction, the following shall be completed:

1. Certificate Holder shall provide shapefiles showing anticipated construction disturbance levels at the site as a submittal to ODOE.
2. Certificate Holder shall provide the revegetation and seeding contractor’s qualifications and scope of work as a submittal to ODOE.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

3. Certificate Holder shall submit baseline soil compaction sample locations and baseline compaction results to ODOE.
4. Certificate Holder shall hold a kick-off meeting with their environmental contractor, construction contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
5. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the construction contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.

Prior to initiation of revegetation, the following shall be completed:

1. Certificate Holder shall hold a kick-off meeting with their environmental contractor, revegetation and seeding contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
2. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the revegetation and seeding contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.
3. Certificate Holder shall complete post-construction soil compaction testing and submit results for review and approval to ODOE.

Throughout construction, revegetation, and operation activities, the Certificate Holder will take appropriate actions to prevent the spread of state and county listed noxious weeds. A stand-alone Draft Noxious Weed Control Plan has also been prepared (see Exhibit P, Attachment P-3[2]; updated for RFA 1, see Attachment 6), which contains information on state and Morrow County listed noxious weeds, noxious weeds observed during surveys, and treatment and monitoring of noxious weeds.

2.0 Site Description

The Facility includes a 1,234-acre site boundary within which all Facility components will be located. The Facility lies within the Columbia Plateau Ecoregion at elevations from 1,000 to 1,100 feet. The Facility is sited entirely on private land, which primarily consists of agriculture land used for growing dryland wheat. Native vegetation within the site boundary has been modified primarily through agricultural conversion, but also through the introduction of exotic grasses and other non-native vegetation.

Habitat mapping and categorization of the site boundary were conducted for the Facility in 2022. Habitat types within the site boundary include Agriculture, Pasture, and Mixed Environs (habitat subtype: Orchards, Vineyards, Wheat Fields, Other Row Crops). Details on habitat types, subtypes, and categories can be found in Exhibit P of the Facility's ASC, especially Attachment P-1 which

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[2] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

contains the biological survey reports. Details on potential disturbance to habitat from construction and operation of the Facility, as well as avoidance and minimization measures, can be found in the ASC Exhibits P and Q[3].

3.0 Description of Disturbance

Construction of the Facility will result in temporary and permanent disturbance (see Exhibits C[4] and P). Section 3.1.1 (below) details the acres of each habitat subtype that will be temporarily and permanently disturbed during construction and operation of the Facility. All areas within the solar array fence are considered a permanent disturbance and will be revegetated for the purposes of site stabilization to reduce erosion, dust pollution, and topsoil depletion, and to reduce potential for invasion by noxious and invasive plants. The entire solar array fence will occupy approximately 1,231 acres. As noted above, this area is considered permanently disturbed; however, vegetation within the solar array fence will be retained and/or revegetated and this area would be reclaimed upon retirement.

Temporary disturbance will occur in areas outside the solar array fence that will be disturbed during construction activities, but which will not be occupied by permanent facilities. Temporary disturbance will occur in association with the construction of aboveground and underground collector and transmission lines, new roads, and perimeter fence.

Prior to construction, a crosswalk of the final version of this Plan will be prepared for use by the construction contractor to facilitate Plan implementation and ensure ground disturbance is minimized to the extent practicable. A kick-off meeting with the Certificate Holder, their environmental contractor, construction contractor, and ODOE will be held at least 14 days prior to construction. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify that anticipated disturbance levels are followed to the extent possible and will document any variances and justifications for those variances for ODOE review.

3.1 Disturbance Levels

Revegetation needs will be determined by a combination of disturbance level and existing vegetative cover. Disturbance levels will primarily be determined by site conditions such as slope, gradient, and existing vegetation. Disturbance levels are defined as follows:

Level 1 - Mowing: Mowing is used to conserve vegetative resources within a facility while mitigating risk of fire and facilitating construction activities. Vegetation will be limited to a height of 12 inches and mowed to no less than 6 inches during construction. Mowing to no less than 6 inches protects perennial grass crowns and allows grasses to regenerate. Depending on facility objectives, vegetation can be allowed to reach a normal height or kept trimmed to a height between 6 inches and the plant's

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[3] Complete Application for Site Certificate, Exhibit Q, May 16, 2024.
[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

full height potential. Crushing of vegetation will be minimal and this disturbance level is designed to have a minimal impact on existing vegetation. This method is least likely to result in invasions of undesirable plant species.

Level 2 – Overland Drive and Crush: Disturbance caused by accessing a facility without significantly modifying the landscape. Vegetation is crushed to the ground, but no surface soil is removed so root structures are left intact. Even though vegetation may be damaged or destroyed, the surface soil and seed bank remain in place. Some crushed vegetation will likely sprout after disturbance ceases. These activities would result in minimal to moderate disturbance. This type of disturbance will result in a faster recovery time for vegetation compared to Levels 3 and 4. Soil seed banks remain largely in place, perennial vegetation can grow back, and minimal external efforts are necessary. This method is less likely to result in invasions of undesirable plant species compared to Levels 3 and 4.

Level 3 – Clear and Cut: Disturbance caused by accessing the facility including having to remove all vegetation in order to improve or provide suitable access for other equipment. All vegetation is removed, soils are compacted, and the root zone or soil A-horizon may be disturbed, but no sub-surface soil is removed. Clear and cut activities would result in moderate disturbance. This type of disturbance will result in moderate recovery times for vegetation. This method has a moderate risk for invasion of undesirable plant species. An example is imprinting to crush vegetation down into the soil or incidental grading and smoothing of surface soils.

Level 4 – Clear and Cut with Soil Removal: Disturbance is caused by removing all vegetation in the impact zone, soils are compacted, and surface soil and subsoil are displaced. These activities result in heavy disturbance. This type of disturbance results in an extensive recovery time for vegetation, and is most likely to lead to invasions of undesirable plant species, which can result in lengthy and expensive control efforts. Includes disc-and-roll construction, and other traditional construction methods where soils are disturbed and no vegetation is left intact. This category includes all work requiring the segregation and replacement of topsoils.

3.1.1 Facility Disturbance

To the maximum extent practicable, Level 1 and Level 2 disturbance will be used during Facility construction. Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable, although construction vehicles driving across the site may affect existing root systems by compacting soils. Grading within solar arrays will be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically, but not exclusively, 10 percent maximum on North slopes and 15 percent maximum in other directions). Areas where the slope and gradient are within panel and racking tolerances will only be graded in road, inverter, and energy storage footprints where possible. Preservation of existing root systems will minimize soil erosion, providing both improved compliance with stormwater and dust management requirements, facilitate revegetation success, and preserve soil productivity for future agricultural use. Construction will be coordinated and sequenced to the extent practicable with landowners to maintain land in current production and

weed control until just prior to construction. This will avoid land being left unmanaged and minimize weed issues that can complicate revegetation.

Prior to construction, the Certificate Holder will provide maps and shapefiles showing anticipated construction disturbance levels at the Facility, along with total acreage and major activities associated with each level. This will serve to demonstrate the Certificate Holder's avoidance and minimization of ground disturbing activities to the extent practicable.

Table 1 presents the estimated maximum acreage of temporary and permanent disturbance to habitat subtypes associated with Facility construction and operation based on the permitted layout. Table 1 will be updated prior to construction to reflect the final disturbance acreage by habitat subtype for the final layout. Figures depicting the location of Facility infrastructure are included in Exhibit C, and a figure depicting habitat subtypes within the site boundary is available in Exhibit P.

Table 1. Maximum Temporary and Permanent Disturbance by Habitat Subtype

ODFW Habitat Category	Habitat Subtype	Permanent Disturbance (Acres)[1, 2]	Temporary Disturbance (Acres) [1]
6	Orchards, Vineyards, Wheat Fields, Other Row Crops	1,231	0.5
	Grand Total[1]	**1,231**	**0.5**

1. Additional details associated with temporary and permanent disturbance are provided in Exhibit C of the ASC. Disturbances were calculated based on the layout permitted in the ASC and will be updated prior to construction based on an updated layout.
2. Acres of permanent disturbance includes the entire area within the solar array area fence including the footprints of all solar components and supporting facilities, as well as the areas outside of the footprint of permanent components and facilities (e.g., areas underneath and between rows of solar panels).

4.0 Reclamation and Revegetation Methods

This plan addresses revegetation methods for temporary disturbance to agricultural lands, as well as revegetation and vegetation management of lands within the solar array fence. Revegetation of temporarily disturbed developed habitat (i.e., Urban and Mixed Environs habitat subtype) will be determined on a case-by-case basis and is not covered further in this plan. Temporary disturbances to agricultural habitat (i.e., Orchards, Vineyards, Wheat Fields, Other Row Crops habitat subtype) will be restored as described in Section 4.5.1. The Certificate Holder will restore temporarily disturbed areas by re-establishing slope, surface stability, and drainage features, as needed, followed by soil preparation and seeding. Soil preparation and seeding techniques are described below.

Revegetation will begin as soon as feasible after completion of each construction phase. Seeding and planting will be done in a timely manner and in the appropriate season to facilitate germination and establishment of seeded species.

Prior to construction, final revegetation methods will be developed for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department and will be incorporated as an amendment to this Plan upon ODOE approval.

4.1 Roles and Responsibilities

A construction contractor qualified to perform revegetation and seeding will be responsible for implementing measures in the National Pollutant Discharge Elimination System (NPDES) 1200-C permit, as well as revegetation activities discussed herein during and immediately after construction. A qualified botanist or revegetation specialist will be responsible for monitoring and reporting on revegetation success. Remedial revegetation actions, if needed during the operation phase, will be performed by a qualified contractor. The Certificate Holder will be responsible for ensuring that all contractors perform work in accordance with permit requirements and all agreed upon methods for revegetation.

The goal of this Plan is to increase the probability of revegetation success, reduce early weed establishment, reduce erosion and dust pollution, protect topsoil for future agricultural use in permanent disturbance areas, and ensure no loss of habitat quality for temporary disturbance to wildlife habitat. To ensure this goal is met, the Certificate Holder will ensure that the contractor selected for revegetation will be a qualified revegetation and seeding contractor with demonstrated experience in the Columbia Plateau. Options for contracting and managing this work include:

- Having the construction contractor subcontract revegetation work out to a qualified revegetation and seeding contractor. The contract will stipulate the Certificate Holder's right to dictate the timing, methods, and management of seeding.
- Contracting directly with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.
- Having the environmental contractor contract with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.

The revegetation and seeding contractor's qualifications and scope of work will be provided as a submittal to ODOE prior to construction. Additionally, a crosswalk of the final version of this Plan will be prepared for use by the revegetation and seeding contractor prior to initiation of revegetation to facilitate Plan implementation. A kick-off meeting with the Certificate Holder, their environmental contractor, revegetation and seeding contractor, and ODOE will be held at least 14 days prior to initiation of revegetation activities. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify seeding methods and timing requirements are followed appropriately and will document any variances and the justifications for those variances. Monitoring and follow-up will be provided as described in Section 6.0 to ensure oversight and increase the probability of revegetation success.

4.2 Soil Reclamation

Soil scientists use a soil penetrometer to field measure subsurface compaction in soil. This tool measures resistance (pressure) to the advance of a cone-tipped rod with a T-handle, vertically through the soil column. The metric intends to measure soil compaction that can inhibit the ability of plants to penetrate the soil. An operator pushes the penetrometer rod with a cone base into the ground with consistent force. A pressure gauge records pressure in pounds per square inch (psi), equaling levels of resistance at differing soil layers. Resistance is measured at 3-inch intervals until the meter goes above 300 psi, which is a level of soil compaction most roots cannot penetrate. For this test compaction would be measured at 3, 6, 9, and 12 inches if the soils allow. Soil compaction testing must be completed in spring or late fall when soils are at field capacity (approximately 24 hours after a soaking rain). Baseline soil compaction measurements will be taken prior to construction. Baseline soil compaction sample locations and baseline compaction results will be submitted to ODOE prior to construction.

1. Baseline and post-construction soil compaction measurements and testing must be done in conditions favorable to soil testing (e.g. non-saturated or frozen soils).
2. Baseline soil compaction measurements will be documented and established by using the above protocol, or other protocol as approved by ODOE, to establish baseline soil conditions within temporary disturbance areas.
3. Recordation of the baseline soil plots must be represented on a map based on final Facility design.
4. Post-construction soil compaction testing following the above protocols must be completed in spring or late fall when soil conditions are favorable to soil testing (non-saturated or frozen soils). Compaction testing will occur after soil stockpiles are replaced and grading is complete but prior to initiation of revegetation activities.
5. If soil monitoring demonstrates that soils are compacted more than 300 psi, then remediation activities must be completed prior to initiation of revegetation activities. See Section 4.3 below, the Facility NPDES 1200-C permit, and applicable Site Certificate Conditions.

In addition, in areas where soil is removed during construction, the following measures will be taken where appropriate:

- During construction, excavated topsoil will be stockpiled separately from subsoil and replaced in proper order with topsoil on the surface to maintain soil productivity. Stockpiled soil will be put back in place prior to revegetation activities.
- Soils will be stabilized during construction using the appropriate best management practices as determined by the onsite stormwater pollution prevention plan implementor.
- Soil preparation will involve standard, commonly used methods (i.e. tracking, decompaction, and tilling), and will consider all relevant site-specific factors, including slope, size of area, and erosion potential. Soils will be de-compacted if necessary to create a

uniform seedbed using an agricultural disc, soil ripper, or similar equipment. Additional details regarding soil preparation are in Section 4.3.

- Topsoil and other soils from noxious weed infested areas will not be moved outside of the infested areas and will be returned to their previous location during reclamation activities to eliminate the transport of weed seeds, roots, or rhizomes.
- Soils from weed-infested areas will be treated with a non-persistent, pre-emergent herbicide prior to initiation of revegetation efforts, depending on site-specific conditions.
- Prior to final regrade and revegetation efforts, any weeds that have grown during periods of construction dormancy should be treated as described in the Noxious Weed Control Plan.
- The construction contractor will use appropriate erosion and sediment control practices (i.e., seeded or unseeded hydromulch, tackifier, weed-free erosion control blankets, weed-free or locally sourced straw mulch) to maintain topsoil during construction in both temporary and permanent disturbance areas.

4.3 Site Preparation

Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable. Areas where the slope and gradient are within the solar panel and racking tolerances will receive minimal grading, with grading in those areas limited to the roads, inverter, and energy storage footprints. In areas where soil is removed during construction, the Certificate Holder will demonstrate adequate soil stabilization to prevent erosion and dust pollution. The following measures will be taken where appropriate:

- Site preparation will take into account all relevant site-specific factors, including slope, size of area, and erosion potential.
- Areas of severe machine or vehicle tracking that would hinder seeding success and are unnecessary for soil stabilization will be regraded.
- In the spring, fall or winter of the year prior to when construction would occur, areas of high erosion risk (e.g., slopes, areas with low vegetative cover) should be seeded with a non-invasive, non-persistent cover crop such as triticale to stabilize soils.
- If soils are not suitable for revegetation, soil amendments may be required. Any imported topsoil, if required, will be demonstrated to be suitable for vegetative success.
- Where soil compaction testing demonstrates that soils are compacted greater than 300 psi, soils will be mechanically scarified (e.g., tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction, to maintain soil productivity, and reduce the potential for erosion on compacted soils. Dry soils should be de-compacted using an agricultural disc, soil ripper, or similar equipment.
- Prior to seeding and/or planting of revegetation areas, soils will be prepared into a firm, fine-textured seedbed that is relatively free of debris. Shallow tilling with a disc, followed by a harrow or drag if necessary, can typically achieve this. If replaced soil is too soft, then

seeds may be buried too deep to properly germinate; a roller or culti-packer should be used to pack down the soil.

- In non-cropland temporary disturbance areas, site complexity will be considered during soil preparation. For instance, it may be desirable to purposely create an uneven, patchy site that allows for depressions and other microsites that result in small variations in aspect and moisture holding to promote complexity.
- Seeded areas will be temporarily stabilized to facilitate establishment. This can be accomplished by application of seedless, certified weed-free hydromulch containing a tackifier or straw mulch crimping. Alternate methods may be proposed by the revegetation and seeding contractor but will require prior written approval by ODOE and must provide demonstrated success in sites with similar wind and soil conditions.
- The Certificate Holder or a designated construction contractor will use mulching and other appropriate practices, as required by the anticipated NPDES 1200-C permit, to control erosion and sediment during construction and revegetation work.

4.4 Revegetation of Permanent Disturbance Areas

During construction, the Certificate Holder will implement site stabilization measures, including seeding of all disturbed areas according to the Certificate Holder's anticipated NPDES 1200-C permit. Approximately 6 months prior to commercial operation of each phase of construction, the Certificate Holder will meet with ODFW, ODOE, and Morrow County Weed Department personnel to review the actual extent and conditions of disturbed areas and confirm the revegetation methods to be implemented.

As portions of the Facility are prepared for installation of Facility components (i.e., grading is complete), but prior to installation, all areas with less than 70 percent vegetative cover should be seeded with a non-invasive, non-persistent cover crop. The cover crop will be selected based on the time of year and site conditions; for example, winter wheat or sterile triticale can be seeded from fall to early spring, while peas should be seeded in spring. Tillage radish and sunflowers can be seeded in spring to break up compaction but are not suitable options for soil stability. A cover crop will stabilize soils and suppress noxious weed infestations to reduce erosion and facilitate revegetation of desired plant species.

Following the completion of each construction phase, permanent disturbance areas will be reseeded with a mix of native or non-invasive, non-native grasses and forbs as appropriate based on disturbance level and actual site conditions (see Section 4.4). All seeds will be obtained from a reputable supplier in compliance with the Oregon Seed Law (OAR 603-056). The final seed mix for permanent disturbance areas will include low growing grasses and pollinator-friendly forbs compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Table 3 in Section 4.7 includes an example of low-growing seed mix for permanent disturbance areas.

4.5 Revegetation of Temporary Disturbance Areas

4.5.1 Agricultural Lands

Temporarily disturbed agricultural lands will be reseeded with the appropriate crop or maintained as fallow in consultation with the landowner or farm operator. The Certificate Holder will consult with the landowner or farm operator to determine the seed mix, application methods, and rates for seed and fertilizer. Success of cropland revegetation will have been achieved when production of the revegetated area is comparable to that of adjacent, non-disturbed croplands of the same type.

Agricultural lands will be reseeded to match the timing of the crop rotation on adjacent cropland to facilitate easy harvest and re-establish the appropriate crop rotation. Agricultural lands that will be seeded in the year that construction is complete can be temporarily hydromulched or otherwise stabilized until seeding can occur in the fall; agricultural lands that will be fallow for a year (i.e., fallow rather than reseeded the year construction is complete) will be planted with a cover crop (dependent on timing of construction closeout) or have continued stabilization with hydromulch, straw mulch crimping, or other best management practices through the fallow year.

Soil compaction as a result of construction activity is a concern for restoring agricultural soils to their pre-construction productivity. Within temporary disturbance areas, the Certificate Holder will excavate and store topsoil separately from subsoil, so that topsoil is replaced and restored appropriately. During post-construction revegetation of temporary disturbance to agricultural lands, the Certificate Holder will loosen agricultural soil by mechanical scarification (tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction. Soil amendment, by addition of organic matter (e.g., compost), may also be necessary to alleviate compaction.

Success determination will involve consultation with the landowner or farm operator, and the Certificate Holder will report to ODOE on the success of agricultural land revegetation efforts. Noxious weed control is necessary for successful revegetation of agricultural lands and will be implemented per the methods described in the Draft Noxious Weed Control Plan (Exhibit P, Attachment P-3; updated for RFA 1, see Attachment 6).

4.5.2 Wildlife Habitat

There is no temporary disturbance to wildlife habitat because no wildlife habitat will be disturbed by Facility construction. Revegetation of wildlife habitat is not discussed in this Plan.

4.6 Seeding Methods

The seeding method and timing of planting will be appropriate to the seed mixes (see Section 4.7), weather conditions (e.g., precipitation, wind speed, temperature, etc.), and site conditions (including area size, slope, and erosion potential) based upon consultation with ODOE, ODA, ODFW, the Morrow County Weed Department, and the seed supplier. Seeding from late September to March is typically recommended; however, the Certificate Holder will consult with ODOE, ODFW,

ODA, Morrow County Weed Department, and/or the seed supplier to determine the optimal timing for seed application based on climatic conditions of the particular year when construction and revegetation efforts are implemented.

Common seed application methods that may be used for revegetation are broadcast seeding, drill seeding, imprint seeding, and hydroseeding; each of these are discussed further below. Other seeding methods may be proposed for review and approval prior to revegetation efforts.

4.6.1 Broadcast Seeding

Broadcast seeding is the application of seed directly to the ground surface. This method may be chosen for areas with shallow and rocky soils, and the type of broadcast spreader would depend on the size of the area to be seeded and the terrain. Broadcast seeding may be completed before or after panel and fence installation.

In this method, the seed mix is typically broadcast at a rate of 20 to 24 pounds pure live seed per acre, or twice the recommended rate for drill seeding; this rate may be adjusted depending on the recommendation of the actual seed supplier and agencies. When feasible, due to the seasonality of when planting can occur, the entire area will be seeded after grading is complete but before placement of Facility components, providing more flexibility in seed application. In those instances where seeding occurs prior to installation of components, follow-up seeding will occur in areas temporarily disturbed by installation and any areas that are deficient in vegetation from the first round of seeding. Immediately following seed application, hydromulch or certified weed-free straw would be applied. Broadcast seeding will not be employed if winds exceed 5 miles per hour. If certified weed-free straw is unavailable, the Certificate Holder or a designated construction contractor will identify a local source of straw. The local source of the straw will be approved by the county weed master and ODFW prior to purchase. This straw will either be crimped into the ground or applied with a tackifier.

4.6.2 Drill Seeding

Drill seeding can be used for larger areas with deeper soils and moderate to gentle terrain to accommodate mechanical equipment. This method provides the advantage of planting the seed at a uniform depth and may provide better soil to seed contact. Drill seeding plants seeds using an agricultural or range seed drill at a rate of 12 to 14 pounds pure live seed per acre, per discussions with a seed supplier and ODFW. The rate may be adjusted depending on the recommendations of the actual seed supplier. Drill seeding will be difficult after Facility components have been installed so it will primarily be used if seeding occurs after grading is complete but before components are installed or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.3 *Imprint Seeding*

Imprint seeding is a no-till drill seeding method used to restore grasslands in areas with low annual precipitation. Seeds will be sown at 20 to 24 pounds pure live seed per acre or according to application rates recommended by the seed supplier. The seeder consists of a heavy metal drum roller with V-shaped, angled teeth and a seed agitator box. The teeth create V-shaped troughs with a depth of 4-7 inches to collect rainwater. The rolling drum presses the seed into the soil, insuring good seed-to-soil contact. The troughs collect rainwater for seed germination and seedling growth. Imprint seeders can be used on steep slopes and generally do not require seed bed preparation before seeding. Seeding can occur on soils with light to moderate vegetative cover, with vegetation acting as a mulch to prevent soil erosion until seedlings are established. Imprint seeders do not work well in areas with shrubs or heavy vegetation cover. Heavily compacted soils may need to be ripped or de-compacted before seeding. Imprint seeding will be difficult after solar components have been installed, so it will primarily be used if seeding occurs after grading is complete but before components are installed, or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.4 *Hydroseeding*

Hydroseeding is a method of hydraulically applying seeds, stabilizers, and soil amendments to the surface of the soil. Hydroseeding is most applicable for areas where drill or broadcast seeding machinery cannot access; this usually includes steeper sloped or narrow terrain but can be used in all terrains. Hydroseeding is feasible after panel installation but before the Facility is fenced. Soil bed preparation is also crucial for growth success and frequently includes tracking perpendicular to the slope to create micro conditions for seed. Flat grading and compaction are not recommended. Seeding rates increase by 30 to 50 percent of broadcast seeding rates (i.e., 30 pounds pure live seed per acre) per consultation with the seed supplier and ODFW. Prior to hydroseeding the tackifier and fertilizer, if included, will be reviewed and approved in consultation with ODOE. Fertilizer should not be used when hydroseeding wildlife habitat.

4.7 Seed Mixes

Two seed mixes are proposed for revegetation efforts: one for revegetation of temporary disturbance areas outside the solar array fence, and one for revegetation of permanent disturbance areas within the solar array fence. Tables 2 and 3 present example seed mixes that would be considered for revegetation. However, the number of seed mixes and composition of final seed mixes will be determined in consultation with ODOE and ODFW and will be based on pre-construction conditions and availability of seed at the time of procurement.

Grassland Seed Mix #1 would be appropriate for revegetation of temporarily disturbed areas outside the solar array fence, with the exception of areas that would be returned to agricultural production following construction (as noted in Section 4.5.1). The example seed mix is presented in Table 2 and contains a mixture of native grasses and native, pollinator-friendly forbs. This seed mix includes a mixture of deep-rooted grasses and flowering plants as these types of species can

capture and filter stormwater, build topsoil, and provide food sources and for native insects (Davis 2021). Forbs included in this seed mix were also chosen based on their bloom period. Including plants that flower throughout the growing season provides a continuous source of nectar and pollen and can attract a variety of pollinators (NRCS 2011).

Table 2. Example Grassland Seed Mix #1

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Bluebunch wheatgrass[1]	*Pseudoroegneria spicata*	35
	Sandberg's bluegrass[2]	*Poa secunda* ssp. *secunda*	15
	Bottlebrush squirreltail	*Elymus elymoides*	10
	Needle-and-thread grass[3]	*Hesperostipa comata*	10
Forbs	Low gumweed	*Grindelia nana*	5
	Hoary aster	*Dieteria* (*Machaeranthera*) *canescens*	5
	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Munro's globemallow[4]	*Sphaeralcea munroana*	5
	Western blue flax	*Linum lewisii*	5
	Yarrow	*Achillea millefolium*	5

1. An alternative to bluebunch wheatgrass is Snake River wheatgrass (*Elymus wawawaiensis*; also sold as "Secar" bluebunch wheatgrass).
2. An alternative to Sandberg's bluegrass is big bluegrass (*Poa secunda* subsp. *juncifolia*; also sold as *P. ampla*).
3. Alternatives to needle-and-thread grass include the non-native bunchgrasses crested wheatgrass (*Agropyron cristatum*) and sheep/hard fescue (*Festuca ovina/F. trachyphylla*).
4. An alternative to Munro's globemallow is blanketflower (*Gaillardia aristata*)

A second grassland seed mix, Grassland Seed Mix #2, is suggested for post-construction revegetation within the solar array fence, including areas that previously consisted of agricultural lands. The example seed mix presented in Table 3 contains a mixture of low-growing native and non-native grasses and native and non-native pollinator friendly forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Similar to Grassland Seed Mix #1, this seed mix includes a mixture of deep-rooted grasses and flowering plants that flower throughout the growing season.

Table 3. Example Grassland Seed Mix #2

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Sandberg's bluegrass	*Poa secunda* ssp. *secunda*	35
	Bottlebrush squirreltail, common squirreltail	*Elymus elymoides* ssp. *elymoides*	15
	Desert fescue[1]	*Vulpia microstachys*	10
	Thurber's needlegrass	*Eriocoma (Achnatherum) thurberianum*	10
Forbs	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Bigseed bisuitroot[2]	*Lomatium macrocarpum*	5
	Erigeron/fleabane	*Erigeron filifolius, E. linearis,* or *E. pumilus*	5
	Oregon sunshine	*Eriophyllum lanatum*	5
	Snow buckwheat	*Eriogonum niveum*	5
	Wollypod milkvetch	*Astragalus purshii*	5

1. Alternatives to desert fescue are sixweeks fescue (*Vulpia octoflora*) or sheep/hard fescue (*Festuca ovina*/*F. trachyphylla*).
2. An alternative to bigseed biscuitroot is longleaf phlox (*Phlox longifolia*).

4.8 Revegetation Methods by Disturbance Level

Revegetation methods for each disturbance level were developed to tailor revegetation to specific conditions (Table 4). Revegetation should follow soil reclamation, site preparation, and seeding methods described in Sections 4.2 through 4.7.

Table 4. Revegetation Methods by Disturbance Level

Disturbance Level	Soil Reclamation	Site Preparation	Seeding
1 – Mowing	Ensure vegetation remains intact.	Retain existing vegetation root systems to prevent erosion. Control weeds.	Seed if necessary to achieve success criteria
2 – Overland Drive and Crush	Measure soil compaction in areas of high vehicle traffic.	Retain existing vegetation root systems and/or mulch to prevent erosion. Decompact soil in areas of high vehicle traffic if necessary. Control weeds.	Seed if necessary to achieve success criteria
3 – Clear and Cut	Measure soil compaction.	Mulch to prevent erosion. Decompact soil if necessary. Control weeds.	Required
4 – Clear and Cut with Soil Removal	Measure soil compaction. Stockpile topsoil separately from subsoil and stabilize during construction.	Mulch to prevent erosion. Decompact soil. Regrade and replace subsoil then topsoil prior to seeding. Control weeds.	Required

5.0 Revegetation Documentation

Records will be kept of revegetation efforts in all temporary and permanent disturbance areas. Records will include:

- Date construction phase was completed;
- Acreage of each disturbance level;
- Description and photos of the affected area;
- Date revegetation was initiated;
- Description of the revegetation effort, including methods and timing;
- Supporting figures representing the location, acres affected, and pre-disturbance condition of the revegetation area; and
- Confirmation from the landowner that temporary disturbances in cropland have been satisfactorily restored.

The Certificate Holder will meet with ODOE at least 14 days prior to initiation of revegetation efforts. The Certificate Holder will update ODOE with these records monthly as revegetation work occurs and will provide ODOE with copies of these records along with submission of the monitoring report that is required by the Site Certificate.

6.0 Monitoring

6.1 Monitoring of Permanent Disturbance Areas

In accordance with the Certificate Holder's anticipated NPDES 1200-C permit all areas within the solar array fence must be revegetated to stabilize soils for the purposes of erosion and dust pollution control. Pursuant to OAR 345-022-0022, construction and operation of the Facility must not result in significant adverse impacts to soils, including but not limited to, erosion. Pursuant to MCZO 3.010.K.3.f.(3), construction or maintenance activities shall not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. Therefore, monitoring is required to demonstrate compliance with the above site stabilization and weed control requirements. The Certificate Holder will monitor permanent disturbance areas to assess the following:

- Dominant species composition;
- Relative cover of desirable and undesirable forbs and grasses;
- Percent cover of bare soil;
- Degree of erosion;
- Presence noxious weeds; and

- Qualitative assessment of overall vigor of vegetation within revegetated areas.

Monitoring will be conducted by a qualified botanist or revegetation specialist and will begin within 60 days of the completion of initial site revegetation. Permanent disturbance areas will be monitored using a meander survey. During the meander survey, the surveyor will walk within the solar array fence and document the assessment items listed above using photos and spatial data collection. Areas of erosion and significant patches of bare soil will be mapped and photographed. The surveyor will record dominant species, overall percent cover of forbs and grasses, and general notes about plant vigor.

Monitoring will be conducted at least once per season during the first year following construction. After the first complete year of monitoring, the Certificate Holder will consult with ODOE to determine if the monitoring cycle can be reduced based on revegetation progress. After five years of monitoring, the Certificate Holder will design a long-term monitoring plan in consultation with ODOE.

6.1.1 Success Criteria

Success criteria outlined below will demonstrate compliance with the soil protection standard (OAR 345-022-0022); NPDES 1200-C permit requirements; and the requirements of MCZO 3.010.K.3.f.(4):

- Establish uniform (i.e., evenly distributed, without large bare areas) perennial, non-invasive vegetation that provides 70 percent or more cover on all exposed areas.

Requirements of the soil protection standard and MCZO 3.010.K.3.f.(4) apply to the construction and operation of the Facility. Therefore, the Certificate Holder shall maintain compliance with revegetation success criteria for all areas within the solar array fence for the life of the Facility. In each monitoring report, the Certificate Holder will include an assessment of whether the area within the solar array fence is meeting or trending toward meeting the revegetation success criteria. Final determination of whether the Certificate Holder is in compliance with the revegetation obligations will be made by ODOE. Remedial actions and/or additional monitoring for areas may be required in areas that have been determined by ODOE not to have met the success criteria.

6.1.2 Reporting

Monitoring reports will be prepared and submitted to ODOE once per season during the first year following construction. After the first year of monitoring is complete, the reporting cycle will be modified to align with the new monitoring cycle determined in consultation with ODOE. The first monitoring report will include a detailed description and timeline of revegetation methods that were implemented including species, amounts, and locations of seed applications and dates revegetation work was performed.

Each monitoring report will include:

- GIS maps of revegetation areas and disturbance levels;
- Monitoring methods;
- Local climatic data (i.e., precipitation, temperature) for the monitoring month and year and percent deviation from the historical average;
- Results of monitoring efforts;
- The investigator's assessment of whether the revegetated areas are trending toward meeting the success criteria;
- Assessments of factors impacting the ability of revegetated area to trend towards meeting the success criteria; and
- Recommendations for adaptive management, if any.

6.2 Monitoring of Temporary Disturbance Areas

Per ODFW recommendations on other projects, temporary disturbance monitoring is not required for temporary disturbance areas less than 0.5 acres or when the area is not sufficiently large to accommodate a monitoring site. Because there are no non-agricultural habitat types with temporary disturbance areas greater than 0.5 acres, no monitoring or reference sites will be established for this Facility.

6.3 Adaptive Management

After each revegetation monitoring visit in either temporary or permanent disturbance areas, the Certificate Holder's qualified investigator will report to the Certificate Holder regarding the revegetation progress of each revegetation area. If applicable, the investigator will make recommendations to the Certificate Holder for reseeding, weed control, or other remedial measures for areas that are not showing progress toward achieving revegetation success. The investigator will provide a description of factors that may be contributing to the lack of revegetation success. The Certificate Holder will include the investigator's recommendations for adaptive management and the measures taken in the next monitoring report. ODOE may require reseeding or other remedial measures in cases where success criteria have not been met.

If a revegetation area is damaged by wildfire during the first 5 years following initial seeding, the Certificate Holder will amend this Plan, subject to ODOE approval, to restore the damaged area. The Certificate Holder will continue to monitor and report on revegetation progress during the remainder of the 5-year period. The Certificate Holder will report to ODOE and ODFW the area impacted by the fire (with a map or figure) within 72 hours of discovery.

6.4 Soil Reclamation Monitoring

Soil measurements conducted per Section 4.2 shall be evaluated to determine whether soils within disturbance areas have compaction readings of greater than 300 psi. If results show soils have compaction readings of greater than 300 psi, then remediation activities must be completed before revegetation can begin. Prior to initiation of revegetation, the Certificate Holder will provide the results of soil compaction testing to ODOE.

7.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

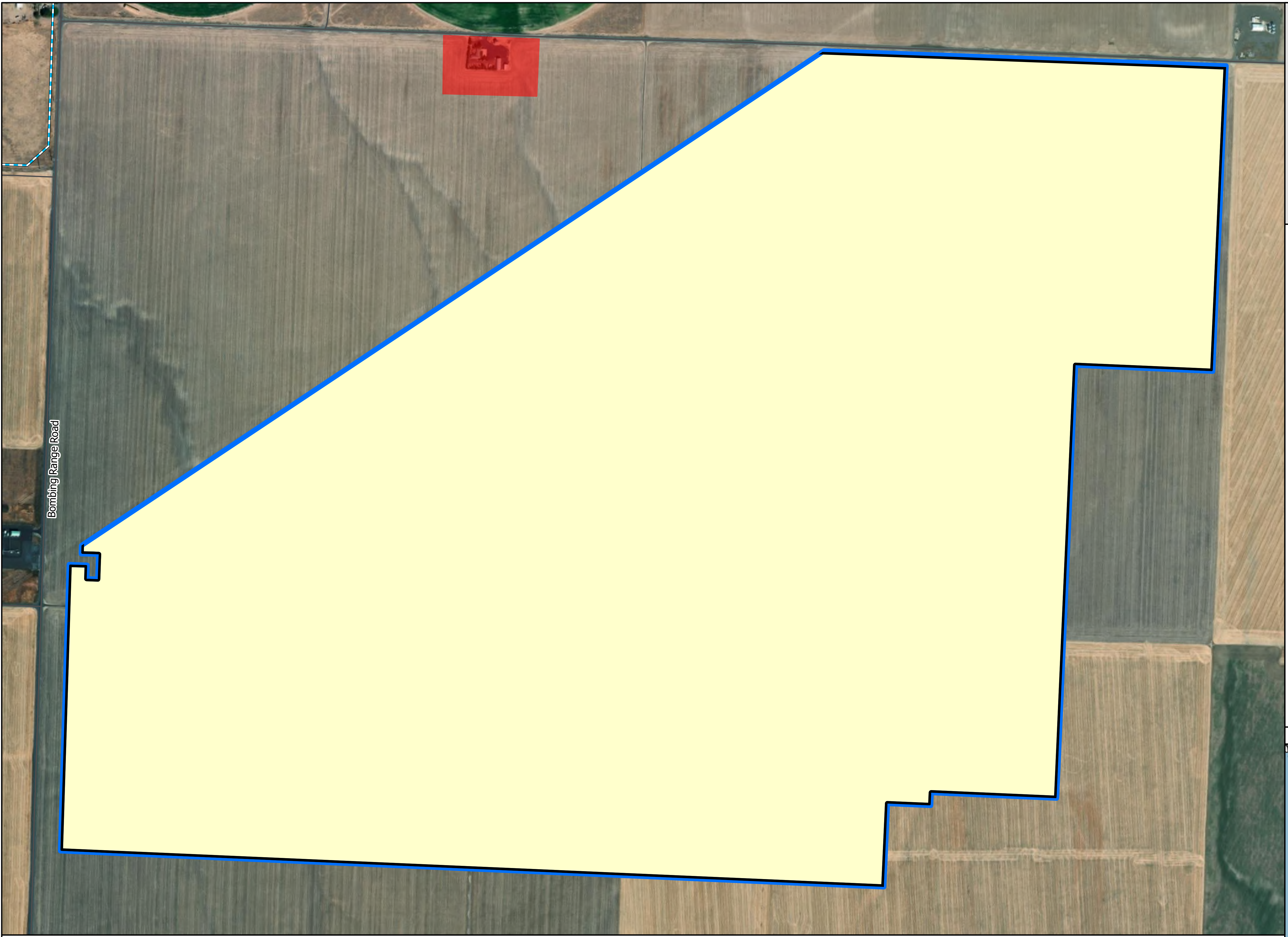
8.0 References

Davis, R. 2021. Global buzz for solar with pollinators and beekeeping. Fresh Energy, Center for Pollinators in Energy. Available at: https://fresh-energy.org/solar-beekeeping-goes-global

Mosley, J. 2018. Targeted Livestock Grazing to Suppress Cheatgrass. Department of Animal and Range Sciences, Montana State University. November. Available at: https://www.montana.edu/extension/sanders/Prescription%20for%20Cheatgrass%20November%2025%202018.pdf

NRCS (Natural Resources Conservation Service). 2011. Plants for Pollinators in the Inland Northwest. U.S.D.A Natural Resources Conservation Service, Spokane, Washington – Boise, Idaho.

Figure



Sunstone Solar Project

Figure 1
Sunstone Solar Project 2

MORROW COUNTY, OR

- ▭ SS 2 Site Boundary
- ▭ Permitted Fenceline
- 🟥 Excluded from Development
- — Local Roads
- ┅ Existing UEC Transmission Line

Habitat Subtypes by Category

Category 4

- 🟪 Intermittent or Ephemeral Stream

Category 6

- 🟨 Orchards, Vineyards, Wheat Fields, Other Row Crop

TETRA TECH PINEGATE RENEWABLES

Reference Map

1:10,000 WGS 1984 UTM Zone 11N

0 0.25 0.5 Miles

NOT FOR CONSTRUCTION

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Sunstone Solar Project 2
Draft Wildlife Monitoring Plan

Prepared for

PINEGATE
RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 2, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

Table of Contents

1.0 Introduction

Sunstone Solar 2, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 2 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities and the anticipated phasing of construction are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Wildlife Monitoring Plan (WMP) describes wildlife monitoring the Certificate Holder will conduct during operation of the Facility. This WMP has the following components:

1. Raptor nest surveys
2. Washington ground squirrel (WAGS; *Urocitellus washingtoni)* monitoring
3. Wildlife Reporting and Handling System (WRHS)
4. Data reporting

This WMP will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE) and the Oregon Department of Fish and Wildlife (ODFW) and will be updated as needed to reflect the final layout of the Facility.

2.0 Raptor Nest Surveys

The objectives of raptor nest surveys are: (1) to count raptor nests on the ground or above ground at the Facility; and (2) to determine whether there are noticeable changes in nesting activity in the local populations of raptor species, with particular focus on Swainson's hawks (*Buteo swainsoni*), the only state sensitive raptor species documented nesting during baseline surveys.

The Certificate Holder will conduct long-term ground-based monitoring of nests identified during the baseline raptor nest surveys, as well as any other nests identified subsequently. The ground-based surveys will be used to evaluate nest success by gathering data on nest occupancy. The Certificate Holder will employ qualified personnel to perform raptor nest surveys.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

2.1 Initial Monitoring

The first monitoring season will be in the first full raptor nesting season after the commercial operating date. During the first monitoring season, the surveyor will conduct one ground survey for raptor nests in late May or early June and additional surveys as described in this section. The ground surveys will be conducted within the site boundary to determine nest occupancy.

All nests discovered during the anticipated pre-construction surveys and any nests discovered during post-construction surveys, whether active or inactive, will be given identification numbers. Global Positioning System (GPS) coordinates will be recorded for each nest. Locations of inactive nests will be recorded because they could become occupied during future years.

After the first monitoring season, the surveyor will analyze this one year of data compared to the baseline data. The Certificate Holder will provide a summary of the first-year results in the monitoring report described in Section 5.0.

2.2 Long-Term Monitoring

The surveyor will conduct raptor nest surveys at 5-year intervals for the life of the Facility.[2] The surveyor will conduct long-term raptor nest surveys following the methods described in Section 2.3 every 5 years after the first monitoring season in years divisible by 5. This may result in a greater than 5-year period between the initial monitoring season and the first long-term monitoring season (e.g., if the initial monitoring season is 2028, the first long-term monitoring season would be 2035 rather than 2033). During each long-term monitoring event biologists will visit all previously identified nest locations in addition to searching the survey area for new nest sites.

In conducting long-term surveys, the surveyor will follow the same survey protocols as the initial survey (Section 2.3), unless the Certificate Holder proposes alternative protocols that are approved by ODOE. In developing an alternative protocol, the Certificate Holder will consult with ODFW and ODOE and will take into consideration other raptor nest monitoring conducted in adjacent or overlapping areas.

The Certificate Holder will analyze the data to identify any trends in the number of raptor breeding attempts the Facility supports and the success of those attempts. The Certificate Holder will submit a report after each year of long-term raptor nest surveys.

2.3 Monitoring Protocol

Qualifications of surveyors: Surveys and nest monitoring will be conducted by professional, qualified biologists with a relevant academic background and sufficient field experience pertaining to avian biology and species identification.

Survey period: Occupancy surveys will be conducted between March 1 and May 31. The survey period may be extended in consultation with ODFW and ODOE.

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[2] As used in this plan, "life of the Facility" means continuously until the Facility is restored and the site certificate is terminated in accordance with OAR 345-027-0110.

Survey area: The survey area will be limited to leased parcels within the Site Boundary, where surveyor access is granted. Surveys will be performed from public roads and project roads, or from participating landowner parcels only, as site conditions safely permit (e.g. snow, mud).

Survey protocol: Biologists will conduct a ground-based search for raptor nest activity using binoculars and/or spotting scopes to search potential nest sites. Previously identified nests will be surveyed to determine the occupancy status of nests. New nests that are discovered will also be surveyed and visited in future monitoring years. A log will be kept to track nest occupancy status on all nests. ArcGIS Online or similar GIS program will be used to locate and track the nests.

Data collection: Data collected during the survey will include, at a minimum, the location, occupancy status, occupying species, activity observed, and condition of each nest.

Nest Location: Nest/Burrow Identification Number: Existing IDs will be used where possible in addition to corresponding GPS waypoint numbers.

Occupying Species: Using four-letter American Ornithologists' Union codes (e.g., SWHA = Swainson's hawk).

Raptor Activity:

- Adult Present: Proximity of the adult to the nest (e.g., on nest, nearby, or unknown).
- Eggs or Young: Number of eggs or young observed.
- Nest Substrate: Structure in which nest was located (e.g., broadleaf tree, cut bank, transmission pole, etc.).
- Nest Height: Height relative to the structure it is on (e.g., on top of transmission pole, 3/4 of height of tree).

Nest Condition: To assess nest condition the following criteria will be used:

- No Longer Present: For nests that are no longer present.
- Unknown: The nest cannot be found, was not surveyed, or the nest is present, but because of its location a determination cannot be made.
- Excellent: Defined cup or nest bowl with a well-maintained rim; adult or young present.
- Good: Nest bowl intact and rim defined; minor repair needed for nest to be used; margins of nest in loose configuration, minor slumping occurring.
- Fair: Nest bowl intact and nest not dilapidated; but needs significant repair in order to be used; material is slumping or sliding.
- Poor: Loose structure of nest bowl still present; nest walls and side falling out; nest is in need of major repair to be used.
- Remnant: Nest bowl not defined; scant material remaining and not usable unless fully rebuilt.

Determination of active nests: Nest occupancy status will be determined using the definitions below.

Active: Defined by the presence of one or more eggs, dependent young, or adults on the nest in the past 10 days during the breeding season, including the period when adults are displaying courtship behaviors and are building or adding to the nest in preparation for egg-laying.

Potentially Active: There is not observable activity during the visit, but active status cannot be confirmed.

Inactive: The inactive status will only be determined if the nest is observed for at least one hour each time over the course of two consecutive visits separated by at least one day.

3.0 Washington Ground Squirrel Monitoring

No WAGS were detected during baseline surveys, but any new colonies that are detected incidentally during other surveys, such as raptor nest monitoring, will be documented and the extent of those colonies delineated and included in future WAGS monitoring and reporting activities.

If any incidental WAGS are detected, the Certificate Holder will employ qualified personnel to monitor these locations every 5 years thereafter in years divisible by five for the life of the Facility (i.e., on the same monitoring schedule as the raptor nest surveys). The survey area will include the colonies (i.e., groups of active burrows) and a buffer of 785 feet in suitable habitat, if accessible. The surveyors will walk linear transects spaced 165 to 230 feet (50 to 70 meters) apart two times between February 15 and May 31. Surveys of each location will be spaced at least 2 weeks apart. Surveyors will record locations of activity centers and colony boundaries using a sub-meter accuracy GPS unit; approximate number of burrows; and representative photographs of burrows and scat. Surveyors will describe habitat characteristics at each location and note any noticeable land use or habitat changes that may have occurred since detection.

After each survey, the Certificate Holder will report the results to ODFW and ODOE and will include maps of the areas surveyed and detection locations. WAGS surveys will not be conducted if there are barriers to WAGS dispersal (i.e., active agriculture fields, highways, perennial waterbodies) or no suitable habitat.

4.0 Wildlife Reporting and Handling System

The Certificate Holder will document fatalities found during routine maintenance activities and any other incidentally detected fatalities. However, systematic post-construction fatality monitoring studies are not likely to produce significant findings or provide meaningful data on impacts based on the attributes of this Facility (especially relative to the costs that they incur to implement) as described below, and therefore no systematic post-construction fatality monitoring study is proposed for the Facility nor is one needed to meet the standards under Oregon Administrative Rule (OAR) 345-022-0060. In a December 2023 meeting with the Certificate Holder and ODOE, ODFW stated they are not requesting a post-construction fatality monitoring study for the Facility. If evidence of significant fatality events is detected by operations and maintenance (O&M) staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring and adaptive management.

Although mortality at the Facility due to collision with infrastructure is possible, as it is with most human development (e.g., buildings), the available literature on avian mortality at utility-scale photovoltaic solar energy sites suggests that mortality at these facilities is comparatively low (Walston et al. 2016, Loss et al. 2014, Kosciuch et al. 2020, Smith et al. 2021). In Oregon, results of a fatality study at a 56-MW photovoltaic facility near Prineville detected only three bird fatalities, only two of which were native birds (i.e., a horned lark [*Eremophila alpestris*] and a dark-eyed junco [*Junco hyemalis*]), during 1 year of standardized searches (ODOE 2020). These results suggest that large fatality events are unlikely at photovoltaic solar facilities in the region but that low numbers of fatalities of common ground-dwelling bird species could be detected at the Facility (ODOE 2020), and may be similar to background mortality levels. Post-construction fatality monitoring studies conducted at utility-scale photovoltaic solar facilities to date have reported lower fatality rates compared to other human development types, with fatalities in general primarily composed of resident ground-nesting birds.

In contrast to wind energy development, impacts to wildlife from photovoltaic solar development are primarily associated with habitat loss rather than direct mortality from collisions. The Facility is located almost entirely on wheat fields, and impacts to wildlife habitat will be minimal, restricted primarily to small tracts of disturbed grasslands. This habitat will be mitigated in accordance with ODFW's Habitat Mitigation Policy (OAR 635-415-0025), as described in the Facility's Exhibit P and Habitat Mitigation Plan (Attachment P-2 to Exhibit P; updated for RFA 1, see Attachment 6). The Certificate Holder will adhere to standard best management practices including following Avian Powerline Interaction Committee guidelines for minimizing avian collisions and electrocutions (APLIC 2006, 2012), primarily burying the medium voltage collector line system, and implementing down-shield lighting for permanent lighting at the substations and O&M buildings, and identifying a licensed local wildlife rehabilitator capable of responding to the Facility in the event of injured wildlife. Based on coordination with ODFW, the Certificate Holder will additionally install flight diverters on the overhead collector line that crosses Sand Hollow. The Certificate Holder will use wildlife-friendly fencing that does not include a top strand. Thus, the Facility has already minimized the risk of avian collision fatalities, based on known risk factors such as lighting (Gehring et al. 2009; Kerlinger et al. 2010; USFWS 2012, 2013).

Additionally, post-construction fatality monitoring is not necessary for the Certificate Holder to meet the standards under OAR 345-022-0060 (i.e., that the design, construction and operation of the facility, taking into account mitigation, are consistent with the general fish and wildlife habitat mitigation goals and standards of OAR 635-415-0025, ODFW's Fish and Wildlife Habitat Mitigation Policy) because the mitigation goals and standards relate to fish and wildlife habitat quality and quantity rather than fatalities of fish and wildlife individuals. OAR 635-415-0025 goals and standards for impacts to Category 2, 3, 4, and 5 habitat (i.e., the habitat categories addressed in the Facility's Habitat Mitigation Plan) include avoidance and, where impacts are unavoidable, mitigation to achieve the goal of no net loss of either habitat quantity or quality (Category 2, 3 and 4 habitat) and/or a net benefit in habitat quantity or quality (Category 2 and 5 habitat). Fatality monitoring, in itself, does not improve or maintain habitat quantity or quality, nor would the results of monitoring affect the habitat mitigation ratios or the size of the mitigation need described in the

Facility's Habitat Mitigation Plan attached to Exhibit P and Attachment 6 for RFA 1. Therefore, a systematic post-construction fatality monitoring study is not necessary for the Energy Facility Siting Council (EFSC) to determine that the Facility is consistent with OAR 635-415-0025

Although standardized fatality searches will not be implemented, all incidentally detected fatalities will be reported in the WRHS. The WRHS is a program for O&M staff to report wildlife (including bird and bat) casualties found during operation of the Facility. O&M staff will be trained in the methods needed to carry out this program. This monitoring program includes the initial response, handling, and reporting of bird and bat carcasses discovered incidental to maintenance operations ("incidental finds"). Approximately 10 permanent O&M staff are anticipated to be on-site for Facility operations and be responsible for WRHS program implementation. If a battery energy storage system is installed, additional workers will be on-site, but they will likely be contract employees and will not be included in WRHS program implementation. As part of routine O&M activities, O&M staff will visit each inverter pad approximately every 6 months to visually inspect equipment. If evidence of significant fatality events is detected by O&M staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring.

All carcasses discovered by O&M staff will be photographed and recorded. If O&M staff find a carcass at the Facility, they will notify qualified personnel who will identify the carcass. If the qualified personnel determines that a carcass is a state or federally threatened or endangered or otherwise protected species, agency reporting procedures and timelines specified in Section 5.0 shall be followed. Information recorded for each carcass and reported to ODFW and ODOE will include the location, date of discovery, species if known, as well as any evidence that might assist in determination of cause of death, such as evidence of electrocution, vehicular strike, wire strike, predation, or disease. Based on coordination with ODFW, feather spots[3] will be documented if found as well, consistent with industry standards; however, feather spots will not necessarily be attributed to a Facility-caused fatality (personal communication with J. Thompson, ODFW, December 13, 2023). Fatalities documented by O&M staff will be reported to ODOE and ODFW annually, as described in Section 5.0.

Prior to construction, the Certificate Holder will develop and implement a protocol for handling injured birds. Any injured native birds found at the Facility may be carefully captured by trained qualified personnel and transported to a qualified rehabilitation specialist approved by ODOE. Alternatively, the Certificate Holder may contact a qualified rehabilitation specialist approved by ODOE to respond to injured wildlife. Blue Mountain Wildlife (https://bluemountainwildlife.org/, 541.278.0215), located in Pendleton, Oregon, has confirmed the ability to respond to injured native wildlife, especially migratory birds, at the Facility (Lynn Tompkins, personal communication, April 11, 2023). The Certificate Holder will pay costs, if any, charged for time and expenses related to care and rehabilitation of injured native birds found on the site, unless the cause of injury is clearly demonstrated to be unrelated to Facility operations.

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[3] Feather spots are defined as at least 5 tail feathers, or 2 primary feathers, or a total of at least 10 feathers with no attached bone or tissue, within 5 meters of each other (CEC and CDFG 2007).

5.0 Data Reporting

The Certificate Holder will report wildlife monitoring methods, data, and data analysis to ODOE for each calendar year in which wildlife monitoring occurs. Monitoring data include raptor nest survey data, WAGS monitoring data (if applicable), and WRHS data. The Certificate Holder may include the reporting of wildlife monitoring data and analysis in the annual report required under OAR 345-026-0080 or submit this information as a separate document at the same time the annual report is submitted. In addition, the Certificate Holder will provide to ODOE data or records generated in carrying out this WMP upon request by ODOE.

The Certificate Holder will notify the U.S. Fish and Wildlife Service and ODFW if any federal or state endangered or threatened species are killed or injured at the Facility within 24 hours of species identification.

6.0 Plan Amendment

This WMP may be amended from time to time by agreement of the Certificate Holder and EFSC. Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this WMP. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

7.0 References

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Inadvertent Discovery Plan

Sunstone Solar Project 2
Morrow County, Oregon

October 2025

Author:
Lara Rooke, MA, RPA

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

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1.0 INTRODUCTION

Pine Gate Renewables (PGR) proposes to construct and operate the approved Sunstone Solar Project 2 (Facility), a solar energy generation facility with related or supporting facilities including an energy storage system on private lands in Morrow County, Oregon. PGR seeks a Site Certificate through the Oregon Department of Energy (ODOE), Oregon Energy Facility Siting Council (EFSC or Council) for the Facility. The Facility will include an up to 200-megawatt (MW) solar project, battery energy storage system, and related or supporting facilities in Morrow County, Oregon. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1). The approved solar facility siting area (Facility site boundary) is located on privately owned agricultural land with areas of sage brush near the drainages and along Sand Hollow Canyon.

To meet the requirements for site certification, PGR must develop an Inadvertent Discovery Plan (IDP) for monitoring construction activities and responding to the discovery of archaeological resources or buried human remains.

2.0 CULTURAL RESOURCES IN THE PROJECT AREA

The entirety of the Facility site boundary and a 2-mile viewshed was surveyed for cultural resources, including pedestrian surveys along with subsurface shovel probing within the Facility site boundary. One Historic Property of Religious or Cultural Significance to Indian Tribes (HPRCSIT), Sand Hollow Battleground, is identified in the Oregon State Historic Preservation Office's (SHPO) archaeological database as overlapping a portion of the Facility site boundary. The HPRCSITs are eligible for listing on the NRHP.

Due to the presence of two culturally important resource areas to the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) within the Facility site boundary and its viewshed, the CTUIR has recommended monitoring to protect potential HPRCSIT-associated subsurface resources. The CTUIR has recommended that monitoring occur in the following areas:

- Within the HPRCSIT boundaries and a 100-foot surrounding buffer area, monitoring should occur for all ground disturbing activities, except driving posts for the solar modules; and
- Monitoring should occur within the Facility site boundary for all excavation work related to the proposed 3-foot-deep collector cable system.

Prior to construction, PGR will develop a Monitoring Plan that incorporates this IDP and includes necessary staff, agency, and tribal contact information once determined. This plan should include monitoring protocols and staffing roles and incorporate input from the CTUIR.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

3.0 PROCEDURES FOR THE DISCOVERY OF ARCHAEOLOGICAL RESOURCES

If any staff, contractors, or subcontractors, including archaeological and/or tribal monitors, believe that they have encountered cultural or archaeological remains of any kind, all work at and adjacent to the discovery shall immediately cease. The area of work stoppage will be adequate to provide for the security, protection, and integrity of the archaeological discovery. A cultural resource discovery may be pre-contact period or historic period in age and consist of (but not limited to):

- Areas of charcoal or charcoal-stained soil and stones;
- Stone tools or waste flakes (i.e., an arrowhead or stone chips);
- Bone, burned rock, or shell, whether or not seen in association with stone tools or chips;
- Clusters of tin cans, ceramics, flat glass, or bottles; and
- Concentrations of brick, railway tracks, or logging or agricultural equipment.

In the event unrecorded archaeological resources are identified during the construction or operation of the Sunstone Solar Project 2, work within 100 feet of the find shall be halted and directed away from the discovery until a Qualified Archaeologist[2] assesses the resource and its significance for inclusion on the NRHP. This assessment will include coordination with the CTUIR. (A wider avoidance area will be required for human remains; see below.) The archaeologist, in coordination with ODOE, the SHPO, Facility personnel, CTUIR, and the landowner, shall make the necessary plans for treatment of the finds and for the evaluation and mitigation of impacts if the finds are found to be eligible for listing on the NRHP.

A Qualified Archaeologist will determine if the resources are archaeological and greater than 50 years old. If the archaeologist believes that the discovery is a cultural resource, he or she in coordination with the PGR Construction Manager will establish a 100-foot avoidance buffer to protect the discovery site where construction activities will be suspended until treatment of the discovery can be determined. Vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery site or avoidance area. Any newly discovered archaeological resource will be considered eligible to the NRHP until determined otherwise. Work in the immediate area will not resume until treatment of the discovery has been completed.

If archaeological artifacts are observed during construction, the Qualified Archaeologist will ensure proper documentation and assessment of any discovered cultural resources. All precontact and historic cultural material discovered during project construction will be recorded by the archaeologist in SHPO's online archaeological site form database. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/sediment descriptions will be prepared for subsurface exposure. Discovery locations will be documented on scaled site plans and site location maps.

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[2] *Qualified Archaeologist* - means a person with qualifications meeting the federal secretary of the interior's standards for a Professional Archaeologist . An individual who has: (A) A post-graduate degree in archaeology, anthropology, history, classics or other germane discipline with a specialization in archaeology, or a documented equivalency of such a degree; (B) Twelve weeks of supervised experience in basic archaeological field research, including both survey and excavation and four weeks of laboratory analysis or curating; and (C) Has designed and executed an archaeological study, as evidenced by a Master of Arts or Master of Science thesis, or report equivalent in scope and quality, dealing with archaeological field research.

If the Qualified Archaeologist in consultation with the SHPO and CTUIR determines that the discovery is an NRHP-eligible cultural resource, they will consult to determine appropriate treatment to be presented and agreed upon in a Memorandum of Agreement (MOA) or other appropriate documentation. Mitigation measures will be developed in consultation with PGR, ODOE, SHPO, CTUIR, and the landowner, and could include avoidance through redesign, conducting data recovery, and/or relocating materials. Treatment measures performed may include protecting in place or data recovery such as mapping, photography, limited probing, and sample collection, or other activity deemed appropriate through an MOA or other appropriate documentation.

If human remains are inadvertently discovered, ODOE, SHPO, the Legislative Commission on Indian Services (LCIS), and CTUIR will decide when construction may continue at the discovery location. Where cultural resources are encountered during construction, but additional project effects to the resources are not anticipated, Facility construction may continue while documentation and assessment of the cultural resources proceed. If continued construction is likely to cause additional impacts to such resources, Facility activities within a radius of 100 feet of the discovery will cease until the Qualified Archaeologist has documented the site, evaluated its significance in consultation with CTUIR, and assessed potential effects to the site.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the discovery of the cultural resource, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 100 foot buffer—work may continue outside of this buffer.
3) Notify PGR Project Manager and ODOE (see Attachment A).
4) Construction Manager will need to contact a Qualified Archaeologist to assess the find.
5) If archaeologist determines the find is an archaeological site or object, contact SHPO. If it is determined to *not* be archaeological, you may continue work.

4.0 PROCEDURES FOR THE DISCOVERY OF HUMAN REMAINS

If human remains and/or associated grave goods are inadvertently encountered during Project activities, the Oregon State legislature protocol[3] for inadvertent discovery of human remains will be followed (Oregon State Legislature 2025). All activity that may cause further disturbance to the remains shall cease and the area secured and protected from further disturbance. A 200-foot avoidance buffer will be utilized for human remains and associated grave goods until appropriate

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[3] https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

treatment is completed. The presence of skeletal remains will be immediately reported to the County Medical Examiner, Oregon State Police, SHPO, and LCIS. The remains will not be touched, moved, or further disturbed. The County Medical Examiner or LCIS State Physical Anthropologist will assume jurisdiction over the human skeletal remains and determine whether those remains are forensic or non-forensic. If the remains are non-forensic, then they will report that finding to SHPO and the State Physical Anthropologist with the LCIS, who will then take jurisdiction over the remains and will notify CTUIR.

Although excavation work in the immediate area of a human remains find will not resume until assessment has been completed, excavation work may continue in other parts of the Facility that have been surveyed for cultural resources. Due to the sensitive nature of such a find, human remains should never be left unattended. No work will resume in the area of a human remains discovery until written authorization has been received from the LCIS and SHPO.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the inadvertent discovery, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 60-meter/200-foot buffer, then work may continue outside of this buffer with caution.
3) Cover remains from view and protect them from damage or exposure, restrict access, and leave in place until directed otherwise. Do not take photographs. Do not speak to the media.
4) Notify (refer to Attachment A for contact information):
    - PGR Project Manager
    - ODOE
    - Oregon State Police **DO NOT CALL 911**
    - SHPO
    - LCIS State Physical Anthropologist
    - CTUIR and other appropriate Native American Tribes determined by LCIS

5) If the site is determined not to be a crime scene by the Oregon State Police, do not move anything! The remains will continue to be secured in place along with any associated funerary objects, and protected from weather, water runoff, and shielded from view.
6) Do not resume any work in the buffered area until a plan is developed and carried out between ODOE, SHPO, LCIS, and appropriate Native American Tribes and you are directed that work may proceed.

5.0 CONFIDENTIALITY

The Facility and employees shall make their best efforts, in accordance with federal and state law, to ensure that its personnel and contractors keep the discovery confidential. The media, or any third-party member or members of the public are not to be contacted or have information regarding the discovery, and any public or media inquiry is to be reported to ODOE. Prior to any release, the responsible agencies and Tribes shall concur on the amount of information, if any, to be released to the public.

To protect fragile, vulnerable, or threatened sites, the National Historic Preservation Act, as amended (Section 304 [16 U.S.C. 470s-3]), and Oregon State law (Oregon Revised Statute 192.501(11)) establishes that the location of archaeological sites, both on land and underwater, shall be confidential.

6.0 REFERENCES

Oregon State Legislature

2025 Electronic document accessed July 2025, https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

ATTACHMENT A: CONTACTS

1. Pine Gate Renewables

Project Manager	To be determined prior to construction

2. Cultural Resource Contacts

Qualified Archaeologist	Lara Rooke, Tetra Tech (425) 217 7625 (Cell)
Oregon SHPO State Archaeologist	John Pouley (503) 480-9164
State Physical Anthropologist, LCIS	Dr. Elissa Bullion (971) 707-1372 or (503) 986-1067

3. Agency Contacts

ODOE	Christopher Clark (503) 871-7254
Oregon State Police	Craig Heuberger (503) 731-0079 or (503) 731-3030 (dispatch)
Morrow County Medical Examiner	(541) 676-5421

4. Tribal Contacts

CTUIR	Teara Farrow Ferman (Human Remains) (541) 429-7230 or (541) 377-2959 (cell) Ashley Morton (Archaeological Resources) (541) 429-7214

Sunstone Solar Project 2

Draft Construction Wildfire Mitigation Plan

Sunstone Solar Project 2
October 2025

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 2, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

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Table of Contents

List of Tables

Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 2, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
EMP	Emergency Management Plan
Facility	Sunstone Solar Project 2
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 2, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 2 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) is attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described in this plan, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final Construction WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.
[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During construction, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to construction of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115, if significantly different from Final Order on ASC and the Request for Amendment 1.

4.0 Inspection and Management

OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;

4.1 Vegetation Management

The Certificate Holder and contractor(s) will maintain vegetation within the Site Boundary and will also maintain a defensible space clearance along Facility features. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

The following best management practices to minimize fire risk from vehicle travel and fueling activities would be implemented at the site during construction:

- The movement of vehicles will be planned and managed to minimize fire risk.
- The contractor(s) will be responsible for identifying and marking paths for all off-road vehicle travel. All off-road vehicle travel will be required to stay on the identified paths. No off-road vehicle travel will be permitted while working alone. Travel off road or parking in vegetated areas will be restricted during fire season.
- Areas with grass that are as tall or taller than the exhaust system of a vehicle must be wetted before vehicles travel through it.
- Workers will be instructed to shut off the engine of any vehicle that gets stuck, and periodically inspect the area adjacent to the exhaust system for evidence of ignition of vegetation. Stuck vehicles will be pulled out rather than “rocked” free and the area will be inspected again after the vehicle has been moved.
- All combustion engines (including but not limited to off road vehicles, chainsaws, and generators) will be equipped with a spark arrester that meets U.S. Forest Service Standard 5100-1.
- The contractor(s) will designate a location for field fueling operations at the temporary construction yards. Any fueling of generators, pumps, etc. shall take place at this location only.
- Fuel containers, if used, shall remain in a vehicle or equipment trailer, parked at a designated location alongside a county right-of-way. No fuel containers shall be in the vehicles that exit the right-of-way except the five-gallon container that is required for the water truck pump.
- Smoking shall only be allowed in designated smoking areas at the Facility.

5.0 Preventative and Minimization Actions for Wildfire Risk

OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;

5.1 Preventative Actions

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads[3]. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present. See Exhibit U[4] for additional discussion of Project fire prevention measures and coordination with local emergency responders.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during construction of the Facility, as applicable.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

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[3] Complete Application for Site Certificate, Exhibit D, May 16, 2024.

[4] Complete Application for Site Certificate, Exhibit U, May 16, 2024.

5.2.2 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fore spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high risk locations, designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.3 Emergency Management Plan

The EMP will be prepared prior to construction by the Certificate Holder and construction contractor and will contain policies and procedures for preparing for and responding to a range of potential emergencies, including fires. Implementation of the EMP will ensure risks to public health and safety and risks to emergency responders are minimized. Any potential fires inside the solar array will be controlled by trained staff who will be able to access the Facility around the clock. These measures will help keep external fires out or internal fires in. The EMP will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The plan will also specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, a construction kickoff meeting to discuss emergency planning, and invitations to observe any emergency drill conducted at the Facility.

In addition to the emergency responses to be stipulated in the EMP, personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

Another safety mitigation measure is to have available on site during construction is a water truck, water buffalo, or tank with minimum 500 gallon capacity.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

The Certificate Holder will track the industry groups and applicable design standards outlined in Table 2 to identify future technologies or best practices that could be implemented at the Facility.

Table 2: Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the O&M building and the substation enclosure.	Remodeling to the O&M and enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

Reference	Description	Method
1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/. 2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf. 3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.		

7.0 References

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IEEE (Institute of Electrical and Electronics Engineers). 2012. Guide for Substation Fire Protection. IEEE Std 979-2012, November, 1–99. https://doi.org/10.1109/IEEESTD.2012.6365301.

IEEE. 2015. Guide for Safety in AC Substation Grounding. IEEE Std 80-2013 (Revision of IEEE Std 80-2000/ Incorporates IEEE Std 80-2013/Cor 1-2015), May, 1–226. https://doi.org/10.1109/IEEESTD.2015.7109078.

Jeevarajan, Judith A., Tapesh Joshi, Mohammad Parhizi, Taina Rauhala, and Daniel Juarez-Robles. 2022. Battery Hazards for Large Energy Storage Systems. *ACS Energy Letters* 7(8):2725-2733. Available online at: https://pubs.acs.org/doi/pdf/10.1021/acsenergylett.2c01400

NERC (North American Electric Reliability Corporation). 2009. Transmission Vegetation Management NERC Standard FAC-003-2 Technical Reference. NERC Standard FAC-003-2 Technical Reference Prepared by the North American Electric Reliability Corporation Vegetation Management Standard Drafting Team. Available online at: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-2.pdf

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NFPA. 2023. NFPA 70, National Electrical Code (NEC). 2023 Edition. Quincy, MA. Available online at: https://catalog.nfpa.org/NFPA-70-National-Electrical-Code-NEC-Softbound-P1194.aspx?icid=D731.

ODF and USFS (Oregon Department of Forestry and U.S. Department of Agriculture Forest Service). 2018. Oregon CWPP Planning Tool. Available online at: https://tools.oregonexplorer.info/oe_htmlviewer/index.html?viewer=wildfireplanning (Accessed October 2022).

Sunstone Solar Project 2
Draft Operational Wildfire Mitigation Plan

Sunstone Solar Project 2
October 2025

Prepared for

Sunstone Solar 2, LLC

Prepared by

Tetra Tech, Inc.

Table of Contents

List of Tables

Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 2, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
EMP	Emergency Management Plan
Facility	Sunstone Solar Project 2
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 2, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 2 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) was attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described above, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers, (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire, (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs, battery components, and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During operation, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires and how to safely respond to fires involving BESS components. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment Update

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to operation of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115.

4.0 Inspection and Management

> *OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;*

4.1 Facility Inspections

Facility components will be inspected quarterly. The supervisory, control, and data acquisition (SCADA) system collects operating and performance data from the Facility as a whole and allows remote operation. The Certificate Holder will monitor the Facility components, such as the substation and solar arrays, 24 hours a day, 7 days a week including shutdown capabilities. These operational monitoring and maintenance measures are also discussed in Section 4.0.

The battery energy storage system may consist of either zinc-based batteries or lithium-ion (Li-ion) batteries and will be stored in completely contained, leak-proof modules. The modules will be stored on a concrete pad to capture any leaks that may occur. Operations and maintenance (O&M) employees will conduct inspections of the battery energy storage systems according to the manufacturer's recommendations, which are assumed to be monthly inspections.

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Section 2.7.1 of Exhibit B summarizes the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected.

Table 2 below provides draft operational inspections for electrical facility components from similar types of facilities. As part of finalizing the final operational WMP, the Certificate Holder may update this table as applicable to facility equipment, standards, and inspections.

Table 2: Draft Operational Inspections for Electrical Components

Inspection	Procedure	Standard	Time frame
Solar Inverter	Visual inspection of inverter and surrounding area.	SPCC Plan[1] Manufacturer's maintenance recommendations	Monthly SPCC Bi-annual Preventative Maintenance
Substation	Visual inspection of MPT, Avian Power Line Interaction Committee (APLIC) measures, and surrounding area.	Manufacturer's maintenance recommendations APLIC[2]	Monthly Yearly (APLIC)
BESS	Visual inspection of BESS, PCS, and surrounding areas	SPCC Plan Manufacturer's maintenance recommendations	Monthly

Inspection	Procedure	Standard	Time frame
Overhead electrical lines	Visual inspection of components, grounding, APLIC measures, vertical clearance distance between conductor and vegetation.	National Energy reliability Corporation (NERC)[3] APLIC	Bi-annual
1. The Operational Spill Prevention, Control, and Countermeasure Plan for the facility will require these components to be inspected monthly for spills. During these inspections, Operational Staff will also visually inspect the component and surrounding area. 2. The Certificate Holder will develop an inspection checklist and program of electrical equipment based on manufacturer's recommendations for individual components. 3. Vegetation maintenance standard FAC-003-0 .			

4.2 Vegetation Management

Vegetation within areas temporarily disturbed during construction of the Facility, as well as revegetation of areas within the solar array fence line area, will be revegetated as outlined in the Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4[3]; updated for RFA 1, see Attachment 6). As noted in the Revegetation and Reclamation Plan, areas within the solar array fence line area will be revegetated with a mixture of low-growing grasses and forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). In addition, vegetation within the solar array fence line area will be managed as needed to reduce fuels for fire. This would include mowing vegetation under solar panels periodically, if required. The Certificate Holder will also maintain a 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

A physical vegetation survey assessment of the fenced area will be completed at least twice a year to monitor for vegetation clearances, maintain fire breaks, as applicable, and monitor for wildfire hazards. One of the vegetation survey assessments will occur in May or June, prior to the start of the dry season, a time when wildfire risk begins to become heightened. The survey will be conducted by the Site Operations Manager and will be used to assess the frequency of any upcoming vegetation maintenance required and identify areas that may need additional attention. The Site Operations Manager will visually assess and document vegetation height, abundance, and areas where vegetation should not be present such as crushed rock bed around collector substations. The vegetation survey assessment will determine that clearances and fire breaks (vegetative clearance areas and areas determined to remain clear to act as permanent fire breaks or areas where temporary fire breaks may be deployed in the event of a fire) are satisfactory, and if not, the mitigation procedures will be implemented (e.g., vegetation management) to ensure clearances and fire breaks are satisfactory The vegetation survey will document::

- Location of observations

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[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

- Species
- Estimated growth rate
- Abundance
- Clearance / Setbacks
- Risk of fire hazard

Additional vegetation surveys may be required throughout the season based on seasonally heightened fire risk. Vegetation Maintenance procedures and BMPs will be followed during operation of the Facility to ensure that vegetation does not grow in a manner that blocks or reduces solar radiation reaching the solar panels and reduce the risk of starting a fire. Vegetation control will employ best management practices (BMPs) and techniques that are most appropriate for the local environment. BMPs may include physical vegetation control such as mowing. Noxious weeds within the site boundary will be controlled in accordance with the Noxious Weed Control Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). Efforts will be made to minimize the use of herbicides and only herbicides approved for use by the U.S. Environmental Protection Agency and Oregon Department of Agriculture will be used. Herbicides used for vegetation management of the site will be selected and used in a manner that fully complies with all applicable laws and regulations.

Vegetation within the fence line and below the solar arrays will be maintained to a height of 18 inches and provide a minimum of 24-inch clear distance to any exposed electrical cables. Exposed electrical wires should be running under the solar panels at the midpoint or higher than the center of the panel. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present.

Ongoing vegetation management to ensure that vegetation does not grow in these graveled areas is outlined in Table 3.

Table 3. Vegetation Management Procedures by Facility Component

Vegetation Management	Procedure	Standard	Time Frame
Solar Inverter	Herbicide application on gravel pad around inverter to prevent vegetation growth.	Institute of Electrical and Electronics Engineers (IEEE) 80[1] National Electrical Code (NEC) 70[2]	Yearly, depending on vegetation condition.
Substation	Herbicide application on substation gravel pad. Highly compacted gravel foundations of substation are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.

Vegetation Management	Procedure	Standard	Time Frame
Battery energy storage system	Herbicide application on gravel pad surrounding the battery energy storage system. Highly compacted gravel foundations of the battery energy storage system are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.
Overhead electrical lines	Mow vegetation to achieve clearance requirements between conductor and ground.	North American Electric Reliability Corporation (NERC)[3]	Yearly, depending on vegetation condition.
1. IEEE (2015) 2. NFPA (2023) 3. NERC (2009)			

5.0 Preventative and Minimization Actions for Wildfire Risk

> *OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;*

5.1 Preventative Actions and Design Features

The Certificate Holder will minimize risk of operation of the facility causing wildfire by implementing a number of systems and procedures. During O&M activities, these will include requirements to conduct welding or metal cutting only in areas cleared of vegetation, and maintaining emergency firefighting equipment on-site. Employees will keep vehicles on roads and off dry grassland when feasible during the dry months of the year, unless such activities are required for emergency purposes, in which case fire precautions will be observed. Fire extinguishers and shovels will be kept in all vehicles. On-site employees will also receive training on fire prevention and response and have on-site fire extinguishers to respond to small fires. In the event of a large fire, emergency responders will be dispatched.

The Certificate Holder will minimize risk of Facility components causing wildfire through preventative actions. In the design of the Facility, the Certificate Holder will implement the design considerations and best practices outlined in Table 4 to minimize electrical fire risk from facility components.

Table 4. Design Considerations for Fire Safety by Facility Component

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Electrical connections by qualified electricians	X	X	X	X
Inspections for mechanical integrity prior to energizations	X	X	X	X

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Lighting protection	X	X	X	X
Corrosion protection	X	X	X	X
Strain relief of connecting cabling	X	X	X	X
Protection against moisture	X	X	X	X
Grounding systems	X	X	X	X
Safety setback from structures	X[1]	X[1]	X[1]	X[2]
Technology specific design standards	X[3]	X[4]	X[5]	X[3]

1. Graveled inside structure's perimeter fence with additional 3-foot gravel setback outside of structure's perimeter fence
2. Vertical and horizontal clearances from structures depends on voltage of conductor.
3. NFPA 70 (.NFPA 2023).
4. IEEE 979 (IEEE 2012).
5. NFPA 1, Chapter 52 (NFPA 2021).

During Facility operations, the areas within the site boundary that are subject to a heightened risk of wildfire include the solar array areas. The solar array areas will have low-growing vegetation maintained below the solar arrays during the operational period of the Facility. Measures for reducing the risk of fire ignition and reducing the risk of equipment damage were a wildfire to occur are discussed further in Section 3.0, including the Facility's vegetation management program (see Section 3.2), and through the emergency response procedures that will be described in the Emergency Management Plan (EMP). The EMP will be developed for the Facility and is outlined below in Section 4.2.5. The collector substation area, transformer pads, and the permanent, fenced parking and storage area will have reduced risk for fire due to the fact that these areas will have a gravel base with no vegetation within a 10-foot perimeter to reduce fire risk.

The Facility components will meet National Electrical Code and Institute of Electrical and Electronics Engineers standards and will not pose a significant fire risk. The solar array will have shielded electrical cabling, as required by applicable code, to prevent electrical fires. In addition, the collector system and substation will have redundant surge arrestors to deactivate the Facility during unusual operational events that could start fires. The collector substation will have also sufficient spacing between equipment to prevent the spread of fire.

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. A 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary will be maintained. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present. See Exhibit U for additional discussion of Project fire prevention measures and

coordination with local emergency responders. Vegetation free areas such as gravel pads or base and facility perimeter and interior roads act as a permanent fire break which could minimize the spread of fires on site or impacts from an external wildfire.

Smoke/fire detectors will be placed around the site that will be tied to the SCADA system and will contact local firefighting services. This communication system allows each solar string, battery energy storage system, and substation to be monitored by a SCADA system, accessed through both the SCADA control room in the substations or remotely. This system monitors these components for variables such as meteorological conditions, critical operating parameters, and power output. The solar array is controlled and monitored via the SCADA system and can be controlled remotely. SCADA software is tuned specifically to the needs of each project by the solar module manufacturer or a third-party SCADA vendor. This system will be monitored 24/7 by a remote operations center.

The Certificate Holder proposes to construct either a direct current–coupled distributed battery energy storage system (located throughout the solar array fence line area at the inverter and transformer sites) or alternating current–coupled battery energy storage system (concentrated in a single location within the solar array fence). The system as a whole will use a series of self-contained containers located within the solar array fence line area. The containers may have their own additional fencing, to be determined prior to construction. Each container will be placed on a concrete foundation. Regardless of the battery technology selected, the containers are estimated to require up to 0.2 to 0.4 acre each with a total of 2,491 containers. Each container is rated for outdoor environments and holds the batteries and a battery management system.

The Facility will use either Li-ion batteries or zinc batteries to store up to 200 MW alternating current of power over a 6-hour discharge duration (1,200 megawatt-hours alternating current) (ASC Exhibit C, Figure C-2[4]).

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Additionally, zinc batteries will have fans and a heating unit for climate control.

The following paragraphs summarize the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected. The chemicals used in Li-ion batteries are generally nontoxic but do present a flammability hazard. Li-ion systems would also include a fire prevention system and cooling units placed either on top of the containers or along the side. Li-ion batteries are susceptible to overheating and typically require cooling systems dedicated to each battery energy storage system enclosure, especially at the utility scale (Jeevarajan et al. 2022). The gas released by an overheating Li-ion cell is mainly carbon dioxide but may also include carbon monoxide, methane, ethylene, and propylene (Jeevarajan et al. 2022).

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[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

The Certificate Holder will implement the following fire prevention and control methods to minimize fire and safety risks for the Li-ion batteries proposed for the battery energy storage system:

- The batteries will be stored in completely contained, leak-proof modules.
- Ample working space will be provided around the battery energy storage system for maintenance and safety purposes.
- Off-site, 24-hour monitoring of the battery energy storage system will be implemented and will include shutdown capabilities.
- Transportation of Li-ion batteries is subject to 49 Code of Federal Regulations (CFR) 173.185 – Department of Transportation Pipeline and Hazardous Material Administration. This regulation contains requirements for prevention of a dangerous evolution of heat; prevention of short circuits; prevention of damage to the terminals; and prevention of batteries coming into contact with other batteries or conductive materials. Adherence to the requirements and regulations, personnel training, safe interim storage, and segregation from other potential waste streams will minimize any public hazard related to transport, use, or disposal of batteries.
- Design of the battery energy storage system will be in accordance with applicable Underwriters Laboratories (UL; specifically, 1642, 1741, 1973, 9540A), National Electric Code, and National Fire Protection Association (specifically 855) standards, which require rigorous industry testing and certification related to fire safety and/or other regulatory requirements applicable to battery storage at the time of construction.
- Additionally, the Certificate Holder will employ the following design practices, as applicable to the available technology and design at time of construction:
    - Use of Li-ion phosphate battery chemistry that does not release oxygen when it decomposes due to temperature;
    - Employment of an advanced and proven battery management system;
    - Qualification testing of battery systems in accordance with UL 9540A (UL Solutions 2025);
    - Employment of Fike fire control panels with 24-hour battery backup at every battery container;
    - Installation of fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems in every battery container;
    - Installation of doors that are equipped with a contact that will shut down the battery container if opened;
    - Installation of fire extinguishing and thermal insulation sheets between each individual battery cell;

  - Implementation of locks and fencing to prevent entry of unauthorized personnel;
  - Installation of remote power disconnect switches; and
  - Clear and visible signs to identify remote power disconnect switches.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during operations of the Facility.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

5.2.2 Electrical Safety Program

All operational workers will be trained in electrical safety and the specific hazards of the Facility. This training will address:

- Minimum experience requirements to work on different types of electrical components;
- Electrical equipment testing and troubleshooting;
- Switching system;
- Provisions for entering high voltage areas (e.g., substation);
- Minimum approach distances; and
- Required personal protective equipment.

5.2.3 Lock Out/Tag Out Program

During maintenance activities, electrical equipment will be de-energized and physically locked or tagged in the de-energized positions to inadvertent events that could result in arc flash.

5.2.4 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fire spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high-risk locations, as designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.5 Emergency Management Plan

Emergency Management will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The final WMP will specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, annual meetings to discuss emergency planning, protocols for how to respond to electrical fires and safely respond to a fire involving BESS components, and invitations to observe any emergency drill conducted at the Facility.

At the beginning of Facility operations, a copy of the site plan indicating the arrangement of the Facility structures, access points, and fire breaks will be provided to the local fire district.

Personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

During times of heightened wildfire risk, a water truck, water buffalo, or tank with minimum 500 gallon capacity will be stationed at the site during operations and maintenance activities.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the amended site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

This Plan will be updated by the Certificate Holder every 5 years. Updates to this Plan will account for changes in local fire protection agency personnel and changes in best practices for minimizing and mitigating fire risk. It is recommended to consult with Morrow County, the local fire department, and the Morrow County Emergency Manager.

After each 5-year review, a copy of the updated plans will be provided to the Oregon Department of Energy with the annual compliance report required under OAR 345-026-008(2).

Every 5 years, the Certificate Holder will review wildfire risk and update this Plan for the site boundary. Evaluation of wildfire risk will be consistent with the requirements of OAR 345-022-0115(1) using current data from reputable sources.

The Certificate Holder may consider revisions to this Plan at its sole discretion to incorporate future best practices or emerging technology depending on whether the new technology is cost effective and suitable for the site conditions. The Certificate Holder will track the industry groups and applicable design standards outlined in Table 5 to identify future technologies or best practices that could be implemented at the Facility.

Table 5. Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].

Reference	Description	Method
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the O&M building and the substation enclosure.	Remodeling to the O&M and enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/.
2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf.
3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.

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Sunstone Solar Project 3

Sunstone Solar Project 3
Draft Fugitive Dust Control Plan

Prepared for

PGR PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 3, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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Table of Contents

List of Attachments

1.0 Introduction

This Fugitive Dust Control Plan (Plan) has been developed by Sunstone Solar 3, LLC (Certificate Holder), a subsidiary of Pine Gate Renewables, LLC, for the approved Sunstone Solar Project 3 (Facility) in Morrow County, Oregon. The purpose of this Plan is to reduce fugitive dust emissions associated with construction-related activities of a photovoltaic energy generation facility with up to 200 megawatts (MW) alternating current and related or supporting facilities, as well as a 1,200 MW-hour distributed battery energy storage system. The majority of the site consists of a mix of fallow fields and fields in small grain production, primarily dryland wheat; no farmlands within the site boundary receive irrigation (the application of water to land for purposes of growing agricultural products; Sunstone Solar 2024). This Plan summarizes the sources of and regulatory issues that relate to fugitive dust emissions; identifies responsibilities, monitoring, and training; and provides reasonable available control methods for fugitive dust in a table for easy reference in the field (Attachment 1).

This is an owner-imposed Plan that is expected to be implemented, maintained, and adaptively managed by the selected contractor throughout all phases of construction. The performance criteria and suggested measures identified in this Plan are minimums, and the contractor is expected to identify and implement additional measures as needed to fully meet all regulatory and public safety performance criteria. As identified in this Plan, the contractor may propose alternative approaches for consideration by the owner.

1.1 Fugitive Dust Sources

The Natural Resources Conservation Service (NRCS) Web Soil Survey identified four major soil types within the project area (NRCS 2025). Approximately 99 percent of the site is composed of Warden silt loam, which is moderately or severely susceptible to erosion from ground disturbance, wind, and vehicle traffic on unpaved roads due to its composition of hemic organic soil materials and very fine sand (NRCS 2025, NRCS 2011). Due to their composition, the retention of moisture in these sediments is thus restricted. Furthermore, these sediment particles have a low resistance to dust propagation and would be transported or drift to adjacent lands due to the lack of water through irrigation; thus, these soils are considered at high risk for fugitive dust.

Fugitive dust can arise from a variety of construction and operational activities associated with solar development. The sources can be grouped into three general categories: dust created from ground-disturbing activities such as clearing and grading, dust created from wind action on bare soils and stockpiles such as those not fully stabilized post-construction with either vegetation or a tackifier, and dust created from traffic on unpaved roads. Sediment is the basis for fugitive dust, meaning that sediment particles can become fugitive dust if they are windborne. Therefore, the thresholds for treating sediment and erosion on the site will be similar if not the same as the thresholds for treating fugitive dust. Maintaining existing vegetation and root systems is the single most effective method for avoiding fugitive dust and sediment. Where existing vegetation and root systems are disturbed, quickly reestablishing vegetation is critical.

1.2 Regulatory Compliance

Fugitive dust is a source of particulate matter with a mean diameter less than 10 microns (PM_{10}) which is one of the seven air pollutants the U.S. Environmental Protection Agency (EPA) regulates under the National Ambient Air Quality Standards (NAAQS). To a lesser extent, fugitive dust is a source of particulate matter with a mean diameter less than 2.5 microns ($PM_{2.5}$), which has proposed regulations pending under NAAQS. These soil particles are very small, can remain suspended in the air for long periods of time, and are easily inhaled into the lungs. Increased risks of death and disease have been linked to periods of high outdoor PM_{10} and $PM_{2.5}$ concentrations. These fine particles can potentially be lifted thousands of feet into the atmosphere and transported across continents and oceans creating global health, ecological, and climate change impacts.

The EPA shares responsibility with the Oregon Department of Environmental Quality (ODEQ) for the implementation of Clean Air Act (CAA) criteria in Oregon. ODEQ implements the CAA rules under the EPA-approved Oregon Administrative Rules (Chapter 340, Division 21 General Emission Standards for Particulate Matter). Fugitive dust is the primary concern related to the CAA at the Project. Fugitive dust is defined by ODEQ as dust that visibly leaves the project site for a period of more than **18 seconds in a 6-minute period,** determined by the attached EPA Method 22 (ODEQ 2019) at the downwind property boundary (Oregon Administrative Rules [OAR] 340-208-0210 (2)-a and -b).

The ODEQ Rule 340-208-0210 contains the following requirements for fugitive dust:

- Reasonable precautions must be taken to prevent particulate matter from becoming airborne. This includes, but is not limited to, the use of water or other chemicals to control dust during construction, on unpaved roads, and during the transport of materials; enclosure of materials stockpiles and covering of open-body trucks; and prompt removal from paved streets of earth or other material.
- If fugitive dust is discovered, ODEQ may require the Facility to cease work until the fugitive dust emissions are controlled. Emissions are considered controlled when fugitive dust is no longer leaving the Facility site for more than 18 seconds in a 6-minute period.

Further, ODEQ Rule 340-208-0300 specifies that it is prohibited to cause or allow any air contaminants (e.g., fugitive dust) to create a nuisance. If ODEQ determines that a nuisance has been created, the agency may pursue informal or formal enforcement actions to abate the nuisance.

A National Pollutant Discharge Elimination System Construction Stormwater Discharge Permit (Oregon 1200-C Construction Stormwater Permit), pursuant to Oregon Revised Statutes 468.050 and Section 402 of the federal Clean Water Act, will be obtained from ODEQ. This permit requires the permit holder to “Prevent wind-blown soil and dust from areas with exposed soil through the appropriate application of water or other dust suppression techniques to control the generation of pollutants that could be discharged in stormwater from the site” (Section 2.2.9) and requires permit holders to implement measures including monitoring, record keeping, reporting of exceedances, and installation, maintenance, and adaptive management of best management practices (BMPs) to control both stormwater and fugitive dust discharges. Implementation of these measures is intended to reduce fugitive dust to a negligible impact and ensure compliance with applicable air quality regulations.

The Morrow County Code regulates nuisances through the Oregon State Statute Chapter 203. Controlling fugitive dust emissions is required to avoid creating a public nuisance, which is defined as “any thing, substance, or act that is a threat to the public health, safety or welfare” (Morrow County Code Enforcement Ordinance ORD-2021-4).

2.0 Fugitive Dust Control Plan

2.1 Responsibility

The expectation is that the Contractor will implement and adaptively manage this Plan, controlling fugitive dust emissions and meeting all regulatory and public safety performance criteria throughout construction. As described in Section 1.2 above, the holder of the Oregon 1200-C permit is required to control fugitive dust emissions, including ensuring compliance by all subcontractors and outside service providers.

If the Certificate Holder identifies that the regulatory and public safety performance criteria are not being met, the Certificate Holder will implement enforcement measures, including but not limited to:

- Issuance of a Non-Conformance and/or Non-Compliance Report.
- Contractor to prepare and submit a corrective action plan.
- Contractor to document corrective actions taken and performance criteria met.
- Partial or full stoppage of work on site through activation of shut-down clause in contract.
- At the Certificate Holder’s sole discretion, an outside contractor may be contracted to implement corrective actions, to be reimbursed by the Contractor.

Additionally, the Certificate Holder may establish a Community Action Council to create an open and ongoing pathway for communication with stakeholders for the Project, including controlling fugitive dust emissions and avoiding the creation of nuisances. The Community Action Council could include representatives from the Morrow County Commissioners’ Office, Morrow County Planning Department, Oregon Department of Transportation, and neighboring landowners. The Contractor will work with the Certificate Holder to determine whether this Community Action Council will be established, and if so, the details of its establishment.

2.2 Monitoring

As required by the 1200-C permit, the permit holder will perform visual monitoring and recordkeeping by a Certified Erosion and Sediment Control or Storm Water Quality Inspector (inspector). The Contractor's construction site manager and inspector will be responsible for ensuring that the measures in this Plan are implemented, monitored, and adaptively managed, and that any exceedances are immediately reported to the Certificate Holder.

The visual monitoring required by the 1200-C permit must occur at least once every 14 calendar days. However, because OAR 340-208-0210 restricts visible fugitive emissions on a continuous standard to a maximum of 18 seconds in a given 6-minute period, and because fugitive dust emissions may provide an immediate public safety concern in this location, this Plan requires that fugitive dust be monitored and controlled on an ongoing basis.

Monitoring for fugitive dust emissions shall include:

- Use of EPA Method 22 (ODEQ 2019; see Attachment 2) as specified in OAR 340-208-0210, at least once a day.
- The observation shall be performed during times of peak construction activity at the downwind property boundary.
- Recording of observations in a fugitive dust inspection log that is kept on site and shall be available digitally to the Certificate Holder. This log shall include all information required in EPA Method 22 and shall also include photos and/or video taken during the observation period to document conditions.
- Installation and operation of a weather station, recording (at a minimum) wind speed and direction.

Triggers for additional, more frequent monitoring will include:

- Observation of visible fugitive dust emissions by Contractor, agency, or the Certificate Holder staff.
- Request by a member of the Community Action Council established by the Certificate Holder.
- Wind speeds greater than 15 miles per hour.
- Receipt of complaints or concerns through the Project Dust Control Hotline.

2.3 Training

EPA Method 22 (ODEQ 2019) does not require a specific certification, but it is necessary that the person responsible for observations completed for this method be knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in the references cited in Method 22 (EPA 2019) or from the lecture portion of the EPA Method 9 certification course. The Contractor shall document in the inspection log how the person responsible for observations meets this requirement.

Construction workers will attend a Worker Environmental Awareness Program training prior to conducting construction activities. This training will include a summary of fugitive dust control measures included in this Plan and the responsibilities of personnel working on the Facility related to fugitive dust control.

2.4 Fugitive Dust Prevention and Management

This document and the attached table are intended to provide guidance to construction personnel on measures intended to minimize impacts and control fugitive dust emissions during construction. It is the responsibility of the Contractor to monitor and adaptively manage the site to maintain compliance with all local, state, and federal requirements. Additionally, this Plan is supplemental to the Contractor's Erosion and Sediment Control Plan and does not substitute for any requirements of ODEQ or other agencies.

This Plan is performance-based. As shown in the flow chart in Figure 1, if fugitive dust emissions in excess of the ODEQ criteria of **18 seconds in a 6-minute period** occur, the Contractor shall:

- Implement adaptive management actions, including altering work operations and/or pause work until the fugitive dust emissions are controlled.
- Document that fugitive dust emissions have been controlled, including monitoring with EPA Method 22.
- In addition to any reporting requirements required in the 1200-C permit, report noncompliance incidents and adaptive management actions taken by the Certificate Holder within 24 hours of occurrence.

The Contractor shall maintain and implement this Plan during all phases of construction. The table in Attachment 1 provides suggested Reasonable Available Control Measures (RACMs) for anticipated fugitive dust sources based on industry-standard BMPs and reasonable precautions specified in the Oregon 1200-C permit, ODEQ's Construction Stormwater Best Management Practices Manual (Manual) (ODEQ 2021), and OAR 340-208-0210. Supplemental RACMs are identified in the table in case initial RACMs are not effective in controlling fugitive dust or are not feasible to implement (Attachment 1).

The Contractor shall identify and implement additional RACMs as needed to control fugitive dust emissions. Additionally, the Contractor may propose alternative approaches and RACMs for controlling fugitive dust. This proposal shall be made in writing and is subject to the approval of the Certificate Holder.

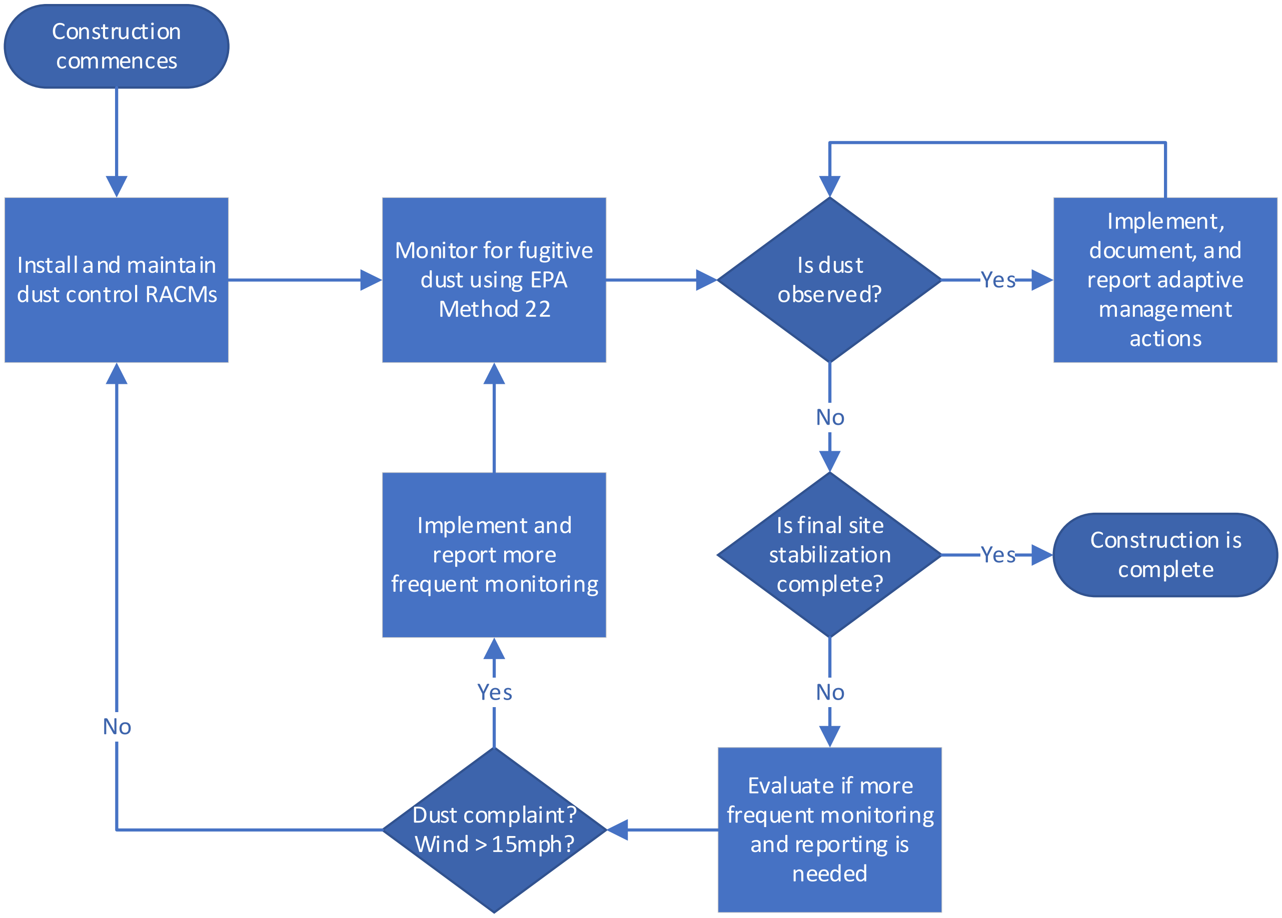

Figure 1. Dust Control Plan Flow Chart

3.0 References

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Attachment 1: Fugitive Dust Sources and Reasonable Available Control Measures

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Fugitive Dust Sources and Reasonable Available Control Measures

Construction Phase	RACM(s)	Supplemental RACM(s)
All Phases of Construction	Daily fugitive dust monitoring and record keeping.	Increase frequency of monitoring.
	Prominent display of Dust Control Hotline signs, providing direct access to the Contractor's site manager or inspector.	If established, proactive engagement with Community Action Council.
	If established, Worker Environmental Awareness Program training for all construction employees.	Additional trainings and refreshers for employees.
	Maintain stockpile of BMPs on site, including sufficient palliatives for a single treatment of all site access roads and sufficient palliatives, mulch, and/or hydromulch for a minimum of 25 percent of the total disturbed area, and machinery for application.	Increase stockpile of palliatives, mulch, and/or hydromulch and add additional BMPs.
	Documentation and reporting of adaptive management actions.	Development and submittal of revised Fugitive Dust Control Plan.
Site Access	Install and maintain stabilized construction entrances at ingress/egress locations and restrict traffic to these locations.	Add additional construction entrance BMPs (e.g., wheel wash).
	Daily sweeping up of sediment from paved surfaces utilizing vacuum sweeper with HEPA filtration.	Increase sweeper frequency.
	Access roads shall be graveled.	Road maintenance and reapplication of gravel.
	Access roads will be stabilized with water or palliative sufficient to eliminate visible and sustained dust from vehicular travel and wind erosion. Reapply stabilization as necessary to maintain dust-free condition.	If water is unavailable or ineffective, or if water use is limited by any agency or regulation, access roads will be stabilized with longer-lasting palliatives.
	Restrict construction traffic to established and stabilized access routes.	Install fencing or barricades to prevent traffic outside of established routes.
	Limit traffic speeds to 15 miles per hour on stabilized unpaved roads within the site as long as such speeds do not create significant visible dust emissions. Traffic speed signs shall be displayed prominently at all site entrances and exits.	Limit traffic speeds within the site to 5 or 10 miles per hour.

Construction Phase	RACM(s)	Supplemental RACM(s)
Clearing, Grading, and Unstable Surfaces	Maintain the natural topography and vegetation of the site to the extent possible, including by limited grading and limited establishment of temporary access roads.	Reduce area being actively worked and stabilize unworked areas.
	Phase construction to expose the minimum amount of soil necessary.	Increase construction phasing to further minimize exposed soil.
	Leave existing vegetation intact to the extent possible.	Utilize mowing and rolling techniques to maintain plant root systems for soil stabilization.
	Minimize disturbance areas and soil exposure to the maximum extent feasible.	Limit work to a portion of the disturbed area until all disturbed areas receive temporary or final stabilization.
	When wind speeds exceed 15 miles per hour, minimize new disturbances to the extent possible and/or mobilize additional water trucks or palliatives to minimize fugitive dust from exposed surfaces.	Stop all ground disturbing activities and apply additional dust control measures until measures are effective or wind speeds slow and fugitive emissions stop.
	Separate and cover topsoil.	Increase maintenance frequency for topsoil cover. Combine methods, such as mulch plus tackifier.
	Stabilize exposed soils within the timeframes established in the 1200-C permit. Stabilize exposed soils in stages based on site conditions and weather.	Stabilize exposed soils more frequently, even if additional work is anticipated within the timeframe established in the 1200-C permit. Reapply stabilization measures following any additional disturbances.
	Temporarily stabilize exposed surfaces to prohibit significant and sustained visible fugitive dust from wind erosion. Utilize BMPs such as mulch, hydromulch with or without seeds, tackifier, spreading stone or gravel, and trackwalking.	Combine stabilization methods, such as mulch plus tackifier, or trackwalking plus hydromulch. Increase frequency of maintenance of stabilization.
	Seed exposed surfaces during the appropriate season with approved temporary or permanent seed mixes.	Reapply seed to newly disturbed areas or areas with poor germination. Use temporary seeding even if additional work is anticipated before final stabilization. Use irrigation to enhance seeding success.
	Gate seals should be tight on dump trucks. Soil load shall be kept below 6 inches of the freeboard of the truck. Drop heights shall be minimized when loaders dump soil into trucks.	Cover haul trucks with a tarp or other suitable cover.

Attachment 2: EPA Method 22

State of Oregon Department of Environmental Quality

OAR 340-208-0210

EPA Method 22

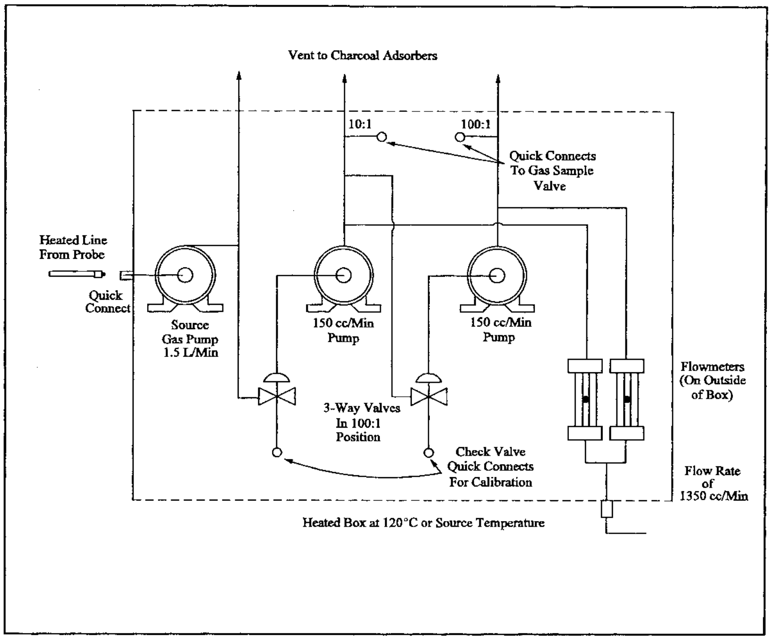


Figure 18-13. Schematic Diagram of the Heated Box Required for Dilution of Sample Gas.

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST

[Respond with initials or number as appropriate]

1. Presurvey data:

A. Grab sample collected ☐ ______

B. Grab sample analyzed for composition ☐ ______

Method GC ☐ ______

GC/MS ☐ ______

Other ☐ ______

C. GC-FID analysis performed ☐ ______

2. Laboratory calibration data:

A. Calibration curves prepared ☐ ______

Number of components ☐ ______

Number of concentrations/component (3 required). ☐ ______

B. Audit samples (optional):

Analysis completed ☐ ______

Verified for concentration ☐ ______

OK obtained for field work ☐ ______

3. Sampling procedures:

A. Method:

Bag sample ☐ ______

Direct interface ☐ ______

Dilution interface ☐ ______

B. Number of samples collected ☐ ______

4. Field Analysis:

A. Total hydrocarbon analysis performed ☐ ______

B. Calibration curve prepared ☐ ______

Number of components ☐ ______

Number of concentrations per component (3 required). ☐ ______

Gaseous Organic Sampling and Analysis Data

Date ____________________

Location ____________________

Plant ____________________

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST (RESPOND WITH INITIALS OR NUMBER AS APPROPRIATE)

1. Pre-survey data	Date
A. Grab sample collected	____
B. Grab sample analyzed for composition	____
Method GC	____
GC/MS	____
Other____________	____
C. GC–FID analysis performed	____
2. Laboratory calibration curves prepared	____
A. Number of components	____
B. Number of concentrations per component (3 required)	____
C. OK obtained for field work	____
3. Sampling procedures.	
A. Method.	
Bag sample	____
Direct interface	____
Dilution interface	____
B. Number of samples collected	____
4. Field Analysis.	
A. Total hydrocarbon analysis performed	____
B. Calibration curve prepared	____
Number of components	____
Number of concentrations per component (3 required)	____

Figure 18–14. Sampling and Analysis Sheet

[36 FR 24877, Dec. 23, 1971]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting appendix A–6 to part 60, see the List of CFR sections Affected, which appears in the Finding Aids section of the printed volume and at *www.fdsys.gov*.

APPENDIX A–7 TO PART 60—TEST METHODS 19 THROUGH 25E

Method 19—Determination of sulfur dioxide removal efficiency and particulate, sulfur dioxide and nitrogen oxides emission rates

Method 20—Determination of nitrogen oxides, sulfur dioxide, and diluent emissions from stationary gas turbines

Method 21—Determination of volatile organic compound leaks

Method 22—Visual determination of fugitive emissions from material sources and smoke emissions from flares

Method 23—Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans From Stationary Sources

Method 24—Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

Method 24A—Determination of volatile matter content and density of printing inks and related coatings

Method 25—Determination of total gaseous nonmethane organic emissions as carbon

Method 25A—Determination of total gaseous organic concentration using a flame ionization analyzer

Method 25B—Determination of total gaseous organic concentration using a nondispersive infrared analyzer

Method 25C—Determination of nonmethane organic compounds (NMOC) in MSW landfill gases

Method 25D—Determination of the Volatile Organic Concentration of Waste Samples

Method 25E—Determination of Vapor Phase Organic Concentration in Waste Samples

The test methods in this appendix are referred to in §60.8 (Performance Tests) and §60.11 (Compliance With Standards and Maintenance Requirements) of 40 CFR part 60, subpart A (General Provisions). Specific uses of these test methods are described in the standards of performance contained in the subparts, beginning with Subpart D.

Within each standard of performance, a section title ''Test Methods and Procedures'' is provided to: (1) Identify the test methods to be used as reference methods to the facility subject to the respective standard and (2) identify any special instructions or conditions to be followed when applying a method to the respective facility. Such instructions (for example, establish sampling rates, volumes, or temperatures) are to be used either in addition to, or as a substitute for procedures in a test method. Similarly, for sources subject to emission monitoring requirements, specific instructions pertaining to any use of a test method as a reference method are provided in the subpart or in Appendix B.

Inclusion of methods in this appendix is not intended as an endorsement or denial of their applicability to sources that are not subject to standards of performance. The methods are potentially applicable to other sources; however, applicability should be confirmed by careful and appropriate evaluation of the conditions prevalent at such sources.

The approach followed in the formulation of the test methods involves specifications for equipment, procedures, and performance. In concept, a performance specification approach would be preferable in all methods because this allows the greatest flexibility to the user. In practice, however, this approach is impractical in most cases because performance specifications cannot be established. Most of the methods described herein, therefore, involve specific equipment specifications and procedures, and only a few methods in this appendix rely on performance criteria.

Minor changes in the test methods should not necessarily affect the validity of the results and it is recognized that alternative and equivalent methods exist. section 60.8 provides authority for the Administrator to specify or approve (1) equivalent methods, (2) alternative methods, and (3) minor changes in the methodology of the test methods. It should be clearly understood that unless otherwise identified all such methods and changes must have prior approval of the Administrator. An owner employing such methods or deviations from the test methods without obtaining prior approval does so at the risk of subsequent disapproval and retesting with approved methods.

Within the test methods, certain specific equipment or procedures are recognized as being acceptable or potentially acceptable and are specifically identified in the methods. The items identified as acceptable options may be used without approval but must be identified in the test report. The potentially approvable options are cited as ''subject to the approval of the Administrator'' or as ''or equivalent.'' Such potentially approvable techniques or alternatives may be used at the discretion of the owner without prior approval. However, detailed descriptions for applying these potentially approvable techniques or alternatives are not provided in the test methods. Also, the potentially approvable options are not necessarily acceptable in all applications. Therefore, an owner electing to use such potentially approvable techniques or alternatives is responsible for: (1) assuring that the techniques or alternatives are in fact applicable and are properly executed; (2) including a written description of the alternative method in the test report (the written method must be clear and must be capable of being performed without additional instruction, and the degree of detail should be similar to the detail contained in the test methods); and (3) providing any rationale or supporting data necessary to show the validity of the alternative in the particular application. Failure to meet these requirements can result in the Administrator's disapproval of the alternative.

METHOD 19—DETERMINATION OF SULFUR DIOXIDE REMOVAL EFFICIENCY AND PARTICULATE MATTER, SULFUR DIOXIDE, AND NITROGEN OXIDE EMISSION RATES

1.0 Scope and Application

1.1 Analytes. This method provides data reduction procedures relating to the following pollutants, but does not include any sample collection or analysis procedures.

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X), including:		
Nitric oxide (NO)	10102–43–9	N/A
Nitrogen dioxide (NO_2)	10102–44–0.	
Particulate matter (PM)	None assigned	N/A
Sulfur dioxide (SO_2)	7499–09–05	N/A

1.2 Applicability. Where specified by an applicable subpart of the regulations, this method is applicable for the determination of (a) PM, SO_2, and NO_X emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions.

2.0 Summary of Method

2.1 Emission Rates. Oxygen (O_2) or carbon dioxide (CO_2) concentrations and appropriate F factors (ratios of combustion gas volumes to heat inputs) are used to calculate pollutant emission rates from pollutant concentrations.

2.2 Sulfur Reduction Efficiency and SO_2 Removal Efficiency. An overall SO_2 emission reduction efficiency is computed from the efficiency of fuel pretreatment systems, where applicable, and the efficiency of SO_2 control devices.

2.2.1 The sulfur removal efficiency of a fuel pretreatment system is determined by fuel sampling and analysis of the sulfur and heat contents of the fuel before and after the pretreatment system.

2.2.2 The SO_2 removal efficiency of a control device is determined by measuring the SO_2 rates before and after the control device.

2.2.2.1 The inlet rates to SO_2 control systems (or, when SO_2 control systems are not used, SO_2 emission rates to the atmosphere) are determined by fuel sampling and analysis.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety [Reserved]

6.0 Equipment and Supplies [Reserved]

7.0 Reagents and Standards [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transport [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedures [Reserved]

12.0 Data Analysis and Calculations

12.1 Nomenclature

B_{wa} = Moisture fraction of ambient air, percent.

B_{ws} = Moisture fraction of effluent gas, percent.

%C = Concentration of carbon from an ultimate analysis of fuel, weight percent.

C_d = Pollutant concentration, dry basis, ng/scm (lb/scf)

$\%CO_{2d}, \%CO_{2w}$ = Concentration of carbon dioxide on a dry and wet basis, respectively, percent.

C_w = Pollutant concentration, wet basis, ng/scm (lb/scf).

D = Number of sampling periods during the performance test period.

E = Pollutant emission rate, ng/J (lb/million Btu).

E_a = Average pollutant rate for the specified performance test period, ng/J (lb/million Btu).

E_{ao}, E_{ai} = Average pollutant rate of the control device, outlet and inlet, respectively, for the performance test period, ng/J (lb/million Btu).

E_{bi} = Pollutant rate from the steam generating unit, ng/J (lb/million Btu)

E_{bo} = Pollutant emission rate from the steam generating unit, ng/J (lb/million Btu).

E_{ci} = Pollutant rate in combined effluent, ng/J (lb/million Btu).

E_{co} = Pollutant emission rate in combined effluent, ng/J (lb/million Btu).

E_d = Average pollutant rate for each sampling period (*e.g.*, 24-hr Method 6B sample or 24-hr fuel sample) or for each fuel lot (*e.g.*, amount of fuel bunkered), ng/J (lb/million Btu).

E_{di} = Average inlet SO_2 rate for each sampling period d, ng/J (lb/million Btu)

E_g = Pollutant rate from gas turbine, ng/J (lb/million Btu).

E_{ga} = Daily geometric average pollutant rate, ng/J (lbs/million Btu) or ppm corrected to 7 percent O_2.

E_{jo}, E_{ji} = Matched pair hourly arithmetic average pollutant rate, outlet and inlet, respectively, ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

E_h = Hourly average pollutant, ng/J (lb/million Btu).

E_{hj} = Hourly arithmetic average pollutant rate for hour ''j,'' ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

EXP = Natural logarithmic base (2.718) raised to the value enclosed by brackets.

F_d, F_w, F_c = Volumes of combustion components per unit of heat content, scm/J (scf/million Btu).

GCV = Gross calorific value of the fuel consistent with the ultimate analysis, kJ/kg (Btu/lb).

GCV_p, GCV_r = Gross calorific value for the product and raw fuel lots, respectively, dry basis, kJ/kg (Btu/lb).

%H = Concentration of hydrogen from an ultimate analysis of fuel, weight percent.

H = Total number of operating hours for which pollutant rates are determined in the performance test period.

H_b = Heat input rate to the steam generating unit from fuels fired in the steam generating unit, J/hr (million Btu/hr).

H_g = Heat input rate to gas turbine from all fuels fired in the gas turbine, J/hr (million Btu/hr).

$\%H_2O$ = Concentration of water from an ultimate analysis of fuel, weight percent.

H_r = Total numbers of hours in the performance test period (*e.g.*, 720 hours for 30-day performance test period).

K = Conversion factor, 10^{-5} (kJ/J)/(%) [10^6 Btu/million Btu].

K_c = (9.57 scm/kg)/% [(1.53 scf/lb)/%].

K_{cc} = (2.0 scm/kg)/% [(0.321 scf/lb)/%].

K_{hd} = (22.7 scm/kg)/% [(3.64 scf/lb)/%].

K_{hw} = (34.74 scm/kg)/% [(5.57 scf/lb)/%].

K_n = (0.86 scm/kg)/% [(0.14 scf/lb)/%].

K_o = (2.85 scm/kg)/% [(0.46 scf/lb)/%].

K_s = (3.54 scm/kg)/% [(0.57 scf/lb)/%].

K_w = (1.30 scm/kg)/% [(0.21 scf/lb)/%].

ln = Natural log of indicated value.

L_p,L_r = Weight of the product and raw fuel lots, respectively, metric ton (ton).

%N = Concentration of nitrogen from an ultimate analysis of fuel, weight percent.

N = Number of fuel lots during the averaging period.

n = Number of fuels being burned in combination.

n_d = Number of operating hours of the affected facility within the performance test period for each E_d determined.

n_t = Total number of hourly averages for which paired inlet and outlet pollutant rates are available within the 24-hr midnight to midnight daily period.

%O = Concentration of oxygen from an ultimate analysis of fuel, weight percent.

$\%O_{2d}$, $\%O_{2w}$ = Concentration of oxygen on a dry and wet basis, respectively, percent.

P_s = Potential SO_2 emissions, percent.

$\%R_f$ = SO_2 removal efficiency from fuel pretreatment, percent.

$\%R_g$ = SO_2 removal efficiency of the control device, percent.

$\%R_{ga}$ = Daily geometric average percent reduction.

$\%R_o$ = Overall SO_2 reduction, percent.

%S = Sulfur content of as-fired fuel lot, dry basis, weight percent.

S_e = Standard deviation of the hourly average pollutant rates for each performance test period, ng/J (lb/million Btu).

$\%S_f$ = Concentration of sulfur from an ultimate analysis of fuel, weight percent.

S_i = Standard deviation of the hourly average inlet pollutant rates for each performance test period, ng/J (lb/million Btu).

S_o = Standard deviation of the hourly average emission rates for each performance test period, ng/J (lb/million Btu).

$\%S_p$, $\%S_r$ = Sulfur content of the product and raw fuel lots respectively, dry basis, weight percent.

$t_{0.95}$ = Values shown in Table 19–3 for the indicated number of data points n.

X_k = Fraction of total heat input from each type of fuel k.

12.2 Emission Rates of PM, SO_2, and NO_X. Select from the following sections the applicable procedure to compute the PM, S_{O2}, or NO_X emission rate (E) in ng/J (lb/million Btu). The pollutant concentration must be in ng/scm (lb/scf) and the F factor must be in scm/J (scf/million Btu). If the pollutant concentration (C) is not in the appropriate units, use Table 19–1 in section 17.0 to make the proper conversion. An F factor is the ratio of the gas volume of the products of combustion to the heat content of the fuel. The dry F factor (F_d) includes all components of combustion less water, the wet F factor (F_w) includes all components of combustion, and the carbon F factor (F_c) includes only carbon dioxide.

NOTE: Since F_w factors include water resulting only from the combustion of hydrogen in the fuel, the procedures using F_w factors are not applicable for computing E from steam generating units with wet scrubbers or with other processes that add water (*e.g.*, steam injection).

12.2.1 Oxygen-Based F Factor, Dry Basis. When measurements are on a dry basis for both O ($\%O_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_d \frac{20.9}{\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-1}$$

12.2.2 Oxygen-Based F Factor, Wet Basis. When measurements are on a wet basis for both O_2 ($\%O_{2w}$) and pollutant (C_w) concentrations, use either of the following:

12.2.2.1 If the moisture fraction of ambient air (B_{wa}) is measured:

$$E = C_w F_w \frac{20.9}{\left[20.9\left(1 - B_{wa}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-2}$$

Instead of actual measurement, B_{wa} may be estimated according to the procedure below.

NOTE: The estimates are selected to ensure that negative errors will not be larger than −1.5 percent. However, positive errors, or over-estimation of emissions by as much as 5 percent may be introduced depending upon the geographic location of the facility and the associated range of ambient moisture.

12.2.2.1.1 B_{wa} = 0.027. This value may be used at any location at all times.

12.2.2.1.2 B_{wa} = Highest monthly average of B_{wa} that occurred within the previous calendar year at the nearest Weather Service Station. This value shall be determined annually and may be used as an estimate for the entire current calendar year.

12.2.2.1.3 B_{wa} = Highest daily average of Bwa that occurred within a calendar month at the nearest Weather Service Station, calculated from the data from the past 3 years. This value shall be computed for each month and may be used as an estimate for the current respective calendar month.

12.2.2.2 If the moisture fraction (B_{ws}) of the effluent gas is measured:

$$E = C_w F_d \frac{20.9}{\left[20.9\left(1 - B_{ws}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-3}$$

12.2.3 Oxygen-Based F Factor, Dry/Wet Basis.

12.2.3.1 When the pollutant concentration is measured on a wet basis (C_w) and O_2 concentration is measured on a dry basis ($\%O_{2d}$), use the following equation:

$$E = \frac{\left(C_w F_d\right)(20.9)}{\left(1 - B_{ws}\right)\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-4}$$

12.2.3.2 When the pollutant concentration is measured on a dry basis (C_d) and the O_2 concentration is measured on a wet basis ($\%O_{2w}$), use the following equation:

$$E = \frac{C_d F_d 20.9}{\dfrac{\left(20.9 - \%O_{2w}\right)}{\left(1 - B_{ws}\right)}} \qquad \text{Eq. 19-5}$$

12.2.4 Carbon Dioxide-Based F Factor, Dry Basis. When measurements are on a dry basis for both CO_2 ($\%CO_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_c \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-6}$$

12.2.5 Carbon Dioxide-Based F Factor, Wet Basis. When measurements are on a wet basis for both CO_2 ($\%CO_{2w}$) and pollutant (C_w) concentrations, use the following equation:

$$E = C_w F_c \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-7}$$

12.2.6 Carbon Dioxide-Based F Factor, Dry/Wet Basis.

12.2.6.1 When the pollutant concentration is measured on a wet basis (C_w) and CO_2 concentration is measured on a dry basis ($\%CO_{2d}$), use the following equation:

$$E = \frac{C_w F_c}{\left(1 - B_{ws}\right)} \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-8}$$

12.2.6.2 When the pollutant concentration is measured on a dry basis (C_d) and CO_2 concentration is measured on a wet basis ($\%CO_{2w}$), use the following equation:

$$E = C_d F_c \left(1 - B_{ws}\right) \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-9}$$

12.2.7 Direct-Fired Reheat Fuel Burning. The effect of direct-fired reheat fuel burning (for the purpose of raising the temperature of the exhaust effluent from wet scrubbers to above the moisture dew-point) on emission rates will be less than 1.0 percent and, therefore, may be ignored.

12.2.8 Combined Cycle-Gas Turbine Systems. For gas turbine-steam generator combined cycle systems, determine the emissions from the steam generating unit or the percent reduction in potential SO_2 emissions as follows:

12.2.8.1 Compute the emission rate from the steam generating unit using the following equation:

$$E_{bo} = E_{co} + \frac{H_g}{H_b}\left(E_{co} - E_g\right) \qquad \text{Eq. 19-10}$$

12.2.8.1.1 Use the test methods and procedures section of 40 CFR Part 60, Subpart GG to obtain E_{co} and E_g. Do not use F_w factors for determining E_g or E_{co}. If an SO_2 control device is used, measure E_{co} after the control device.

12.2.8.1.2 Suitable methods shall be used to determine the heat input rates to the steam generating units (H_b) and the gas turbine (H_g).

12.2.8.2 If a control device is used, compute the percent of potential SO_2 emissions (P_s) using the following equations:

$$E_{bi} = E_{ci} - \frac{H_g}{H_b}\left(E_{ci} - E_g\right) \qquad \text{Eq. 19-11}$$

$$P_s = 100\left(1 - \frac{E_{bo}}{E_{bi}}\right) \qquad \text{Eq. 19-12}$$

NOTE: Use the test methods and procedures section of Subpart GG to obtain E_{ci} and E_g. Do not use F_w factors for determining E_g or E_{ci}.

12.3 F Factors. Use an average F factor according to section 12.3.1 or determine an applicable F factor according to section 12.3.2. If combined fuels are fired, prorate the applicable F factors using the procedure in section 12.3.3.

12.3.1 Average F Factors. Average F factors (F_d, F_w, or F_c) from Table 19–2 in section 17.0 may be used.

12.3.2 Determined F Factors. If the fuel burned is not listed in Table 19–2 or if the owner or operator chooses to determine an F factor rather than use the values in Table 19–2, use the procedure below:

12.3.2.1 Equations. Use the equations below, as appropriate, to compute the F factors:

$$F_d = \frac{K\left(K_{hd}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O\right)}{GCV} \qquad \text{Eq. 19-13}$$

$$F_w = \frac{K\left[K_{hw}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O + K_w\%H_2O\right]}{GCV_w} \qquad \text{Eq. 19-14}$$

$$F_c = \frac{K\left(K_{cc}\%C\right)}{GCV} \qquad \text{Eq. 19-15}$$

NOTE: Omit the $\%H_2O$ term in the equations for F_w if %H and %O include the unavailable hydrogen and oxygen in the form of H_2O.)

12.3.2.2 Use applicable sampling procedures in section 12.5.2.1 or 12.5.2.2 to obtain samples for analyses.

12.3.2.3 Use ASTM D 3176–74 or 89 (all cited ASTM standards are incorporated by reference—see §60.17) for ultimate analysis of the fuel.

12.3.2.4 Use applicable methods in section 12.5.2.1 or 12.5.2.2 to determine the heat content of solid or liquid fuels. For gaseous fuels, use ASTM D 1826–77 or 94 (incorporated by reference—see §60.17) to determine the heat content.

12.3.3 F Factors for Combination of Fuels. If combinations of fuels are burned, use the following equations, as applicable unless otherwise specified in an applicable subpart:

$$F_d = \sum_{k=1}^{n}\left(X_k F_{dk}\right) \qquad \text{Eq. 19-16}$$

$$F_w = \sum_{k=1}^{n}\left(X_k F_{wk}\right) \qquad \text{Eq. 19-17}$$

$$F_c = \sum_{k=1}^{n}\left(X_k F_{ck}\right) \qquad \text{Eq. 19-18}$$

12.4 Determination of Average Pollutant Rates.

12.4.1 Average Pollutant Rates from Hourly Values. When hourly average pollutant rates (E_h), inlet or outlet, are obtained (*e.g.*, CEMS values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{1}{H}\sum_{j=1}^{n} E_{hj} \qquad \text{Eq. 19-19}$$

12.4.2 Average Pollutant Rates from Other than Hourly Averages. When pollutant rates are determined from measured values representing longer than 1-hour periods (*e.g.*, daily fuel sampling and analyses or Method 6B values), or when pollutant rates are determined from combinations of 1-hour and longer than 1-hour periods (*e.g.*, CEMS and Method 6B values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{\sum_{j=1}^{D}\left(n_d E_d\right)_j}{\sum_{j=1}^{D} n_{dj}} \qquad \text{Eq. 19-20}$$

12.4.3 Daily Geometric Average Pollutant Rates from Hourly Values. The geometric average pollutant rate (E_{ga}) is computed using the following equation:

$$E_{ga} = \exp\left[\frac{1}{n_t}\sum_{j=1}^{n_t}\left[\ln\left(E_{hj}\right)\right]\right] \qquad \text{Eq. 19-21}$$

12.5 Determination of Overall Reduction in Potential Sulfur Dioxide Emission.

12.5.1 Overall Percent Reduction. Compute the overall percent SO_2 reduction ($\%R_o$) using the following equation:

$$\%R_o = 100\left[1.0 - \left(1.0 - \frac{\%R_f}{100}\right)\left(1.0 - \frac{\%R_g}{100}\right)\right] \qquad \text{Eq. 19-22}$$

12.5.2 Pretreatment Removal Efficiency (Optional). Compute the SO_2 removal efficiency from fuel pretreatment ($\%R_f$) for the averaging period (*e.g.*, 90 days) as specified in the applicable regulation using the following equation:

$$\%R_f = 100\left[1.0 - \frac{\sum_{j=1}^{N}\left(\frac{\%S_{pj}}{GCV_{pj}}\right)L_{pj}}{\sum_{j=1}^{N}\left(\frac{\%S_{rj}}{GCV_{rj}}\right)L_{rj}}\right] \qquad \text{Eq. 19-23}$$

NOTE: In calculating $\%R_f$, include %S and GCV values for all fuel lots that are not pretreated and are used during the averaging period.

12.5.2.1 Solid Fossil (Including Waste) Fuel/Sampling and Analysis.

NOTE: For the purposes of this method, raw fuel (coal or oil) is the fuel delivered to the desulfurization (pretreatment) facility. For oil, the input oil to the oil desulfurization process (*e.g.*, hydrotreatment) is considered to be the raw fuel.

12.5.2.1.1 Sample Increment Collection. Use ASTM D 2234–76, 96, 97a, or 98 (incorporated by reference—see §60.17), Type I, Conditions A, B, or C, and systematic spacing. As used in this method, systematic spacing is intended to include evenly spaced increments in time or increments based on equal weights of coal passing the collection area. As a minimum, determine the number and weight of increments required per gross sample representing each coal lot according to Table 2 or Paragraph 7.1.5.2 of ASTM D 2234. Collect one gross sample for each lot of raw coal and one gross sample for each lot of product coal.

12.5.2.1.2 ASTM Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of product coal is the weight of product coal from one type of raw coal. The lot size of raw coal is the weight of raw coal used to produce one lot of product coal. Typically, the lot size is the weight of coal processed in a 1-day (24-hour) period. If more than one type of coal is treated and produced in 1 day, then gross samples must be collected and analyzed for each type of coal. A coal lot size equaling the 90-day quarterly fuel quantity for a steam generating unit may be used if representative sampling can be conducted for each raw coal and product coal.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.1.3 Gross Sample Analysis. Use ASTM D 2013–72 or 86 to prepare the sample, ASTM D 3177–75 or 89 or ASTM D 4239–85, 94, or 97 to determine sulfur content (%S), ASTM D 3173–73 or 87 to determine moisture content, and ASTM D 2015–77 (Reapproved 1978) or 96, D 3286–85 or 96, or D 5865–98 or 10 to determine gross calorific value (GCV) (all standards cited are incorporated by reference—see §60.17 for acceptable versions of the standards) on a dry basis for each gross sample.

12.5.2.2 Liquid Fossil Fuel-Sampling and Analysis. See Note under section 12.5.2.1.

12.5.2.2.1 Sample Collection. Follow the procedures for continuous sampling in ASTM D 270 or D 4177–95 (incorporated by reference—see §60.17) for each gross sample from each fuel lot.

12.5.2.2.2 Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of a product oil is the weight of product oil from one pretreatment facility and intended as one shipment (ship load, barge load, etc.). The lot size of raw oil is the weight of each crude liquid fuel type used to produce a lot of product oil.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.2.3 Sample Analysis. Use ASTM D 129–64, 78, or 95, ASTM D 1552–83 or 95, or ASTM D 4057–81 or 95 to determine the sulfur content (%S) and ASTM D 240–76 or 92 (all standards cited are incorporated by reference—see §60.17) to determine the GCV of each gross sample. These values may be assumed to be on a dry basis. The owner or operator of an affected facility may elect to determine the GCV by sampling the oil combusted on the first steam generating unit operating day of each calendar month and then using the lowest GCV value of the three GCV values per quarter for the GCV of all oil combusted in that calendar quarter.

12.5.2.3 Use appropriate procedures, subject to the approval of the Administrator, to determine the fraction of total mass input derived from each type of fuel.

12.5.3 Control Device Removal Efficiency. Compute the percent removal efficiency ($\%R_g$) of the control device using the following equation:

$$\%R_g = 100\left(1.0 - \frac{E_{ao}}{E_{ai}}\right) \qquad \text{Eq. 19-24}$$

12.5.3.1 Use continuous emission monitoring systems or test methods, as appropriate, to determine the outlet SO_2 rates and, if appropriate, the inlet SO_2 rates. The rates may be determined as hourly (E_h) or other sampling period averages (E_d). Then, compute the average pollutant rates for the performance test period (E_{ao} and E_{ai}) using the procedures in section 12.4.

12.5.3.2 As an alternative, as-fired fuel sampling and analysis may be used to determine inlet SO_2 rates as follows:

12.5.3.2.1 Compute the average inlet SO_2 rate (E_{di}) for each sampling period using the following equation:

$$E_{di} = K\frac{\%S}{GCV} \qquad \text{Eq. 19-25}$$

Where:

$$K = 2\times10^7\left(\frac{\text{ng SO}_2}{\%\text{S}}\right)\left(\frac{(\text{kJ})}{\text{J}}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^4\left(\frac{\text{lb SO}_2}{\%\text{S}}\right)\left(\frac{\text{Btu}}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4 to determine the average inlet SO_2 rate for the performance test period (E_{ai}).

12.5.3.2.2 Collect the fuel samples from a location in the fuel handling system that provides a sample representative of the fuel bunkered or consumed during a steam generating unit operating day. For the purpose of as-fired fuel sampling under section 12.5.3.2 or section 12.6, the lot size for coal is the weight of coal bunkered or consumed during each steam generating unit operating day. The lot size for oil is the weight of oil supplied to the ‘‘day’’ tank or consumed during each steam generating unit operating day. For reporting and calculation purposes, the gross sample shall be identified with the calendar day on which sampling began. For steam generating unit operating days when a coal-fired steam generating unit is operated without coal being added to the bunkers, the coal analysis from the previous ‘‘as bunkered’’ coal sample shall be used until coal is bunkered again. For steam generating unit operating days when an oil-fired steam generating unit is operated without oil being added to the oil ‘‘day’’ tank, the oil analysis from the previous day shall be used until the ‘‘day’’ tank is filled again. Alternative definitions of fuel lot size may be used, subject to prior approval of the Administrator.

12.5.3.2.3 Use ASTM procedures specified in section 12.5.2.1 or 12.5.2.2 to determine %S and GCV.

12.5.4 Daily Geometric Average Percent Reduction from Hourly Values. The geometric average percent reduction ($\%R_{ga}$) is computed using the following equation:

$$\%R_{ga} = 100\left[1 - \text{EXP}\left(\frac{1}{n_t}\sum_{j=1}^{n_t} 1\text{n}\frac{E_{jo}}{E_{ji}}\right)\right] \qquad \text{Eq. 19-26}$$

NOTE: The calculation includes only paired data sets (hourly average) for the inlet and outlet pollutant measurements.

12.6 Sulfur Retention Credit for Compliance Fuel. If fuel sampling and analysis procedures in section 12.5.2.1 are being used to determine average SO_2 emission rates (E_{as}) to the atmosphere from a coal-fired steam generating unit when there is no SO_2 control device, the following equation may be used to adjust the emission rate for sulfur retention credits (no credits are allowed for oil-fired systems) (E_{di}) for each sampling period using the following equation:

$$E_{di} = 0.97K \, \frac{\%S}{GDV} \qquad \text{Eq. 19-27}$$

Where:

$$K = 2 \times 10^7 \left(\frac{\text{ng } SO_2}{\%S}\right)\left(\frac{kJ}{J}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2 \times 10^4 \left(\frac{\text{lb } SO_2}{\%S}\right)\left(\frac{\text{Btu}}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4.2 to determine the average SO_2 emission rate to the atmosphere for the performance test period (E_{ao}).

12.7 Determination of Compliance When Minimum Data Requirement Is Not Met.

12.7.1 Adjusted Emission Rates and Control Device Removal Efficiency. When the minimum data requirement is not met, the Administrator may use the following adjusted emission rates or control device removal efficiencies to determine compliance with the applicable standards.

12.7.1.1 Emission Rate. Compliance with the emission rate standard may be determined by using the lower confidence limit of the emission rate (E_{ao}*) as follows:

$$E_{ao}^{*} = E_{ao} - t_{0.95} S_o \qquad \text{Eq. 19-28}$$

12.7.1.2 Control Device Removal Efficiency. Compliance with the overall emission reduction ($\%R_o$) may be determined by using the lower confidence limit of the emission rate (E_{ao}*) and the upper confidence limit of the inlet pollutant rate (E_{ai}*) in calculating the control device removal efficiency ($\%R_g$) as follows:

$$\%R_g = 100 \left(1.0 - \frac{E_{ao}^{*}}{E_{ai}^{*}}\right) \qquad \text{Eq. 19-29}$$

$$E_{ai}^{*} = E_{ai} + t_{0.95} S_i \qquad \text{Eq. 19-30}$$

12.7.2 Standard Deviation of Hourly Average Pollutant Rates. Compute the standard deviation (S_e) of the hourly average pollutant rates using the following equation:

$$S_e = \sqrt{\frac{1}{H} - \frac{1}{H_r}} \sqrt{\frac{\sum_{j=1}^{H} \left(E_{hj} - E_a\right)^2}{H - 1}} \qquad \text{Eq. 19-31}$$

Equation 19–19 through 19–31 may be used to compute the standard deviation for both the outlet (S_o) and, if applicable, inlet (S_i) pollutant rates.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References [Reserved]

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION

From	To	Multiply by
g/scm	ng/scm	10^9
mg/scm	ng/scm	10^6
lb/scf	ng/scm	1.602×10^{13}

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION—Continued

From	To	Multiply by
ppm SO_2	ng/scm	2.66×10^6
ppm NO_X	ng/scm	1.912×10^6
ppm SO_2	lb/scf	1.660×10^{-7}
ppm NO_X	lb/scf	1.194×10^{-7}

TABLE 19–2—F FACTORS FOR VARIOUS FUELS[1]

Fuel Type	F_d		F_w		F_c	
	dscm/J	dscf/10^6 Btu	wscm/J	wscf/10^6 Btu	scm/J	scf/10^6 Btu
Coal:						
Anthracite[2]	2.71×10^{-7}	10,100	2.83×10^{-7}	10,540	0.530×10^{-7}	1,970
Bituminus[2]	2.63×10^{-7}	9,780	2.86×10^{-7}	10,640	0.484×10^{-7}	1,800
Lignite	2.65×10^{-7}	9,860	3.21×10^{-7}	11,950	0.513×10^{-7}	1,910
Oil[3]	2.47×10^{-7}	9,190	2.77×10^{-7}	10,320	0.383×10^{-7}	1,420
Gas:.						
Natural	2.34×10^{-7}	8,710	2.85×10^{-7}	10,610	0.287×10^{-7}	1,040
Propane	2.34×10^{-7}	8,710	2.74×10^{-7}	10,200	0.321×10^{-7}	1,190
Butane	2.34×10^{-7}	8,710	2.79×10^{-7}	10,390	0.337×10^{-7}	1,250
Wood	2.48×10^{-7}	9,240			0.492×10^{-7}	1,830
Wood Bark	2.58×10^{-7}	9,600			0.516×10^{-7}	1,920
Municipal	2.57×10^{-7}	9,570			0.488×10^{-7}	1,820
Solid Waste						

[1] Determined at standard conditions: 20 °C (68 °F) and 760 mm Hg (29.92 in Hg)
[2] As classified according to ASTM D 388.
[3] Crude, residual, or distillate.

TABLE 19–3—VALUES FOR $T_{0.95}$*

n[1]	$t_{0.95}$	n[1]	$t_{0.95}$	n[1]	$t_{0.95}$
2	6.31	8	1.89	22–26	1.71
3	2.42	9	1.86	27–31	1.70
4	2.35	10	1.83	32–51	1.68
5	2.13	11	1.81	52–91	1.67
6	2.02	12–16	1.77	92–151	1.66
7	1.94	17–21	1.73	152 or more	1.65

[1]The values of this table are corrected for n-1 degrees of freedom. Use n equal to the number (H) of hourly average data points.

METHOD 20—DETERMINATION OF NITROGEN OXIDES, SULFUR DIOXIDE, AND DILUENT EMISSIONS FROM STATIONARY GAS TURBINES

1.0 Scope and Application

What is Method 20?

Method 20 contains the details you must follow when using an instrumental analyzer to determine concentrations of nitrogen oxides, oxygen, carbon dioxide, and sulfur dioxide in the emissions from stationary gas turbines. This method follows the specific instructions for equipment and performance requirements, supplies, sample collection and analysis, calculations, and data analysis in the methods listed in section 2.0.

1.1 Analytes. What does this method determine?

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X) as nitrogen dioxide:	10102–43–9	Typically <2% of Calibration Span.
Nitric oxide (NO)	10102–44–0	
Nitrogen dioxide NO_2.		
Diluent oxygen (O_2) or carbon dioxide (CO_2)		Typically <2% of Calibration Span.
Sulfur dioxide (SO_X)	7446–09–5	Typically <2% of Calibration Span.

1.2 Applicability. When is this method required? The use of Method 20 may be required by specific New Source Performance Standards, Clean Air Marketing rules, and State Implementation Plans and permits where

measuring SO_2, NO_X, CO_2, and/or O_2 concentrations in stationary gas turbines emissions are required. Other regulations may also require its use.

1.3 Data Quality Objectives. How good must my collected data be? Refer to section 1.3 of Method 7E.

2.0 Summary of Method

In this method, NO_X, O_2 (or CO_2), and SO_X are measured using the following methods found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 3A—Determination of Oxygen and Carbon Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(c) Method 6C—Determination of Sulfur Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(d) Method 7E—Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(e) Method 19—Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates.

3.0 Definitions

Refer to section 3.0 of Method 7E for the applicable definitions.

4.0 Interferences

Refer to section 4.0 of Methods 3A, 6C, and 7E as applicable.

5.0 Safety

Refer to section 5.0 of Method 7E.

6.0 Equipment and Supplies

The measurement system design is shown in Figure 7E–1 of Method 7E. Refer to the appropriate methods listed in section 2.0 for equipment and supplies.

7.0 Reagents and Standards

Refer to the appropriate methods listed in section 2.0 for reagents and standards.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling Site and Sampling Points. Follow the procedures of section 8.1 of Method 7E. For the stratification test in section 8.1.2, determine the diluent-corrected pollutant concentration at each traverse point.

8.2 Initial Measurement System Performance Tests. You must refer to the appropriate methods listed in section 2.0 for the measurement system performance tests as applicable.

8.3 Interference Check. You must follow the procedures in section 8.3 of Method 3A or 6C, or section 8.2.7 of Method 7E (as appropriate).

8.4 Sample Collection. You must follow the procedures of section 8.4 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

8.5 Post-Run System Bias Check, Drift Assessment, and Alternative Dynamic Spike Procedure. You must follow the procedures of sections 8.5 and 8.6 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

9.0 Quality Control

Follow quality control procedures in section 9.0 of Method 7E.

10.0 Calibration and Standardization

Follow the procedures for calibration and standardization in section 10.0 of Method 7E.

11.0 Analytical Procedures

Because sample collection and analysis are performed together (see section 8), additional discussion of the analytical procedure is not necessary.

12.0 Calculations and Data Analysis

You must follow the procedures for calculations and data analysis in section 12.0 of the appropriate method listed in section 2.0. Follow the procedures in section 12.0 of Method 19 for calculating fuel-specific F factors, diluent-corrected pollutant concentrations, and emission rates.

13.0 Method Performance

The specifications for the applicable performance checks are the same as in section 13.0 of Method 7E.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures

Refer to section 16.0 of the appropriate method listed in section 2.0 for alternative procedures.

17.0 References

Refer to section 17.0 of the appropriate method listed in section 2.0 for references.

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Refer to section 18.0 of the appropriate method listed in section 2.0 for tables, diagrams, flowcharts, and validation data.

METHOD 21—DETERMINATION OF VOLATILE ORGANIC COMPOUND LEAKS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile Organic Compounds (VOC).	No CAS number assigned.

1.2 Scope. This method is applicable for the determination of VOC leaks from process equipment. These sources include, but are not limited to, valves, flanges and other connections, pumps and compressors, pressure relief devices, process drains, open-ended valves, pump and compressor seal system degassing vents, accumulator vessel vents, agitator seals, and access door seals.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A portable instrument is used to detect VOC leaks from individual sources. The instrument detector type is not specified, but it must meet the specifications and performance criteria contained in section 6.0. A leak definition concentration based on a reference compound is specified in each applicable regulation. This method is intended to locate and classify leaks only, and is not to be used as a direct measure of mass emission rate from individual sources.

3.0 Definitions

3.1 *Calibration gas* means the VOC compound used to adjust the instrument meter reading to a known value. The calibration gas is usually the reference compound at a known concentration approximately equal to the leak definition concentration.

3.2 *Calibration precision* means the degree of agreement between measurements of the same known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration.

3.3 *Leak definition concentration* means the local VOC concentration at the surface of a leak source that indicates that a VOC emission (leak) is present. The leak definition is an instrument meter reading based on a reference compound.

3.4 *No detectable emission* means a local VOC concentration at the surface of a leak source, adjusted for local VOC ambient concentration, that is less than 2.5 percent of the specified leak definition concentration. that indicates that a VOC emission (leak) is not present.

3.5 *Reference compound* means the VOC species selected as the instrument calibration basis for specification of the leak definition concentration. (For example, if a leak definition concentration is 10,000 ppm as methane, then any source emission that results in a local concentration that yields a meter reading of 10,000 on an instrument meter calibrated with methane would be classified as a leak. In this example, the leak definition concentration is 10,000 ppm and the reference compound is methane.)

3.6 *Response factor* means the ratio of the known concentration of a VOC compound to the observed meter reading when measured using an instrument calibrated with the reference compound specified in the applicable regulation.

3.7 *Response time* means the time interval from a step change in VOC concentration at the input of the sampling system to the time at which 90 percent of the corresponding final value is reached as displayed on the instrument readout meter.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Pollutants. Several of the compounds, leaks of which may be determined by this method, may be irritating or corrosive to tissues (*e.g.*, heptane) or may be toxic (*e.g.*, benzene, methyl alcohol). Nearly all are fire hazards. Compounds in emissions should be determined through familiarity with the source. Appropriate precautions can be found in reference documents, such as reference No. 4 in section 16.0.

6.0 Equipment and Supplies

A VOC monitoring instrument meeting the following specifications is required:

6.1 The VOC instrument detector shall respond to the compounds being processed. Detector types that may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption, and photoionization.

6.2 The instrument shall be capable of measuring the leak definition concentration specified in the regulation.

6.3 The scale of the instrument meter shall be readable to ±2.5 percent of the specified leak definition concentration.

6.4 The instrument shall be equipped with an electrically driven pump to ensure that a sample is provided to the detector at a constant flow rate. The nominal sample flow rate, as measured at the sample probe tip, shall be 0.10 to 3.0 l/min (0.004 to 0.1 ft^3/min) when the probe is fitted with a glass wool plug or filter that may be used to prevent plugging of the instrument.

6.5 The instrument shall be equipped with a probe or probe extension or sampling not to exceed 6.4 mm (¼ in) in outside diameter,

with a single end opening for admission of sample.

6.6 The instrument shall be intrinsically safe for operation in explosive atmospheres as defined by the National Electrical Code by the National Fire Prevention Association or other applicable regulatory code for operation in any explosive atmospheres that may be encountered in its use. The instrument shall, at a minimum, be intrinsically safe for Class 1, Division 1 conditions, and/or Class 2, Division 1 conditions, as appropriate, as defined by the example code. The instrument shall not be operated with any safety device, such as an exhaust flame arrestor, removed.

7.0 Reagents and Standards

7.1 Two gas mixtures are required for instrument calibration and performance evaluation:

7.1.1 Zero Gas. Air, less than 10 parts per million by volume (ppmv) VOC.

7.1.2 Calibration Gas. For each organic species that is to be measured during individual source surveys, obtain or prepare a known standard in air at a concentration approximately equal to the applicable leak definition specified in the regulation.

7.2 Cylinder Gases. If cylinder calibration gas mixtures are used, they must be analyzed and certified by the manufacturer to be within 2 percent accuracy, and a shelf life must be specified. Cylinder standards must be either reanalyzed or replaced at the end of the specified shelf life.

7.3 Prepared Gases. Calibration gases may be prepared by the user according to any accepted gaseous preparation procedure that will yield a mixture accurate to within 2 percent. Prepared standards must be replaced each day of use unless it is demonstrated that degradation does not occur during storage.

7.4 Mixtures with non-Reference Compound Gases. Calibrations may be performed using a compound other than the reference compound. In this case, a conversion factor must be determined for the alternative compound such that the resulting meter readings during source surveys can be converted to reference compound results.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Instrument Performance Evaluation. Assemble and start up the instrument according to the manufacturer's instructions for recommended warmup period and preliminary adjustments.

8.1.1 Response Factor. A response factor must be determined for each compound that is to be measured, either by testing or from reference sources. The response factor tests are required before placing the analyzer into service, but do not have to be repeated at subsequent intervals.

8.1.1.1 Calibrate the instrument with the reference compound as specified in the applicable regulation. Introduce the calibration gas mixture to the analyzer and record the observed meter reading. Introduce zero gas until a stable reading is obtained. Make a total of three measurements by alternating between the calibration gas and zero gas. Calculate the response factor for each repetition and the average response factor.

8.1.1.2 The instrument response factors for each of the individual VOC to be measured shall be less than 10 unless otherwise specified in the applicable regulation. When no instrument is available that meets this specification when calibrated with the reference VOC specified in the applicable regulation, the available instrument may be calibrated with one of the VOC to be measured, or any other VOC, so long as the instrument then has a response factor of less than 10 for each of the individual VOC to be measured.

8.1.1.3 Alternatively, if response factors have been published for the compounds of interest for the instrument or detector type, the response factor determination is not required, and existing results may be referenced. Examples of published response factors for flame ionization and catalytic oxidation detectors are included in References 1–3 of section 17.0.

8.1.2 Calibration Precision. The calibration precision test must be completed prior to placing the analyzer into service and at subsequent 3-month intervals or at the next use, whichever is later.

8.1.2.1 Make a total of three measurements by alternately using zero gas and the specified calibration gas. Record the meter readings. Calculate the average algebraic difference between the meter readings and the known value. Divide this average difference by the known calibration value and multiply by 100 to express the resulting calibration precision as a percentage.

8.1.2.2 The calibration precision shall be equal to or less than 10 percent of the calibration gas value.

8.1.3 Response Time. The response time test is required before placing the instrument into service. If a modification to the sample pumping system or flow configuration is made that would change the response time, a new test is required before further use.

8.1.3.1 Introduce zero gas into the instrument sample probe. When the meter reading has stabilized, switch quickly to the specified calibration gas. After switching, measure the time required to attain 90 percent of the final stable reading. Perform this test sequence three times and record the results. Calculate the average response time.

8.1.3.2 The instrument response time shall be equal to or less than 30 seconds. The instrument pump, dilution probe (if any), sample probe, and probe filter that will be used

during testing shall all be in place during the response time determination.

8.2 Instrument Calibration. Calibrate the VOC monitoring instrument according to section 10.0.

8.3 Individual Source Surveys.

8.3.1 Type I—Leak Definition Based on Concentration. Place the probe inlet at the surface of the component interface where leakage could occur. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained. Leave the probe inlet at this maximum reading location for approximately two times the instrument response time. If the maximum observed meter reading is greater than the leak definition in the applicable regulation, record and report the results as specified in the regulation reporting requirements. Examples of the application of this general technique to specific equipment types are:

8.3.1.1 Valves. The most common source of leaks from valves is the seal between the stem and housing. Place the probe at the interface where the stem exits the packing gland and sample the stem circumference. Also, place the probe at the interface of the packing gland take-up flange seat and sample the periphery. In addition, survey valve housings of multipart assembly at the surface of all interfaces where a leak could occur.

8.3.1.2 Flanges and Other Connections. For welded flanges, place the probe at the outer edge of the flange-gasket interface and sample the circumference of the flange. Sample other types of nonpermanent joints (such as threaded connections) with a similar traverse.

8.3.1.3 Pumps and Compressors. Conduct a circumferential traverse at the outer surface of the pump or compressor shaft and seal interface. If the source is a rotating shaft, position the probe inlet within 1 cm of the shaft-seal interface for the survey. If the housing configuration prevents a complete traverse of the shaft periphery, sample all accessible portions. Sample all other joints on the pump or compressor housing where leakage could occur.

8.3.1.4 Pressure Relief Devices. The configuration of most pressure relief devices prevents sampling at the sealing seat interface. For those devices equipped with an enclosed extension, or horn, place the probe inlet at approximately the center of the exhaust area to the atmosphere.

8.3.1.5 Process Drains. For open drains, place the probe inlet at approximately the center of the area open to the atmosphere. For covered drains, place the probe at the surface of the cover interface and conduct a peripheral traverse.

8.3.1.6 Open-ended Lines or Valves. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.7 Seal System Degassing Vents and Accumulator Vents. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.8 Access door seals. Place the probe inlet at the surface of the door seal interface and conduct a peripheral traverse.

8.3.2 Type II—''No Detectable Emission''. Determine the local ambient VOC concentration around the source by moving the probe randomly upwind and downwind at a distance of one to two meters from the source. If an interference exists with this determination due to a nearby emission or leak, the local ambient concentration may be determined at distances closer to the source, but in no case shall the distance be less than 25 centimeters. Then move the probe inlet to the surface of the source and determine the concentration as outlined in section 8.3.1. The difference between these concentrations determines whether there are no detectable emissions. Record and report the results as specified by the regulation. For those cases where the regulation requires a specific device installation, or that specified vents be ducted or piped to a control device, the existence of these conditions shall be visually confirmed. When the regulation also requires that no detectable emissions exist, visual observations and sampling surveys are required. Examples of this technique are:

8.3.2.1 Pump or Compressor Seals. If applicable, determine the type of shaft seal. Perform a survey of the local area ambient VOC concentration and determine if detectable emissions exist as described in section 8.3.2.

8.3.2.2 Seal System Degassing Vents, Accumulator Vessel Vents, Pressure Relief Devices. If applicable, observe whether or not the applicable ducting or piping exists. Also, determine if any sources exist in the ducting or piping where emissions could occur upstream of the control device. If the required ducting or piping exists and there are no sources where the emissions could be vented to the atmosphere upstream of the control device, then it is presumed that no detectable emissions are present. If there are sources in the ducting or piping where emissions could be vented or sources where leaks could occur, the sampling surveys described in section 8.3.2 shall be used to determine if detectable emissions exist.

8.3.3 Alternative Screening Procedure.

8.3.3.1 A screening procedure based on the formation of bubbles in a soap solution that is sprayed on a potential leak source may be used for those sources that do not have continuously moving parts, that do not have surface temperatures greater than the boiling point or less than the freezing point of the soap solution, that do not have open

areas to the atmosphere that the soap solution cannot bridge, or that do not exhibit evidence of liquid leakage. Sources that have these conditions present must be surveyed using the instrument technique of section 8.3.1 or 8.3.2.

8.3.3.2 Spray a soap solution over all potential leak sources. The soap solution may be a commercially available leak detection solution or may be prepared using concentrated detergent and water. A pressure sprayer or squeeze bottle may be used to dispense the solution. Observe the potential leak sites to determine if any bubbles are formed. If no bubbles are observed, the source is presumed to have no detectable emissions or leaks as applicable. If any bubbles are observed, the instrument techniques of section 8.3.1 or 8.3.2 shall be used to determine if a leak exists, or if the source has detectable emissions, as applicable.

9.0 Quality Control

Section	Quality control measure	Effect
8.1.2	Instrument calibration precision check	Ensure precision and accuracy, respectively, of instrument response to standard.
10.0	Instrument calibration.	

10.0 Calibration and Standardization

10.1 Calibrate the VOC monitoring instrument as follows. After the appropriate warmup period and zero internal calibration procedure, introduce the calibration gas into the instrument sample probe. Adjust the instrument meter readout to correspond to the calibration gas value.

NOTE: If the meter readout cannot be adjusted to the proper value, a malfunction of the analyzer is indicated and corrective actions are necessary before use.

11.0 Analytical Procedures [Reserved]

12.0 Data Analyses and Calculations [Reserved]

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Dubose, D.A., and G.E. Harris. Response Factors of VOC Analyzers at a Meter Reading of 10,000 ppmv for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81051. September 1981.

2. Brown, G.E., *et al.* Response Factors of VOC Analyzers Calibrated with Methane for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–022. May 1981.

3. DuBose, D.A. *et al.* Response of Portable VOC Analyzers to Chemical Mixtures. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–110. September 1981.

4. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 22—VISUAL DETERMINATION OF FUGITIVE EMISSIONS FROM MATERIAL SOURCES AND SMOKE EMISSIONS FROM FLARES

NOTE: This method is not inclusive with respect to observer certification. Some material is incorporated by reference from Method 9.

1.0 Scope and Application

This method is applicable for the determination of the frequency of fugitive emissions from stationary sources, only as specified in an applicable subpart of the regulations. This method also is applicable for the determination of the frequency of visible smoke emissions from flares.

2.0 Summary of Method

2.1 Fugitive emissions produced during material processing, handling, and transfer operations or smoke emissions from flares are visually determined by an observer without the aid of instruments.

2.2 This method is used also to determine visible smoke emissions from flares used for combustion of waste process materials.

2.3 This method determines the amount of time that visible emissions occur during the observation period (*i.e.*, the accumulated emission time). This method does not require that the opacity of emissions be determined. Since this procedure requires only the determination of whether visible emissions occur and does not require the determination of opacity levels, observer certification according to the procedures of Method 9 is not required. However, it is necessary that the observer is knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative

to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in References 1 and 2 or from the lecture portion of the Method 9 certification course.

3.0 Definitions

3.1 *Emission frequency* means the percentage of time that emissions are visible during the observation period.

3.2 *Emission time* means the accumulated amount of time that emissions are visible during the observation period.

3.3 *Fugitive emissions* means emissions generated by an affected facility which is not collected by a capture system and is released to the atmosphere. This includes emissions that (1) escape capture by process equipment exhaust hoods; (2) are emitted during material transfer; (3) are emitted from buildings housing material processing or handling equipment; or (4) are emitted directly from process equipment.

3.4 *Observation period* means the accumulated time period during which observations are conducted, not to be less than the period specified in the applicable regulation.

3.5 *Smoke emissions* means a pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission.

4.0 Interferences

4.1 Occasionally, fugitive emissions from sources other than the affected facility (*e.g.*, road dust) may prevent a clear view of the affected facility. This may particularly be a problem during periods of high wind. If the view of the potential emission points is obscured to such a degree that the observer questions the validity of continuing observations, then the observations shall be terminated, and the observer shall clearly note this fact on the data form.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment

6.1 Stopwatches (two). Accumulative type with unit divisions of at least 0.5 seconds.

6.2 Light Meter. Light meter capable of measuring illuminance in the 50 to 200 lux range, required for indoor observations only.

7.0 Reagents and Supplies [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transfer [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

11.1 Selection of Observation Location. Survey the affected facility, or the building or structure housing the process to be observed, and determine the locations of potential emissions. If the affected facility is located inside a building, determine an observation location that is consistent with the requirements of the applicable regulation (*i.e.*, outside observation of emissions escaping the building/structure or inside observation of emissions directly emitted from the affected facility process unit). Then select a position that enables a clear view of the potential emission point(s) of the affected facility or of the building or structure housing the affected facility, as appropriate for the applicable subpart. A position at least 4.6 m (15 feet), but not more than 400 m (0.25 miles), from the emission source is recommended. For outdoor locations, select a position where the sunlight is not shining directly in the observer's eyes.

11.2 Field Records.

11.2.1 Outdoor Location. Record the following information on the field data sheet (Figure 22–1): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record also the estimated wind speed, wind direction, and sky condition. Sketch the process unit being observed, and note the observer location relative to the source and the sun. Indicate the potential and actual emission points on the sketch.

11.2.2 Indoor Location. Record the following information on the field data sheet (Figure 22–2): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record as appropriate the type, location, and intensity of lighting on the data sheet. Sketch the process unit being observed, and note the observer location relative to the source. Indicate the potential and actual fugitive emission points on the sketch.

11.3 Indoor Lighting Requirements. For indoor locations, use a light meter to measure the level of illumination at a location as close to the emission source(s) as is feasible. An illumination of greater than 100 lux (10 foot candles) is considered necessary for proper application of this method.

11.4 Observations.

11.4.1 Procedure. Record the clock time when observations begin. Use one stopwatch to monitor the duration of the observation

period. Start this stopwatch when the observation period begins. If the observation period is divided into two or more segments by process shutdowns or observer rest breaks (see section 11.4.3), stop the stopwatch when a break begins and restart the stopwatch without resetting it when the break ends. Stop the stopwatch at the end of the observation period. The accumulated time indicated by this stopwatch is the duration of observation period. When the observation period is completed, record the clock time. During the observation period, continuously watch the emission source. Upon observing an emission (condensed water vapor is not considered an emission), start the second accumulative stopwatch; stop the watch when the emission stops. Continue this procedure for the entire observation period. The accumulated elapsed time on this stopwatch is the total time emissions were visible during the observation period (*i.e.,* the emission time.)

11.4.2 Observation Period. Choose an observation period of sufficient length to meet the requirements for determining compliance with the emission standard in the applicable subpart of the regulations. When the length of the observation period is specifically stated in the applicable subpart, it may not be necessary to observe the source for this entire period if the emission time required to indicate noncompliance (based on the specified observation period) is observed in a shorter time period. In other words, if the regulation prohibits emissions for more than 6 minutes in any hour, then observations may (optional) be stopped after an emission time of 6 minutes is exceeded. Similarly, when the regulation is expressed as an emission frequency and the regulation prohibits emissions for greater than 10 percent of the time in any hour, then observations may (optional) be terminated after 6 minutes of emission are observed since 6 minutes is 10 percent of an hour. In any case, the observation period shall not be less than 6 minutes in duration. In some cases, the process operation may be intermittent or cyclic. In such cases, it may be convenient for the observation period to coincide with the length of the process cycle.

11.4.3 Observer Rest Breaks. Do not observe emissions continuously for a period of more than 15 to 20 minutes without taking a rest break. For sources requiring observation periods of greater than 20 minutes, the observer shall take a break of not less than 5 minutes and not more than 10 minutes after every 15 to 20 minutes of observation. If continuous observations are desired for extended time periods, two observers can alternate between making observations and taking breaks.

11.5 Recording Observations. Record the accumulated time of the observation period on the data sheet as the observation period duration. Record the accumulated time emissions were observed on the data sheet as the emission time. Record the clock time the observation period began and ended, as well as the clock time any observer breaks began and ended.

12.0 Data Analysis and Calculations

If the applicable subpart requires that the emission rate be expressed as an emission frequency (in percent), determine this value as follows: Divide the accumulated emission time (in seconds) by the duration of the observation period (in seconds) or by any minimum observation period required in the applicable subpart, if the actual observation period is less than the required period, and multiply this quotient by 100.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Missan, R., and A. Stein. Guidelines for Evaluation of Visible Emissions Certification, Field Procedures, Legal Aspects, and Background Material. EPA Publication No. EPA-340/1-75-007. April 1975.

2. Wohlschlegel, P., and D.E. Wagoner. Guideline for Development of a Quality Assurance Program: Volume IX—Visual Determination of Opacity Emissions from Stationary Sources. EPA Publication No. EPA-650/4-74-005i. November 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

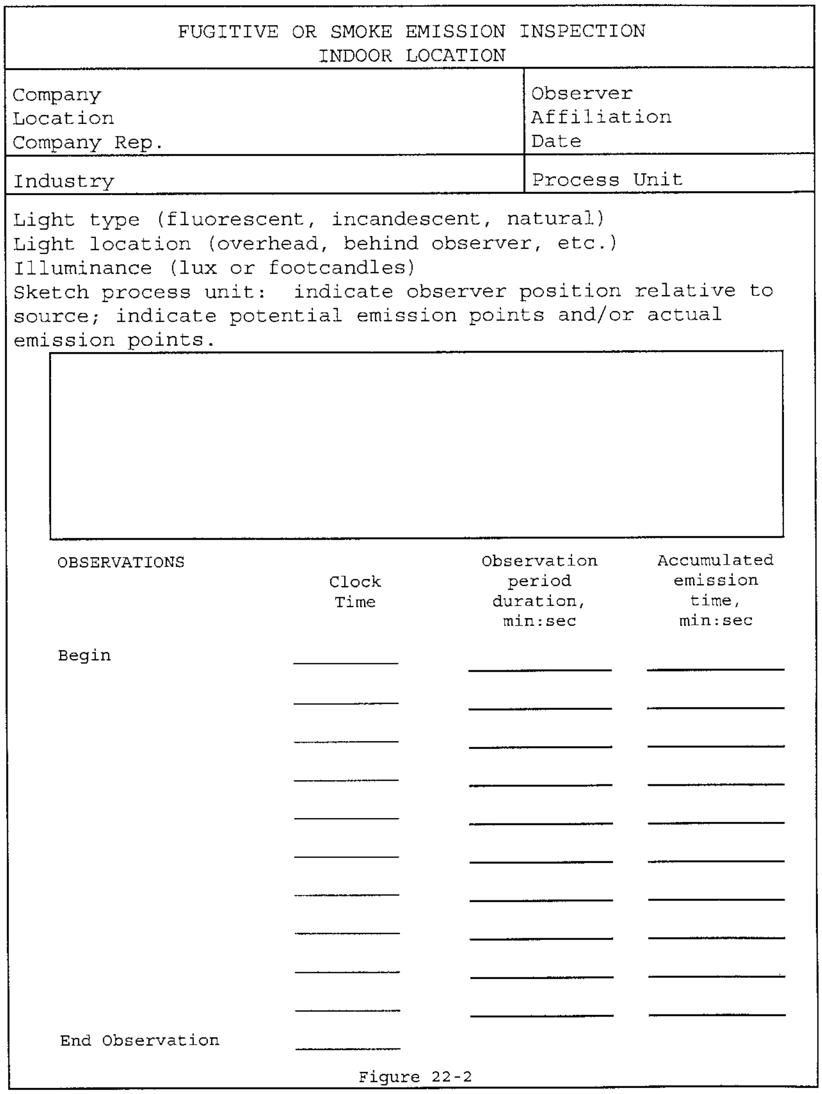
FUGITIVE OR SMOKE EMISSION INSPECTION
OUTDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Sky Conditions Precipitation	Wind Direction Wind Speed
Industry	Process Unit

Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin Observation	________		
		________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________		
End Observation		________	________
	________		

Figure 22-1



FUGITIVE OR SMOKE EMISSION INSPECTION
INDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Industry	Process Unit

Light type (fluorescent, incandescent, natural)
Light location (overhead, behind observer, etc.)
Illuminance (lux or footcandles)
Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
End Observation	________		

Figure 22-2

METHOD 23—DETERMINATION OF POLYCHLORINATED DIBENZO-P-DIOXINS AND POLYCHLORINATED DIBENZOFURANS FROM STATIONARY SOURCES

1. Applicability and Principle

1.1 Applicability. This method is applicable to the determination of polychlorinated dibenzo-p-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) from stationary sources.

1.2 Principle. A sample is withdrawn from the gas stream isokinetically and collected in the sample probe, on a glass fiber filter, and on a packed column of adsorbent material. The sample cannot be separated into a particle vapor fraction. The PCDD's and

PCDF's are extracted from the sample, separated by high resolution gas chromatography, and measured by high resolution mass spectrometry.

2. Apparatus

2.1 Sampling. A schematic of the sampling train used in this method is shown in Figure 23–1. Sealing greases may not be used in assembling the train. The train is identical to that described in section 2.1 of Method 5 of this appendix with the following additions:

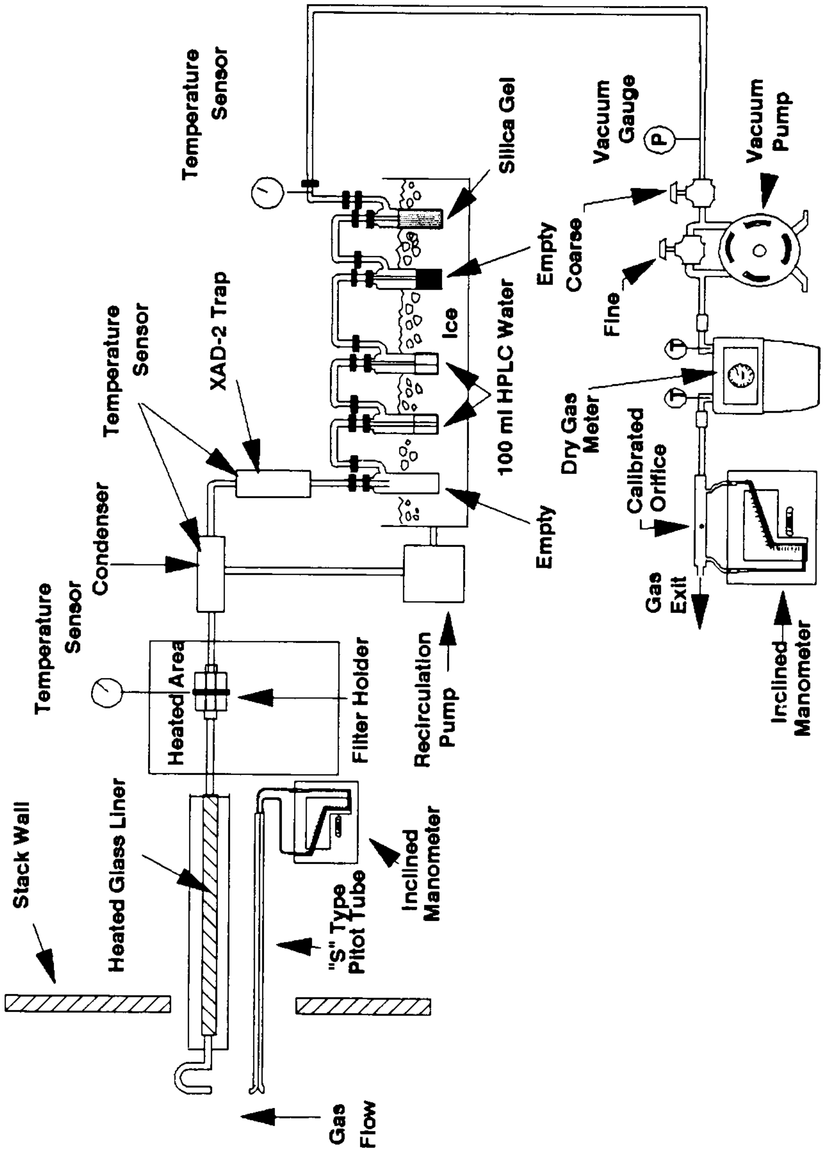


Figure 23.1 Sampling train

2.1.1 Nozzle. The nozzle shall be made of nickel, nickel-plated stainless steel, quartz, or borosilicate glass.

2.1.2 Sample Transfer Lines. The sample transfer lines, if needed, shall be heat traced, heavy walled TFE (½ in. OD with ⅛ in. wall) with connecting fittings that are capable of forming leak-free, vacuum-tight connections without using sealing greases. The line shall be as short as possible and must be maintained at 120 °C.

2.1.1 Filter Support. Teflon or Teflon-coated wire.

2.1.2 Condenser. Glass, coil type with compatible fittings. A schematic diagram is shown in Figure 23–2.

2.1.3 Water Bath. Thermostatically controlled to maintain the gas temperature exiting the condenser at <20 °C (68 °F).

2.1.4 Adsorbent Module. Glass container to hold the solid adsorbent. A shematic diagram is shown in Figure 23–2. Other physical configurations of the resin trap/condenser assembly are acceptable. The connecting fittings shall form leak-free, vacuum tight seals. No sealant greases shall be used in the sampling train. A coarse glass frit is included to retain the adsorbent.

2.2 Sample Recovery.

2.2.1 Fitting Caps. Ground glass, Teflon tape, or aluminum foil (Section 2.2.6) to cap off the sample exposed sections of the train.

2.2.2 Wash Bottles. Teflon, 500-ml.

2.2.3 Probe-Liner Probe-Nozzle, and Filter-Holder Brushes. Inert bristle brushes with precleaned stainless steel or Teflon handles. The probe brush shall have extensions of stainless steel or Teflon, at least as long as the probe. The brushes shall be properly sized and shaped to brush out the nozzle, probe liner, and transfer line, if used.

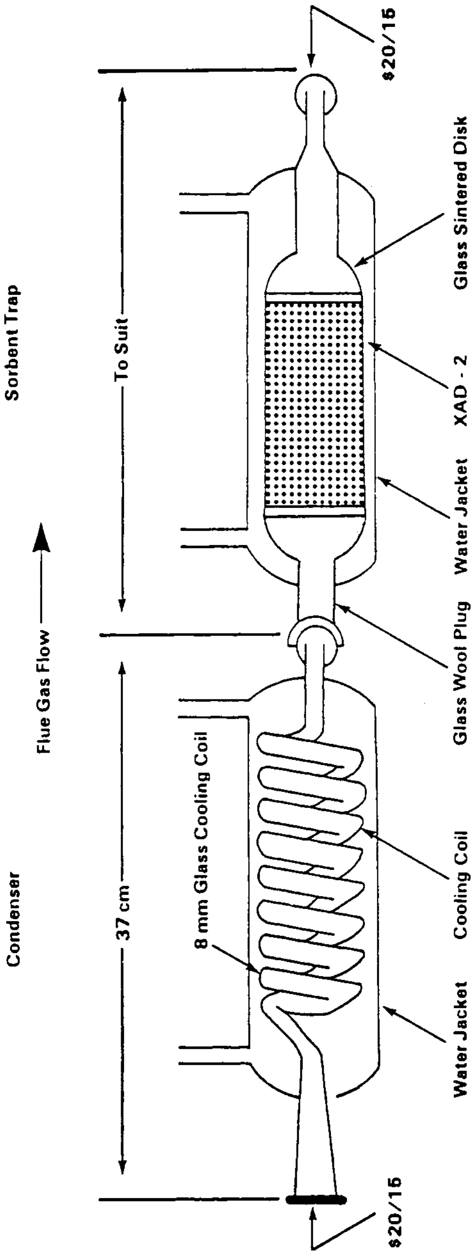


Figure 23.2. Condenser and adsorbent trap

2.2.4 Filter Storage Container. Sealed filter holder, wide-mouth amber glass jar with Teflon-lined cap, or glass petri dish.

2.2.5 Balance. Triple beam.

2.2.6 Aluminum Foil. Heavy duty, hexane-rinsed.

2.2.7 Storage Container. Air-tight container to store silica gel.

2.2.8 Graduated Cylinder. Glass, 250-ml with 2-ml graduation.

2.2.9 Glass Sample Storage Container. Amber glass bottle for sample glassware washes, 500- or 1000-ml, with leak free Teflon-lined caps.

2.3 Analysis.

2.3.1 Sample Container. 125- and 250-ml flint glass bottles with Teflon-lined caps.

2.3.2 Test Tube. Glass.

2.3.3 Soxhlet Extraction Apparatus. Capable of holding 43 × 123 mm extraction thimbles.

2.3.4 Extraction Thimble. Glass, precleaned cellulosic, or glass fiber.

2.3.5 Pasteur Pipettes. For preparing liquid chromatographic columns.

2.3.6 Reacti-vials. Amber glass, 2-ml, silanized prior to use.

2.3.7 Rotary Evaporator. Buchi/Brinkman RF–121 or equivalent.

2.3.8 Nitrogen Evaporative Concentrator. N-Evap Analytical Evaporator Model III or equivalent.

2.3.9 Separatory Funnels. Glass, 2-liter.

2.3.10 Gas Chromatograph. Consisting of the following components:

2.3.10.1 Oven. Capable of maintaining the separation column at the proper operating temperature ±°C and performing programmed increases in temperature at rates of at least 40 °C/min.

2.3.10.2 Temperature Gauge. To monitor column oven, detector, and exhaust temperatures ±1 °C.

2.3.10.3 Flow System. Gas metering system to measure sample, fuel, combustion gas, and carrier gas flows.

2.3.10.4 Capillary Columns. A fused silica column, 60 × 0.25 mm inside diameter (ID), coated with DB–5 and a fused silica column, 30 m × 0.25 mm ID coated with DB–225. Other column systems may be used provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

2.3.11 Mass Spectrometer. Capable of routine operation at a resolution of 1:10000 with a stability of ±5 ppm.

2.3.12 Data System. Compatible with the mass spectrometer and capable of monitoring at least five groups of 25 ions.

2.3.13 Analytical Balance. To measure within 0.1 mg.

3. Reagents

3.1 Sampling.

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Standard Method D 2986–71 (Reapproved 1978) (incorporated by reference—see § 60.17).

3.1.1.1 Precleaning. All filters shall be cleaned before their initial use. Place a glass extraction thimble and 1 g of silica gel and a plug of glass wool into a Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Place no more than 50 filters in the thimble onto the silica gel bed and top with the cleaned glass wool. Charge the Soxhlet with toluene and reflux for 16 hours. After extraction, allow the Soxhlet to cool, remove the filters, and dry them under a clean N_2 stream. Store the filters in a glass petri dish sealed with Teflon tape.

3.1.2 Adsorbent Resin. Amberlite XAD–2 resin. Thoroughly cleaned before initial use.

3.1.2.1 Cleaning Procedure. This procedure may be carried out in a giant Soxhlet extractor. An all-glass filter thimble containing an extra-course frit is used for extraction of XAD–2. The frit is recessed 10–15 mm above a crenelated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass wool plug and a stainless steel ring because it floats on methylene chloride. This process involves sequential extraction in the following order.

Solvent	Procedure
Water	Initial rinse: Place resin in a beaker, rinse once with water, and discard. Fill with water a second time, let stand overnight, and discard.
Water	Extract with water for 8 hours.
Methanol	Extract for 22 hours.
Methylene Chloride	Extract for 22 hours.
Toluene	Extract for 22 hours.

3.1.2.2 Drying.

3.1.2.2.1 Drying Column. Pyrex pipe, 10.2 cm ID by 0.6 m long, with suitable retainers.

3.1.2.2.2 Procedure. The adsorbent must be dried with clean inert gas. Liquid nitrogen from a standard commercial liquid nitrogen cylinder has proven to be a reliable source of large volumes of gas free from organic contaminants. Connect the liquid nitrogen cylinder to the column by a length of cleaned copper tubing, 0.95 cm ID, coiled to pass through a heat source. A convenient heat source is a water-bath heated from a steam line. The final nitrogen temperature should only be warm to the touch and not over 40 °C. Continue flowing nitrogen through the adsorbent until all the residual solvent is removed. The flow rate should be sufficient to gently agitate the particles but not so excessive as the cause the particles to fracture.

3.1.2.3 Quality Control Check. The adsorbent must be checked for residual toluene.

3.1.2.3.1 Extraction. Weigh 1.0 g sample of dried resin into a small vial, add 3 ml of toluene, cap the vial, and shake it well.

3.1.2.3.2 Analysis. Inject a 2 µl sample of the extract into a gas chromatograph operated under the following conditions:

Column: 6 ft × ⅛ in stainless steel containing 10 percent OV–101 on 100/120 Supelcoport.
Carrier Gas: Helium at a rate of 30 ml/min.
Detector: Flame ionization detector operated at a sensitivity of 4×10^{-11} A/mV.
Injection Port Temperature: 250 °C.
Detector Temperature: 305 °C.
Oven Temperature: 30 °C for 4 min; programmed to rise at 40 °C/min until it reaches 250 °C; return to 30 °C after 17 minutes.

Compare the results of the analysis to the results from the reference solution. Prepare the reference solution by injection 2.5 µl of methylene chloride into 100 ml of toluene. This corresponds to 100 µg of methylene chloride per g of adsorbent. The maximum acceptable concentration is 1000 µg/g of adsorbent. If the adsorbent exceeds this level, drying must be continued until the excess methylene chloride is removed.

3.1.2.4 Storage. The adsorbent must be used within 4 weeks of cleaning. After cleaning, it may be stored in a wide mouth amber glass container with a Teflon-lined cap or placed in one of the glass adsorbent modules tightly sealed with glass stoppers. If precleaned adsorbent is purchased in sealed containers, it must be used within 4 weeks after the seal is broken.

3.1.3 Glass Wool. Cleaned by sequential immersion in three aliquots of methylene chloride, dried in a 110 °C oven, and stored in a methylene chloride-washed glass jar with a Teflon-lined screw cap.

3.1.4 Water. Deionized distilled and stored in a methylene chloride-rinsed glass container with a Teflon-lined screw cap.

3.1.5 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175 °C (350 °F) for two hours. New silica gel may be used as received. Alternately other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.6 Chromic Acid Cleaning Solution. Dissolve 20 g of sodium dichromate in 15 ml of water, and then carefully add 400 ml of concentrated sulfuric acid.

3.2 Sample Recovery.

3.2.2 Acetone. Pesticide quality.

3.2.2 Methylene Chloride. Pesticide qualtity.

3.2.3 Toluene. Pesticide quality.

3.3 Analysis.

3.3.1 Potassium Hydroxide. ACS grade, 2-percent (weight/volume) in water.

3.3.2 Sodium Sulfate. Granulated, reagent grade. Purify prior to use by rinsing with methylene chloride and oven drying. Store the cleaned material in a glass container with a Teflon-lined screw cap.

3.3.3 Sulfuric Acid. Reagent grade.

3.3.4 Sodium Hydroxide. 1.0 N. Weigh 40 g of sodium hydroxide into a 1-liter volumetric flask. Dilute to 1 liter with water.

3.3.5 Hexane. Pesticide grade.

3.3.6 Methylene Chloride. Pesticide grade.

3.3.7 Benzene. Pesticide Grade.

3.3.8 Ethyl Acetate.

3.3.9 Methanol. Pesticide Grade.

3.3.10 Toluene. Pesticide Grade.

3.3.11 Nonane. Pesticide Grade.

3.3.12 Cyclohexane. Pesticide Grade.

3.3.13 Basic Alumina. Activity grade 1, 100–200 mesh. Prior to use, activate the alumina by heating for 16 hours at 130 °C before use. Store in a desiccator. Pre-activated alumina may be purchased from a supplier and may be used as received.

3.3.14 Silica Gel. Bio-Sil A, 100–200 mesh. Prior to use, activate the silica gel by heating for at least 30 minutes at 180 °C. After cooling, rinse the silica gel sequentially with methanol and methylene chloride. Heat the rinsed silica gel at 50 °C for 10 minutes, then increase the temperature gradually to 180 °C over 25 minutes and maintain it at this temperature for 90 minutes. Cool at room temperature and store in a glass container with a Teflon-lined screw cap.

3.3.15 Silica Gel Impregnated with Sulfuric Acid. Combine 100 g of silica gel with 44 g of concentrated sulfuric acid in a screw capped glass bottle and agitate thoroughly. Disperse the solids with a stirring rod until a uniform mixture is obtained. Store the mixture in a glass container with a Teflon-lined screw cap.

3.3.16 Silica Gel Impregnated with Sodium Hydroxide. Combine 39 g of 1 N sodium hydroxide with 100 g of silica gel in a screw capped glass bottle and agitate thoroughly. Disperse solids with a stirring rod until a uniform mixture is obtained. Store the mixture in glass container with a Teflon-lined screw cap.

3.3.17 Carbon/Celite. Combine 10.7 g of AX–21 carbon with 124 g of Celite 545 in a 250-ml glass bottle with a Teflon-lined screw cap. Agitate the mixture thoroughly until a uniform mixture is obtained. Store in the glass container.

3.3.18 Nitrogen. Ultra high purity.

3.3.19 Hydrogen. Ultra high purity.

3.3.20 Internal Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Internal Standards'' in 10 ml of nonane.

3.3.21 Surrogate Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Surrogate Standards'' in 10 ml of nonane.

3.3.22 Recovery Standard Solution. Prepare a stock standard solution containing the

isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Recovery Standards'' in 10 ml of nonane.

4. Procedure

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation.

4.1.1.1 Cleaning Glassware. All glass components of the train upstream of and including the adsorbent module, shall be cleaned as described in section 3A of the ''Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.'' Special care shall be devoted to the removal of residual silicone grease sealants on ground glass connections of used glassware. Any residue shall be removed by soaking the glassware for several hours in a chromic acid cleaning solution prior to cleaning as described above.

4.1.1.2 Adsorbent Trap. The traps must be loaded in a clean area to avoid contamination. They may not be loaded in the field. Fill a trap with 20 to 40 g of XAD–2. Follow the XAD–2 with glass wool and tightly cap both ends of the trap. Add 100 µl of the surrogate standard solution (section 3.3.21) to each trap.

4.1.1.3 Sample Train. It is suggested that all components be maintained according to the procedure described in APTD–0576. Alternative mercury-free thermometers may be used if the thermometers are, at a minimum, equivalent in terms of performance or suitably effective for the specific temperature measurement application.

4.1.1.4 Silica Gel. Weigh several 200 to 300 g portions of silica gel in an air tight container to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel may be weighed directly in its impinger or sampling holder just prior to sampling.

4.1.1.5 Filter. Check each filter against light for irregularities and flaws or pinhole leaks. Pack the filters flat in a clean glass container.

4.1.2 Preliminary Determinations. Same as section 4.1.2 of Method 5.

4.1.3 Preparation of Collection Train.

4.1.3.1 During preparation and assembly of the sampling train, keep all train openings where contamination can enter, sealed until just prior to assembly or until sampling is about to begin.

NOTE: Do not use sealant grease in assembling the train.

4.1.3.2 Place approximately 100 ml of water in the second and third impingers, leave the first and fourth impingers empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fifth impinger.

4.1.3.3 Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

4.1.3.4 Assemble the train as shown in Figure 23–1.

4.1.3.5 Turn on the adsorbent module and condenser coil recirculating pump and begin monitoring the adsorbent module gas entry temperature. Ensure proper sorbent temperature gas entry temperature before proceeding and before sampling is initiated. It is extremely important that the XAD–2 adsorbent resin temperature never exceed 50 °C because thermal decomposition will occur. During testing, the XAD–2 temperature must not exceed 20 °C for efficient capture of the PCDD's and PCDF's.

4.1.4 Leak-Check Procedure. Same as Method 5, section 4.1.4.

4.1.5 Sample Train Operation. Same as Method 5, section 4.1.5.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Seal the nozzle end of the sampling probe with Teflon tape or aluminum foil.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe. Remove the probe from the train and close off both ends with aluminum foil. Seal off the inlet to the train with Teflon tape, a ground glass cap, or aluminum foil.

Transfer the probe and impinger assembly to the cleanup area. This area shall be clean and enclosed so that the chances of losing or contaminating the sample are minimized. Smoking, which could contaminate the sample, shall not be allowed in the cleanup area.

Inspect the train prior to and during disassembly and note any abnormal conditions, e.g., broken filters, colored impinger liquid, etc. Treat the samples as follows:

4.2.1 Container No. 1. Either seal the filter holder or carefully remove the filter from the filter holder and place it in its identified container. Use a pair of cleaned tweezers to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the container any particulate matter and filter fibers which adhere to the filter holder gasket, by using a dry inert bristle brush and a sharp-edged blade. Seal the container.

4.2.2 Adsorbent Module. Remove the module from the train, tightly cap both ends, label it, cover with aluminum foil, and store it on ice for transport to the laboratory.

4.2.3 Container No. 2. Quantitatively recover material deposited in the nozzle, probe transfer lines, the front half of the filter holder, and the cyclone, if used, first, by

brushing while rinsing three times each with acetone and then, by rinsing the probe three times with methylene chloride. Collect all the rinses in Container No. 2.

Rinse the back half of the filter holder three times with acetone. Rinse the connecting line between the filter and the condenser three times with acetone. Soak the connecting line with three separate portions of methylene chloride for 5 minutes each. If using a separate condenser and adsorbent trap, rinse the condenser in the same manner as the connecting line. Collect all the rinses in Container No. 2 and mark the level of the liquid on the container.

4.2.4 Container No. 3. Repeat the methylene chloride-rinsing described in section 4.2.3 using toluene as the rinse solvent. Collect the rinses in Container No. 3 and mark the level of the liquid on the container.

4.2.5 Impinger Water. Measure the liquid in the first three impingers to within ±1 ml by using a graduated cylinder or by weighing it to within ±0.5 g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

Discard the liquid after measuring and recording the volume or weight.

4.2.7 Silica Gel. Note the color of the indicating silica gel to determine if it has been completely spent and make a mention of its condition. Transfer the silica gel from the fifth impinger to its original container and seal. If a moisture determination is made, follow the applicable procedures in sections 8.7.6.3 and 11.2.3 of Method 5 to handle and weigh the silica gel. If moisture is not measured, the silica gel may be disposed.

5. Analysis

All glassware shall be cleaned as described in section 3A of the ‘‘Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.’’ All samples must be extracted within 30 days of collection and analyzed within 45 days of extraction.

5.1 Sample Extraction.

5.1.1 Extraction System. Place an extraction thimble (section 2.3.4), 1 g of silica gel, and a plug of glass wool into the Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Remove the extraction thimble from the extraction system and place it in a glass beaker to catch the solvent rinses.

5.1.2 Container No. 1 (Filter). Transfer the contents directly to the glass thimble of the extraction system and extract them simultaneously with the XAD–2 resin.

5.1.3 Adsorbent Cartridge. Suspend the adsorbent module directly over the extraction thimble in the beaker (See section 5.1.1). The glass frit of the module should be in the up position. Using a Teflon squeeze bottle containing toluene, flush the XAD–2 into the thimble onto the bed of cleaned silica gel. Thoroughly rinse the glass module catching the rinsings in the beaker containing the thimble. If the resin is wet, effective extraction can be accomplished by loosely packing the resin in the thimble. Add the XAD–2 glass wool plug into the thimble.

5.1.4 Container No. 2 (Acetone and Methylene Chloride). Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus, at a temperature of less than 37 °C. Rinse the sample container three times with small portions of methylene chloride and add these to the concentrated solution and concentrate further to near dryness. This residue contains particulate matter removed in the rinse of the train probe and nozzle. Add the concentrate to the filter and the XAD–2 resin in the Soxhlet apparatus described in section 5.1.1.

5.1.5 Extraction. Add 100 µl of the internal standard solution (Section 3.3.20) to the extraction thimble containing the contents of the adsorbent cartridge, the contents of Container No. 1, and the concentrate from section 5.1.4. Cover the contents of the extraction thimble with the cleaned glass wool plug to prevent the XAD–2 resin from floating into the solvent reservoir of the extractor. Place the thimble in the extractor, and add the toluene contained in the beaker to the solvent reservoir. Pour additional toluene to fill the reservoir approximately ⅔ full. Add Teflon boiling chips and assemble the apparatus. Adjust the heat source to cause the extractor to cycle three times per hour. Extract the sample for 16 hours. After extraction, allow the Soxhlet to cool. Transfer the toluene extract and three 10-ml rinses to the rotary evaporator. Concentrate the extract to approximately 10 ml. At this point the analyst may choose to split the sample in half. If so, split the sample, store one half for future use, and analyze the other according to the procedures in sections 5.2 and 5.3. In either case, use a nitrogen evaporative concentrator to reduce the volume of the sample being analyzed to near dryness. Dissolve the residue in 5 ml of hexane.

5.1.6 Container No. 3 (Toluene Rinse). Add 100 µl of the Internal Standard solution (section 3.3.2) to the contents of the container. Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus at a temperature of less than 37 °C. Rinse the sample container apparatus at a temperature of less than 37 °C. Rinse the sample container three times with small portions of toluene and add these to the concentrated solution and concentrate further to near dryness. Analyze the extract separately according to the procedures in sections 5.2 and 5.3, but concentrate the solution in a rotary evaporator apparatus rather than a nitrogen evaporative concentrator.

5.2 Sample Cleanup and Fractionation.

5.2.1 Silica Gel Column. Pack one end of a glass column, 20 mm × 230 mm, with glass wool. Add in sequence, 1 g silica gel, 2 g of sodium hydroxide impregnated silica gel, 1 g silica gel, 4 g of acid-modified silica gel, and 1 g of silica gel. Wash the column with 30 ml of hexane and discard it. Add the sample extract, dissolved in 5 ml of hexane to the column with two additional 5-ml rinses. Elute the column with an additional 90 ml of hexane and retain the entire eluate. Concentrate this solution to a volume of about 1 ml using the nitrogen evaporative concentrator (section 2.3.7).

5.2.2 Basic Alumina Column. Shorten a 25-ml disposable Pasteur pipette to about 16 ml. Pack the lower section with glass wool and 12 g of basic alumina. Transfer the concentrated extract from the silica gel column to the top of the basic alumina column and elute the column sequentially with 120 ml of 0.5 percent methylene chloride in hexane followed by 120 ml of 35 percent methylene chloride in hexane. Discard the first 120 ml of eluate. Collect the second 120 ml of eluate and concentrate it to about 0.5 ml using the nitrogen evaporative concentrator.

5.2.3 AX–21 Carbon/Celite 545 Column. Remove the botton 0.5 in. from the tip of a 9-ml disposable Pasteur pipette. Insert a glass fiber filter disk in the top of the pipette 2.5 cm from the constriction. Add sufficient carbon/celite mixture to form a 2 cm column. Top with a glass wool plug. In some cases AX–21 carbon fines may wash through the glass wool plug and enter the sample. This may be prevented by adding a celite plug to the exit end of the column. Rinse the column in sequence with 2 ml of 50 percent benzene in ethyl acetate, 1 ml of 50 percent methylene chloride in cyclohexane, and 2 ml of hexane. Discard these rinses. Transfer the concentrate in 1 ml of hexane from the basic alumina column to the carbon/celite column along with 1 ml of hexane rinse. Elute the column sequentially with 2 ml of 50 percent methylene chloride in hexane and 2 ml of 50 percent benzene in ethyl acetate and discard these eluates. Invert the column and elute in the reverse direction with 13 ml of toluene. Collect this eluate. Concentrate the eluate in a rotary evaporator at 50 °C to about 1 ml. Transfer the concentrate to a Reacti-vial using a toluene rinse and concentrate to a volume of 200 µl using a stream of N_2. Store extracts at room temperature, shielded from light, until the analysis is performed.

5.3 Analysis. Analyze the sample with a gas chromatograph coupled to a mass spectrometer (GC/MS) using the instrumental parameters in sections 5.3.1 and 5.3.2. Immediately prior to analysis, add a 20 µl aliquot of the Recovery Standard solution from Table 1 to each sample. A 2 µl aliquot of the extract is injected into the GC. Sample extracts are first analyzed using the DB–5 capillary column to determine the concentration of each isomer of PCDD's and PCDF's (tetra-through octa-). If tetra-chlorinated dibenzofurans are detected in this analysis, then analyze another aliquot of the sample in a separate run, using the DB–225 column to measure the 2,3,7,8 tetra-chloro dibenzofuran isomer. Other column systems may be used, provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

5.3.1 Gas Chromatograph Operating Conditions.

5.3.1.1 Injector. Configured for capillary column, splitless, 250 °C.

5.3.1.2 Carrier Gas. Helium, 1–2 ml/min.

5.3.1.3 Oven. Initially at 150 °C. Raise by at least 40 °C/min to 190 °C and then at 3 °C/min up to 300 °C.

5.3.2 High Resolution Mass Spectrometer.

5.3.2.1 Resolution. 10000 m/e.

5.3.2.2 Ionization Mode. Electron impact.

5.3.2.3 Source Temperature 250 °C.

5.3.2.4 Monitoring Mode. Selected ion monitoring. A list of the various ions to be monitored is summarized in Table 3.

5.3.2.5 Identification Criteria. The following identification criteria shall be used for the characterization of polychlorinated dibenzodioxins and dibenzofurans.

1. The integrated ion-abundance ratio (M/M + 2 or M + 2/M + 4) shall be within 15 percent of the theoretical value. The acceptable ion-abundance ratio ranges for the identification of chlorine-containing compounds are given in Table 4.

2. The retention time for the analytes must be within 3 seconds of the corresponding ^{13}C-labeled internal standard, surrogate or alternate standard.

3. The monitored ions, shown in Table 3 for a given analyte, shall reach their maximum within 2 seconds of each other.

4. The identification of specific isomers that do not have corresponding ^{13}C-labeled standards is done by comparison of the relative retention time (RRT) of the analyte to the nearest internal standard retention time with reference (i.e., within 0.005 RRT units) to the comparable RRT's found in the continuing calibration.

5. The signal to noise ratio for all monitored ions must be greater than 2.5.

6. The confirmation of 2, 3, 7, 8–TCDD and 2, 3, 7, 8–TCDF shall satisfy all of the above identification criteria.

7. For the identification of PCDF's, no signal may be found in the corresponding PCDPE channels.

5.3.2.6 Quantification. The peak areas for the two ions monitored for each analyte are summed to yield the total response for each analyte. Each internal standard is used to quantify the indigenous PCDD's or PCDF's in its homologous series. For example, the $^{13}C_{12}$–2,3,7,8-tetra chlorinated dibenzodioxin is used to calculate the concentrations of all

other tetra chlorinated isomers. Recoveries of the tetra- and penta- internal standards are calculated using the $^{13}C_{12}$–1,2,3,4–TCDD. Recoveries of the hexa- through octa- internal standards are calculated using $^{13}C_{12}$–1,2,3,7,8,9–HxCDD. Recoveries of the surrogate standards are calculated using the corresponding homolog from the internal standard.

6. Calibration

Same as Method 5 with the following additions.

6.1 GC/MS System.

6.1.1 Initial Calibration. Calibrate the GC/MS system using the set of five standards shown in Table 2. The relative standard deviation for the mean response factor from each of the unlabeled analytes (Table 2) and of the internal, surrogate, and alternate standards shall be less than or equal to the values in Table 5. The signal to noise ratio for the GC signal present in every selected ion current profile shall be greater than or equal to 2.5. The ion abundance ratios shall be within the control limits in Table 4.

6.1.2 Daily Performance Check.

6.1.2.1 Calibration Check. Inject on µl of solution Number 3 from Table 2. Calculate the relative response factor (RRF) for each compound and compare each RRF to the corresponding mean RRF obtained during the initial calibration. The analyzer performance is acceptable if the measured RRF's for the labeled and unlabeled compounds for the daily run are within the limits of the mean values shown in Table 5. In addition, the ion-abundance ratios shall be within the allowable control limits shown in Table 4.

6.1.2.2 Column Separation Check. Inject a solution of a mixture of PCDD's and PCDF's that documents resolution between 2,3,7,8–TCDD and other TCDD isomers. Resolution is defined as a valley between peaks that is less than 25 percent of the lower of the two peaks. Identify and record the retention time windows for each homologous series.

Perform a similar resolution check on the confirmation column to document the resolution between 2,3,7,8 TCDF and other TCDF isomers.

6.2 Lock Channels. Set mass spectrometer lock channels as specified in Table 3. Monitor the quality control check channels specified in Table 3 to verify instrument stability during the analysis.

7. Quality Control

7.1 Sampling Train Collection Efficiency Check. Add 100 µl of the surrogate standards in Table 1 to the absorbent cartridge of each train before collecting the field samples.

7.2 Internal Standard Percent Recoveries. A group of nine carbon labeled PCDD's and PCDF's representing, the tetra-through octachlorinated homologues, is added to every sample prior to extraction. The role of the internal standards is to quantify the native PCDD's and PCDF's present in the sample as well as to determine the overall method efficiency. Recoveries of the internal standards must be between 40 to 130 percent for the tetra-through hexachlorinated compounds while the range is 25 to 130 percent for the higher hepta- and octachlorinated homologues.

7.3 Surrogate Recoveries. The five surrogate compounds in Table 2 are added to the resin in the adsorbent sampling cartridge before the sample is collected. The surrogate recoveries are measured relative to the internal standards and are a measure of collection efficiency. They are not used to measure native PCDD's and PCDF's. All recoveries shall be between 70 and 130 percent. Poor recoveries for all the surrogates may be an indication of breakthrough in the sampling train. If the recovery of all standards is below 70 percent, the sampling runs must be repeated. As an alternative, the sampling runs do not have to be repeated if the final results are divided by the fraction of surrogate recovery. Poor recoveries of isolated surrogate compounds should not be grounds for rejecting an entire set of the samples.

7.4 Toluene QA Rinse. Report the results of the toluene QA rinse separately from the total sample catch. Do not add it to the total sample.

8.0 [Reserved]

9. Calculations

Same as Method 5, section 6 with the following additions.

9.1 Nomenclature.

A_{ai} = Integrated ion current of the noise at the retention time of the analyte.

A^*_{ci} = Integrated ion current of the two ions characteristic of the internal standard i in the calibration standard.

A_{cij} = Integrated ion current of the two ions characteristic of compound i in the jth calibration standard.

A^*_{cij} = Integrated ion current of the two ions characteristic of the internal standard i in the jth calibration standard.

A_{csi} = Integrated ion current of the two ions characteristic of surrogate compound i in the calibration standard.

A_i = Integrated ion current of the two ions characteristic of compound i in the sample.

A^*_i = Integrated ion current of the two ions characteristic of internal standard i in the sample.

A_{rs} = Integrated ion current of the two ions characteristic of the recovery standard.

A_{si} = Integrated ion current of the two ions characteristic of surrogate compound i in the sample.

C_i = Concentration of PCDD or PCDF i in the sample, pg/M^3.

C_T = Total concentration of PCDD's or PCDF's in the sample, pg/M^3.

m_{ci} = Mass of compound i in the calibration standard injected into the analyzer, pg.

m_{rs} = Mass of recovery standard in the calibration standard injected into the analyzer, pg.

m_{si} = Mass of surrogate compound in the calibration standard, pg.

RRF_i = Relative response factor.

RRF_{rs} = Recovery standard response factor.

RRF_s = Surrogate compound response factor.

9.2 Average Relative Response Factor.

$$RRF_i = \frac{1}{n}\sum_{j=1}^{n}\frac{A_{cij}\, m^{*}_{ci}}{A^{*}_{cij}\, m_{ci}} \qquad \text{Eq. 23-1}$$

9.3 Concentration of the PCDD's and PCDF's.

$$C_i = \frac{m_i{}^{*} A_i}{A_i{}^{*} RRF_i V_{mstd}} \qquad \text{Eq. 23-2}$$

9.4 Recovery Standard Response Factor.

$$RRF_{rs} = \frac{A_{ci}{}^{*} m_{rs}}{A_{rs} m_{ci}{}^{*}} \qquad \text{Eq. 23-3}$$

9.5 Recovery of Internal Standards (R*).

$$R^{*} = \frac{A_i{}^{*} m_{rs}}{A_{rs} RF_{rs} m_i{}^{*}} \times 100\% \qquad \text{Eq. 23-4}$$

9.6 Surrogate Compound Response Factor.

$$RRF_s = \frac{A_{ci}{}^{*} m_s}{A_{cis} m_{ci}{}^{*}} \qquad \text{Eq. 23-5}$$

9.7 Recovery of Surrogate Compounds (R_s).

$$R_s = \frac{A_s m_i{}^{*}}{A_i{}^{*} RRF_s m_s} \times 100\% \qquad \text{Eq. 23-6}$$

9.8 Minimum Detectable Limit (MDL).

$$MDL = \frac{2.5\ A_{ai} m_i{}^{*}}{A_{ci}{}^{*} RRF_i} \qquad \text{Eq. 23-7}$$

9.9 Total Concentration of PCDD's and PCDF's in the Sample.

$$C_{Tr} = \sum_{i=1}^{n} C_i \qquad \text{Eq. 23-8}$$

Any PCDD's or PCDF's that are reported as nondetected (below the MDL) shall be counted as zero for the purpose of calculating the total concentration of PCDD's and PCDF's in the sample.

10. Bibliography

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3. Thompson, J. R. (ed.). Analysis of Pesticide Residues in Human and Environmental Samples. U.S. Environmental Protection Agency. Research Triangle Park, NC. 1974.

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TABLE 1—COMPOSITION OF THE SAMPLE FORTIFICATION AND RECOVERY STANDARDS SOLUTIONS

Analyte	Concentration (pg/μl)
Internal Standards:	
$^{13}C_{12}$-2,3,7,8-TCDD	100
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100
$^{13}C_{12}$-OCDD	100
$^{13}C_{12}$-2,3,7,8-TCDF	100
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100
Surrogate Standards:	
$^{37}Cl_4$-2,3,7,8-TCDD	100
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	100
$^{13}C_{12}$-2,3,4,7,8-PeCDF	100
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	100
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	100
Recovery Standards:	
$^{13}C_{12}$-1,2,3,4-TCDD	500
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS

Compound	Concentrations (pg/μL)				
	Solution No.				
	1	2	3	4	5
Alternate Standard:					
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	2.5	5	25	250	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS—Continued

Compound	Concentrations (pg/μL)				
	Solution No.				
	1	2	3	4	5
Recovery Standards:					
$^{13}C_{12}$-1,2,3,4-TCDD ..	100	100	100	100	100
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100

TABLE 3—ELEMENTAL COMPOSITIONS AND EXACT MASSES OF THE IONS MONITORED BY HIGH RESOLUTION MASS SPECTROMETRY FOR PCDD'S AND PCDF'S

Descriptor No.	Accurate mass	Ion type	Elemental composition	Analyte
2	292.9825	LOCK	$C_{7}F_{11}$	PFK
	303.9016	M	$C_{12}H_{4}{}^{35}Cl_{4}O$	TCDF
	305.8987	M + 2	$C_{12}H_{4}{}^{35}Cl^{37}O$	TCDF
	315.9419	M	${}^{13}C_{12}H_{4}{}^{35}Cl_{4}O$	TCDF (S)
	317.9389	M + 2	${}^{13}C_{12}H_{4}{}^{35}Cl_{3}{}^{37}ClO$	TCDF (S)
	319.8965	M	$C_{12}H_{4}{}^{35}ClO_{2}$	TCDD
	321.8936	M + 2	$C_{12}H_{4}{}^{35}Cl_{3}{}^{37}ClO_{2}$	TCDD
	327.8847	M	$C_{12}H_{4}{}^{37}Cl_{4}O_{2}$	TCDD (S)
	330.9792	QC	$C_{7}F_{13}$	PFK
	331.9368	M	${}^{13}C_{12}H_{4}{}^{35}Cl_{4}O_{2}$	TCDD (S)
	333.9339	M + 2	${}^{13}C_{12}H_{4}{}^{35}Cl^{37}ClO_{2}$	TCDD (S)
	339.8597	M + 2	$C_{12}H_{3}{}^{35}Cl_{4}{}^{37}ClO$	PECDF
	341.8567	M + 4	$C_{12}H_{3}{}^{35}Cl_{3}{}^{37}Cl_{2}O$	PeCDF
	351.9000	M + 2	${}^{13}C_{12}H_{3}{}^{35}Cl_{4}{}^{37}ClO$	PeCDF (S)
	353.8970	M + 4	${}^{13}C_{12}H_{3}{}^{35}Cl^{3537}Cl_{2}O$	PeCDF (S)
	355.8546	M + 2	$C_{12}H_{3}{}^{35}Cl_{3}37ClO_{2}$	PeCDD
	357.8516	M + 4	$C_{12}H_{3}{}^{35}Cl_{3}{}^{37}Cl_{2}O_{2}$	PeCDD
	367.8949	M + 2	${}^{13}C_{12}H_{3}{}^{35}Cl_{4}{}^{37}ClO_{2}$	PeCDD (S)
	369.8919	M + 4	${}^{13}C_{12}H_{3}{}^{35}Cl_{3}{}^{37}\ Cl_{2}O_{2}$	PeCDD (S)
	375.8364	M + 2	$C_{12}H_{4}{}^{35}Cl_{5}{}^{37}ClO$	HxCDPE
	409.7974	M + 2	$C_{12}H_{3}{}^{35}Cl_{6}{}^{37}ClO$	HpCPDE
3	373.8208	M + 2	$C_{12}H_{2}35Cl_{5}{}^{37}ClO$	HxCDF
	375.8178	M + 4	$C_{12}H_{2}{}^{35}Cl_{4}{}^{37}Cl_{2}O$	HxCDF
	383.8639	M	${}^{13}C_{12}H_{2}{}^{35}Cl_{6}O$	HxCDF (S)
	385.8610	M + 2	${}^{13}C_{12}H_{2}{}^{35}Cl_{5}{}^{37}ClO$	HxCDF (S)
	389.8157	M + 2	$C_{12}H_{2}{}^{35}Cl_{5}{}^{37}ClO_{2}$	HxCDD
	391.8127	M + 4	$C_{12}H_{2}{}^{35}Cl_{4}{}^{37}Cl_{2}O_{2}$	HxCDD
	392.9760	LOCK	$C_{9}F_{15}$	PFK
	401.8559	M + 2	${}^{13}C_{12}H_{2}{}^{35}Cl_{5}{}^{37}ClO_{2}$	HxCDD (S)
	403.8529	M + 4	${}^{13}C_{12}H_{2}{}^{35}Cl_{4}{}^{37}Cl_{2}O$	HxCDD (S)
	445.7555	M + 4	$C_{12}H_{2}{}^{35}Cl_{6}{}^{37}Cl_{2}O$	OCDPE
	430.9729	QC	$C_{9}F_{17}$	PFK
4	407.7818	M + 2	$C_{12}H^{35}Cl_{6}{}^{37}ClO$	HpCDF
	409.7789	M + 4	$C_{12}H^{35}Cl_{5}{}^{37}Cl_{2}O$	HpCDF
	417.8253	M	${}^{13}C_{12}H^{35}Cl_{7}O$	HpCDF (S)
	419.8220	M + 2	${}^{13}C_{12}H^{35}Cl_{6}{}^{37}ClO$	HpCDF (S)
	423.7766	M + 2	$C_{12}H^{35}Cl_{6}{}^{37}ClO_{2}$	HpCDD
	425.7737	M + 4	$C_{12}H^{35}Cl_{5}{}^{37}Cl_{2}O_{2}$	HpCDD
	435.8169	M + 2	${}^{13}C_{12}H^{35}Cl_{6}{}^{37}ClO_{2}$	HpCDD (S)
	437.8140	M + 4	${}^{13}C_{12}H^{35}Cl_{5}{}^{37}Cl_{2}O_{2}$	HpCDD (S)
	479.7165	M + 4	$C_{12}H^{35}Cl_{7}{}^{37}Cl_{2}O$	NCPDE
	430.9729	LOCK	$C_{9}F_{17}$	PFK
	441.7428	M + 2	$C_{12}{}^{35}Cl_{7}{}^{37}ClO$	OCDF
	443.7399	M + 4	$C_{12}{}^{35}Cl_{6}{}^{37}Cl_{2}O$	OCDF
	457.7377	M + 2	$C_{12}{}^{35}Cl_{7}{}^{37}ClO_{2}$	OCDD
	459.7348	M + 4	$C_{12}{}^{35}Cl_{6}{}^{37}Cl_{2}O_{2}$	OCDD
	469.7779	M + 2	${}^{13}C_{12}{}^{35}Cl_{7}{}^{37}ClO_{2}$	OCDD (S)
	471.7750	M + 4	${}^{13}C_{12}{}^{35}Cl_{6}{}^{37}Cl_{2}O_{2}$	OCDD (S)
	513.6775	M + 4	$C_{12}{}^{35}Cl_{8}{}^{37}Cl_{2}O_{2}$	DCDPE
	442.9728	QC	$C_{10}F_{17}$	PFK

(a) The following nuclidic masses were used:
H = 1.007825
C = 12.000000
${}^{13}C$ = 13.003355
F = 18.9984
O = 15.994915
${}^{35}Cl$ = 34.968853
${}^{37}Cl$ = 36.965903

S = Labeled Standard
QC = Ion selected for monitoring instrument stability during the GC/MS analysis.

TABLE 4—ACCEPTABLE RANGES FOR ION-ABUNDANCE RATIOS OF PCDD'S AND PCDF'S

No. of chlorine atoms	Ion type	Theoretical ratio	Control limits	
			Lower	Upper
4	M/M + 2	0.77	0.65	0.89
5	M + 2/M + 4	1.55	1.32	1.78
6	M + 2/M + 4	1.24	1.05	1.43
6 [a]	M/M + 2	0.51	0.43	0.59
7 [b]	M/M + 2	0.44	0.37	0.51
7	M + 2/M + 4	1.04	0.88	1.20
8	M + 2/M + 4	0.89	0.76	1.02

[a] Used only for ^{13}C-HxCDF.
[b] Used only for ^{13}C-HpCDF.

TABLE 5—MINIMUM REQUIREMENTS FOR INITIAL AND DAILY CALIBRATION RESPONSE FACTORS

Compound	Relative response factors	
	Initial calibration RSD	Daily calibration % difference
Unlabeled Analytes:		
2,3,7,8-TCDD	25	25
2,3,7,8-TCDF	25	25
1,2,3,7,8-PeCDD	25	25
1,2,3,7,8-PeCDF	25	25
2,3,4,7,8-PeCDF	25	25
1,2,4,5,7,8-HxCDD	25	25
1,2,3,6,7,8-HxCDD	25	25
1,2,3,7,8,9-HxCDD	25	25
1,2,3,4,7,8-HxCDF	25	25
1,2,3,6,7,8-HxCDF	25	25
1,2,3,7,8,9-HxCDF	25	25
2,3,4,6,7,8-HxCDF	25	25
1,2,3,4,6,7,8-HpCDD	25	25
1,2,3,4,6,7,8-HpCDF	25	25
OCDD	25	25
OCDF	30	30
Internal Standards:		
^{13}C$_{12}$-2,3,7,8-TCDD	25	25
^{13}C$_{12}$-1,2,3,7,8-PeCDD	30	30
^{13}C$_{12}$-1,2,3,6,7,8-HxCDD	25	25
^{13}C$_{12}$-1,2,3,4,6,7,8-HpCDD	30	30
^{13}C$_{12}$-OCDD	30	30
^{13}C$_{12}$-2,3,7,8-TCDF	30	30
^{13}C$_{12}$-1,2,3,7,8-PeCDF	30	30
^{13}C$_{12}$-1,2,3,6,7,8-HxCDF	30	30
^{13}C$_{12}$-1,2,3,4,6,7,8-HpCDF	30	30
Surrogate Standards:		
^{37}Cl$_4$-2,3,7,8-TCDD	25	25
^{13}C$_{12}$-2,3,4,7,8-PeCDF	25	25
^{13}C$_{12}$-1,2,3,4,7,8-HxCDD	25	25
^{13}C$_{12}$-1,2,3,4,7,8-HxCDF	25	25
^{13}C$_{12}$-1,2,3,4,7,8,9-HpCDF	25	25
Alternate Standard:		
^{13}C$_{12}$-1,2,3,7,8,9-HxCDF	25	25

METHOD 24—DETERMINATION OF VOLATILE MATTER CONTENT, WATER CONTENT, DENSITY, VOLUME SOLIDS, AND WEIGHT SOLIDS OF SURFACE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds	No CAS Number assigned
Water.	7732–18–5

1.2 Applicability. This method is applicable for the determination of volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

1.3 Precision and Bias. Intra-and inter-laboratory analytical precision statements are presented in section 13.1. No bias has been identified.

2.0 Summary of Method

2.1 Standard methods are used to determine the volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

3.0 Definitions

3.1 *Waterborne coating* means any coating which contains more than 5 percent water by weight in its volatile fraction.

3.2 *Multicomponent coatings* are coatings that are packaged in two or more parts, which are combined before application. Upon combination a coreactant from one part of the coating chemically reacts, at ambient conditions, with a coreactant from another part of the coating.

3.3 *Ultraviolet (UV) radiation-cured coatings* are coatings which contain unreacted monomers that are polymerized by exposure to ultraviolet light.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Several of the compounds that may be contained in the coatings analyzed by this method may be irritating or corrosive to tissues (e.g., heptane) or may be toxic (e.g., benzene, methyl alcohol). Nearly all are fire hazards.

Appropriate precautions can be found in reference documents, such as Reference 3 of section 16.0.

6.0 Equipment and Supplies

The equipment and supplies specified in the ASTM methods listed in sections 6.1 through 6.6 (incorporated by reference—see §60.17 for acceptable versions of the methods) are required:

6.1 ASTM D 1475–60, 80, or 90, Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products.

6.2 ASTM D 2369–81, 87, 90, 92, 93, or 95, Standard Test Method for Volatile Content of Coatings.

6.3 ASTM D 3792–79 or 91, Standard Test Method for Water Content of Water Reducible Paints by Direct Injection into a Gas Chromatograph.

6.4 ASTM D 4017–81, 90, or 96a, Standard Test Method for Water in Paints and Paint Materials by the Karl Fischer Titration Method.

6.5 ASTM 4457–85 91, Standard Test Method for Determination of Dichloromethane and 1,1,1-Trichloroethane in Paints and Coatings by Direct Injection into a Gas Chromatograph.

6.6 ASTM D 5403–93, Standard Test Methods for Volatile Content of Radiation Curable Materials.

6.7 ASTM D 6419–00, Test Method for Volatile Content of Sheet-Fed and Coldset Web Offset Printing Inks.

7.0 Reagents and Standards

7.1 The reagents and standards specified in the ASTM methods listed in sections 6.1 through 6.6 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 1 of section 16.0.

9.0 Quality Control

9.1 Reproducibility

NOTE: Not applicable to UV radiation-cured coatings). The variety of coatings that may be subject to analysis makes it necessary to verify the ability of the analyst and the analytical procedures to obtain reproducible results for the coatings tested. Verification is accomplished by running duplicate analyses on each sample tested (Sections 11.2 through 11.4) and comparing the results with the intra-laboratory precision statements (Section 13.1) for each parameter.

9.2 Confidence Limits for Waterborne Coatings. Because of the inherent increased imprecision in the determination of the VOC content of waterborne coatings as the weight percent of water increases, measured parameters for waterborne coatings are replaced with appropriate confidence limits (Section 12.6). These confidence limits are based on measured parameters and inter-laboratory precision statements.

10.0 Calibration and Standardization

10.1 Perform the calibration and standardization procedures specified in the ASTM methods listed in sections 6.1 through 6.6.

11.0 Analytical Procedure

Additional guidance can be found in Reference 2 of section 16.0.

11.1 Non Thin-film Ultraviolet Radiation-cured (UV radiation-cured) Coatings.

11.1.1 Volatile Content. Use the procedure in ASTM D 5403 to determine the volatile matter content of the coating except the curing test described in NOTE 2 of ASTM D 5403 is required.

11.1.2 Water Content. To determine water content, follow section 11.3.2.

11.1.3 Coating Density. To determine coating density, follow section 11.3.3.

11.1.4 Solids Content. To determine solids content, follow section 11.3.4.

11.1.5 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the equation in section 12.2. If C is less than 0.2 g and A is greater than or equal to 225 cm^2 (35 in^2) then the coating or ink is considered a thin-film UV radiation-cured coating and ASTM D 5403 is not applicable.

NOTE: As noted in section 1.4 of ASTM D 5403, this method may not be applicable to radiation curable materials wherein the volatile material is water.

11.2 Multi-component Coatings.

11.2.1 Sample Preparation.

11.2.1.1 Prepare about 100 ml of sample by mixing the components in a storage container, such as a glass jar with a screw top or a metal can with a cap. The storage container should be just large enough to hold the mixture. Combine the components (by weight or volume) in the ratio recommended by the manufacturer. Tightly close the container between additions and during mixing to prevent loss of volatile materials. However, most manufacturers mixing instructions are by volume. Because of possible error caused by expansion of the liquid when measuring the volume, it is recommended that the components be combined by weight. When weight is used to combine the components and the manufacturer's recommended ratio is by volume, the density must be determined by section 11.3.3.

11.2.1.2 Immediately after mixing, take aliquots from this 100 ml sample for determination of the total volatile content, water content, and density.

11.2.2 Volatile Content. To determine total volatile content, use the apparatus and

reagents described in ASTM D2369 (incorporated by reference; see §60.17 for the approved versions of the standard), respectively, and use the following procedures:

11.2.2.1 Weigh and record the weight of an aluminum foil weighing dish. Add 3 ±1 ml of suitable solvent as specified in ASTM D2369 to the weighing dish. Using a syringe as specified in ASTM D2369, weigh to 1 mg, by difference, a sample of coating into the weighing dish. For coatings believed to have a volatile content less than 40 weight percent, a suitable size is 0.3 + 0.10 g, but for coatings believed to have a volatile content greater than 40 weight percent, a suitable size is 0.5 ±0.1 g.

NOTE: If the volatile content determined pursuant to section 12.4 is not in the range corresponding to the sample size chosen repeat the test with the appropriate sample size. Add the specimen dropwise, shaking (swirling) the dish to disperse the specimen completely in the solvent. If the material forms a lump that cannot be dispersed, discard the specimen and prepare a new one. Similarly, prepare a duplicate. The sample shall stand for a minimum of 1 hour, but no more than 24 hours prior to being oven cured at 110 ±5 °C (230 ±9 °F) for 1 hour.

11.2.2.2 Heat the aluminum foil dishes containing the dispersed specimens in the forced draft oven for 60 min at 110 ±5 °C (230 ±9 °F). Caution—provide adequate ventilation, consistent with accepted laboratory practice, to prevent solvent vapors from accumulating to a dangerous level.

11.2.2.3 Remove the dishes from the oven, place immediately in a desiccator, cool to ambient temperature, and weigh to within 1 mg.

11.2.2.4 Run analyses in pairs (duplicate sets) for each coating mixture until the criterion in section 11.4 is met. Calculate W_V following Equation 24–2 and record the arithmetic average.

11.2.3 Water Content. To determine water content, follow section 11.3.2.

11.2.4 Coating Density. To determine coating density, follow section 11.3.3.

11.2.5 Solids Content. To determine solids content, follow section 11.3.4.

11.2.6 Exempt Solvent Content. To determine the exempt solvent content, follow section 11.3.5.

NOTE: For all other coatings (*i.e.*, water-or solvent-borne coatings) not covered by multicomponent or UV radiation-cured coatings, analyze as shown below:

11.3 Water-or Solvent-borne coatings.

11.3.1 Volatile Content. Use the procedure in ASTM D 2369 to determine the volatile matter content (may include water) of the coating.

11.3.1.1 Record the following information:

W_1 = weight of dish and sample before heating, g

W_2 = weight of dish and sample after heating, g

W_3 = sample weight, g.

11.3.1.2 Calculate the weight fraction of the volatile matter (W_v) for each analysis as shown in section 12.3.

11.3.1.3 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.1.4 Record the arithmetic average (W_v).

11.3.2 Water Content. For waterborne coatings only, determine the weight fraction of water (W_w) using either ASTM D 3792 or ASTM D 4017.

11.3.2.1 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.2.2 Record the arithmetic average (w_w).

11.3.3 Coating Density. Determine the density (Dc, kg/l) of the surface coating using the procedure in ASTM D 1475.

11.3.3.1 Run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement in section 13.1.

11.3.3.2 Record the arithmetic average (D_c).

11.3.4 Solids Content. Determine the volume fraction (V_s) solids of the coating by calculation using the manufacturer's formulation.

11.3.5 Exempt Solvent Content. Determine the weight fraction of exempt solvents (W_E) by using ASTM Method D4457. Run a duplicate set of determinations and record the arithmetic average (W_E).

11.4 Sample Analysis Criteria. For W_v and W_w, run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement for that parameter. For D_c, run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement. If, after several attempts, it is concluded that the ASTM procedures cannot be used for the specific coating with the established intra-laboratory precision (excluding UV radiation-cured coatings), the U.S. Environmental Protection Agency (EPA) will assume responsibility for providing the necessary procedures for revising the method or precision statements upon written request to: Director, Emissions, Monitoring, and Analysis Division, MD–14, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

12.0 Calculations and Data Analysis

12.1 Nomenclature.

A = Area of substrate, cm^2, (in^2).

C = Amount of coating or ink added to the substrate, g.

D_c = Density of coating or ink, g/cm^3 (g/in^3).

F = Manufacturer's recommended film thickness, cm (in).
W_o = Weight fraction of nonaqueous volatile matter, g/g.
W_s = Weight fraction of solids, g/g.
W_v = Weight fraction of the volatile matter, g/g.
W_w = Weight fraction of the water, g/g.

12.2 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the following equation:

$$C = F\,A\,D_c \qquad \text{Eq. 24-1}$$

12.3 Calculate W_v for each analysis as shown below:

$$W_v = \frac{W_1 - W_2}{W_3} \qquad \text{Eq. 24-2}$$

12.4 Nonaqueous Volatile Matter.

12.4.1 Solvent-borne Coatings.

$$W_o = W_v \qquad \text{Eq. 24-3}$$

12.4.2 Waterborne Coatings.

$$W_o = W_v - W_w \qquad \text{Eq. 24-4}$$

12.4.3 Coatings Containing Exempt Solvents.

$$W_o = W_v - W_E - W_w \qquad \text{Eq. 24-5}$$

12.5 Weight Fraction Solids.

$$W_s = 1 - W_v \qquad \text{Eq. 24-6}$$

12.6 Confidence Limit Calculations for Waterborne Coatings. To calculate the lower confidence limit, subtract the appropriate inter-laboratory precision value from the measured mean value for that parameter. To calculate the upper confidence limit, add the appropriate inter-laboratory precision value to the measured mean value for that parameter. For W_v and D_c, use the lower confidence limits; for W_w, use the upper confidence limit. Because W_s is calculated, there is no adjustment for this parameter.

13.0 Method Performance

13.1 Analytical Precision Statements. The intra-and inter-laboratory precision statements are given in Table 24–1 in section 17.0.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as specified in section 6.0, with the addition of the following:

1. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

2. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A.

EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

3. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 24–1—ANALYTICAL PRECISION STATEMENTS

	Intra-laboratory	Inter-laboratory
Volatile matter content, W_v	±0.015 $\overline{W}_v$	±0.047 $\overline{W}_v$
Water content, W_w	±0.029 $\overline{W}_w$	±0.075 $\overline{W}_w$
Density, D_c	±0.001 kg/l	±0.002 kg/l

METHOD 24A—DETERMINATION OF VOLATILE MATTER CONTENT AND DENSITY OF PUBLICATION ROTOGRAVURE INKS AND RELATED PUBLICATION ROTOGRAVURE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds (VOC).	No CAS number assigned.

1.2 Applicability. This method is applicable for the determination of the VOC content and density of solvent-borne (solvent-reducible) publication rotogravure inks and related publication rotogravure coatings.

2.0 Summary of Method

2.1 Separate procedures are used to determine the VOC weight fraction and density of the ink or related coating and the density of the solvent in the ink or related coating. The VOC weight fraction is determined by measuring the weight loss of a known sample quantity which has been heated for a specified length of time at a specified temperature. The density of both the ink or related coating and solvent are measured by a standard procedure. From this information, the VOC volume fraction is calculated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Some of the compounds that may be contained in the inks or related coatings analyzed by this method may be irritating or corrosive to tissues or may be toxic. Nearly all are fire hazards. Appropriate precautions can be found in reference documents, such as Reference 6 of section 16.0.

6.0 Equipment and Supplies

The following equipment and supplies are required for sample analysis:

6.1 Weighing Dishes. Aluminum foil, 58 mm (2.3 in.) in diameter by 18 mm (0.7 in.) high, with a flat bottom. There must be at least three weighing dishes per sample.

6.2 Disposable Syringe. 5 ml.

6.3 Analytical Balance. To measure to within 0.1 mg.

6.4 Oven. Vacuum oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) and an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) for 4 hours. Alternatively, a forced draft oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) for 24 hours.

6.5 The equipment and supplies specified in ASTM D 1475–60, 80, or 90 (incorporated by reference—see § 60.17).

7.0 Reagents and Standards

7.1 The reagents and standards specified in ASTM D 1475–60, 80, or 90 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 4 of section 16.0.

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

Additional guidance can be found in Reference 5 of section 16.0.

11.1 VOC Weight Fraction. Shake or mix the ink or related coating sample thoroughly to assure that all the solids are completely suspended. Label and weigh to the nearest 0.1 mg a weighing dish and record this weight (M_{x1}). Using a 5 ml syringe, without a needle, extract an aliquot from the ink or related coating sample. Weigh the syringe and aliquot to the nearest 0.1 mg and record this weight (M_{cy1}). Transfer 1 to 3 g of the aliquot to the tared weighing dish. Reweigh the syringe and remaining aliquot to the nearest 0.1 mg and record this weight (M_{cy2}). Heat the weighing dish with the transferred aliquot in a vacuum oven at an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) and a temperature of 120 ±2 °C (248 ±4 °F) for 4 hours. Alternatively, heat the weighing dish with the transferred aliquot in a forced draft oven at a temperature of 120 ±2 °C for 24 hours. After the weighing dish has cooled, reweigh it to the nearest 0.1 mg and record the weight (M_{x2}). Repeat this procedure two times for each ink or related coating sample, for a total of three samples.

11.2 Ink or Related Coating Density. Determine the density of the ink or related coating (D_c) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the ink or related coating density as the arithmetic average ($\bar{D}_c$) of the three determinations.

11.3 Solvent Density. Determine the density of the solvent (D_o) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the solvent density as the arithmetic average ($\bar{D}_o$) of the three determinations.

12.0 Calculations and Data Analysis

12.1 VOC Weight Fraction. For each determination, calculate the volatile organic content weight fraction (W_o) using the following equation:

$$W_o = \frac{M_{x1} + M_{cy1} - M_{cy2} - M_{x2}}{M_{cy1} - M_{cy2}} \qquad \text{Eq. 24A-1}$$

Make a total of three determinations. Report the VOC weight fraction as the arithmetic average ($\bar{W}_o$) of the three determinations.

12.2 VOC Volume Fraction. Calculate the volume fraction volatile organic content (V_o) using the following equation:

$$V_o = \frac{\overline{W}_o \overline{D}_c}{\overline{D}_o} \qquad \text{Eq. 24A-2}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. ASTM Designation D 1475.

2. Teleconversation. Wright, Chuck, Inmont Corporation with Reich, R., A., Radian Corporation. September 25, 1979, Gravure Ink Analysis.

3. Teleconversation. Oppenheimer, Robert, Gravure Research Institute with Burt, Rick, Radian Corporation, November 5, 1979, Gravure Ink Analysis.

4. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

5. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A. EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

6. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25—DETERMINATION OF TOTAL GASEOUS NONMETHANE ORGANIC EMISSIONS AS CARBON

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total gaseous nonmethane organic compounds (TGNMO)	N/A	Dependent upon analytical equipment.

1.2 Applicability.

1.2.1 This method is applicable for the determination of volatile organic compounds (VOC) (measured as total gaseous nonmethane organics (TGNMO) and reported as carbon) in stationary source emissions. This method is not applicable for the determination of organic particulate matter.

1.2.2 This method is not the only method that applies to the measurement of VOC. Costs, logistics, and other practicalities of source testing may make other test methods more desirable for measuring VOC contents of certain effluent streams. Proper judgment is required in determining the most applicable VOC test method. For example, depending upon the molecular composition of the organics in the effluent stream, a totally automated semicontinuous nonmethane organics (NMO) analyzer interfaced directly to the source may yield accurate results. This approach has the advantage of providing emission data semicontinuously over an extended time period.

1.2.3 Direct measurement of an effluent with a flame ionization detector (FID) analyzer may be appropriate with prior characterization of the gas stream and knowledge that the detector responds predictably to the organic compounds in the stream. If present, methane (CH_4) will, of course, also be measured. The FID can be used under any of the following limited conditions: (1) Where only one compound is known to exist; (2) when the organic compounds consist of only hydrogen and carbon; (3) where the relative percentages of the compounds are known or can be determined, and the FID responses to the compounds are known; (4) where a consistent mixture of the compounds exists before and after emission control and only the relative concentrations are to be assessed; or (5) where the FID can be calibrated against mass standards of the compounds emitted (solvent emissions, for example).

1.2.4 Another example of the use of a direct FID is as a screening method. If there is enough information available to provide a rough estimate of the analyzer accuracy, the FID analyzer can be used to determine the VOC content of an uncharacterized gas stream. With a sufficient buffer to account for possible inaccuracies, the direct FID can be a useful tool to obtain the desired results without costly exact determination.

1.2.5 In situations where a qualitative/quantitative analysis of an effluent stream is desired or required, a gas chromatographic FID system may apply. However, for sources emitting numerous organics, the time and expense of this approach will be formidable.

2.0 Summary of Method

2.1 An emission sample is withdrawn from the stack at a constant rate through a heated filter and a chilled condensate trap by means of an evacuated sample tank. After sampling is completed, the TGNMO are determined by independently analyzing the condensate trap and sample tank fractions and combining the analytical results. The organic content of the condensate trap fraction is determined by oxidizing the NMO to carbon dioxide (CO_2) and quantitatively collecting in the effluent in an evacuated vessel; then a portion of the CO_2 is reduced to CH_4 and measured by an FID. The organic content of the sample tank fraction is measured by injecting a portion of the sample into a gas chromatographic column to separate the NMO from carbon monoxide (CO), CO_2, and CH_4; the NMO are oxidized to CO_2, reduced to CH_4, and measured by an FID. In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 Carbon Dioxide and Water Vapor. When carbon dioxide (CO_2) and water vapor are present together in the stack, they can produce a positive bias in the sample. The magnitude of the bias depends on the concentrations of CO_2 and water vapor. As a guideline, multiply the CO_2 concentration, expressed as volume percent, times the water vapor concentration. If this product does not exceed 100, the bias can be considered insignificant. For example, the bias is not significant for a source having 10 percent CO_2 and 10 percent water vapor, but it might be significant for a source having 10 percent CO_2 and 20 percent water vapor.

4.2. Particulate Matter. Collection of organic particulate matter in the condensate trap would produce a positive bias. A filter is included in the sampling equipment to minimize this bias.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

6.1 Sample Collection. The sampling system consists of a heated probe, heated filter, condensate trap, flow control system, and sample tank (see Figure 25–1). The TGNMO sampling equipment can be constructed from commercially available components and components fabricated in a machine shop. The following equipment is required:

6.1.1 Heated Probe. 6.4-mm (¼-in.) OD stainless steel tubing with a heating system capable of maintaining a gas temperature at the exit end of at least 129 °C (265 °F). The probe shall be equipped with a temperature sensor at the exit end to monitor the gas temperature. A suitable probe is shown in Figure 25–1. The nozzle is an elbow fitting attached to the front end of the probe while the temperature sensor is inserted in the side arm of a tee fitting attached to the rear of the probe. The probe is wrapped with a suitable length of high temperature heating tape, and then covered with two layers of glass cloth insulation and one layer of aluminum foil or an equivalent wrapping.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.2 Filter Holder. 25-mm (15⁄16-in.) ID Gelman filter holder with 303 stainless steel body and 316 stainless steel support screen with the Viton O-ring replaced by a Teflon O-ring.

6.1.3 Filter Heating System.

6.1.3.1 A metal box consisting of an inner and an outer shell separated by insulating material with a heating element in the inner shell capable of maintaining a gas temperature at the filter of 121 ±3 °C (250 ±5 °F). The heating box shall include temperature sensors to monitor the gas temperature immediately upstream and immediately downstream of the filter.

6.1.3.2 A suitable heating box is shown in Figure 25–2. The outer shell is a metal box that measures 102 mm × 280 mm × 292 mm (4 in. × 11 in. × 11½ in.), while the inner shell is a metal box measuring 76 mm × 229 mm × 241 mm (3 in. × 9 in. × 9½ in.). The inner box is supported by 13-mm (½-in.) phenolic rods. The void space between the boxes is filled with ceramic fiber insulation which is sealed in place by means of a silicon rubber bead around the upper sides of the box. A removable lid made in a similar manner, with a 25-mm (1-in.) gap between the parts is used to cover the heating chamber. The inner box is heated with a 250-watt cartridge heater, shielded by a stainless steel shroud. The heater is regulated by a thermostatic temperature controller which is set to maintain a gas temperature of 121 °C (250 °F) as measured by the temperature sensor upstream of the filter.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.4 Condensate Trap. 9.5-mm (⅜-in.) OD 316 stainless steel tubing bent into a U-shape. Exact dimensions are shown in Figure

25–3. The tubing shall be packed with coarse quartz wool, to a density of approximately 0.11 g/cm^3 before bending. While the condensate trap is packed with dry ice in the Dewar, an ice bridge may form between the arms of the condensate trap making it difficult to remove the condensate trap. This problem can be prevented by attaching a steel plate between the arms of the condensate trap in the same plane as the arms to completely fill the intervening space.

6.1.5 Valve. Stainless steel control valve for starting and stopping sample flow.

6.1.6 Metering Valve. Stainless steel valve for regulating the sample flow rate through the sample train.

6.1.7 Rate Meter. Rotameter, or equivalent, capable of measuring sample flow in the range of 60 to 100 cm^3/min (0.13 to 0.21 ft^3/hr).

6.1.8 Sample Tank. Stainless steel or aluminum tank with a minimum volume of 4 liters (0.14 ft^3).

NOTE: Sample volumes greater than 4 liters may be required for sources with low organic concentrations.

6.1.9 Mercury Manometer. U-tube manometer or absolute pressure gauge capable of measuring pressure to within 1 mm Hg in the range of 0 to 900 mm.

6.1.10 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

6.2 Condensate Recovery. The system for the recovery of the organics captured in the condensate trap consists of a heat source, an oxidation catalyst, a nondispersive infrared (NDIR) analyzer, and an intermediate collection vessel (ICV). Figure 25–4 is a schematic of a typical system. The system shall be capable of proper oxidation and recovery, as specified in section 10.1.1. The following major components are required:

6.2.1 Heat Source. Sufficient to heat the condensate trap (including probe) to a temperature of 200 °C (390 °F). A system using both a heat gun and an electric tube furnace is recommended.

6.2.2 Heat Tape. Sufficient to heat the connecting tubing between the water trap and the oxidation catalyst to 100 °C (212 °F).

6.2.3 Oxidation Catalyst. A suitable length of 9.5 mm (3⁄8-in.) OD Inconel 600 tubing packed with 15 cm (6 in.) of 3.2 mm (3⁄8-in.) diameter 19 percent chromia on alumina pellets. The catalyst material is packed in the center of the catalyst tube with quartz wool packed on either end to hold it in place.

6.2.4 Water Trap. Leak-proof, capable of removing moisture from the gas stream.

6.2.5 Syringe Port. A 6.4-mm (1⁄4-in.) OD stainless steel tee fitting with a rubber septum placed in the side arm.

6.2.6 NDIR Detector. Capable of indicating CO_2 concentration in the range of zero to 5 percent, to monitor the progress of combustion of the organic compounds from the condensate trap.

6.2.7 Flow-Control Valve. Stainless steel, to maintain the trap conditioning system near atmospheric pressure.

6.2.8 Intermediate Collection Vessel. Stainless steel or aluminum, equipped with a female quick connect. Tanks with nominal volumes of at least 6 liters (0.2 ft^3) are recommended.

6.2.9 Mercury Manometer. Same as described in section 6.1.9.

6.2.10 Syringe. 10-ml gas-tight glass syringe equipped with an appropriate needle.

6.2.11 Syringes. 10-μl and 50-μl liquid injection syringes.

6.2.12 Liquid Sample Injection Unit. 316 Stainless steel U-tube fitted with an injection septum (see Figure 25–7).

6.3 Analysis.

6.3.1 NMO Analyzer. The NMO analyzer is a gas chromatograph (GC) with backflush capability for NMO analysis and is equipped with an oxidation catalyst, reduction catalyst, and FID. Figures 25–5 and 25–6 are schematics of a typical NMO analyzer. This semicontinuous GC/FID analyzer shall be capable of: (1) Separating CO, CO_2, and CH_4 from NMO, (2) reducing the CO_2 to CH_4 and quantifying as CH_4, and (3) oxidizing the NMO to CO_2, reducing the CO_2 to CH_4 and quantifying as CH_4, according to section 10.1.2. The analyzer consists of the following major components:

6.3.1.1 Oxidation Catalyst. A suitable length of 9.5-mm (3⁄8-in.) OD Inconel 600 tubing packed with 5.1 cm (2 in.) of 19 percent chromia on 3.2-mm (1⁄8-in.) alumina pellets. The catalyst material is packed in the center of the tube supported on either side by quartz wool. The catalyst tube must be mounted vertically in a 650 °C (1200 °F) furnace. Longer catalysts mounted horizontally may be used, provided they can meet the specifications of section 10.1.2.1.

6.3.1.2 Reduction Catalyst. A 7.6-cm (3-in.) length of 6.4-mm (1⁄4-in.) OD Inconel tubing fully packed with 100-mesh pure nickel powder. The catalyst tube must be mounted vertically in a 400 °C (750 °F) furnace.

6.3.1.3 Separation Column(s). A 30-cm (1-ft) length of 3.2-mm (1⁄8-in.) OD stainless steel tubing packed with 60/80 mesh Unibeads 1S followed by a 61-cm (2-ft) length of 3.2-mm (1⁄8-in.) OD stainless steel tubing packed with 60/80 mesh Carbosieve G. The Carbosieve and Unibeads columns must be baked separately at 200 °C (390 °F) with carrier gas flowing through them for 24 hours before initial use.

6.3.1.4 Sample Injection System. A single 10-port GC sample injection valve or a group of valves with sufficient ports fitted with a sample loop properly sized to interface with the NMO analyzer (1-cc loop recommended).

6.3.1.5 FID. An FID meeting the following specifications is required:

6.3.1.5.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.2.3.

6.3.1.5.2 Range. A full scale range of 10 to 50,000 ppm CH_4. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.3.1.6 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the analytical results.

6.3.2 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 1 mm Hg.

6.3.3 Temperature Sensor. Capable of measuring the laboratory temperature within 1 °C (2 °F).

6.3.4 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

7.0 Reagents and Standards

7.1 Sample Collection. The following reagents are required for sample collection:

7.1.1 Dry Ice. Solid CO2, crushed.

7.1.2 Coarse Quartz Wool. 8 to 15 um.

7.1.3 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Method D2986–71, 78, or 95a (incorporated by reference—see § 60.17). Test data from the supplier's quality control program are sufficient for this purpose.

7.2 NMO Analysis. The following gases are required for NMO analysis:

7.2.1 Carrier Gases. Helium (He) and oxygen (O_2) containing less than 1 ppm CO_2 and less than 0.1 ppm hydrocarbon.

7.2.2 Fuel Gas. Hydrogen (H_2), at least 99.999 percent pure.

7.2.3 Combustion Gas. Either air (less than 0.1 ppm total hydrocarbon content) or O_2 (purity 99.99 percent or greater), as required by the detector.

7.3 Condensate Analysis. The following are required for condensate analysis:

7.3.1 Gases. Containing less than 1 ppm carbon.

7.3.1.1 Air.

7.3.1.2 Oxygen.

7.3.2 Liquids. To conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society.

7.3.2.1 Hexane.

7.3.2.2 Decane.

7.4 Calibration. For all calibration gases, the manufacturer must recommend a maximum shelf life for each cylinder (i.e., the length of time the gas concentration is not expected to change more than ±5 percent from its certified value). The date of gas cylinder preparation, certified organic concentration, and recommended maximum shelf life must be affixed to each cylinder before shipment from the gas manufacturer to the buyer. The following calibration gases are required:

7.4.1 Oxidation Catalyst Efficiency Check Calibration Gas. Gas mixture standard with nominal concentration of 1 percent methane in air.

7.4.2 FID Linearity and NMO Calibration Gases. Three gas mixture standards with nominal propane concentrations of 20 ppm, 200 ppm, and 3000 ppm, in air.

7.4.3 CO_2 Calibration Gases. Three gas mixture standards with nominal CO_2 concentrations of 50 ppm, 500 ppm, and 1 percent, in air.

NOTE: Total NMO less than 1 ppm required for 1 percent mixture.

7.4.4 NMO Analyzer System Check Calibration Gases. Four calibration gases are needed as follows:

7.4.4.1 Propane Mixture. Gas mixture standard containing (nominal) 50 ppm CO, 50 ppm CH_4, 1 percent CO_2, and 20 ppm C_3H_8, prepared in air.

7.4.4.2 Hexane. Gas mixture standard containing (nominal) 50 ppm hexane in air.

7.4.4.3 Toluene. Gas mixture standard containing (nominal) 20 ppm toluene in air.

7.4.4.4 Methanol. Gas mixture standard containing (nominal) 100 ppm methanol in air.

8.0 Sample Collection, Preservation, Transport, and Storage

8.1 Sampling Equipment Preparation.

8.1.1 Condensate Trap Cleaning. Before its initial use and after each use, a condensate trap should be thoroughly cleaned and checked to ensure that it is not contaminated. Both cleaning and checking can be accomplished by installing the trap in the condensate recovery system and treating it as if it were a sample. The trap should be heated as described in section 11.1.3. A trap may be considered clean when the CO_2 concentration in its effluent gas drops below 10 ppm. This check is optional for traps that most recently have been used to collect samples which were then recovered according to the procedure in section 11.1.3.

8.1.2 Sample Tank Evacuation and Leak-Check. Evacuate the sample tank to 10 mm Hg absolute pressure or less. Then close the sample tank valve, and allow the tank to sit for 60 minutes. The tank is acceptable if a change in tank vacuum of less than 1 mm Hg is noted. The evacuation and leak-check may be conducted either in the laboratory or the field.

8.1.3 Sampling Train Assembly. Just before assembly, measure the tank vacuum using a mercury manometer. Record this vacuum, the ambient temperature, and the barometric pressure at this time. Close the sample tank valve and assemble the sampling

system as shown in Figure 25–1. Immerse the condensate trap body in dry ice at least 30 minutes before commencing sampling to improve collection efficiency. The point where the inlet tube joins the trap body should be 2.5 to 5 cm (1 to 2 in.) above the top of the dry ice.

8.1.4 Pretest Leak-Check. A pretest leak-check is required. Calculate or measure the approximate volume of the sampling train from the probe tip to the sample tank valve. After assembling the sampling train, plug the probe tip, and make certain that the sample tank valve is closed. Turn on the vacuum pump, and evacuate the sampling system from the probe tip to the sample tank valve to an absolute pressure of 10 mm Hg or less. Close the purge valve, turn off the pump, wait a minimum period of 10 minutes, and recheck the indicated vacuum. Calculate the maximum allowable pressure change based on a leak rate of 1 percent of the sampling rate using Equation 25–1, section 12.2. If the measured pressure change exceeds the allowable, correct the problem and repeat the leak-check before beginning sampling.

8.2 Sample Collection.

8.2.1 Unplug the probe tip, and place the probe into the stack such that the probe is perpendicular to the duct or stack axis; locate the probe tip at a single preselected point of average velocity facing away from the direction of gas flow. For stacks having a negative static pressure, seal the sample port sufficiently to prevent air in-leakage around the probe. Set the probe temperature controller to 129 °C (265 °F) and the filter temperature controller to 121 °C (250 °F). Allow the probe and filter to heat for about 30 minutes before purging the sample train.

8.2.2 Close the sample valve, open the purge valve, and start the vacuum pump. Set the flow rate between 60 and 100 cm^3/min (0.13 and 0.21 ft^3/hr), and purge the train with stack gas for at least 10 minutes.

8.2.3 When the temperatures at the exit ends of the probe and filter are within the corresponding specified ranges, check the dry ice level around the condensate trap, and add dry ice if necessary. Record the clock time. To begin sampling, close the purge valve and stop the pump. Open the sample valve and the sample tank valve. Using the flow control valve, set the flow through the sample train to the proper rate. Adjust the flow rate as necessary to maintain a constant rate (±10 percent) throughout the duration of the sampling period. Record the sample tank vacuum and flowmeter setting at 5-minute intervals. (See Figure 25–8.) Select a total sample time greater than or equal to the minimum sampling time specified in the applicable subpart of the regulations; end the sampling when this time period is reached or when a constant flow rate can no longer be maintained because of reduced sample tank vacuum.

NOTE: If sampling had to be stopped before obtaining the minimum sampling time (specified in the applicable subpart) because a constant flow rate could not be maintained, proceed as follows: After closing the sample tank valve, remove the used sample tank from the sampling train (without disconnecting other portions of the sampling train). Take another evacuated and leak-checked sample tank, measure and record the tank vacuum, and attach the new tank to the sampling train. After the new tank is attached to the sample train, proceed with the sampling until the required minimum sampling time has been exceeded.

8.3 Sample Recovery. After sampling is completed, close the flow control valve, and record the final tank vacuum; then record the tank temperature and barometric pressure. Close the sample tank valve, and disconnect the sample tank from the sample system. Disconnect the condensate trap at the inlet to the rate meter, and tightly seal both ends of the condensate trap. Do not include the probe from the stack to the filter as part of the condensate sample.

8.4 Sample Storage and Transport. Keep the trap packed in dry ice until the samples are returned to the laboratory for analysis. Ensure that run numbers are identified on the condensate trap and the sample tank(s).

9.0 Quality Control

Section	Quality control measure	Effect
10.1.1	Initial performance check of condensate recovery apparatus.	Ensure acceptable condensate recovery efficiency.
10.1.2, 10.2	NMO analyzer initial and daily performance checks.	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial Performance Checks.

10.1.1 Condensate Recovery Apparatus. Perform these tests before the system is first placed in operation, after any shutdown of 6 months or more, and after any major modification of the system, or at the frequency recommended by the manufacturer.

10.1.1.1 Carrier Gas and Auxiliary O_2 Blank Check. Analyze each new tank of carrier gas or auxiliary O_2 with the NMO analyzer to

check for contamination. Treat the gas cylinders as noncondensible gas samples, and analyze according to the procedure in section 11.2.3. Add together any measured CH_4, CO, CO_2, or NMO. The total concentration must be less than 5 ppm.

10.1.1.2 Oxidation Catalyst Efficiency Check.

10.1.1.2.1 With a clean condensate trap installed in the recovery system or a ⅛″ stainless steel connector tube, replace the carrier gas cylinder with the high level methane standard gas cylinder (Section 7.4.1). Set the four-port valve to the recovery position, and attach an ICV to the recovery system. With the sample recovery valve in vent position and the flow-control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

10.1.1.2.2 After the NDIR response has stabilized, switch the sample recovery valve from vent to collect. When the manometer or pressure gauge begins to register a slight positive pressure, open the flow-control valve. Keep the flow adjusted such that the pressure in the system is maintained within 10 percent of atmospheric pressure. Continue collecting the sample in a normal manner until the ICV is filled to a nominal gauge pressure of 300 mm Hg. Close the ICV valve, and remove the ICV from the system. Place the sample recovery valve in the vent position, and return the recovery system to its normal carrier gas and normal operating conditions. Analyze the ICV for CO_2 using the NMO analyzer; the catalyst efficiency is acceptable if the CO_2 concentration is within 2 percent of the methane standard concentration.

10.1.1.3 System Performance Check. Construct a liquid sample injection unit similar in design to the unit shown in Figure 25–7. Insert this unit into the condensate recovery and conditioning system in place of a condensate trap, and set the carrier gas and auxiliary O_2 flow rates to normal operating levels. Attach an evacuated ICV to the system, and switch from system vent to collect. With the carrier gas routed through the injection unit and the oxidation catalyst, inject a liquid sample (see sections 10.1.1.3.1 to 10.1.1.3.4) into the injection port. Operate the trap recovery system as described in section 11.1.3. Measure the final ICV pressure, and then analyze the vessel to determine the CO_2 concentration. For each injection, calculate the percent recovery according to section 12.7. Calculate the relative standard deviation for each set of triplicate injections according to section 12.8. The performance test is acceptable if the average percent recovery is 100 ±5 percent and the relative standard deviation is less than 2 percent for each set of triplicate injections.

10.1.1.3.1 50 μl hexane.

10.1.1.3.2 10 μl hexane.

10.1.1.3.3 50 μl decane.

10.1.1.3.4 10 μl decane.

10.1.2 NMO Analyzer. Perform these tests before the system is first placed in operation, after any shutdown longer than 6 months, and after any major modification of the system.

10.1.2.1 Oxidation Catalyst Efficiency Check. Turn off or bypass the NMO analyzer reduction catalyst. Make triplicate injections of the high level methane standard (Section 7.4.1). The oxidation catalyst operation is acceptable if the FID response is less than 1 percent of the injected methane concentration.

10.1.2.2 Reduction Catalyst Efficiency Check. With the oxidation catalyst unheated or bypassed and the heated reduction catalyst bypassed, make triplicate injections of the high level methane standard (Section 7.4.1). Repeat this procedure with both catalysts operative. The reduction catalyst operation is acceptable if the responses under both conditions agree within 5 percent of their average.

10.1.2.3 NMO Analyzer Linearity Check Calibration. While operating both the oxidation and reduction catalysts, conduct a linearity check of the analyzer using the propane standards specified in section 7.4.2. Make triplicate injections of each calibration gas. For each gas (*i.e.*, each set of triplicate injections), calculate the average response factor (area/ppm C) for each gas, as well as and the relative standard deviation (according to section 12.8). Then calculate the overall mean of the response factor values. The instrument linearity is acceptable if the average response factor of each calibration gas is within 2.5 percent of the overall mean value and if the relative standard deviation gas is less than 2 percent of the overall mean value. Record the overall mean of the propane response factor values as the NMO calibration response factor (RF_{NMO}). Repeat the linearity check using the CO_2 standards specified in section 7.4.3. Make triplicate injections of each gas, and then calculate the average response factor (area/ppm C) for each gas, as well as the overall mean of the response factor values. Record the overall mean of the response factor values as the CO_2 calibration response factor (RF_{CO2}). The RF_{CO2} must be within 10 percent of the RF_{NMO}.

10.1.2.4 System Performance Check. Check the column separation and overall performance of the analyzer by making triplicate injections of the calibration gases listed in section 7.4.4. The analyzer performance is acceptable if the measured NMO value for each gas (average of triplicate injections) is within 5 percent of the expected value.

10.2 NMO Analyzer Daily Calibration. The following calibration procedures shall be performed before and immediately after the

analysis of each set of samples, or on a daily basis, whichever is more stringent:

10.2.1 CO_2 Response Factor. Inject triplicate samples of the high level CO_2 calibration gas (Section 7.4.3), and calculate the average response factor. The system operation is adequate if the calculated response factor is within 5 percent of the RF_{CO2} calculated during the initial performance test (Section 10.1.2.3). Use the daily response factor (DRF_{CO2}) for analyzer calibration and the calculation of measured CO_2 concentrations in the ICV samples.

10.2.2 NMO Response Factors. Inject triplicate samples of the mixed propane calibration cylinder gas (Section 7.4.4.1), and calculate the average NMO response factor. The system operation is adequate if the calculated response factor is within 10 percent of the RF_{NMO} calculated during the initial performance test (Section 10.1.2.4). Use the daily response factor (DRF_{NMO}) for analyzer calibration and calculation of NMO concentrations in the sample tanks.

10.3 Sample Tank and ICV Volume. The volume of the gas sampling tanks used must be determined. Determine the tank and ICV volumes by weighing them empty and then filled with deionized distilled water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedure

11.1 Condensate Recovery. See Figure 25–9. Set the carrier gas flow rate, and heat the catalyst to its operating temperature to condition the apparatus.

11.1.1 Daily Performance Checks. Each day before analyzing any samples, perform the following tests:

11.1.1.1 Leak-Check. With the carrier gas inlets and the sample recovery valve closed, install a clean condensate trap in the system, and evacuate the system to 10 mm Hg absolute pressure or less. Monitor the system pressure for 10 minutes. The system is acceptable if the pressure change is less than 2 mm Hg.

11.1.1.2 System Background Test. Adjust the carrier gas and auxiliary oxygen flow rate to their normal values of 100 cc/min and 150 cc/min, respectively, with the sample recovery valve in vent position. Using a 10-ml syringe, withdraw a sample from the system effluent through the syringe port. Inject this sample into the NMO analyzer, and measure the CO_2 content. The system background is acceptable if the CO_2 concentration is less than 10 ppm.

11.1.1.3 Oxidation Catalyst Efficiency Check. Conduct a catalyst efficiency test as specified in section 10.1.1.2. If the criterion of this test cannot be met, make the necessary repairs to the system before proceeding.

11.1.2 Condensate Trap CO_2 Purge and Sample Tank Pressurization.

11.1.2.1 After sampling is completed, the condensate trap will contain condensed water and organics and a small volume of sampled gas. This gas from the stack may contain a significant amount of CO_2 which must be removed from the condensate trap before the sample is recovered. This is accomplished by purging the condensate trap with zero air and collecting the purged gas in the original sample tank.

11.1.2.2 Begin with the sample tank and condensate trap from the test run to be analyzed. Set the four-port valve of the condensate recovery system in the CO_2 purge position as shown in Figure 25–9. With the sample tank valve closed, attach the sample tank to the sample recovery system. With the sample recovery valve in the vent position and the flow control valve fully open, evacuate the manometer or pressure gauge to the vacuum of the sample tank. Next, close the vacuum pump valve, open the sample tank valve, and record the tank pressure.

11.1.2.3 Attach the dry ice-cooled condensate trap to the recovery system, and initiate the purge by switching the sample recovery valve from vent to collect position. Adjust the flow control valve to maintain atmospheric pressure in the recovery system. Continue the purge until the CO_2 concentration of the trap effluent is less than 5 ppm. CO_2 concentration in the trap effluent should be measured by extracting syringe samples from the recovery system and analyzing the samples with the NMO analyzer. This procedure should be used only after the NDIR response has reached a minimum level. Using a 10-ml syringe, extract a sample from the syringe port prior to the NDIR, and inject this sample into the NMO analyzer.

11.1.2.4 After the completion of the CO_2 purge, use the carrier gas bypass valve to pressurize the sample tank to approximately 1,060 mm Hg absolute pressure with zero air.

11.1.3 Recovery of the Condensate Trap Sample (See Figure 25–10).

11.1.3.1 Attach the ICV to the sample recovery system. With the sample recovery valve in a closed position, between vent and collect, and the flow control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

11.1.3.2 Begin auxiliary oxygen flow to the oxidation catalyst at a rate of 150 cc/min, then switch the four-way valve to the trap recovery position and the sample recovery valve to collect position. The system should now be set up to operate as indicated in Figure 25–10. After the manometer or pressure gauge begins to register a slight positive pressure, open the flow control valve. Adjust the flow-control valve to maintain atmospheric pressure in the system within 10 percent.

11.1.3.3 Remove the condensate trap from the dry ice, and allow it to warm to ambient temperature while monitoring the NDIR response. If, after 5 minutes, the CO_2 concentration of the catalyst effluent is below 10,000 ppm, discontinue the auxiliary oxygen flow to the oxidation catalyst. Begin heating the trap by placing it in a furnace preheated to 200 °C (390 °F). Once heating has begun, carefully monitor the NDIR response to ensure that the catalyst effluent concentration does not exceed 50,000 ppm. Whenever the CO_2 concentration exceeds 50,000 ppm, supply auxiliary oxygen to the catalyst at the rate of 150 cc/min. Begin heating the tubing that connected the heated sample box to the condensate trap only after the CO_2 concentration falls below 10,000 ppm. This tubing may be heated in the same oven as the condensate trap or with an auxiliary heat source such as a heat gun. Heating temperature must not exceed 200 °C (390 °F). If a heat gun is used, heat the tubing slowly along its entire length from the upstream end to the downstream end, and repeat the pattern for a total of three times. Continue the recovery until the CO_2 concentration drops to less than 10 ppm as determined by syringe injection as described under the condensate trap CO_2 purge procedure (Section 11.1.2).

11.1.3.4 After the sample recovery is completed, use the carrier gas bypass valve to pressurize the ICV to approximately 1060 mm Hg absolute pressure with zero air.

11.2 Analysis. Once the initial performance test of the NMO analyzer has been successfully completed (see section 10.1.2) and the daily CO_2 and NMO response factors have been determined (see section 10.2), proceed with sample analysis as follows:

11.2.1 Operating Conditions. The carrier gas flow rate is 29.5 cc/min He and 2.2 cc/min O_2. The column oven is heated to 85 °C (185 °F). The order of elution for the sample from the column is CO, CH_4, CO_2, and NMO.

11.2.2 Analysis of Recovered Condensate Sample. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (380 °F) as rapidly as possible. A rate of 30 °C/min (90 °F) has been shown to be adequate. Record the value obtained for the condensible organic material (C_{cm}) measured as CO_2 and any measured NMO. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average C_{cm}.

11.2.3 Analysis of Sample Tank. Perform the analysis as described in section 11.2.2, but record only the value measured for NMO (C_{tm}).

12.0 Data Analysis and Calculations

Carry out the calculations, retaining at least one extra significant figure beyond that of the acquired data. Round off figures after final calculations. All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature.

C = TGNMO concentration of the effluent, ppm C equivalent.

C_c = Calculated condensible organic (condensate trap) concentration of the effluent, ppm C equivalent.

C_{cm} = Measured concentration (NMO analyzer) for the condensate trap ICV, ppm CO_2.

C_t = Calculated noncondensible organic concentration (sample tank) of the effluent, ppm C equivalent.

C_{tm} = Measured concentration (NMO analyzer) for the sample tank, ppm NMO.

F = Sampling flow rate, cc/min.

L = Volume of liquid injected, µl.

M = Molecular weight of the liquid injected, g/g-mole.

M_c = TGNMO mass concentration of the effluent, mg C/dsm^3.

N = Carbon number of the liquid compound injected (N = 12 for decane, N = 6 for hexane).

n = Number of data points.

P_f = Final pressure of the intermediate collection vessel, mm Hg absolute.

P_b = Barometric pressure, cm Hg.

P_{ti} = Gas sample tank pressure before sampling, mm Hg absolute.

P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.

q = Total number of analyzer injections of intermediate collection vessel during analysis (where k = injection number, 1 * * * q).

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 * * * r).

r = Density of liquid injected, g/cc.

T_f = Final temperature of intermediate collection vessel, °K.

T_{ti} = Sample tank temperature before sampling, °K.

T_t = Sample tank temperature at completion of sampling, °K.

T_{tf} = Sample tank temperature after pressurizing, °K.

V = Sample tank volume, m^3.

V_t = Sample train volume, cc.

V_v = Intermediate collection vessel volume, m^3.

V_s = Gas volume sampled, dsm^3.

x_i = Individual measurements.

$\bar{x}$ = Mean value.

ΔP = Allowable pressure change, cm Hg.
Θ = Leak-check period, min.

12.2 Allowable Pressure Change. For the pretest leak-check, calculate the allowable pressure change using Equation 25–1:

$$\Delta P = 0.01\ \frac{FP_b\Theta}{V_t} \qquad \text{Eq. 25-1}$$

12.3 Sample Volume. For each test run, calculate the gas volume sampled using Equation 25–2:

$$V_s = 0.3857\ V\left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}\right) \qquad \text{Eq. 25-2}$$

12.4 Noncondensible Organics. For each sample tank, determine the concentration of nonmethane organics (ppm C) using Equation 25–3:

$$C_t = \left(\frac{\frac{P_{tf}}{T_{tf}}}{\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}}\right)\left(\frac{1}{r}\sum_{j=1}^{r} C_{tm_j}\right) \qquad \text{Eq. 25-3}$$

12.5 Condensible Organics. For each condensate trap determine the concentration of organics (ppm C) using Equation 25–4:

$$C_c = 0.3857\frac{V_v P_f}{V_s T_f}\left(\frac{1}{q}\sum_{k=1}^{q} C_{cm_k}\right) \qquad \text{Eq. 25-4}$$

12.6 TGNMO Mass Concentration. Determine the TGNMO mass concentration as carbon for each test run, using Equation 25–5:

$$M_c = 0.4993\left(C_t + C_c\right) \qquad \text{Eq. 25-5}$$

12.7 Percent Recovery. Calculate the percent recovery for the liquid injections to the condensate recovery and conditioning system using Equation 25–6:

$$\text{Percent Recovery} = K\ \frac{M\,V_v P_t C_{cm}}{L\,P\,T_f N} \qquad \text{Eq. 25-6}$$

where K = 1.604 (°K)(g-mole)(%)/(mm Hg)(ml)(m^3)(ppm).

12.8 Relative Standard Deviation. Use Equation 25–7 to calculate the relative standard deviation (RSD) of percent recovery and analyzer linearity.

$$RSD = \frac{100}{\bar{x}}\left[\frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}{n-1}\right]^{\frac{1}{2}} \qquad \text{Eq. 25-7}$$

13.0 Method Performance

13.1 Range. The minimum detectable limit of the method has been determined to be 50 parts per million by volume (ppm). No upper limit has been established.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, A.E., S. Witz, and R.D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, MA. June 15–20, 1975.) 14 p.

2. Salo, A.E., W.L. Oaks, and R.D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, CO. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

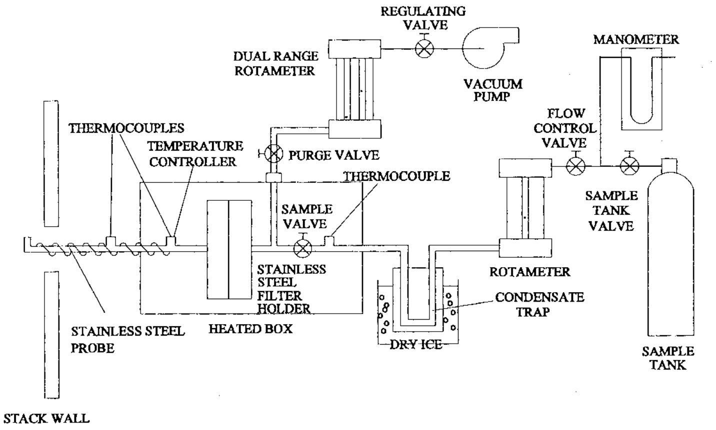


Figure 25-1. Sampling Train

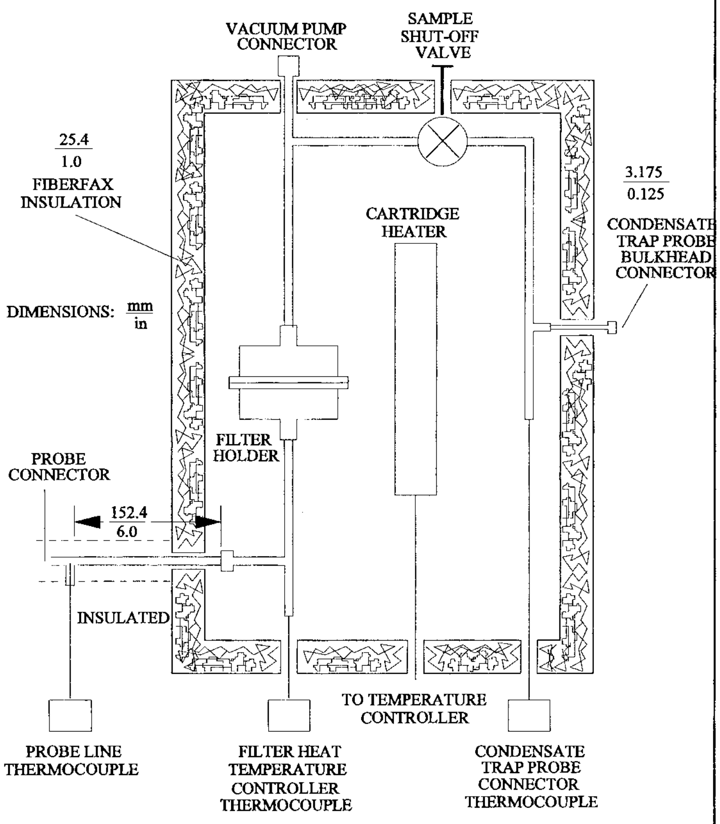


Figure 25-2. Out-of-stack Filter Box

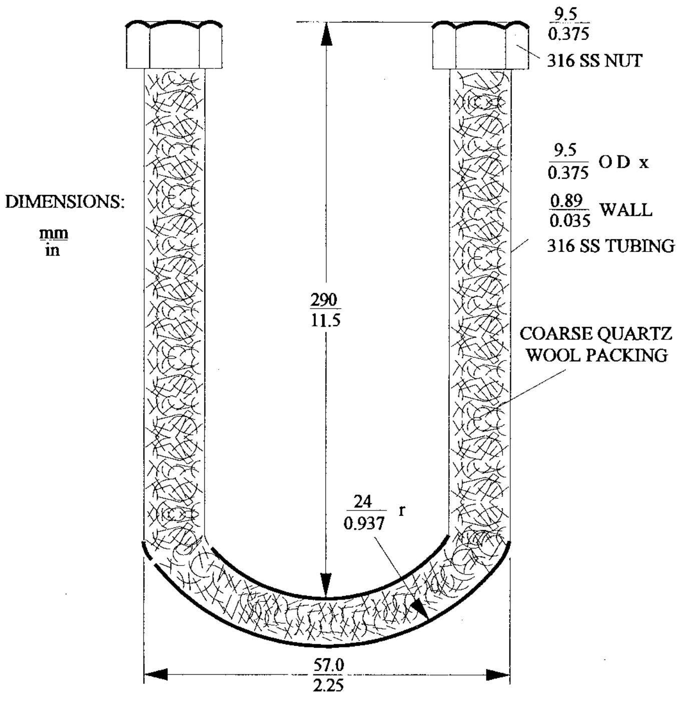


Figure 25-3. Condensate Trap

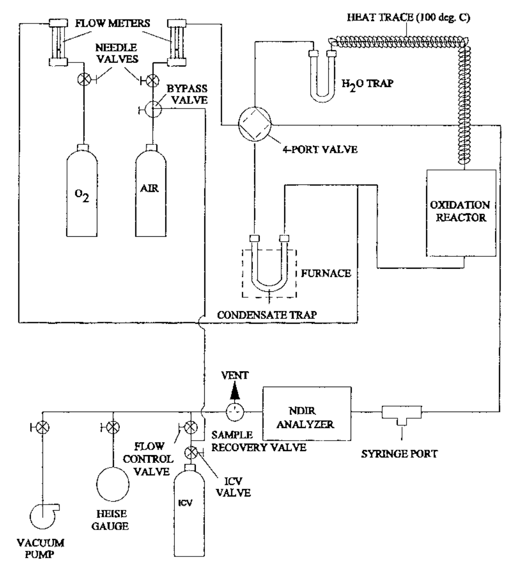


Figure 25-4. Condensate Recovery System

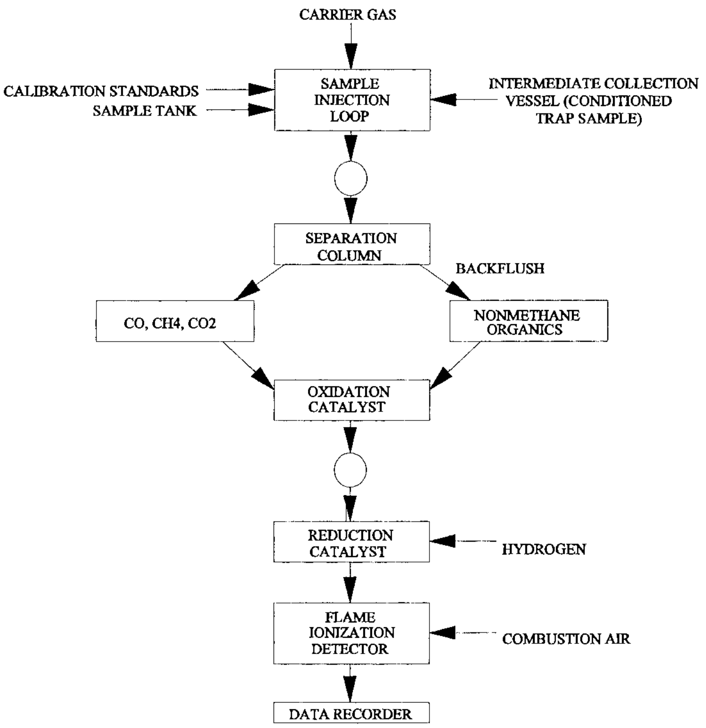


Figure 25-5. Simplified Schematic of Nonmethane Organic (NMO) Analyzer

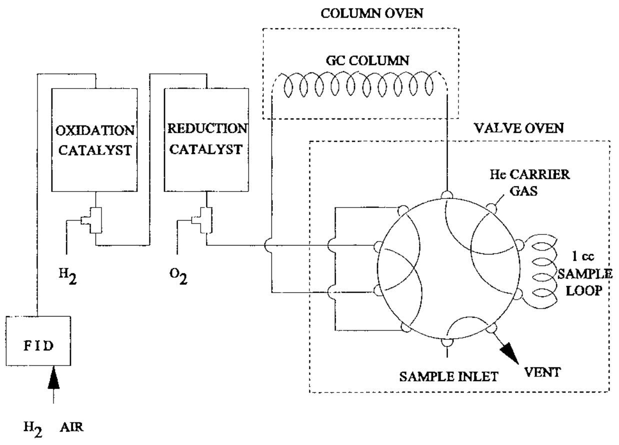


Figure 25-6. Nonmethane Organic Analyzer (NMO)

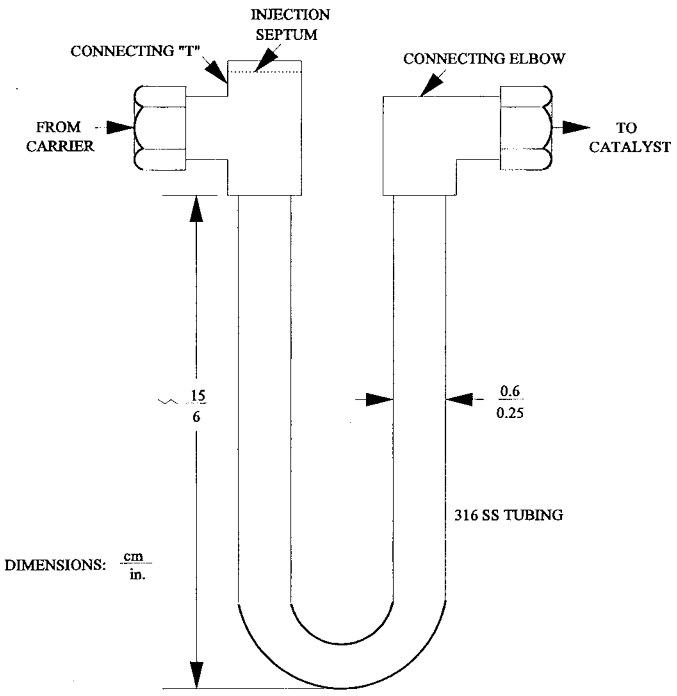
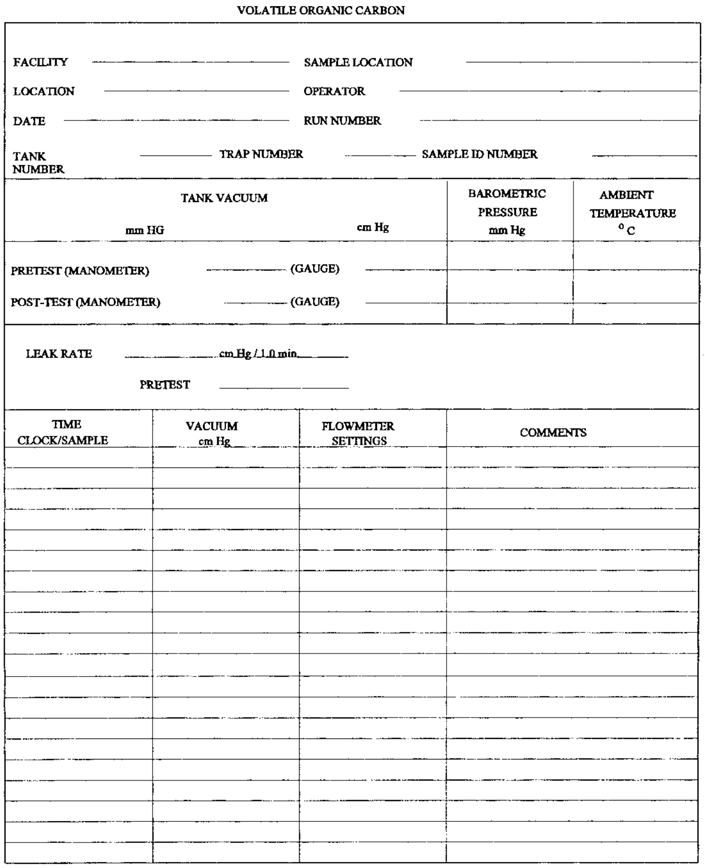


Figure 25-7. Liquid Sample Injection Unit



VOLATILE ORGANIC CARBON

FACILITY ______ SAMPLE LOCATION ______

LOCATION ______ OPERATOR ______

DATE ______ RUN NUMBER ______

TANK NUMBER ______ TRAP NUMBER ______ SAMPLE ID NUMBER ______

TANK VACUUM mm HG	TANK VACUUM cm Hg	BAROMETRIC PRESSURE mm Hg	AMBIENT TEMPERATURE °C
PRETEST (MANOMETER) ______	(GAUGE) ______		
POST-TEST (MANOMETER) ______	(GAUGE) ______		

LEAK RATE ______ cm Hg / 1.0 min. ______

PRETEST ______

TIME CLOCK/SAMPLE	VACUUM cm Hg	FLOWMETER SETTINGS	COMMENTS

Figure 25-8. Example Field Data Form

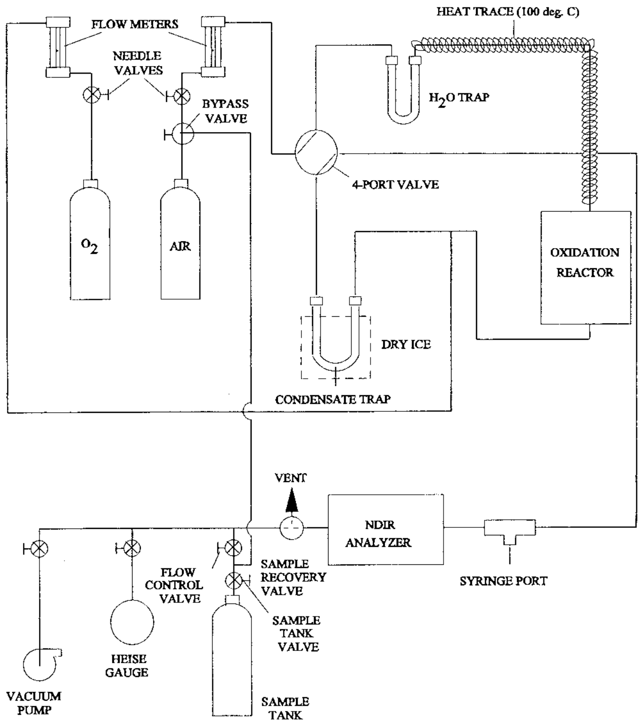


Figure 25-9. Condensate Recovery System, CO2 Purge

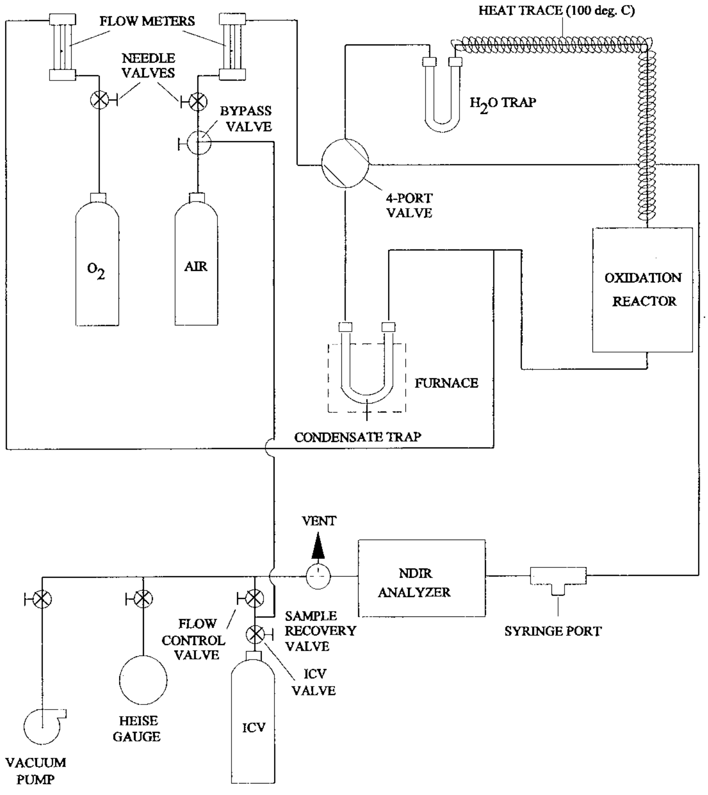


Figure 25-10. Condensate Recovery System, Collection of Trap Organics

Method 25A—Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A gas sample is extracted from the source through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

3.1 *Calibration drift* means the difference in the measurement system response to a midlevel calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

3.2 *Calibration error* means the difference between the gas concentration indicated by the measurement system and the know concentration of the calibration gas.

3.3 *Calibration gas* means a known concentration of a gas in an appropriate diluent gas.

3.4 *Measurement system* means the total equipment required for the determination of the gas concentration. The system consists of the following major subsystems:

3.4.1 *Sample interface* means that portion of a system used for one or more of the following: sample acquisition, sample transportation, sample conditioning, or protection of the analyzer(s) from the effects of the stack effluent.

3.4.2 *Organic analyzer* means that portion of the measurement system that senses the gas to be measured and generates an output proportional to its concentration.

3.5 *Response time* means the time interval from a step change in pollutant concentration at the inlet to the emission measurement system to the time at which 95 percent of the corresponding final value is reached as displayed on the recorder.

3.6 *Span Value* means the upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the applicable emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected concentration. For convenience, the span value should correspond to 100 percent of the recorder scale.

3.7 *Zero drift* means the difference in the measurement system response to a zero level calibration gas before or after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

6.1 Measurement System. Any measurement system for total organic concentration that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 25A–1. All sampling components leading to the analyzer shall be heated ≥110 °C (220 °F) throughout the sampling period, unless safety reasons are cited (Section 5.2) The essential components of the measurement system are described below:

6.1.1 Organic Concentration Analyzer. A flame ionization analyzer (FIA) capable of meeting or exceeding the specifications of this method. The flame ionization detector block shall be heated >120 °C (250 °F).

6.1.2 Sample Probe. Stainless steel, or equivalent, three-hole rake type. Sample holes shall be 4 mm (0.16-in.) in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

6.1.3 Heated Sample Line. Stainless steel or Teflon'' tubing to transport the sample gas

to the analyzer. The sample line should be heated (≥110 °C) to prevent any condensation.

6.1.4 Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are applicable.

6.1.5 Particulate Filter. An in-stack or an out-of-stack glass fiber filter is recommended if exhaust gas particulate loading is significant. An out-of-stack filter should be heated to prevent any condensation.

6.1.6 Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

7.0 Reagents and Standards

7.1 Calibration Gases. The calibration gases for the gas analyzer shall be propane in air or propane in nitrogen. Alternatively, organic compounds other than propane can be used; the appropriate corrections for response factor must be made. Calibration gases shall be prepared in accordance with the procedure listed in Citation 2 of section 16. Additionally, the manufacturer of the cylinder should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change more than ±2 percent from the certified value. For calibration gas values not generally available (*i.e.*, organics between 1 and 10 percent by volume), alternative methods for preparing calibration gas mixtures, such as dilution systems (Test Method 205, 40 CFR Part 51, Appendix M), may be used with prior approval of the Administrator.

7.1.1 Fuel. A 40 percent H_2/60 percent N_2 gas mixture is recommended to avoid an oxygen synergism effect that reportedly occurs when oxygen concentration varies significantly from a mean value.

7.1.2 Zero Gas. High purity air with less than 0.1 part per million by volume (ppmv) of organic material (propane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

7.1.3 Low-level Calibration Gas. An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value.

7.1.4 Mid-level Calibration Gas. An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value.

7.1.5 High-level Calibration Gas. An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Selection of Sampling Site. The location of the sampling site is generally specified by the applicable regulation or purpose of the test (*i.e.*, exhaust stack, inlet line, etc.). The sample port shall be located to meet the testing requirements of Method 1.

8.2 Location of Sample Probe. Install the sample probe so that the probe is centrally located in the stack, pipe, or duct and is sealed tightly at the stack port connection.

8.3 Measurement System Preparation. Prior to the emission test, assemble the measurement system by following the manufacturer's written instructions for preparing sample interface and the organic analyzer. Make the system operable (Section 10.1).

8.4 Calibration Error Test. Immediately prior to the test series (within 2 hours of the start of the test), introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then introduce low-level and mid-level calibration gases successively to the measurement system. Record the analyzer responses for low-level and mid-level calibration gases and determine the differences between the measurement system responses and the predicted responses. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and must be replaced or repaired prior to testing. No adjustments to the measurement system shall be conducted after the calibration and before the drift check (Section 8.6.2). If adjustments are necessary before the completion of the test series, perform the drift checks prior to the required adjustments and repeat the calibration following the adjustments. If multiple electronic ranges are to be used, each additional range must be checked with a mid-level calibration gas to verify the multiplication factor.

8.5 Response Time Test. Introduce zero gas into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. Record the time from the concentration change to the measurement system response equivalent to 95 percent of the step change. Repeat the test three times and average the results.

8.6 Emission Measurement Test Procedure.

8.6.1 Organic Measurement. Begin sampling at the start of the test period, recording time and any required process information as appropriate. In particulate, note on the recording chart, periods of process interruption or cyclic operation.

8.6.2 Drift Determination. Immediately following the completion of the test period and hourly during the test period, reintroduce the zero and mid-level calibration gases, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until both the zero and calibration drift checks are made.) Record the analyzer response. If the drift values exceed the specified limits, invalidate the test results preceding the check and repeat the test following corrections to the measurement system. Alternatively, recalibrate the test measurement system as in section 8.4 and report the results using both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

NOTE: Note on the recording chart periods of process interruption or cyclic operation.

9.0 Quality Control

Method section	Quality control measure	Effect
8.4	Zero and calibration drift tests	Ensures that bias introduced by drift in the measurement system output during the run is no greater than 3 percent of span.

10.0 Calibration and Standardization

10.1 FIA equipment can be calibrated for almost any range of total organic concentrations. For high concentrations of organics (>1.0 percent by volume as propane), modifications to most commonly available analyzers are necessary. One accepted method of equipment modification is to decrease the size of the sample to the analyzer through the use of a smaller diameter sample capillary. Direct and continuous measurement of organic concentration is a necessary consideration when determining any modification design.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

12.1 Determine the average organic concentration in terms of ppmv as propane or other calibration gas. The average shall be determined by integration of the output recording over the period specified in the applicable regulation. If results are required in terms of ppmv as carbon, adjust measured concentrations using Equation 25A–1.

$$C_c = K\,C_{meas} \qquad \text{Eq. 25A-1}$$

Where:

C_c = Organic concentration as carbon, ppmv.

C_{meas} = Organic concentration as measured, ppmv.

K = Carbon equivalent correction factor.
= 2 for ethane.
= 3 for propane.
= 4 for butane.
= Appropriate response factor for other organic calibration gases.

13.0 Method Performance

13.1 Measurement System Performance Specifications.

13.1.1 Zero Drift. Less than ±3 percent of the span value.

13.1.2 Calibration Drift. Less than ±3 percent of span value.

13.1.3 Calibration Error. Less than ±5 percent of the calibration gas value.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Measurement of Volatile Organic Compounds—Guideline Series. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA–450/2–78–041. June 1978. p. 46–54.

2. EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards. U.S. Environmental Protection Agency, Quality Assurance and Technical Support Division. Research Triangle Park, N.C. September 1993.

3. Gasoline Vapor Emission Laboratory Evaluation—Part 2. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. EMB Report No. 75–GAS–6. August 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

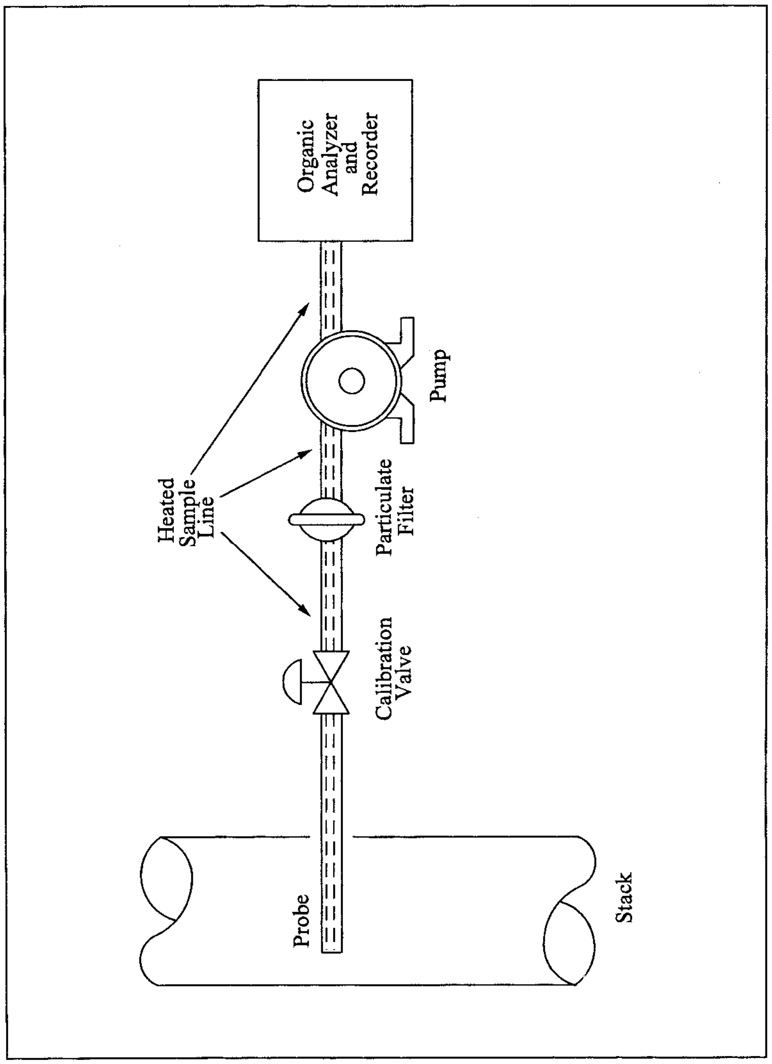


Figure 25A-1. Organic Concentration Measurement System.

METHOD 25B—DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A NONDISPERSIVE INFRARED ANALYZER

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 1, Method 6C, and Method 25A.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes. Other organic materials may be measured using the general procedure in this method, the appropriate calibration gas, and an analyzer set to the appropriate absorption band.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a nondispersive infrared analyzer (NDIR). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

Same as Method 25A, section 3.0.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

Same as Method 25A, section 6.0, with the exception of the following:

6.1 Organic Concentration Analyzer. A nondispersive infrared analyzer designed to measure alkane organics and capable of meeting or exceeding the specifications in this method.

7.0 Reagents and Standards

Same as Method 25A, section 7.1. No fuel gas is required for an NDIR.

8.0 Sample Collection, Preservation, Storage, and Transport

Same as Method 25A, section 8.0.

9.0 Quality Control

Same as Method 25A, section 9.0.

10.0 Calibration and Standardization

Same as Method 25A, section 10.0.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

Same as Method 25A, section 12.0.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as Method 25A, section 16.0.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25C—DETERMINATION OF NONMETHANE ORGANIC COMPOUNDS (NMOC) IN LANDFILL GASES

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling and analytical) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should also have a thorough knowledge of EPA Method 25.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Nonmethane organic compounds (NMOC).	No CAS number assigned.

1.2 Applicability. This method is applicable to the sampling and measurement of NMOC as carbon in landfill gases (LFG).

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A sample probe that has been perforated at one end is driven or augured to a depth of 0.9 m (3 ft) below the bottom of the landfill cover. A sample of the landfill gas is extracted with an evacuated cylinder. The NMOC content of the gas is determined by

injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4); the NMOC are oxidized to CO_2, reduced to CH_4, and measured by a flame ionization detector (FID). In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Since this method is complex, only experienced personnel should perform this test. LFG contains methane, therefore explosive mixtures may exist on or near the landfill. It is advisable to take appropriate safety precautions when testing landfills, such as refraining from smoking and installing explosion-proof equipment.

6.0 Equipment and Supplies

6.1 Sample Probe. Stainless steel, with the bottom third perforated. Teflon probe liners and sampling lines are also allowed. Non-perforated probes are allowed as long as they are withdrawn to create a gap equivalent to having the bottom third perforated. The sample probe must be capped at the bottom and must have a threaded cap with a sampling attachment at the top. The sample probe must be long enough to go through and extend no less than 0.9 m (3 ft) below the landfill cover. If the sample probe is to be driven into the landfill, the bottom cap should be designed to facilitate driving the probe into the landfill.

6.2 Sampling Train.

6.2.1 Rotameter with Flow Control Valve. Capable of measuring a sample flow rate of 100 ±10 ml/min. The control valve must be made of stainless steel.

6.2.2 Sampling Valve. Stainless steel.

6.2.3 Pressure Gauge. U-tube mercury manometer, or equivalent, capable of measuring pressure to within 1 mm Hg (0.5 in H_2O) in the range of 0 to 1,100 mm Hg (0 to 590 in H_2O).

6.2.4 Sample Tank. Stainless steel or aluminum cylinder, equipped with a stainless steel sample tank valve.

6.3 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg (5.4 in H_2O).

6.4 Purging Pump. Portable, explosion proof, and suitable for sampling NMOC.

6.5 Pilot Probe Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.1.

6.5.1 Pilot Probe. Tubing of sufficient strength to withstand being driven into the landfill by a post driver and an outside diameter of at least 6 mm (0.25 in.) smaller than the sample probe. The pilot probe shall be capped on both ends and long enough to go through the landfill cover and extend no less than 0.9 m (3 ft) into the landfill.

6.5.2 Post Driver and Compressor. Capable of driving the pilot probe and the sampling probe into the landfill. The Kitty Hawk portable post driver has been found to be acceptable.

6.6 Auger Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.2.

6.6.1 Auger. Capable of drilling through the landfill cover and to a depth of no less than 0.9 m (3 ft) into the landfill.

6.6.2 Pea Gravel.

6.6.3 Bentonite.

6.7 NMOC Analyzer, Barometer, Thermometer, and Syringes. Same as in sections 6.3.1, 6.3.2, 6.33, and 6.2.10, respectively, of Method 25.

7.0 Reagents and Standards

7.1 NMOC Analysis. Same as in Method 25, section 7.2.

7.2 Calibration. Same as in Method 25, section 7.4, except omit section 7.4.3.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sample Tank Evacuation and Leak-Check. Conduct the sample tank evacuation and leak-check either in the laboratory or the field. Connect the pressure gauge and sampling valve to the sample tank. Evacuate the sample tank to 10 mm Hg (5.4 in H_2O) absolute pressure or less. Close the sampling valve, and allow the tank to sit for 30 minutes. The tank is acceptable if no change more than ±2 mm is noted. Include the results of the leak-check in the test report.

8.2 Sample Probe Installation. The tester may use the procedure in section 8.2.1 or 8.2.2.

8.2.1 Pilot Probe Procedure. Use the post driver to drive the pilot probe at least 0.9 m (3 ft) below the landfill cover. Alternative procedures to drive the probe into the landfill may be used subject to the approval of the Administrator's designated representative.

8.2.1.1 Remove the pilot probe and drive the sample probe into the hole left by the pilot probe. The sample probe shall extend at least 0.9 m (3 ft) below the landfill cover and shall protrude about 0.3 m (1 ft) above the landfill cover. Seal around the sampling probe with bentonite and cap the sampling probe with the sampling probe cap.

8.2.2 Auger Procedure. Use an auger to drill a hole to at least 0.9 m (3 ft) below the landfill cover. Place the sample probe in the hole and backfill with pea gravel to a level 0.6 m (2 ft) from the surface. The sample probe shall protrude at least 0.3 m (1 ft) above the landfill cover. Seal the remaining area around the probe with bentonite. Allow 24

hours for the landfill gases to equilibrate inside the augured probe before sampling.

8.2.3 Driven Probes. Closed-point probes may be driven directly into the landfill in a single step. This method may not require backfilling if the probe is adequately sealed by its insertion. Unperforated probes that are inserted in this manner and withdrawn at a distance from a detachable tip to create an open space are also acceptable.

8.3 Sample Train Assembly. Just before assembling the sample train, measure the sample tank vacuum using the pressure gauge. Record the vacuum, the ambient temperature, and the barometric pressure at this time. Assemble the sampling probe purging system as shown in Figure 25C–1.

8.4 Sampling Procedure. Open the sampling valve and use the purge pump and the flow control valve to evacuate at least two sample probe volumes from the system at a flow rate of 500 ml/min or less. Close the sampling valve and replace the purge pump with the sample tank apparatus as shown in Figure 25C–2. Open the sampling valve and the sample tank valve and, using the flow control valve, sample at a flow rate of 500 ml/min or less until either a constant flow rate can no longer be maintained because of reduced sample tank vacuum or the appropriate composite volume is attained. Disconnect the sampling tank apparatus and pressurize the sample cylinder to approximately 1,060 mm Hg (567 in. H_2O) absolute pressure with helium, and record the final pressure. Alternatively, the sample tank may be pressurized in the lab.

8.4.1 The following restrictions apply to compositing samples from different probe sites into a single cylinder: (1) Individual composite samples per cylinder must be of equal volume; this must be verified by recording the flow rate, sampling time, vacuum readings, or other appropriate volume measuring data, (2) individual composite samples must have a minimum volume of 1 liter unless data is provided showing smaller volumes can be accurately measured, and (3) composite samples must not be collected using the final cylinder vacuum as it diminishes to ambient pressure.

8.4.2 Use Method 3C to determine the percent N_2 in each cylinder. The presence of N_2 indicates either infiltration of ambient air into the landfill gas sample or an inappropriate testing site has been chosen where anaerobic decomposition has not begun. The landfill gas sample is acceptable if the concentration of N_2 is less than 20 percent. Alternatively, Method 3C may be used to determine the oxygen content of each cylinder as an air infiltration test. With this option, the oxygen content of each cylinder must be less than 5 percent.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
8.4.2	Verify that landfill gas sample contains less than 20 percent N_2 or 5 percent O_2.	Ensures that ambient air was not drawn into the landfill gas sample and gas was sampled from an appropriate location.
10.1, 10.2	NMOC analyzer initial and daily performance checks.	Ensures precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial NMOC Analyzer Performance Test. Same as in Method 25, section 10.1, except omit the linearity checks for CO_2 standards.

10.2 NMOC Analyzer Daily Calibration.

10.2.1 NMOC Response Factors. Same as in Method 25, section 10.2.2.

10.3 Sample Tank Volume. The volume of the gas sampling tanks must be determined. Determine the tank volumes by weighing them empty and then filled with deionized water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedures

11.1 The oxidation, reduction, and measurement of NMOC's is similar to Method 25. Before putting the NMOC analyzer into routine operation, conduct an initial performance test. Start the analyzer, and perform all the necessary functions in order to put the analyzer into proper working order. Conduct the performance test according to the procedures established in section 10.1. Once the performance test has been successfully completed and the NMOC calibration response factor has been determined, proceed with sample analysis as follows:

11.1.1 Daily Operations and Calibration Checks. Before and immediately after the analysis of each set of samples or on a daily basis (whichever occurs first), conduct a calibration test according to the procedures established in section 10.2. If the criteria of the daily calibration test cannot be met, repeat

the NMOC analyzer performance test (Section 10.1) before proceeding.

11.1.2 Operating Conditions. Same as in Method 25, section 11.2.1.

11.1.3 Analysis of Sample Tank. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (383 °F) as rapidly as possible. A rate of 30 °C/min (54 °F/min) has been shown to be adequate. Record the value obtained for any measured NMOC. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average as C_{tm}.

12.0 Data Analysis and Calculations

NOTE: All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature

B_w = Moisture content in the sample, fraction.
C_{N2} = N_2 concentration in the diluted sample gas.
C_{mN2} = Measured N_2 concentration, fraction in landfill gas.
C_{mOx} = Measured Oxygen concentration, fraction in landfill gas.
C_{Ox} = Oxygen concentration in the diluted sample gas.
C_t = Calculated NMOC concentration, ppmv C equivalent.
C_{tm} = Measured NMOC concentration, ppmv C equivalent.
P_b = Barometric pressure, mm Hg.
P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.
P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.
P_{ti} = Gas sample tank pressure after evacuation, mm Hg absolute.
P_w = Vapor pressure of H_2O (from Table 25C–1), mm Hg.
r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 . . . r).
T_t = Sample tank temperature at completion of sampling, °K.
T_{ti} = Sample tank temperature before sampling, °K.
T_{tf} = Sample tank temperature after pressuring, °K.

12.2 Water Correction. Use Table 25C–1 (Section 17.0), the LFG temperature, and barometric pressure at the sampling site to calculate B_w.

$$B_w = \frac{P_w}{P_b} \qquad \text{Eq. 25C-1}$$

12.3 Nitrogen Concentration in the landfill gas. Use equation 25C–2 to calculate the measured concentration of nitrogen in the original landfill gas.

$$C_{N2} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right] C_{mN2} \qquad \text{Eq.25C-2}$$

12.4 Oxygen Concentration in the landfill gas. Use equation 25C–3 to calculate the measured concentration of oxygen in the original landfill gas.

$$C_{Ox} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right] C_{mOx} \qquad \text{Eq.25C-3}$$

12.5 You must correct the NMOC Concentration for the concentration of nitrogen or oxygen based on which gas or gases passes the requirements in section 9.1.

12.5.1 NMOC Concentration with nitrogen correction. Use Equation 25C–4 to calculate the concentration of NMOC for each sample tank when the nitrogen concentration is less than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}\right)\left(1 - \frac{99}{78}C_{N2}\right) - B_w} \frac{1}{r} \sum_{j=1}^{r} C_{tm(j)} \qquad \text{Eq.25C-4}$$

12.5.2 NMOC Concentration with oxygen correction. Use Equation 25C–5 to calculate the concentration of NMOC for each sample tank if the landfill gas oxygen is less than 5 percent and the landfill gas nitrogen concentration is greater than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}\right)\left(1 - \frac{99}{21}C_{Ox}\right) - B_w} \frac{1}{r} \sum_{j=1}^{r} C_{tm(j)} \qquad \text{Eq.25C-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts. June 15–20, 1975.) 14 p.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

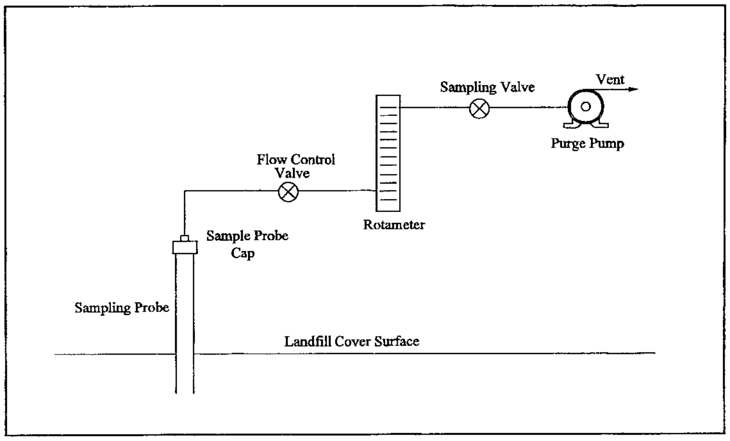


Figure 25C-1. Schematic of Sampling Probe Purging System

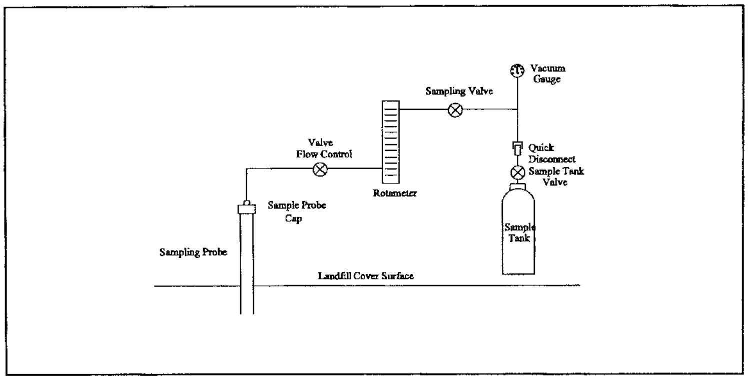


Figure 25C-2. Schematic of Sampling Train.

TABLE 25C–1—MOISTURE CORRECTION

Temperature, °C	Vapor Pressure of H_2O, mm Hg	Temperature, °C	Vapor Pressure of H_2O, mm Hg
4	6.1	18	15.5
6	7.0	20	17.5
8	8.0	22	19.8
10	9.2	24	22.4
12	10.5	26	25.2
14	12.0	28	28.3
16	13.6	30	31.8

METHOD 25D—DETERMINATION OF THE VOLATILE ORGANIC CONCENTRATION OF WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) or an electrolytic conductivity detector (ELCD) because knowledge beyond the scope of this presentation is required.

1.0 Scope and Application

1.1 Analyte. Volatile Organic Compounds. No CAS No. assigned.

1.2 Applicability. This method is applicable for determining the volatile organic (VO) concentration of a waste sample.

2.0 Summary of Method

2.1 Principle. A sample of waste is obtained at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). The sample is suspended in an organic/aqueous matrix, then heated and purged with nitrogen for 30 min. in order to separate certain organic compounds. Part of the sample is analyzed for carbon concentration, as methane, with an FID, and part of the sample is analyzed for chlorine concentration, as chloride, with an ELCD. The VO concentration is the sum of the carbon and chlorine content of the sample.

3.0 Definitions

3.1 *Well-mixed* in the context of this method refers to turbulent flow which results in multiple-phase waste in effect behaving as single-phase waste due to good mixing.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1 Sampling. The following equipment is required:

6.1.1 Sampling Tube. Flexible Teflon, 0.25 in. ID (6.35 mm).

6.1.2 Sample Container. Borosilicate glass, 40-mL, and a Teflon-lined screw cap capable of forming an air tight seal.

6.1.3 Cooling Coil. Fabricated from 0.25 in (6.35 mm). ID 304 stainless steel tubing with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Purging Apparatus. For separating the VO from the waste sample. A schematic of the system is shown in Figure 25D–1. The purging apparatus consists of the following major components.

6.2.1.1 Purging Flask. A glass container to hold the sample while it is heated and purged with dry nitrogen. The cap of the purging flask is equipped with three fittings: one for a purging lance (fitting with the #7 Ace-thread), one for the Teflon exit tubing (side fitting, also a #7 Ace-thread), and a third (a 50-mm Ace-thread) to attach the base of the purging flask as shown in Figure 25D–2. The base of the purging flask is a 50-mm ID (2 in) cylindrical glass tube. One end of the tube is open while the other end is sealed. Exact dimensions are shown in Figure 25D–2.

6.2.1.2 Purging Lance. Glass tube, 6-mm OD (0.2 in) by 30 cm (12 in) long. The purging end of the tube is fitted with a four-arm bubbler with each tip drawn to an opening 1 mm (0.04 in) in diameter. Details and exact dimensions are shown in Figure 25D–2.

6.2.1.3 Coalescing Filter. Porous fritted disc incorporated into a container with the same dimensions as the purging flask. The details of the design are shown in Figure 25D–3.

6.2.1.4 Constant Temperature Chamber. A forced draft oven capable of maintaining a uniform temperature around the purging flask and coalescing filter of 75 ±2 °C (167 ±3.6 °F).

6.2.1.5 Three-way Valve. Manually operated, stainless steel. To introduce calibration gas into system.

6.2.1.6 Flow Controllers. Two, adjustable. One capable of maintaining a purge gas flow rate of 6 ±0.06 L/min (0.2 ±0.002 ft^3/min) The other capable of maintaining a calibration gas flow rate of 1–100 mL/min (0.00004–0.004 ft^3/min).

6.2.1.7 Rotameter. For monitoring the air flow through the purging system (0–10 L/min)(0–0.4 ft^3/min).

6.2.1.8 Sample Splitters. Two heated flow restrictors (placed inside oven or heated to 120 ±10 °C (248 ±18 °F)). At a purge rate of 6 L/min (0.2 ft^3/min), one will supply a constant flow to the first detector (the rest of the flow will be directed to the second sample splitter). The second splitter will split the analytical flow between the second detector and the flow restrictor. The approximate flow to the FID will be 40 mL/min (0.0014 ft^3/min) and to the ELCD will be 15 mL/min (0.0005 ft^3/min), but the exact flow must be adjusted to be compatible with the individual detector and to meet its linearity requirement. The two sample splitters will be connected to each other by 1/8′ OD (3.175 mm) stainless steel tubing.

6.2.1.9 Flow Restrictor. Stainless steel tubing, 1/8′ OD (3.175 mm), connecting the second sample splitter to the ice bath. Length is determined by the resulting pressure in the purging flask (as measured by the pressure gauge). The resulting pressure from the use of the flow restrictor shall be 6–7 psig.

6.2.1.10 Filter Flask. With one-hole stopper. Used to hold ice bath. Excess purge gas is vented through the flask to prevent condensation in the flowmeter and to trap volatile organic compounds.

6.2.1.11 Four-way Valve. Manually operated, stainless steel. Placed inside oven, used to bypass purging flask.

6.2.1.12 On/Off Valves. Two, stainless steel. One heat resistant up to 130 °C (266 °F) and placed between oven and ELCD. The other a toggle valve used to control purge gas flow.

6.2.1.13 Pressure Gauge. Range 0–40 psi. To monitor pressure in purging flask and coalescing filter.

6.2.1.14 Sample Lines. Teflon, 1/4′ OD (6.35 mm), used inside the oven to carry purge gas to and from purging chamber and to and from coalescing filter to four-way valve. Also used to carry sample from four-way valve to first sample splitter.

6.2.1.15 Detector Tubing. Stainless steel, 1/8′ OD (3.175 mm), heated to 120 ±10 °C (248 ±18 °F) . Used to carry sample gas from each sample splitter to a detector. Each piece of tubing must be wrapped with heat tape and insulating tape in order to insure that no cold spots exist. The tubing leading to the ELCD will also contain a heat-resistant on-off valve (Section 6.2.1.12) which shall also be wrapped with heat-tape and insulation.

6.2.2 Volatile Organic Measurement System. Consisting of an FID to measure the carbon concentration of the sample and an ELCD to measure the chlorine concentration.

6.2.2.1 FID. A heated FID meeting the following specifications is required.

6.2.2.1.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.1.

6.2.2.1.2 Range. A full scale range of 50 pg carbon/sec to 50 μg carbon/sec. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.1.3 Data Recording System. A digital integration system compatible with the FID for permanently recording the output of the detector. The recorder shall have the capability to start and stop integration at points selected by the operator or it shall be capable of the ‘‘integration by slices’’ technique (this technique involves breaking down the chromatogram into smaller increments, integrating the area under the curve for each portion, subtracting the background for each portion, and then adding all of the areas together for the final area count).

6.2.2.2 ELCD. An ELCD meeting the following specifications is required. 1-propanol must be used as the electrolyte. The electrolyte flow through the conductivity cell shall be 1 to 2 mL/min (0.00004 to 0.00007 ft^3/min).

NOTE: A ¼-in. ID (6.35 mm) quartz reactor tube is strongly recommended to reduce carbon buildup and the resulting detector maintenance.

6.2.2.2.1 Linearity. A linear response (±10 percent) over the response range as demonstrated by the procedures in section 10.1.2.

6.2.2.2.2 Range. A full scale range of 5.0 pg/sec to 500 ng/sec chloride. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.2.3 Data Recording System. A digital integration system compatible with the output voltage range of the ELCD. The recorder must have the capability to start and stop integration at points selected by the operator or it shall be capable of performing the ‘‘integration by slices’’ technique.

7.0 Reagents and Standards

7.1 Sampling.

7.1.1 Polyethylene Glycol (PEG). Ninety-eight percent pure with an average molecular weight of 400. Before using the PEG, remove any organic compounds that might be detected as volatile organics by heating it to 120 °C (248 °F) and purging it with nitrogen at a flow rate of 1 to 2 L/min (0.04 to 0.07 ft^3/min) for 2 hours. The cleaned PEG must be stored under a 1 to 2 L/min (0.04 to 0.07 ft^3/min) nitrogen purge until use. The purge apparatus is shown in Figure 25D–4.

7.2 Analysis.

7.2.1 Sample Separation. The following are required for the sample purging step.

7.2.1.1 PEG. Same as section 7.1.1.

7.2.1.2 Purge Gas. Zero grade nitrogen (N_2), containing less than 1 ppm carbon.

7.2.2 Volatile Organics Measurement. The following are required for measuring the VO concentration.

7.2.2.1 Hydrogen (H_2). Zero grade H_2, 99.999 percent pure.

7.2.2.2 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2.2.3 Calibration Gas. Pressurized gas cylinder containing 10 percent propane and 1 percent 1,1-dichloroethylene by volume in nitrogen.

7.2.2.4 Water. Deionized distilled water that conforms to American Society for Testing and Materials Specification D 1193–74, Type 3, is required for analysis. At the option of the analyst, the $KMnO_4$ test for oxidizable organic matter may be omitted when high concentrations are not expected to be present.

7.2.2.5 1-Propanol. ACS grade or better. Electrolyte Solution. For use in the ELCD.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling.

8.1.1 Sampling Plan Design and Development. Use the procedures in chapter nine of Reference 1 in section 16 as guidance in developing a sampling plan.

8.1.2 Single Phase or Well-mixed Waste.

8.1.2.1 Install a sampling tap to obtain the sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). Assemble the sampling apparatus as shown in Figure 25D–5.

8.1.2.2 Prepare the sampling containers as follows: Pour 30 mL of clean PEG into the container. PEG will reduce but not eliminate the loss of organics during sample collection. Weigh the sample container with the screw cap, the PEG, and any labels to the nearest 0.01 g and record the weight (m_{st}). Store the containers in an ice bath until 1 hour before sampling (PEG will solidify at ice bath temperatures; allow the containers to reach room temperature before sampling).

8.1.2.3 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.1.2.4 After purging, stop the sample flow and direct the sampling tube to a preweighed sample container, prepared as described in section 8.1.2.2. Keep the tip of the tube below the surface of the PEG during sampling to minimize contact with the atmosphere. Sample at a flow rate such that the temperature of the waste is less than 10 °C (50 °F). Fill the sample container and immediately cap it (within 5 seconds) so that a minimum headspace exists in the container. Store immediately in a cooler and cover with ice.

8.1.3 Multiple-phase Waste. Collect a 10 g sample of each phase of waste generated using the procedures described in section 8.1.2 or 8.1.5. Each phase of the waste shall be analyzed as a separate sample. Calculate the weighted average VO concentration of the waste using Equation 25D–13 (Section 12.14).

8.1.4 Solid waste. Add approximately 10 g of the solid waste to a container prepared in the manner described in section 8.1.2.2, minimizing headspace. Cap and chill immediately.

8.1.5 Alternative to Tap Installation. If tap installation is impractical or impossible, fill a large, clean, empty container by submerging the container into the waste below the surface of the waste. Immediately fill a container prepared in the manner described in section 8.1.2.2 with approximately 10 g of the waste collected in the large container. Minimize headspace, cap and chill immediately.

8.1.6 Alternative sampling techniques may be used upon the approval of the Administrator.

8.2 Sample Recovery.

8.2.1 Assemble the purging apparatus as shown in Figures 25D–1 and 25D–2. The oven shall be heated to 75 ±2 °C (167 ±3.6 °F). The sampling lines leading from the oven to the detectors shall be heated to 120 ±10 °C (248 ±18 °F) with no cold spots. The flame ionization detector shall be operated with a heated block. Adjust the purging lance so that it reaches the bottom of the chamber.

8.2.2 Remove the sample container from the cooler, and wipe the exterior of the container to remove any extraneous ice, water, or other debris. Reweigh the sample container to the nearest 0.01 g, and record the weight (m_{sf}). Pour the contents of the sample container into the purging flask, rinse the sample container three times with a total of 20 mL of PEG (since the sample container originally held 30 mL of PEG, the total volume of PEG added to the purging flask will be 50 mL), transferring the rinsings to the purging flask after each rinse. Cap purging flask between rinses. The total volume of PEG in the purging flask shall be 50 mL. Add 50 mL of water to the purging flask.

9.0 Quality Control

9.1 Quality Control Samples. If audit samples are not available, prepare and analyze the two types of quality control samples (QCS) listed in Sections 9.1.1 and 9.1.2. Before placing the system in operation, after a shutdown of greater than six months, and after any major modifications, analyze each QCS in triplicate. For each detector, calculate the percent recovery by dividing measured concentration by theoretical concentration and multiplying by 100. Determine the mean percent recovery for each detector for each QCS triplicate analysis. The RSD for any triplicate analysis shall be ≤10 percent. For QCS 1 (methylene chloride), the percent recovery shall be ≥90 percent for carbon as methane, and ≥55 percent for chlorine as chloride. For QCS 2 (1,3-dichloro-2-propanol), the percent recovery shall be ≤15 percent for carbon as methane, and ≤6 percent for chlorine as chloride. If the analytical system does not meet the above-mentioned criteria for both detectors, check the system parameters (temperature, system pressure, purge rate, etc.), correct the problem, and repeat the triplicate analysis of each QCS.

9.1.1 QCS 1, Methylene Chloride. Prepare a stock solution by weighing, to the nearest 0.1 mg, 55 µL of HPLC grade methylene chloride in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 µL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze

the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 3.777×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 1.670×10^{-2}.

9.1.2 QCS 2, 1,3-dichloro-2-propanol. Prepare a stock solution by weighing, to the nearest 0.1 mg, 60 µL of high purity grade 1,3-dichloro-2-propanol in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 µL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 7.461×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 1.099×10^{-2}.

9.1.3 Routine QCS Analysis. For each set of compliance samples (in this context, set is per facility, per compliance test), analyze one QCS 1 and one QCS 2 sample. The percent recovery for each sample for each detector shall be ±13 percent of the mean recovery established for the most recent set of QCS triplicate analysis (Section 9.4). If the sample does not meet this criteria, check the system components and analyze another QCS 1 and 2 until a single set of QCS meet the ±13 percent criteria.

10.0 Calibration and Standardization

10.1 Initial Performance Check of Purging System. Before placing the system in operation, after a shutdown of greater than six months, after any major modifications, and at least once per month during continuous operation, conduct the linearity checks described in sections 10.1.1 and 10.1.2. Install calibration gas at the three-way calibration gas valve. See Figure 25D–1.

10.1.1 Linearity Check Procedure. Using the calibration standard described in section 7.2.2.3 and by varying the injection time, it is possible to calibrate at multiple concentration levels. Use Equation 25D–3 to calculate three sets of calibration gas flow rates and run times needed to introduce a total mass of carbon, as methane, (m_c) of 1, 5, and 10 mg into the system (low, medium and high FID calibration, respectively). Use Equation 25D–4 to calculate three sets of calibration gas flow rates and run times needed to introduce a total chloride mass (m_{ch}) of 1, 5, and 10 mg into the system (low, medium and high ELCD calibration, respectively). With the system operating in standby mode, allow the FID and the ELCD to establish a stable baseline. Set the secondary pressure regulator of the calibration gas cylinder to the same pressure as the purge gas cylinder and set the proper flow rate with the calibration flow controller (see Figure 25D–1). The calibration gas flow rate can be measured with a flowmeter attached to the vent position of the calibration gas valve. Set the four-way bypass valve to standby position so that the calibration gas flows through the coalescing filter only. Inject the calibration gas by turning the calibration gas valve from vent position to inject position. Continue the calibration gas flow for the appropriate period of time before switching the calibration valve to vent position. Continue recording the response of the FID and the ELCD for 5 min after switching off calibration gas flow. Make triplicate injections of all six levels of calibration.

10.1.2 Linearity Criteria. Calculate the average response factor (Equations 25D–5 and 25D–6) and the relative standard deviation (RSD) (Equation 25D–10) at each level of the calibration curve for both detectors. Calculate the overall mean of the three response factor averages for each detector. The FID linearity is acceptable if each response factor is within 5 percent of the overall mean and if the RSD for each set of triplicate injections is less than 5 percent. The ELCD linearity is acceptable if each response factor is within 10 percent of the overall mean and if the RSD for each set of triplicate injections is less than 10 percent. Record the overall mean value of the response factors for the FID and the ELCD. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2 Daily Calibrations.

10.2.1 Daily Linearity Check. Follow the procedures outlined in section 10.1.1 to analyze the medium level calibration for both the FID and the ELCD in duplicate at the start of the day. Calculate the response factors and the RSDs for each detector. For the FID, the calibration is acceptable if the average response factor is within 5 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 5 percent. For the ELCD, the calibration is acceptable if the average response factor is within 10 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 10 percent. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2.2 Calibration Range Check.

10.2.2.1 If the waste concentration for either detector falls below the range of calibration for that detector, use the procedure outlined in section 10.1.1 to choose two calibration points that bracket the new target

concentration. Analyze each of these points in triplicate (as outlined in section 10.1.1) and use the criteria in section 10.1.2 to determine the linearity of the detector in this ‘‘mini-calibration’’ range.

10.2.2.2 After the initial linearity check of the mini-calibration curve, it is only necessary to test one of the points in duplicate for the daily calibration check (in addition to the points specified in section 10.2.1). The average daily mini-calibration point should fit the linearity criteria specified in section 10.2.1. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat the calibration procedure mentioned in the first paragraph of section 10.2.2. A mini-calibration curve for waste concentrations above the calibration curve for either detector is optional.

10.3 Analytical Balance. Calibrate against standard weights.

11.0 Analysis

11.1 Sample Analysis.

11.1.1 Turn on the constant temperature chamber and allow the temperature to equilibrate at 75 ±2 °C (167 ±3.6 °F). Turn the four-way valve so that the purge gas bypasses the purging flask, the purge gas flowing through the coalescing filter and to the detectors (standby mode). Turn on the purge gas. Allow both the FID and the ELCD to warm up until a stable baseline is achieved on each detector. Pack the filter flask with ice. Replace ice after each run and dispose of the waste water properly. When the temperature of the oven reaches 75 ±2 °C (167 ±3.6 °F), start both integrators and record baseline. After 1 min, turn the four-way valve so that the purge gas flows through the purging flask, to the coalescing filter and to the sample splitters (purge mode). Continue recording the response of the FID and the ELCD. Monitor the readings of the pressure gauge and the rotameter. If the readings fall below established setpoints, stop the purging, determine the source of the leak, and resolve the problem before resuming. Leaks detected during a sampling period invalidate that sample.

11.1.2 As the purging continues, monitor the output of the detectors to make certain that the analysis is proceeding correctly and that the results are being properly recorded. Every 10 minutes read and record the purge flow rate, the pressure and the chamber temperature. Continue the purging for 30 minutes.

11.1.3 For each detector output, integrate over the entire area of the peak starting at 1 minute and continuing until the end of the run. Subtract the established baseline area from the peak area. Record the corrected area of the peak. See Figure 25D–6 for an example integration.

11.2 Water Blank. A water blank shall be analyzed for each batch of cleaned PEG prepared. Transfer about 60 mL of water into the purging flask. Add 50 mL of the cleaned PEG to the purging flask. Treat the blank as described in sections 8.2 and 8.3, excluding section 8.2.2. Calculate the concentration of carbon and chlorine in the blank sample (assume 10 g of waste as the mass). A VO concentration equivalent to ≤10 percent of the applicable standard may be subtracted from the measured VO concentration of the waste samples. Include all blank results and documentation in the test report.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A_b = Area under the water blank response curve, counts.
A_c = Area under the calibration response curve, counts.
A_s = Area under the sample response curve, counts.
C = Concentration of volatile organics in the sample, ppmw.
C_c = Concentration of carbon, as methane, in the calibration gas, mg/L.
C_{ch} = Concentration of chloride in the calibration gas, mg/L.
C_j = VO concentration of phase j, ppmw.
DR_t = Average daily response factor of the FID, mg CH_4/counts.
Dr_{th} = Average daily response factor of the ELCD, mg Cl^-/counts.
F_j = Weight fraction of phase j present in the waste.
m_c = Mass of carbon, as methane, in a calibration run, mg.
m_{ch} = Mass of chloride in a calibration run, mg.
m_s = Mass of the waste sample, g.
m_{sc} = Mass of carbon, as methane, in the sample, mg.
m_{sf} = Mass of sample container and waste sample, g.
m_{sh} = Mass of chloride in the sample, mg.
m_{st} = Mass of sample container prior to sampling, g.
m_{VO} = Mass of volatile organics in the sample, mg.
n = Total number of phases present in the waste.
P_p = Percent propane in calibration gas (L/L).
P_{vc} = Percent 1,1-dichloroethylene in calibration gas (L/L).
Q_c = Flow rate of calibration gas, L/min.
t_c = Length of time standard gas is delivered to the analyzer, min.
W = Weighted average VO concentration, ppmw.

12.2 Concentration of Carbon, as Methane, in the Calibration Gas.

$$C_c = (19.681 \times P_p) + (13.121 \times P_{vc}) \qquad \text{Eq. 25D-1}$$

12.3 Concentration of Chloride in the Calibration Gas.

$$C_{ch} = 28.998 \times P_{vc} \qquad \text{Eq. 25D-2}$$

12.4 Mass of Carbon, as Methane, in a Calibration Run.

$$M_c = C_c \times Q_c \times t_c \qquad \text{Eq. 25D-3}$$

12.5 Mass of Chloride in a Calibration Run.

$$m_{ch} = C_{ch} \times Q_c \times t_c \qquad \text{Eq. 25D-4}$$

12.6 FID Response Factor, mg/counts.

$$DR_t = \frac{m_c}{A_c} \qquad \text{Eq. 25D-5}$$

12.7 ELCD Response Factor, mg/counts.

$$DR_{th} = \frac{m_{ch}}{A_c} \qquad \text{Eq. 25D-6}$$

12.8 Mass of Carbon in the Sample.

$$m_{sc} = DR_t(A_s - A_b) \qquad \text{Eq. 25D-7}$$

12.9 Mass of Chloride in the Sample.

$$m_{sh} = DR_{th}(A_s - A_b) \qquad \text{Eq. 25D-8}$$

12.10 Mass of Volatile Organics in the Sample.

$$m_{vo} = m_{sc} + m_{sh} \qquad \text{Eq. 25D-9}$$

12.11 Relative Standard Deviation.

$$RSD = \frac{100}{\bar{x}} \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} \qquad \text{Eq. 25D-10}$$

12.12 Mass of Sample.

$$m_s = m_{sf} - m_{st} \qquad \text{Eq. 25D-11}$$

12.13 Concentration of Volatile Organics in Waste.

$$C = \frac{(m_{vo} \times 1000)}{m_s} \qquad \text{Eq. 25D-12}$$

12.14 Weighted Average VO Concentration of Multi-phase Waste.

$$W = \sum_{j=1}^{n} F_j \, x \, \overline{C}_j \qquad \text{Eq. 25D-13}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. ‘‘Test Methods for Evaluating Solid Waste, Physical/Chemistry Methods’’, U.S. Environmental Protection Agency. Publication SW–846, 3rd Edition, November 1986 as amended by Update I, November 1990.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

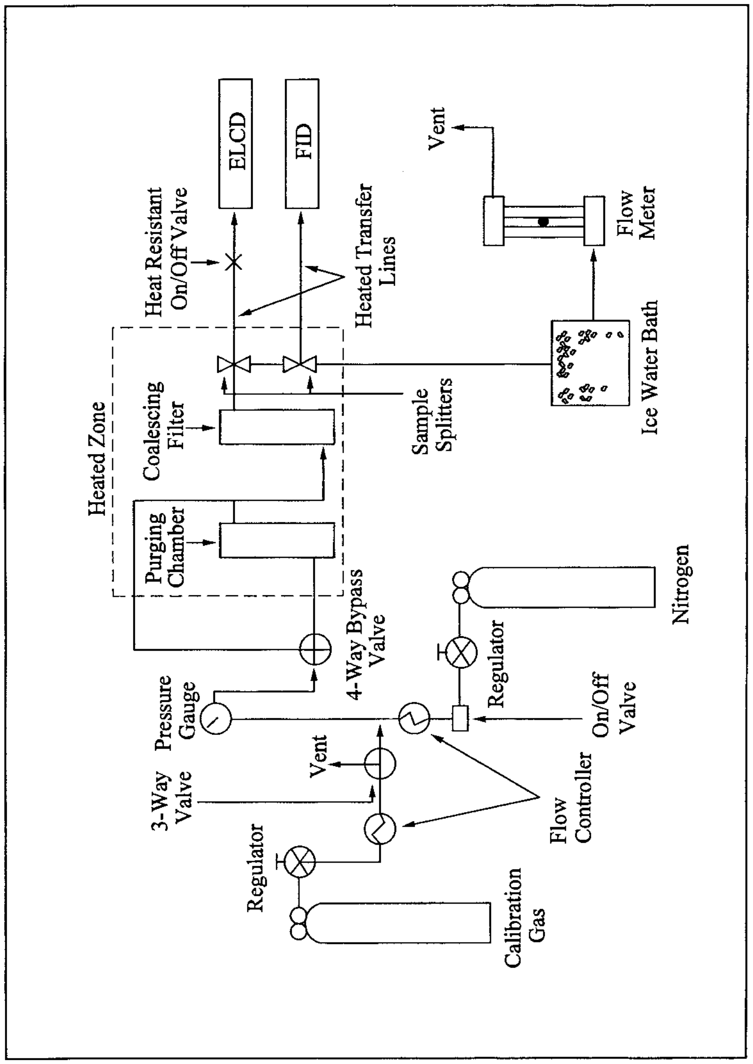


Figure 25D-1. Schematic of Purging Apparatus.

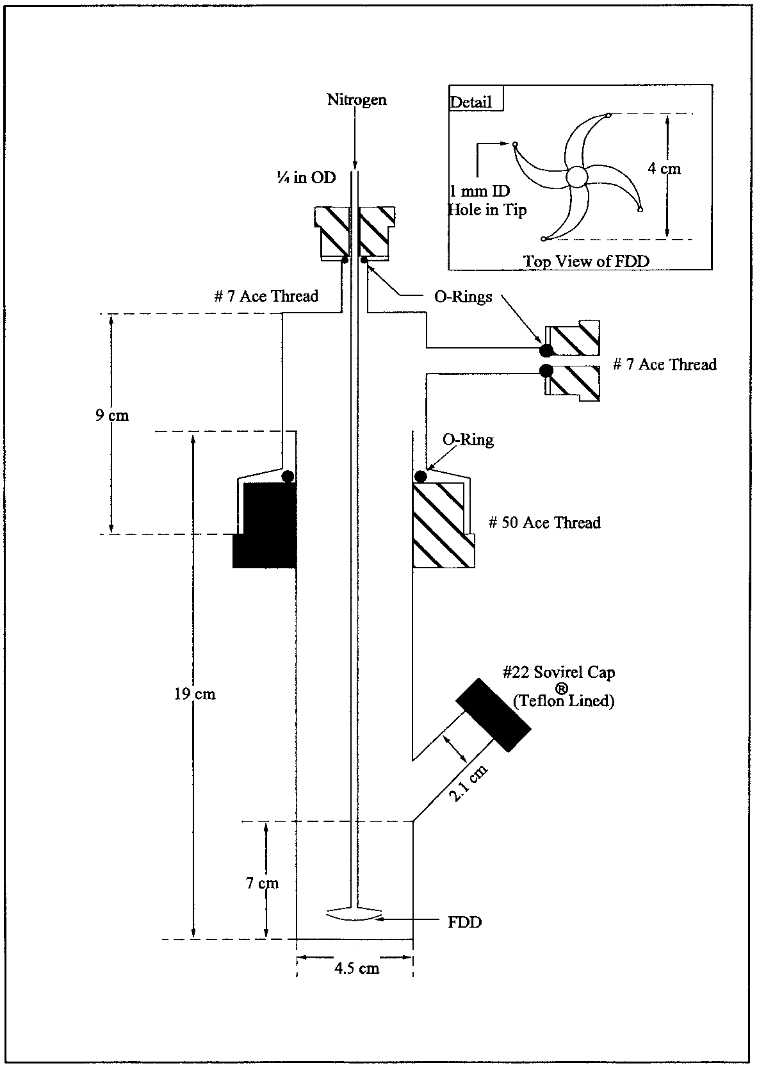
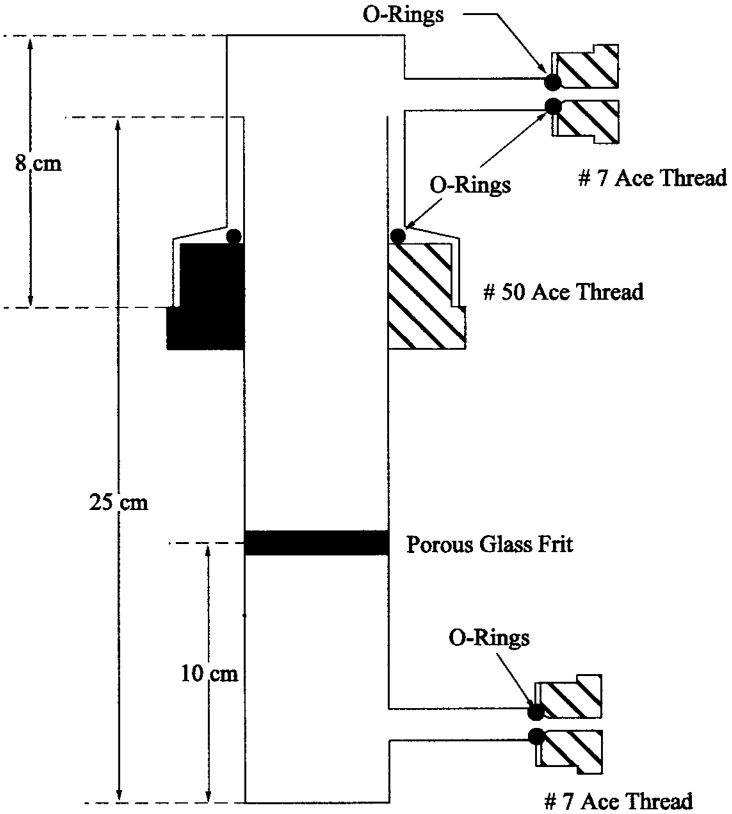


Figure 25D-2. Purging Lance.


O-Rings
8 cm
O-Rings
7 Ace Thread
50 Ace Thread
25 cm
Porous Glass Frit
O-Rings
10 cm
7 Ace Thread

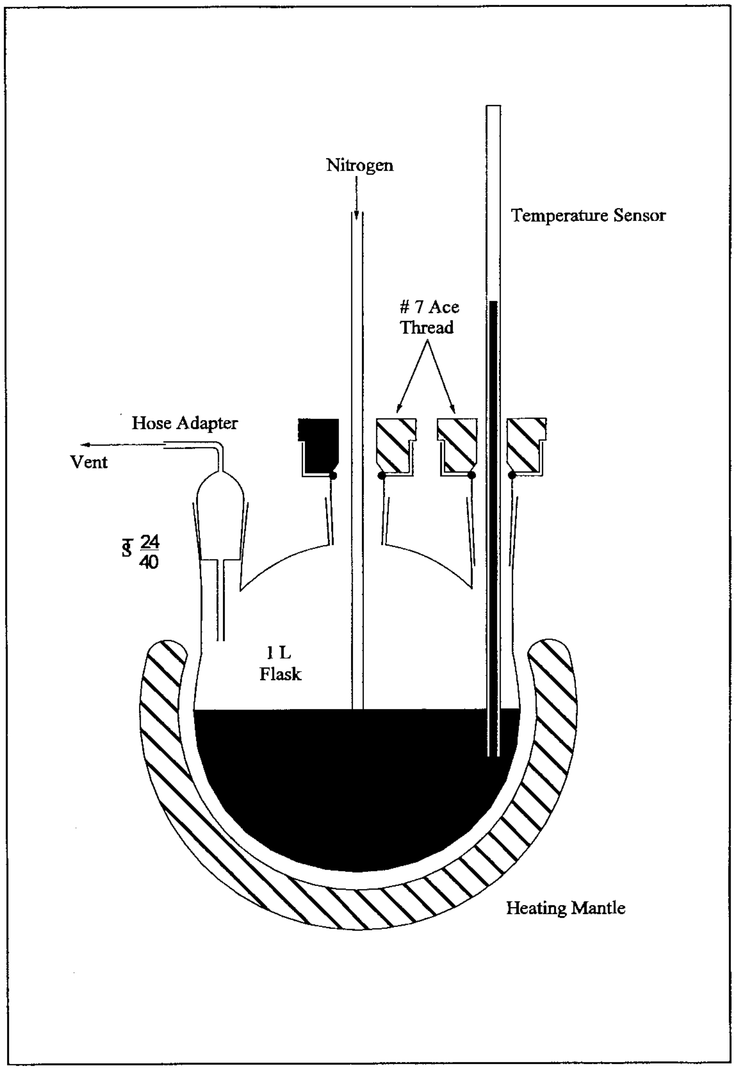


Figure 25D-4. Schematic of PEG Cleaning System.

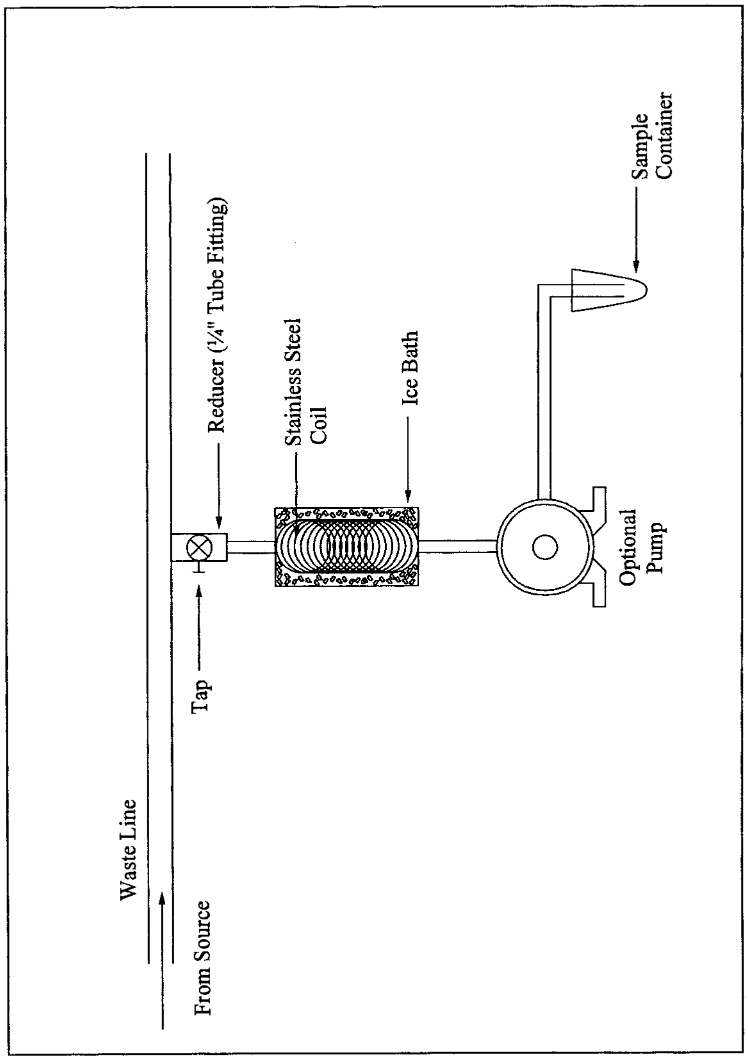


Figure 25D-5. Schematic of Sampling Apparatus.

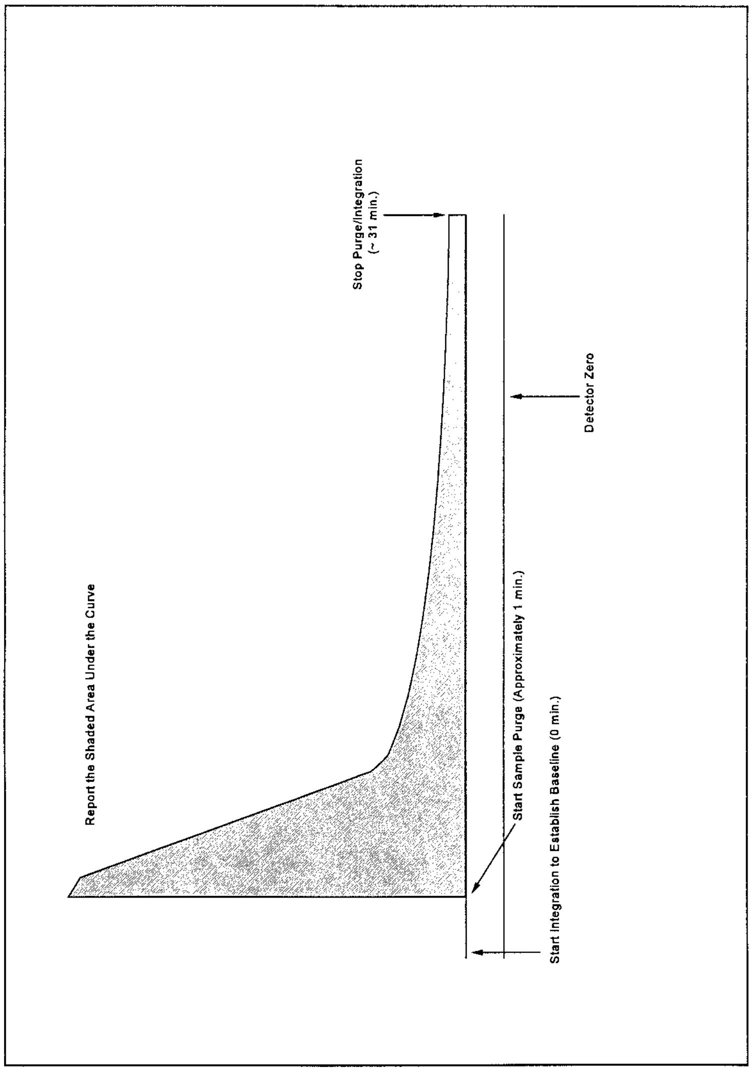


Figure 25D-6. Example Integration of Either Detector.

METHOD 25E—DETERMINATION OF VAPOR PHASE ORGANIC CONCENTRATION IN WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) nor by those who are unfamiliar with source sampling because knowledge beyond the scope of this presentation is required. This method is not inclusive with respect to specifications (*e.g.*, reagents and standards) and calibration procedures. Some material is incorporated by reference from other methods. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 106, part 61, Appendix B, and Method 18, part 60, Appendix A.

1.0 Scope and Application

1.1 Applicability. This method is applicable for determining the vapor pressure of waste cited by an applicable regulation.

1.2 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 The headspace vapor of the sample is analyzed for carbon content by a headspace analyzer, which uses an FID.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 The analyst shall select the operating parameters best suited to the requirements for a particular analysis. The analyst shall produce confirming data through an adequate supplemental analytical technique and have the data available for review by the Administrator.

5.0 Safety [Reserved]

6.0 Equipment and Supplies

6.1 Sampling. The following equipment is required:

6.1.1 Sample Containers. Vials, glass, with butyl rubber septa, Perkin-Elmer Corporation Numbers 0105–0129 (glass vials), B001–0728 (gray butyl rubber septum, plug style), 0105–0131 (butyl rubber septa), or equivalent. The seal must be made from butyl rubber. Silicone rubber seals are not acceptable.

6.1.2 Vial Sealer. Perkin-Elmer Number 105–0106, or equivalent.

6.1.3 Gas-Tight Syringe. Perkin-Elmer Number 00230117, or equivalent.

6.1.4 The following equipment is required for sampling.

6.1.4.1 Tap.

6.1.4.2 Tubing. Teflon, 0.25-in. ID.

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1.4.3 Cooling Coil. Stainless steel (304), 0.25 in.-ID, equipped with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Balanced Pressure Headspace Sampler. Perkin-Elmer HS–6, HS–100, or equivalent, equipped with a glass bead column instead of a chromatographic column.

6.2.2 FID. An FID meeting the following specifications is required.

6.2.2.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.2.

6.2.2.2 Range. A full scale range of 1 to 10,000 parts per million (ppm) propane (C_3H_8). Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.3 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the output of the detector.

6.2.4 Temperature Sensor. Capable of reading temperatures in the range of 30 to 60 °C (86 to 140 °F) with an accuracy of ±0.1 °C (±0.2 °F).

7.0 Reagents and Standards

7.1 Analysis. The following items are required for analysis.

7.1.1 Hydrogen (H_2). Zero grade hydrogen, as required by the FID.

7.1.2 Carrier Gas. Zero grade nitrogen, containing less than 1 ppm carbon (C) and less than 1 ppm carbon dioxide.

7.1.3 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2 Calibration and Linearity Check.

7.2.1 Stock Cylinder Gas Standard. 100 percent propane. The manufacturer shall: (a) Certify the gas composition to be accurate to ±3 percent or better (see section 7.2.1.1); (b) recommend a maximum shelf life over which the gas concentration does not change by greater than ±5 percent from the certified value; and (c) affix the date of gas cylinder preparation, certified propane concentration, and recommended maximum shelf life to the cylinder before shipment to the buyer.

7.2.1.1 Cylinder Standards Certification. The manufacturer shall certify the concentration of the calibration gas in the cylinder by (a) directly analyzing the cylinder and (b) calibrating his analytical procedure on the day of cylinder analysis. To calibrate his analytical procedure, the manufacturer shall use, as a minimum, a three-point calibration curve.

7.2.1.2 Verification of Manufacturer's Calibration Standards. Before using, the manufacturer shall verify each calibration standard by (a) comparing it to gas mixtures prepared in accordance with the procedure described in section 7.1 of Method 106 of Part 61, Appendix B, or by (b) calibrating it against Standard Reference Materials (SRM's) prepared by the National Bureau of Standards, if such SRM's are available. The agreement between the initially determined concentration value and the verification concentration value must be within ±5 percent. The manufacturer must reverify all calibration standards on a time interval consistent with the shelf life of the cylinder standards sold.

8.0 Sampling Collection, Preservation, Storage, and Transport

8.1 Install a sampling tap to obtain a sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to

the atmosphere). Assemble the sampling apparatus as shown in Figure 25E–1.

8.2 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.3 After purging, stop the sample flow and transfer the Teflon sampling tube to a sample container. Sample at a flow rate such that the temperature of the waste is <10 °C (<50 °F). Fill the sample container halfway (±5 percent) and cap it within 5 seconds. Store immediately in a cooler and cover with ice.

8.4 Alternative sampling techniques may be used upon the approval of the Administrator.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
10.2, 10.3	FID calibration and response check	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Use the procedures in sections 10.2 to calibrate the headspace analyzer and FID and check for linearity before the system is first placed in operation, after any shutdown longer than 6 months, and after any modification of the system.

10.2 Calibration and Linearity. Use the procedures in section 10 of Method 18 of Part 60, Appendix A, to prepare the standards and calibrate the flowmeters, using propane as the standard gas. Fill the calibration standard vials halfway (±5 percent) with deionized water. Purge and fill the airspace with calibration standard. Prepare a minimum of three concentrations of calibration standards in triplicate at concentrations that will bracket the applicable cutoff. For a cutoff of 5.2 kPa (0.75 psi), prepare nominal concentrations of 30,000, 50,000, and 70,000 ppm as propane. For a cutoff of 27.6 kPa (4.0 psi), prepare nominal concentrations of 200,000, 300,000, and 400,000 ppm as propane.

10.2.1 Use the procedures in section 11.3 to measure the FID response of each standard. Use a linear regression analysis to calculate the values for the slope (k) and the y-intercept (b). Use the procedures in sections 12.3 and 12.2 to test the calibration and the linearity.

10.3 Daily FID Calibration Check. Check the calibration at the beginning and at the end of the daily runs by using the following procedures. Prepare 2 calibration standards at the nominal cutoff concentration using the procedures in section 10.2. Place one at the beginning and one at the end of the daily run. Measure the FID response of the daily calibration standard and use the values for k and b from the most recent calibration to calculate the concentration of the daily standard. Use an equation similar to 25E–2 to calculate the percent difference between the daily standard and C_s. If the difference is within 5 percent, then the previous values for k and b can be used. Otherwise, use the procedures in section 10.2 to recalibrate the FID.

11.0 Analytical Procedures

11.1 Allow one hour for the headspace vials to equilibrate at the temperature specified in the regulation. Allow the FID to warm up until a stable baseline is achieved on the detector.

11.2 Check the calibration of the FID daily using the procedures in section 10.3.

11.3 Follow the manufacturer's recommended procedures for the normal operation of the headspace sampler and FID.

11.4 Use the procedures in sections 12.4 and 12.5 to calculate the vapor phase organic vapor pressure in the samples.

11.5 Monitor the output of the detector to make certain that the results are being properly recorded.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A = Measurement of the area under the response curve, counts.

b = y-intercept of the linear regression line.

C_a = Measured vapor phase organic concentration of sample, ppm as propane.

C_{ma} = Average measured vapor phase organic concentration of standard, ppm as propane.

C_m = Measured vapor phase organic concentration of standard, ppm as propane.

C_s = Calculated standard concentration, ppm as propane.

k = Slope of the linear regression line.

P_{bar} = Atmospheric pressure at analysis conditions, mm Hg (in. Hg).

P* = Organic vapor pressure in the sample, kPa (psi).

PD = Percent difference between the average measured vapor phase organic concentration (C_m) and the calculated standard concentration (C_s).

RSD = Relative standard deviation.

$\beta = 1.333 \times 10^{-7}$ kPa/[(mm Hg)(ppm)], (4.91×10^{-7} psi/[(in. Hg)(ppm)])

12.2 Linearity. Use the following equation to calculate the measured standard concentration for each standard vial.

$$C_m = kA + b \qquad \text{Eq. 25E-1}$$

12.2.1 Calculate the average measured standard concentration (C_{ma}) for each set of triplicate standards and use the following equation to calculate PD between C_{ma} and C_s. The instrument linearity is acceptable if the PD is within five for each standard.

$$PD = \frac{C_s - C_{ma}}{C_s} \times 100 \qquad \text{Eq. 25E-2}$$

12.3. Relative Standard Deviation (RSD). Use the following equation to calculate the RSD for each triplicate set of standards.

$$RSD = \frac{100}{C_{ma}} \sqrt{\frac{\sum (C_m - C_{ma})^2}{2}} \qquad \text{Eq. 25E-3}$$

The calibration is acceptable if the RSD is within five for each standard concentration.

12.4 Concentration of organics in the headspace. Use the following equation to calculate the concentration of vapor phase organics in each sample.

$$C_a = kA + b \qquad \text{Eq. 25E-4}$$

12.5 Vapor Pressure of Organics in the Headspace Sample. Use the following equation to calculate the vapor pressure of organics in the sample.

$$P^* = \beta P_{bar} C_a \qquad \text{Eq. 25E-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. ‘‘Determination of Solvent Vapor Concentrations by Total Combustion Analysis: a Comparison of Infared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. ‘‘Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) p. 25.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

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Sunstone Solar Project 3
Draft Noxious Weed Control Plan

Prepared for

PINEGATE
RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 3, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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List of Tables

Appendices

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1.0 Introduction

Sunstone Solar 3, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 3 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Noxious Weed Control Plan has been prepared to comply with Oregon Administrative Rule 660-033-0130 (38)(h)(D), which states, in regard to photovoltaic solar power generation facilities, that:

> C*onstruction or maintenance activities will not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. This provision may be satisfied by the submittal and county approval of a weed control plan prepared by an adequately qualified individual that includes a long-term maintenance agreement. The approved plan shall be attached to the decision as a condition of approval*.

Noxious weeds are non-native, aggressive plants with the potential to cause significant damage to native ecosystems and/or cause significant economic losses. Noxious weeds are opportunistic plant species that readily flourish in disturbed areas, are difficult to control, and thereby can compete with and/or prevent native plant species from re-establishing. Notably, the likelihood of introduction or explosion of noxious weeds is correlated with new disturbances in a region, such as large-scale construction projects. In addition, noxious weed species can adversely affect the structure, composition, and success of revegetation efforts associated with construction-related temporary disturbances.

The intent of this Plan is to provide clear methods to prevent the introduction and spread of designated noxious weeds from the construction and operation of the Facility, control existing populations of noxious weeds within construction areas, and monitor the success of efforts to prevent and control noxious weeds. The Certificate Holder and its contractors will be responsible for implementing the methods detailed in this Plan.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

Prior to construction, the Certificate Holder shall finalize this plan by completing the following:

- Conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform pre-construction weed treatment.
- Develop final noxious weed monitoring methods in consultation with ODOE and incorporate as an amendment to this plan upon ODOE approval.
- Update Table 2 in consultation with ODOE and the Morrow County Weed Department.
- Provide records demonstrating all personnel have been trained on noxious weed control.
- Provide evidence that existing noxious weed infestations have been identified and treated in a manner consistent with Morrow County recommendations.
- Consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern.

2.0 Regulatory Framework

2.1 State of Oregon

In Oregon, a noxious weed is defined under Oregon Revised Statutes (ORS) 569.175 as "a terrestrial, aquatic, or marine plant designated by the State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.". Noxious weeds have been declared by ORS 569.350 as a menace to public welfare, and control of these plants is the responsibility of private landowners and operators, as well as county, state, and federal governments.

The Oregon State Weed Board (OSWB) was created by the Oregon Department of Agriculture (ODA) under ORS 569.600. OSWB provides recommendations for noxious weed control at the state-level and is responsible for updating the State Noxious Weed List. The OSWB and the ODA classify noxious weeds in Oregon in accordance with the ODA Noxious Weed Policy and Classification System (ODA 2024). There are three designations under the State's system:

- **A Listed Weed:** A weed of known economic importance that occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent.
    - **Recommended Action:** Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed:** A weed of economic importance that is regionally abundant but may have limited distribution in some counties.

  - **Recommended Action:** Limited to intensive control at the state, county, or regional level as determined on a site-specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.

- **T-Designated Weed:** A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

2.2 Morrow County

The Morrow County Code Enforcement Ordinance establishes procedures for enforcing Morrow County Code through the authority granted to general law counties by ORS Chapter 203. Section 11 of the county Code Enforcement Ordinance, updated on July 5, 2021, establishes Morrow County as a weed control district, defines what is considered a noxious weed or weed of economic importance, identifies the responsibility of private landowners to control weeds, and outlines the authority of the weed control district and Morrow County Weed Program Manager/Inspector to administer and enforce weed control in the ordinance (Morrow County 2021).

Morrow County has its own weed classification system that differs from the state. Morrow County defines two classifications of weeds (Morrow County 2025):

- **Noxious Weeds - "A List":** Any plant that is determined by the weed advisory board and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land, or property under provisions of Oregon State Statute and thus mandated for control.
- **Weeds of Economic Importance - "B List":** Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

2.3 State and County Weed Lists

The ODA lists 46 Class A species and 88 Class B species for the state of Oregon, 19 of which are T-designated (ODA 2024; Appendix A). Morrow County specifically recognizes 36 species of noxious weeds (Appendix B; Morrow County 2025). Although not all the Morrow County listed noxious weeds noted in Appendix B occur in the vicinity of the Facility, the Certificate Holder and its contractors should be aware of the entire list while monitoring and controlling weeds. Noxious weeds known to occur in the vicinity of the site boundary are discussed in Section 3.0.

3.0 Noxious Weeds Identified at the Facility

In June, 2022 Tetra Tech completed rare plant and habitat categorization surveys within and adjacent to the original Sunstone Solar Project site boundary[2]. During those surveys, four listed noxious weed species were documented, including three ODA-listed noxious weed species and four Morrow County listed species noxious weed species. Table 1 lists the noxious weed species observed, their noxious weed designation (i.e., status), and the frequency of observations. Locations of these noxious weeds documented during surveys are included in Exhibit P, Attachment P-1 of the ASC[3]. Three of the four noxious weed species observed were state and/or County "B" listed weeds (Table 1; Morrow County 2025, ODA 2024). One species, rush skeletonweed (*Chondrilla juncea*), is an "A" List Weed in Morrow County and a state "T"-designated weed, meaning that ODA has targeted this species for prevention and control (Morrow County 2025; ODA 2024). Note that none of these noxious weed species observations are located within the Sunstone Solar Project 3/Facility site boundary, however, due to the likelihood that these species could be found at the Facility in the future, they are retained for awareness and noxious weed prevention purposes.

Cereal rye (*Secale cereale*) was abundant in the previously disturbed areas outside of active crop fields and was generally found in previously disturbed ground. Rush skeletonweed was found in isolated small populations or single individuals on the hillside between active cropland and a gravel county road. Puncturevine (*Tribulus terrestris*) and jointed goatgrass (*Aegilops cylindrica*) were found in the highly disturbed border in between active cropland and roads. The Certificate Holder will conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform management actions. The Certificate Holder may coordinate with landowners regarding noxious weed presence. Identified noxious weed infestations will be treated prior to construction.

Table 1. Noxious Weeds Observed during Surveys in 2022

Scientific Name	Common Name	Oregon State Status[1]	Morrow County Status[1]	Frequency
Aegilops cylindrica	Jointed goatgrass	B	B	Few small patches.
Chondrilla juncea	Rush skeletonweed	B*, T	A	Occasional single plants.
Secale cereale	Cereal rye	Not listed	B	Scattered large-sized patches.
Tribulus terrestris	Puncturevine	B*	B	Few small to large-sized patches.

1. Definitions for state and county noxious weed status are provided in Sections 2.1 and 2.2, respectively. Species marked with a (*) are targeted for biocontrol (ODA 2024).

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[2] Site Certificate for the Sunstone Solar Project, November 18, 2024.

[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

In addition to noxious weeds, cheatgrass, an invasive annual grass, was identified in grassland habitats within the site boundary. While this species is not listed as a noxious weed by the state or county, it and other invasive annual grasses can adversely impact habitat and can increase fire risk. To address these issues and maintain compliance with the requirements of the Revegetation Plan required under Condition PRE-FW-01, the certificate holder will monitor the spread of these species as explained in Section 4.3 and 4.4.

4.0 Noxious Weed Management

This section of this Plan describes the steps the Certificate Holder will take to prevent and control the establishment and spread of noxious weed species during both construction and operation of the Facility. Noxious weed control methods for the Facility described in this Plan have been developed utilizing information from the ODA Noxious Weed Control Program and the Morrow County Weed Department.

The management of noxious weeds will be considered throughout all stages of construction and operation of the Facility and will include:

- **Prevention:** Implementing measures to prevent the spread of noxious weeds during construction, operation, and maintenance activities.
- **Treatment:** Treating noxious weed populations with their appropriate control methods, at appropriate time intervals.
- **Monitoring:** Assessing noxious weed changes within the Facility site boundary over time and ensuring that legacy as well as new weed populations are not increasing their distributions.

The Certificate Holder's objective is to prevent the introduction of new noxious weed populations and the spread of existing noxious weed populations. The methods described below will be implemented to minimize the spread of noxious weeds during construction activities. New noxious weeds detected during post-construction revegetation will be considered a result of construction activities and will be controlled accordingly.

4.1 Prevention

Prior to the start of construction, all personnel will be trained on the importance of noxious weed control. As part of start-up activities, and to help facilitate the avoidance of existing infestations and identification of new infestations, the Certificate Holder or their construction contractor will provide information and training to all construction personnel regarding noxious weed identification and prevention strategies. Operations and maintenance personnel will be similarly informed. The importance of preventing the spread of noxious weeds in areas not currently infested and controlling the proliferation of noxious weeds already present within or near the Facility will be emphasized.

The Certificate Holder will implement the following best management practices to minimize the spread of noxious weeds during construction activities, revegetation efforts, and operation and maintenance activities. The following practices center around ensuring that noxious weed seeds or reproductive plant fragments are not unintentionally dispersed within or outside of the Facility boundaries by personnel or their vehicles. These practices allow for responsible movement around sites with noxious weeds already present, and ensure that new populations or species are not accidentally introduced into the Facility boundaries.

- Flagging and treating areas of noxious weed infestations prior to construction to alert construction personnel;
- Limiting vehicle access to designated routes, whether existing roads or newly constructed roads, and the outer limits of construction disturbances per the final design for the Facility;
- Limiting vehicle traffic in noxious weed-infested areas;
- Cleaning construction vehicles each time they enter or exit the Facility at a wash station located inside the Facility at vehicle ingress/egress points;
- Cleaning vehicles and equipment associated with ground disturbance and movement of topsoil utilizing a mobile wash station after performing work in noxious weed-infested areas and prior to performing work in non-infested areas;
- Where feasible, not moving topsoil and other soils from noxious weed infested areas outside of the infested areas and returning them to their previous location during reclamation activities;
- Treating soils from infested areas with a pre-emergent herbicide prior to initiation of revegetation efforts;
- Providing information regarding target noxious weed species at the operations and maintenance buildings;
- Treating noxious weeds via biological, mechanical or chemical control (see Section 4.2);
- Preventing conditions favorable for noxious weed germination and spread by revegetating temporarily disturbed areas as soon as practicable;
- Monitoring areas of disturbance for noxious weeds after construction (see Section 4.3), during the normal course of revegetation maintenance of temporary workspaces, and implementing control measures as appropriate;
- Revegetating the site with appropriate, local native seed or native plants; when these are not available, non-invasive, and non-persistent non-native species may be used; and
- Ensuring that seed and straw mulch used for site rehabilitation and revegetation are certified free of noxious weed seed and propagules.

4.2 Treatment

Control of noxious weeds and other invasive weed species will be implemented through biological, mechanical, chemical, or biological control measures. The control method used will depend on the

weed species and size of infestation, time of year, proximity to intact native habitats, and resources available (Tu et al. 2003). Generally, mechanical control is best suited for small infestations of tap-rooted weeds that can be hand pulled or large occurrences in areas where mowing or soil disturbance is acceptable. Chemical control is used for most occurrences of perennial weeds with rhizomes or stolons and large occurrences of any weed in areas where mowing or soil disturbance are not recommended. Successful noxious weed control programs typically combine mechanical and chemical treatment strategies (USEPA 2008).

The Certificate Holder will be responsible for hiring a qualified contractor to implement the treatment of noxious weeds. The Certificate Holder will ensure that noxious weed management actions will be conducted by specialists with the following qualifications:

- Experience in native plant, non-native and invasive plants, and noxious weed identification;
- Experience in noxious weed mapping;
- If chemical control is used, specialists must possess a Commercial or Public Pesticide Applicator License from the ODA or possess an Immediately Supervised Pesticide Trainee License and be supervised by a licensed applicator;
- Training in noxious weed management or Integrated Pest Management with an emphasis in noxious weeds;
- Experience in coordination with agencies and private landowners; and
- No recent (within one year) violations on the contractor’s record.

Existing noxious weed populations will be prevented from expanding in size and density and will not be spread to new sites. Existing populations of A listed noxious weeds will be eliminated. If it is determined that noxious weeds have invaded areas immediately adjacent to the Facility (e.g., areas visible just beyond the outer limits of construction disturbances associated with the Facility or along access roads) as a result of construction, the Certificate Holder will contact the landowner and seek approval to treat those noxious weed populations.

Long-term weed control methods will be described in a long-term monitoring plan as described in Section 4.3. The main factor in long-term weed control is successful revegetation with non-weedy species as described in the Draft Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). If feasible, long-term management of vegetation within the Facility solar array fence line may include prescriptive sheep and goat grazing by an authorized contractor, if approved by Morrow County, ODFW and ODOE. As noted above, short-term noxious weed control will be done through mechanical or chemical treatment. However, it will be important to ensure that the short-term treatment does not affect the establishment of the native perennial cover that will help provide the long-term control. Additionally, early detection and control of small noxious weed populations before they can expand into larger populations is extremely important for successful weed control efforts.

Noxious weed control will continue for the life of the Facility to meet the identified success criteria described in Section 4.3. Supplemental seeding of desirable species may be needed to meet and/or

maintain compliance with success criteria. Fertilizer application will be limited in areas treated for noxious weeds, as fertilizer can stimulate the growth of noxious weeds, and the timing of revegetation activities will need to be coordinated with noxious weed treatments.

4.2.1 Biological

Biological control involves the use of prescribed insects, fungi and livestock to control noxious weeds to achieve management objectives. Biological control methods are typically targeted to a specific species or plant to control its persistence. They are also used for maintenance in targeted areas for vegetation management control in height and density that includes mitigating fire risk and erosion. Biological control is environmentally friendly and should be the first consideration when applicable.

4.2.2 Mechanical Treatment

Mechanical treatment will be the preferred method of treatment for existing noxious weed populations where appropriate within the boundaries of the Facility. Mechanical control methods rely on removal of plants, seed heads, and/or cutting roots with a shovel or other hand tools or equipment that can be used to remove, mow, or disc noxious weed populations. Hand removal of plants is also included under this treatment method. Mechanical methods are useful for smaller, isolated populations of noxious weeds in areas of sensitive habitats. Additionally, hand removal of small infestations can minimize soil disturbance, allowing desirable species to remain and limiting conditions favorable for noxious weeds.

For some large noxious weed occurrences, mowing, tilling, discing, or other mechanical techniques may be used to reduce thatch prior to chemical application so that herbicide can more effectively make contact with the target species. However, some rhizomatous plants can spread by discing or tillage. In addition, rush skeletonweed, which was identified near the Facility (Section 3.0), can reproduce vegetatively from small segments of root, and discing or tilling can facilitate the spread of this species. As such, implementation of discing will be species-specific and avoided in areas where rush skeletonweed individuals have been found.

If tilling or discing is employed in areas that will be revegetated following construction, subsequent seeding will be conducted to re-establish desirable vegetative cover that will stabilize the soils and slow the potential re-invasion of noxious weeds. Discing, tilling, or other mechanical treatments that disturb the soil surface within native habitats will also be avoided in favor of herbicide application, which is an effective means of reducing the size of noxious weed populations as well as preventing the establishment of new infestations. Previously unbroken ground or fallow areas should not be tilled or rod-weeded to maintain native biocrusts and prevent exposing weed seeds.

4.2.3 Chemical Treatment

Chemical control can effectively remove noxious weeds through use of selective herbicide when mechanical control is not feasible. The specific herbicide used and the timing of application will be

chosen based on the specific noxious weed being treated, as appropriate herbicides differ between species and types of plants (i.e., dicots such as rush skeletonweed versus monocots such as jointed goatgrass). Example treatment methods, as well as the recommended timing of treatments for the four target noxious weeds identified within the Facility, are summarized in Table 2. The status of herbicide approval (e.g., confirming herbicides are approved for use by the U.S. Environmental Protection Agency [EPA] and ODA) will be checked annually.

Prior to construction and every fall season during facility operation, the Certificate Holder or its contractor will consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern, to allow for adaptive weed management given changes in weed control effectiveness from noxious weed species tolerance to herbicide treatment over time. Results of the consultation shall be reported in the Certificate Holder's annual monitoring report. Any alternative control methods can be proposed by the Certificate Holder or its contractors after consulting with the Morrow County Weed Department and included in the Certificate Holder's annual monitoring report.

Herbicides will be applied on identified, treatable, noxious weed infestations. The Certificate Holder or their contractors will coordinate with the Morrow County Weed Department to determine which populations are treatable and will notify landowners of proposed herbicide use on their lands prior to application. If a noxious weed population is deemed to be untreatable (e.g., too widespread and established in an area to successfully control), the Certificate Holder will implement the applicable prevention measures discussed in Section 4.1, except for treatment with herbicides.

Table 2. Example Treatment for Target Noxious Weed Species

Scientific Name	Common Name	Treatment Method and Timing
Aegilops cylindrica	Jointed goatgrass	**Glyphosate** – Apply to actively growing plants emerged before bolt stage (i.e., stage of growth where growth is focused on seed development versus leaf development). • Rate: 0.38 to 0.75 lb ae/a[1] **Imazapic –** Apply pre-emergence in fall. Due to the residual effect of this herbicide, it will not be used in areas to be revegetated. • Rate: 0.063 to 0.188 lb/a[1] **Sulfometuron** – Apply in fall or in late winter before jointed goatgrass is 3 inches tall. • Rate: 1 to 1.5 oz ai/a (1.33 to 2 oz/a)[1]
Chondrilla juncea	Rush skeletonweed	**2,4-D or MCPA –** Apply to rosettes in the spring immediately before or during bolting. • Rate: 2 lb ae/a[1] **Aminopyralid (Milestone) –** Spring or fall when rosettes are present. • Rate: 1.75 oz ae/a (7 fluid oz/a Milestone)[1] **Clopyralid –** Apply to rosettes in fall or up to early bolting in spring. • Rate: 0.25 to 0.375 lb ae/a (0.66 to 1 pint/a)[1]

Scientific Name	Common Name	Treatment Method and Timing
		Picloram – Apply from late fall to early spring. For best results, apply just before or during bolting. • Rate: 1 lb ae/a[1]
Secale cereale	Cereal rye	Postemergence, non-selective herbicides such as glyphosate can control cereal rye. Glyphosate does not provide residual weed control, so any plants that emerge after treatment will not be controlled. Other herbicides that have found to provide control include Clethodim, Hexazinone, Rimsulfuron, Sethoxydim, and Sulfometuron.
Tribulus terrestris	Puncturevine	**2,4-D amine or 2,4-D LV ester–** Apply every 3 weeks during growing season or when new seedlings appear. • Rate: 1 to 2 lb ae in 10 to 20 gal water for spot treatments **Bentazon (Basagran) + imazamox (Raptor)–** Apply to small, actively growing puncture vine • Rate: 0.75 to 1 lb ai/A bentazon + 0.031 lb ai/a imazamox (4 oz/A Raptor) **Bromacil + diuron–** Apply before weeds emerge. • Rate: 8 lb ai/A (10 lb/a)[1] **Chlorsulfuron–** Apply late fall or late winter preemergence to growth. Needs moisture to activate. • Rate: 1 oz ai/a (1.5 oz/a)[1] **Fomesafen –** Apply pre- and postemergence, depending on crop. • Rate: 1 to 2 pints/A (0.25 to 0.5 lb ai/a)[1] **Imazapic –** Apply early postemergence when plants are cracking. • Rate: 0.125 to 0.188 lb ai/a[1] **Indaziflam –** Apply at least several weeks prior to expected germination of puncture vine. Apply to dry soils when rain is not expected for at least 48 hours. Can be successfully applied several months in advance of weed germination. • Rate: Grazed areas 0.046 to 0.065 lb ai/a (3.5 to 5 oz/a Rejuvra); areas not grazed or cut for hay 0.046 to 0.09 lb ai/A (3.5 to 7 oz/a Rejuvra). Use lower rates only where weed pressure is light and shorter period of residual activity is desired. **Norflurazon –** Apply in fall to spring, before puncture vine emerges. • Rate: Refer to label. Adjust rates depending on soil texture and organic matter **Paraquat –** Apply as a postemergence spray to puncture vine foliage • Rate: 0.38 to 0.49 lb ai/a[1] •

Sources: DiTomaso e al. 2013; LCNWCB 2022; Prather and Peachey 2022.

[1] a = acre; ae = acid equivalent; ai = active ingredient; lb= pound; oz = ounces

4.2.3.1 Herbicide Application and Handling

Herbicide application will occur within the appropriate season and during the appropriate timeframe to achieve desired results, as approved by ODOE and the county weed departments. Herbicide application will adhere to EPA and ODA standards. Only those herbicides that are approved by the EPA and ODA will be used. In general, application of herbicides will not occur when the following conditions exists:

- Wind velocity exceeds 15 miles per hour for granular application, or exceeds 10 miles per hour for liquid applications;
- Snow or ice covers the foliage of target species; or
- Adverse weather conditions are forecasted within the next few days.

Hand application methods (e.g., backpack spraying) may be used in roadless areas or in rough terrain. Vehicle-mounted sprayers (e.g., handgun, boom, and injector) will be used mainly in open areas that are readily accessible by vehicle. Calibration checks of equipment will be conducted prior to spraying activities, as well as periodically throughout use, to ensure that appropriate application rates are achieved.

Herbicides will be transported to the Facility daily with the following stipulations:

- Only the quantity needed for that day’s work will be transported.
- Concentrate will be transported in approved containers only, and in a manner that will prevent spilling, stored separately from food, clothing, and safety equipment.
- Mixing will be done off-site and at a distance greater than 200 feet from open or flowing water, wetlands, or other sensitive species’ habitat. No herbicides will be applied at these areas unless authorized by the appropriate regulatory agencies.
- All herbicide equipment and containers will be inspected daily for leaks.
- Herbicides use will be in accordance with all manufacture’s label recommendations and warnings.

4.2.3.2 Herbicide Spills and Cleanups

All appropriate precautions will be taken to avoid herbicide spills. In the event of a spill, cleanup will be immediate. Contractors will keep spill kits in their vehicles and in an appropriate storage shed to allow for quick and effective response to spills. Items included in the spill kit will be:

- Protective clothing and gloves;
- Adsorptive clay, “kitty litter,” or other commercial adsorbent;
- Plastic bags and a bucket;
- A shovel;
- A fiber brush and screw-in handle;
- A dustpan;

- Caution tape;
- Highway flares (use on existing hard-top roads only); and
- Detergent.

Response to an herbicide spill will vary with the size and location of the spill, but general procedures include:

- Stopping the leak;
- Containing the spilled material;
- Traffic control;
- Dressing the clean-up team in protective clothing;
- Cleaning up and removing the spilled herbicide, as well as the contaminated adsorptive material and soil; and
- Transporting the spilled herbicide and contaminated material to an authorized disposal site.

4.2.3.3 Herbicide Spill Reporting

All herbicide contractors will have readily available copies of the appropriate material safety data sheets for the herbicides used at their disposal and will keep copies of the material safety data sheets in the application vehicle. If an herbicide spill of any size occurs, the appropriate agency and spill coordinators will be notified promptly. In case of a spill into wetlands and waterbodies, the appropriate federal, state, and county agencies will be notified immediately. All herbicide spills equal to or greater than 200 pounds or 25 gallons of pesticide residue will be reported to the Oregon Emergency Response System in accordance with applicable laws and requirements (OAR 340-142-0050; ODEQ 2024). The Certificate Holder will report all herbicide spills to ODOE by phone or email within 24 hours with follow up reporting as appropriate.

4.3 Monitoring

Weed inspections will occur across the entire Facility through visual inspection of the site while driving and/or walking. Final monitoring methods will be determined in consultation with ODOE prior to construction and will be incorporated as an amendment to this plan upon ODOE approval. Monitoring will be conducted by a qualified botanist or weed specialist and will begin in the first growing season after seeding. Monitoring for noxious weeds and other undesirable weed species will occur at least five times per year including in the spring, June, July, and August for summer annuals and in the fall during the first two years following construction to capture the different life cycles of noxious weed species. This will allow real-time assessment of weed growth and inform proactive weed control measures to prevent large scale infestations. Frequent checks during early revegetation efforts will enable the Certificate Holder to respond to new weed infestations in a timely manner and ensure the success of the site's revegetation. These inspections will be used to inform ongoing weed control efforts.

The initial monitoring survey will be scheduled slightly before herbicide application, as applicable, to identify any noxious weed species within the areas to be treated, with a focus on target noxious weed species observed prior to construction (Table 1), or other populations of target noxious weeds not previously observed.

Monitoring will assess the success of noxious weed treatments and will document any new noxious weed infestations observed. During the first two years following construction, the Certificate Holder will meet with ODOE and the Morrow County Weed Department at least once per season to provide updates on weed infestations and control measures at the Facility. These results will also be summarized in annual monitoring reports that describe the treatments performed, treatment success, make recommendations to improve treatment success (if necessary), and note any new target noxious weed species or emergence. Reports will be submitted to the Oregon Department of Energy (ODOE), Oregon Department of Fish and Wildlife (ODFW), and Morrow County annually.

Based on the success of control efforts after the second year of monitoring, the Certificate Holder will consult with ODOE and ODFW to determine if the monitoring cycle can be reduced for years three to five. After five years of monitoring, the Certificate Holder will design a long-term weed control plan in consultation with ODOE and the Morrow County Weed Department. The Certificate Holder will maintain ongoing communication with individual landowners, the Morrow County Weed Department, and ODOE regarding noxious weeds within the Facility. Landowners may also contact the Certificate Holder directly to report the presence of noxious weeds related to Facility activity. The Certificate Holder will control the noxious weeds on a case-by-case basis and prepare a summary of measures taken for that landowner. During the operational period of the Facility, the Certificate Holder will control noxious weeds as described in the long-term weed control plan. The Certificate Holder will report the investigator's findings and recommendations regarding weed control in the Facility's annual report required per OAR 345-026-0080.

The following contact information for the Morrow County Weed Program Manager will be used and updated as needed:

Corey Sweeney, Weed Program Manager
Morrow County Public Works
365 West Highway 74
Lexington, OR 97839
(541) 989-9502
mcweed@co.morrow.or.us

4.4 Success Criteria

Success criteria outlined below are designed to demonstrate compliance with OAR 660-033-0130(38)(D) to prevent the introduction and spread of noxious weed species. In each annual monitoring report, the Certificate Holder will include an assessment of whether the Facility is meeting or trending toward meeting the noxious weed control success criteria. Compliance with the Facility Site Certificate will be demonstrated through documentation of meeting these success criteria for the life of the Facility.

- Class A and Class B noxious weed presence within the solar array fence line will not exceed 15 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Class T noxious weed presence within the solar array fence line will not exceed 5 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Invasive Annual Grasses and other Undesirable Species will not exceed more then 50 percent cover within any 1 acre area or more than 30 percent cover within the solar array fence line.
- During revegetation of temporary disturbance areas outside of the solar array fence line presence and cover of noxious weeds is 75 percent or less than that of the reference site.

5.0 Roles and Responsibilities

The Certificate Holder is the overall responsible party for construction and operation of the Facility and implementation of the noxious weed management activities described in this Plan. However, the Certificate Holder may use contractors to complete tasks associated with noxious weed management and monitoring. Example responsible parties and their roles may include:

Monitoring Contractor

- Perform site visits to document noxious weed occurrences.
- Provide summary memo after each visit to Certificate Holder's operations manager outlining findings and treatment recommendations.
- Communicate directly with Weed Management Contractor and provide maps, and photos of noxious weed species locations to Weed Management Contractor.
- Communicate with Morrow County Weed Program Manager, and ODA about noxious weed survey findings and treatment plans.
- Prepare annual report for the Facility describing noxious weed monitoring findings and treatments.
- Organize and attend quarterly calls with the Certificate Holder and Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Certificate Holder Site Manager

- Communicate findings and recommendations from Monitoring Contractor to the Weed Management Contractor.
- Document the work performed by the Weed Management Contractor and provide documentation to Monitoring Contractor. Documentation should include type and quantity

of herbicides applied, dates applied, and any associated EPA/U.S. Department of Environmental Quality licensing/documentation of chemicals used.

- Reviews annual reports to ensure all treatments performed by the Weed Management Contractor are documented.
- Maintain landowner communications, providing guidance to the Monitoring Contractor and Weed Management Contractor regarding landowner restrictions/requests for performing noxious weed monitoring/treatment on their properties.
- Attend quarterly calls with Monitoring Contractor and the Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Weed Management Contractor

- Review Monitoring Contractor memos describing noxious weed occurrences and recommendations and plan appropriate treatment to address those issues.
- Communicate treatment plan to the Certificate Holder.
- Maintain records of when, where, and what type of noxious weed treatments are being performed.
- Maintain all appropriate documentation of chemicals applied. Shares documentation during the quarterly calls with the Certificate Holder and Monitoring Contractor, and prior to Annual Report preparation.
- Attend quarterly calls with Monitoring Contractor and Certificate Holder.

Morrow County

- Review Monitoring Contractor memos describing weed occurrences and recommendations.
- Attend quarterly calls and provide recommendations.

6.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE. This Plan may also be amended periodically as the Certificate Holder continues to evaluate and modify, as needed, agricultural dual use activities at the Facility.

7.0 References

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Appendix A: Oregon State Noxious Weed List

OREGON
DEPARTMENT OF
AGRICULTURE

Noxious Weed Policy
and Classification System
2024

Noxious Weed Control Program

Address: 635 Capitol Street NE, Salem, Oregon 97301
Phone: (503) 986-4625 **Fax:** (503) 986-4786
www.oregon.gov/ODA/programs/Weeds/Pages/AboutWeeds.aspx

Mission Statement

To protect Oregon’s natural resources and agricultural economy from the invasion and proliferation of invasive noxious weeds.

Program Overview

The Oregon Department of Agriculture (ODA) Noxious Weed Control Program provides statewide leadership for coordination and management of state listed noxious weeds. The state program focuses on noxious weed control efforts by implementing early detection and rapid response projects for new invasive noxious weeds, implementing biological control, implementing statewide inventory and survey, assisting the public and cooperators through technology transfer and noxious weed education, maintaining noxious weed data and maps for priority listed noxious weeds, and assisting land managers and cooperators with integrated weed management projects. The Noxious Weed Control Program also supports the Oregon State Weed Board (OSWB) with administration of the OSWB Grant Program, developing statewide management objectives, developing weed risk assessments, and maintaining the state noxious weed list.

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Program Manager
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(503) 986-4625

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Noxious Weed Control Policy and Classification System

Definition

"Noxious weed" means a terrestrial, aquatic or marine plant designated by the Oregon State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.

Noxious weeds have become so thoroughly established and are spreading so rapidly on private, state, county, and federally owned lands, that they have been declared by ORS 569.350 to be a menace to public welfare. Steps leading to eradication, where possible, and intensive control are necessary. It is further recognized that the responsibility for eradication and intensive control rests not only on the private landowner and operator, but also on the county, state, and federal governments.

Weed Control Policy

Therefore, it shall be the policy of ODA to:

1. Assess non-native plants through risk assessment processes and make recommendations to the Oregon State Weed Board for potential listing.
2. Rate and classify weeds at the state level.
3. Prevent the establishment and spread of listed noxious weeds.
4. Encourage and implement the control or containment of infestations of listed noxious weed species and, if possible, eradicate them.
5. Develop and manage a biological weed control program.
6. Increase awareness of potential economic losses and other undesirable effects of existing and newly invading noxious weeds, and to act as a resource center for the dissemination of information.
7. Encourage and assist in the organization and operation of noxious weed control programs with government agencies and other weed management entities.
8. Develop partnerships with county weed control districts, universities, and other cooperators in the development of control methods.
9. Conduct statewide noxious weed surveys and weed control efficacy studies.

Weed Classification System

The purpose of this Classification System is to:

1. Act as the ODA's official guideline for prioritizing and implementing noxious weed control projects.
2. Assist the ODA in the distribution of available funds through the Oregon State Weed Board to assist county weed programs, cooperative weed management groups, private landowners, and other weed management entities.
3. Serve as a model for private and public sectors in developing noxious weed classification systems that aid in setting effective noxious weed control strategies.

Criteria for Determining Economic and Environmental Significance

Detrimental Effects

1. A plant species that causes or has the potential to cause severe negative impacts to Oregon’s agricultural economy and natural resources.
2. A plant species that has the potential to or does endanger native flora and fauna by its encroachment into forest, range, aquatic and conservation areas.
3. A plant species that has the potential or does hamper the full utilization and enjoyment of recreational areas.
4. A plant species that is poisonous, injurious, or otherwise harmful to humans and/or animals.

Plant Reproduction

1. A plant that reproduces by seed capable of being dispersed over wide areas or that is long-lived, or produced in large numbers.
2. A plant species that reproduces and spreads by tubers, creeping roots, stolons, rhizomes, or other natural vegetative means.

Distribution

1. A weed of known economic importance which occurs in Oregon in small enough infestations to make eradication/containment possible; or not known to occur, but its presence in neighboring states makes future occurrence seem imminent.
2. A weed of economic or ecological importance and of limited distribution in Oregon.
3. A weed that has not infested the full extent of its potential habitat in Oregon.

Difficulty of Control

A plant species that is not easily controlled with current management practices such as chemical, cultural, biological, and physical methods.

Noxious Weed Control Classification Definitions

Noxious weeds, for the purpose of this system, shall be listed as either A or B, and may also be designated as T, which are priority targets for control, as directed by the Oregon State Weed Board.

- **A Listed Weed**:
  A weed of known economic importance which occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent (Table I).
  Recommended action: Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed**:
  A weed of economic importance which is regionally abundant, but which may have limited distribution in some counties (Table II).
  Recommended action: Limited to intensive control at the state, county or regional level as determined on a site specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.
- **T-Designated Weed (T)**:
  A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

Weed Biological Control

Oregon implements biological control, or “biocontrol” as part of its integrated pest management approach to managing noxious weeds. This is the practice of using host-specific natural enemies such as insects or pathogens to control noxious weeds. The Oregon Department of Agriculture Noxious Weed Program has adopted the International Code of Best Practices for biological control of weeds. Only safe, effective, and federally-approved natural enemies will be used for biocontrol.

Table I: A Listed Weeds

Common Name	Scientific Name
African rue	*Peganum harmala*
Camelthorn	*Alhagi pseudalhagi*
Cape-ivy	*Delairea odorata*
Coltsfoot	*Tussilago farfara*
Common frogbit	*Hydrocharis morsus-ranae*
Cordgrass	
Common	*Spartina anglica*
Dense-flowered	*Spartina densiflora*
Saltmeadow	*Spartina patens*
Smooth	*Spartina alterniflora*
Delta arrowhead	*Sagittaria platyphyla*
European water chestnut	*Trapa natans*
Flowering rush	*Butomus umbellatus*
Garden yellow loosestrife	*Lysimachia vulgaris*
Giant hogweed	*Heracleum mantegazzianum*
Goatgrass	
Barbed	*Aegilops triuncialis*
Ovate	*Aegilops ovata*
Goatsrue	*Galega officinalis*
Hawkweed	
King-devil	*Hieracium piloselloides*
Mouse-ear	*Hieracium pilosella*
Orange	*Hieracium aurantiacum*
Yellow	*Hieracium floribundum*
Hoary alyssum	*Berteroa incana*
Hydrilla	*Hydrilla verticillata*
Japanese dodder	*Cuscuta japonica*
Kudzu	*Pueraria lobata*
Matgrass	*Nardus stricta*
Oblong spurge	*Euphorbia oblongata*
Palmer amaranth	*Amaranthus palmeri*
Paterson's curse	*Echium plantagineum*
Purple nutsedge	*Cyperus rotundus*
Ravennagrass	*Saccharum ravennae*
Squarrose knapweed	*Centaurea virgata*

(Continued) Table I: A Listed Weeds

Common Name	Scientific Name
Starthistle	
Iberian	*Centaurea iberica*
Purple	*Centaurea calcitrapa*
Thistle	
Plumeless	*Carduus acanthoides*
Smooth distaff	*Carthamus baeticus*
Taurian	*Onopordum tauricum*
Turkish	*Carduus cinereus*
Welted (curly plumeless)	*Carduus crispus*
Woolly distaff	*Carthamus lanatus*
Water soldiers	*Stratiotes aloides*
West Indian spongeplant	*Limnobium laevigatum*
White bryonia	*Bryonia alba*
Yellow floating heart	*Nymphoides peltata*
Yellowtuft	*Alyssum murale, A. corsicum*

Table II: B Listed Weeds

Common Name	Scientific Name
Armenian (Himalayan) blackberry	*Rubus armeniacus (R. procerus, R. discolor)*
Biddy-biddy	*Acaena novae-zelandiae*
Broom	
French*****	*Genista monspessulana*
Portuguese (T)	*Cytisus striatus*
Scotch*****	*Cytisus scoparius*
Spanish	*Spartium junceum*
Butterfly bush	*Buddleja davidii (B. variabilis)*
Common bugloss (T)	*Anchusa officinalis*
Common crupina **(T)**	*Crupina vulgaris*
Common reed	*Phragmities australis ssp. australis*
Common viper's bugloss (T)	*Echium vulgare*
Cutleaf teasel	*Dipsacus laciniatus*
Dyer's woad (T)	*Isatis tinctoria*
English hawthorn	*Crataegus monogyna*
Eurasian watermilfoil	*Myriophyllum spicatum*
False brome	*Brachypodium sylvaticum*
Field bindweed	*Convolvulus arvensis*
Garlic mustard (T)	*Alliaria petiolata*
Geranium	
Herb Robert	*Geranium robertianum*
Shiny leaf	*Geranium lucidum*
Giant reed (T)	*Arundo donax*
Gorse***** (T)	*Ulex europaeus*
Halogeton	*Halogeton glomeratus*
Houndstongue	*Cynoglossum officinale*

* Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Indigo bush	*Amorpha fruticosa*
Ivy	
Atlantic	*Hedera hibernica*
English	*Hedera helix*
Jointed goatgrass	*Aegilops cylindrica*
Jubata grass	*Cortaderia jubata*
Knapweed	
Diffuse*****	*Centaurea diffusa*
Meadow*****	*Centaurea pratensis*
Russian*****	*Acroptilon repens*
Spotted*****	*Centaurea stoebe (C. maculosa)*
Knotweed	
Bohemian*****	*Fallopia x bohemica*
Giant*****	*Fallopia sachalinensis (Polygonum)*
Himalayan	*Polygonum polystachyum*
Japanese*****	*Fallopia japonica (Polygonum)*
Kochia	*Kochia scoparia*
Lesser celandine	*Ranunculus ficaria*
Meadow hawkweed (T)	*Pilosella caespitosum (Hieracium)*
Mediterranean sage*	*Salvia aethiopis*
Medusahead rye	*Taeniatherum caput-medusae*
Old man’s beard	*Clematis vitalba*
Parrot feather	*Myriophyllum aquaticum*
Perennial peavine	*Lathyrus latifolius*
Perennial pepperweed (T)	*Lepidium latifolium*
Pheasant’s eye	*Adonis aestivalis*
Pine echium (T)	*Echium pininana*
Poison hemlock*****	*Conium maculatum*
Policeman’s helmet	*Impatiens glandulifera*
Primrose-willow	
Large-flower (T)	*Ludwigia grandiflora*
Water primrose (T)	*Ludwigia hexapetala*
Floating (T)	*Ludwigia peploides*

*Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Puncturevine*	*Tribulus terrestris*
Purple loosestrife*	*Lythrum salicaria*
Ribbongrass (T)	*Phalaris arundinacea var. Picta*
Rose	
Dog	*Rosa canina*
Sweetbriar	*Rosa rubiginosa*
Rush skeletonweed* (T)	*Chondrilla juncea*
Saltcedar* (T)	*Tamarix ramosissima*
Small broomrape	*Orabanche minor*
South American waterweed	*Egeria densa (Elodea)*
Spanish heath	*Erica lusitanica*
Spurge laurel	*Daphne laureola*
Spurge	
Leafy* (T)	*Euphorbia esula*
Myrtle	*Euphorbia myrsinites*
St. Johnswort	*Hypericum perforatum*
Sulfur cinquefoil	*Potentilla recta*
Swainsonpea	*Sphaerophysa salsula*
Tansy ragwort* (T)	*Senecio jacobaea (Jacobaea vulgaris)*
Thistle	
Bull	*Cirsium vulgare*
Canada*	*Cirsium arvense*
Italian	*Carduus pycnocephalus*
Milk	*Silybum marianum*
Musk	*Carduus nutans*
Scotch	*Onopordum acanthium*
Slender-flowered	*Carduus tenuiflorus*
Toadflax	
Dalmatian*	*Linaria dalmatica*
Yellow*	*Linaria vulgaris*
Tree of heaven	*Ailanthus altissima*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Ventenata grass	*Ventenata dubia*
Whitetop	
Hairy	*Lepidium pubescens*
Lens-podded	*Lepidium chalepensis*
Whitetop (hoary cress)*****	*Lepidium draba*
Yellow archangel	*Lamiastrum galeobdolon*
Yellow flag iris	*Iris pseudacorus*
Yellow nutsedge	*Cyperus esculentus*
Yellow starthistle*	*Centaurea solstitialis*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

Appendix B: Morrow County Noxious Weed List

Morrow County Weed List:

NOXIOUS WEEDS

Noxious Weeds – "A" List" – Any plant that is determined by the weed advisory board, and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land or property under provisions of Oregon State Statute and thus mandated for control.

Rush Skeletonweed

Yellow Starthistle

Tansy Ragwort

Yellow Toadflax

Dalmatian Toadflax

Mediterranean Sage

Leafy Spurge

Spikeweed

Musk Thistle

Scotch Thistle

Purple Loosestrife

Common Crupina

Whitetop (Hoary Cress)

Houndstongue

Flowering Rush

Yellow Flag Iris

Plumeless Thistle

WEEDS OF ECONOMIC IMPORTANCE

Weeds of Economic Importance – “B” List – Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

Poison Hemlock

Canada Thistle

Jointed Goatgrass

St. Johnswort

Perennial Sowthistle

Field Bindweed

Cereal Rye

Johnsongrass

Russian Knapweed

Diffuse Knapweed

Spotted Knapweed

Field Dodder

Water Hemlock

Medusahead Rye

Puncturevine

Kochia

Perennial Pepperweed

Myrtle Spurge

Ventenata

Morrow County Weed Advisory Board

The Morrow Soil and Water Conservation District Board also serves as the Weed Advisory Board

Sunstone Solar Project 3
Draft Revegetation and Reclamation Plan

Prepared for

PINEGATE RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 3, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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1.0 Introduction

Sunstone Solar 3, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 3 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon (Figure 1). The proposed Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 200 MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Revegetation and Reclamation Plan (Plan) has been prepared to guide revegetation of areas temporarily disturbed during construction of the Facility, as well as revegetation within the solar array fence in compliance with Site Certificate Conditions PRE-FW-01 and PRE-SP-01. This Plan will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE), the Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Agriculture (ODA), and Morrow County Weed Department to reflect the final layout of the Facility.

Prior to construction, this Plan shall be finalized based on the following:

1. Certificate Holder shall finalize the Plan based on disturbance associated with the final design/layout by disturbance level and habitat type and category.
2. Certificate Holder shall develop and incorporate maps showing anticipated construction disturbance levels along with the total acreage and major activities associated with each level.
3. Certificate Holder shall update Table 1 prior to construction to reflect the disturbance acreage by habitat subtype for the final layout.
4. Certificate Holder shall develop and incorporate revegetation methods for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department.

Prior to construction, the following shall be completed:

1. Certificate Holder shall provide shapefiles showing anticipated construction disturbance levels at the site as a submittal to ODOE.

2. Certificate Holder shall provide the revegetation and seeding contractor’s qualifications and scope of work as a submittal to ODOE.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

3. Certificate Holder shall submit baseline soil compaction sample locations and baseline compaction results to ODOE.
4. Certificate Holder shall hold a kick-off meeting with their environmental contractor, construction contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
5. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the construction contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.

Prior to initiation of revegetation, the following shall be completed:

1. Certificate Holder shall hold a kick-off meeting with their environmental contractor, revegetation and seeding contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
2. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the revegetation and seeding contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.
3. Certificate Holder shall complete post-construction soil compaction testing and submit results for review and approval to ODOE.

Throughout construction, revegetation, and operation activities, the Certificate Holder will take appropriate actions to prevent the spread of state and county listed noxious weeds. A stand-alone Draft Noxious Weed Control Plan has also been prepared (see Exhibit P, Attachment P-3[2]; updated for RFA 1, see Attachment 6), which contains information on state and Morrow County listed noxious weeds, noxious weeds observed during surveys, and treatment and monitoring of noxious weeds.

2.0 Site Description

The Facility includes a 1,165-acre site boundary within which all Facility components will be located. The Facility lies within the Columbia Plateau Ecoregion at elevations from 1,070 to 1,140 feet. The Facility is sited entirely on private land, which primarily consists of agriculture land used for growing dryland wheat. Native vegetation within the site boundary has been modified primarily through agricultural conversion, but also through the introduction of exotic grasses and other non-native vegetation.

Habitat mapping and categorization of the site boundary were conducted for the Facility in 2022. Habitat types within the site boundary include Agriculture, Pasture, and Mixed Environs (habitat

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[2] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

subtype: Orchards, Vineyards, Wheat Fields, Other Row Crops) and Developed (habitat subtype: Urban and Mixed Environs). Details on habitat types, subtypes, and categories can be found in Exhibit P of the Facility's ASC, especially Attachment P-1 which contains the biological survey reports. Details on potential disturbance to habitat from construction and operation of the Facility, as well as avoidance and minimization measures, can be found in the ASC Exhibits P and Q[3].

3.0 Description of Disturbance

Construction of the Facility will result in temporary and permanent disturbance (see Exhibits C[4] and P). Section 3.1.1 (below) details the acres of each habitat subtype that will be temporarily and permanently disturbed during construction and operation of the Facility. All areas within the solar array fence are considered a permanent disturbance and will be revegetated for the purposes of site stabilization to reduce erosion, dust pollution, and topsoil depletion, and to reduce potential for invasion by noxious and invasive plants. The entire solar array fence will occupy approximately 1,138 acres. As noted above, this area is considered permanently disturbed; however, vegetation within the solar array fence will be retained and/or revegetated and this area would be reclaimed upon retirement.

Temporary disturbance will occur in areas outside the solar array fence that will be disturbed during construction activities, but which will not be occupied by permanent facilities. Temporary disturbance will occur in association with the construction of aboveground and underground collector and transmission lines, new roads, and perimeter fence.

Prior to construction, a crosswalk of the final version of this Plan will be prepared for use by the construction contractor to facilitate Plan implementation and ensure ground disturbance is minimized to the extent practicable. A kick-off meeting with the Certificate Holder, their environmental contractor, construction contractor, and ODOE will be held at least 14 days prior to construction. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify that anticipated disturbance levels are followed to the extent possible and will document any variances and justifications for those variances for ODOE review.

3.1 Disturbance Levels

Revegetation needs will be determined by a combination of disturbance level and existing vegetative cover. Disturbance levels will primarily be determined by site conditions such as slope, gradient, and existing vegetation. Disturbance levels are defined as follows:

Level 1 - Mowing: Mowing is used to conserve vegetative resources within a facility while mitigating risk of fire and facilitating construction activities. Vegetation will be limited to a height of 12 inches and mowed to no less than 6 inches during construction. Mowing to no less than 6 inches protects

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[3] Complete Application for Site Certificate, Exhibit Q, May 16, 2024.

[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

perennial grass crowns and allows grasses to regenerate. Depending on facility objectives, vegetation can be allowed to reach a normal height or kept trimmed to a height between 6 inches and the plant's full height potential. Crushing of vegetation will be minimal and this disturbance level is designed to have a minimal impact on existing vegetation. This method is least likely to result in invasions of undesirable plant species.

Level 2 – Overland Drive and Crush: Disturbance caused by accessing a facility without significantly modifying the landscape. Vegetation is crushed to the ground, but no surface soil is removed so root structures are left intact. Even though vegetation may be damaged or destroyed, the surface soil and seed bank remain in place. Some crushed vegetation will likely sprout after disturbance ceases. These activities would result in minimal to moderate disturbance. This type of disturbance will result in a faster recovery time for vegetation compared to Levels 3 and 4. Soil seed banks remain largely in place, perennial vegetation can grow back, and minimal external efforts are necessary. This method is less likely to result in invasions of undesirable plant species compared to Levels 3 and 4.

Level 3 – Clear and Cut: Disturbance caused by accessing the facility including having to remove all vegetation in order to improve or provide suitable access for other equipment. All vegetation is removed, soils are compacted, and the root zone or soil A-horizon may be disturbed, but no sub-surface soil is removed. Clear and cut activities would result in moderate disturbance. This type of disturbance will result in moderate recovery times for vegetation. This method has a moderate risk for invasion of undesirable plant species. An example is imprinting to crush vegetation down into the soil or incidental grading and smoothing of surface soils.

Level 4 – Clear and Cut with Soil Removal: Disturbance is caused by removing all vegetation in the impact zone, soils are compacted, and surface soil and subsoil are displaced. These activities result in heavy disturbance. This type of disturbance results in an extensive recovery time for vegetation, and is most likely to lead to invasions of undesirable plant species, which can result in lengthy and expensive control efforts. Includes disc-and-roll construction, and other traditional construction methods where soils are disturbed and no vegetation is left intact. This category includes all work requiring the segregation and replacement of topsoils.

3.1.1 Facility Disturbance

To the maximum extent practicable, Level 1 and Level 2 disturbance will be used during Facility construction. Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable, although construction vehicles driving across the site may affect existing root systems by compacting soils. Grading within solar arrays will be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically, but not exclusively, 10 percent maximum on North slopes and 15 percent maximum in other directions). Areas where the slope and gradient are within panel and racking tolerances will only be graded in road, inverter, and energy storage footprints where possible. Preservation of existing root systems will minimize soil erosion, providing both improved compliance with stormwater and dust management requirements, facilitate revegetation success, and preserve soil productivity for future agricultural use. Construction will be coordinated and sequenced to the extent practicable with landowners to maintain land in current production and weed control until just prior to construction. This will avoid land being left unmanaged and minimize weed issues that can complicate revegetation.

Prior to construction, the Certificate Holder will provide maps and shapefiles showing anticipated construction disturbance levels at the Facility, along with total acreage and major activities associated with each level. This will serve to demonstrate the Certificate Holder's avoidance and minimization of ground disturbing activities to the extent practicable.

Table 1 presents the estimated maximum acreage of temporary and permanent disturbance to habitat subtypes associated with Facility construction and operation based on the permitted layout. Table 1 will be updated prior to construction to reflect the final disturbance acreage by habitat subtype for the final layout. Figures depicting the location of Facility infrastructure are included in Exhibit C, and a figure depicting habitat subtypes within the site boundary is available in Exhibit P.

Table 1. Maximum Temporary and Permanent Disturbance by Habitat Subtype

ODFW Habitat Category	Habitat Subtype	Permanent Disturbance (Acres)[1, 2]	Temporary Disturbance (Acres) [1]
6	Orchards, Vineyards, Wheat Fields, Other Row Crops	1,133	1.4
	Urban and Mixed Environs	5.0	<0.1
	Grand Total[1]	**1,138**	**1.5**

Note: Totals in this table may not appear to sum correctly due to rounding. <0.1 means greater than zero but less than 0.05 acre disturbance.

1. Additional details associated with temporary and permanent disturbance are provided in Exhibit C of the ASC. Disturbances were calculated based on the layout permitted in the ASC and will be updated prior to construction based on an updated layout.
2. Acres of permanent disturbance includes the entire area within the solar array area fence including the footprints of all solar components and supporting facilities, as well as the areas outside of the footprint of permanent components and facilities (e.g., areas underneath and between rows of solar panels).

4.0 Reclamation and Revegetation Methods

This plan addresses revegetation methods for temporary disturbance to agricultural lands, as well as revegetation and vegetation management of lands within the solar array fence. Revegetation of temporarily disturbed developed habitat (i.e., Urban and Mixed Environs habitat subtype) will be determined on a case-by-case basis and is not covered further in this plan. Temporary disturbance to agricultural habitat (i.e., Orchards, Vineyards, Wheat Fields, Other Row Crops habitat subtype) will be restored as described in Section 4.5.1. The Certificate Holder will restore temporarily disturbed areas by re-establishing slope, surface stability, and drainage features, as needed, followed by soil preparation and seeding. Soil preparation and seeding techniques are described below.

Revegetation will begin as soon as feasible after completion of each construction phase. Seeding and planting will be done in a timely manner and in the appropriate season to facilitate germination and establishment of seeded species.

Prior to construction, final revegetation methods will be developed for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department and will be incorporated as an amendment to this Plan upon ODOE approval.

4.1 Roles and Responsibilities

A construction contractor qualified to perform revegetation and seeding will be responsible for implementing measures in the National Pollutant Discharge Elimination System (NPDES) 1200-C permit, as well as revegetation activities discussed herein during and immediately after construction. A qualified botanist or revegetation specialist will be responsible for monitoring and reporting on revegetation success. Remedial revegetation actions, if needed during the operation phase, will be performed by a qualified contractor. The Certificate Holder will be responsible for ensuring that all contractors perform work in accordance with permit requirements and all agreed upon methods for revegetation.

The goal of this Plan is to increase the probability of revegetation success, reduce early weed establishment, reduce erosion and dust pollution, protect topsoil for future agricultural use in permanent disturbance areas, and ensure no loss of habitat quality for temporary disturbance to wildlife habitat. To ensure this goal is met, the Certificate Holder will ensure that the contractor selected for revegetation will be a qualified revegetation and seeding contractor with demonstrated experience in the Columbia Plateau. Options for contracting and managing this work include:

- Having the construction contractor subcontract revegetation work out to a qualified revegetation and seeding contractor. The contract will stipulate the Certificate Holder's right to dictate the timing, methods, and management of seeding.
- Contracting directly with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.
- Having the environmental contractor contract with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.

The revegetation and seeding contractor's qualifications and scope of work will be provided as a submittal to ODOE prior to construction. Additionally, a crosswalk of the final version of this Plan will be prepared for use by the revegetation and seeding contractor prior to initiation of revegetation to facilitate Plan implementation. A kick-off meeting with the Certificate Holder, their environmental contractor, revegetation and seeding contractor, and ODOE will be held at least 14 days prior to initiation of revegetation activities. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify seeding methods and timing requirements are followed appropriately and will document any variances and the justifications for those variances. Monitoring and follow-up will be provided as described in Section 6.0 to ensure oversight and increase the probability of revegetation success.

4.2 Soil Reclamation

Soil scientists use a soil penetrometer to field measure subsurface compaction in soil. This tool measures resistance (pressure) to the advance of a cone-tipped rod with a T-handle, vertically through the soil column. The metric intends to measure soil compaction that can inhibit the ability of plants to penetrate the soil. An operator pushes the penetrometer rod with a cone base into the ground with consistent force. A pressure gauge records pressure in pounds per square inch (psi), equaling levels of resistance at differing soil layers. Resistance is measured at 3-inch intervals until the meter goes above 300 psi, which is a level of soil compaction most roots cannot penetrate. For this test compaction would be measured at 3, 6, 9, and 12 inches if the soils allow. Soil compaction testing must be completed in spring or late fall when soils are at field capacity (approximately 24 hours after a soaking rain). Baseline soil compaction measurements will be taken prior to construction. Baseline soil compaction sample locations and baseline compaction results will be submitted to ODOE prior to construction.

1. Baseline and post-construction soil compaction measurements and testing must be done in conditions favorable to soil testing (e.g. non-saturated or frozen soils).
2. Baseline soil compaction measurements will be documented and established by using the above protocol, or other protocol as approved by ODOE, to establish baseline soil conditions within temporary disturbance areas.
3. Recordation of the baseline soil plots must be represented on a map based on final Facility design.
4. Post-construction soil compaction testing following the above protocols must be completed in spring or late fall when soil conditions are favorable to soil testing (non-saturated or frozen soils). Compaction testing will occur after soil stockpiles are replaced and grading is complete but prior to initiation of revegetation activities.
5. If soil monitoring demonstrates that soils are compacted more than 300 psi, then remediation activities must be completed prior to initiation of revegetation activities. See Section 4.3 below, the Facility NPDES 1200-C permit, and applicable Site Certificate Conditions.

In addition, in areas where soil is removed during construction, the following measures will be taken where appropriate:

- During construction, excavated topsoil will be stockpiled separately from subsoil and replaced in proper order with topsoil on the surface to maintain soil productivity. Stockpiled soil will be put back in place prior to revegetation activities.
- Soils will be stabilized during construction using the appropriate best management practices as determined by the onsite stormwater pollution prevention plan implementor.
- Soil preparation will involve standard, commonly used methods (i.e. tracking, decompaction, and tilling), and will consider all relevant site-specific factors, including slope, size of area, and erosion potential. Soils will be de-compacted if necessary to create a

uniform seedbed using an agricultural disc, soil ripper, or similar equipment. Additional details regarding soil preparation are in Section 4.3.

- Topsoil and other soils from noxious weed infested areas will not be moved outside of the infested areas and will be returned to their previous location during reclamation activities to eliminate the transport of weed seeds, roots, or rhizomes.
- Soils from weed-infested areas will be treated with a non-persistent, pre-emergent herbicide prior to initiation of revegetation efforts, depending on site-specific conditions.
- Prior to final regrade and revegetation efforts, any weeds that have grown during periods of construction dormancy should be treated as described in the Noxious Weed Control Plan.
- The construction contractor will use appropriate erosion and sediment control practices (i.e., seeded or unseeded hydromulch, tackifier, weed-free erosion control blankets, weed-free or locally sourced straw mulch) to maintain topsoil during construction in both temporary and permanent disturbance areas.

4.3 Site Preparation

Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable. Areas where the slope and gradient are within the solar panel and racking tolerances will receive minimal grading, with grading in those areas limited to the roads, inverter, and energy storage footprints. In areas where soil is removed during construction, the Certificate Holder will demonstrate adequate soil stabilization to prevent erosion and dust pollution. The following measures will be taken where appropriate:

- Site preparation will take into account all relevant site-specific factors, including slope, size of area, and erosion potential.
- Areas of severe machine or vehicle tracking that would hinder seeding success and are unnecessary for soil stabilization will be regraded.
- In the spring, fall or winter of the year prior to when construction would occur, areas of high erosion risk (e.g., slopes, areas with low vegetative cover) should be seeded with a non-invasive, non-persistent cover crop such as triticale to stabilize soils.
- If soils are not suitable for revegetation, soil amendments may be required. Any imported topsoil, if required, will be demonstrated to be suitable for vegetative success.
- Where soil compaction testing demonstrates that soils are compacted greater than 300 psi, soils will be mechanically scarified (e.g., tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction, to maintain soil productivity, and reduce the potential for erosion on compacted soils. Dry soils should be de-compacted using an agricultural disc, soil ripper, or similar equipment.
- Prior to seeding and/or planting of revegetation areas, soils will be prepared into a firm, fine-textured seedbed that is relatively free of debris. Shallow tilling with a disc, followed by a harrow or drag if necessary, can typically achieve this. If replaced soil is too soft, then

seeds may be buried too deep to properly germinate; a roller or culti-packer should be used to pack down the soil.

- In non-cropland temporary disturbance areas, site complexity will be considered during soil preparation. For instance, it may be desirable to purposely create an uneven, patchy site that allows for depressions and other microsites that result in small variations in aspect and moisture holding to promote complexity.
- Seeded areas will be temporarily stabilized to facilitate establishment. This can be accomplished by application of seedless, certified weed-free hydromulch containing a tackifier or straw mulch crimping. Alternate methods may be proposed by the revegetation and seeding contractor but will require prior written approval by ODOE and must provide demonstrated success in sites with similar wind and soil conditions.
- The Certificate Holder or a designated construction contractor will use mulching and other appropriate practices, as required by the anticipated NPDES 1200-C permit, to control erosion and sediment during construction and revegetation work.

4.4 Revegetation of Permanent Disturbance Areas

During construction, the Certificate Holder will implement site stabilization measures, including seeding of all disturbed areas according to the Certificate Holder's anticipated NPDES 1200-C permit. Approximately 6 months prior to commercial operation of each phase of construction, the Certificate Holder will meet with ODFW, ODOE, and Morrow County Weed Department personnel to review the actual extent and conditions of disturbed areas and confirm the revegetation methods to be implemented.

As portions of the Facility are prepared for installation of Facility components (i.e., grading is complete), but prior to installation, all areas with less than 70 percent vegetative cover should be seeded with a non-invasive, non-persistent cover crop. The cover crop will be selected based on the time of year and site conditions; for example, winter wheat or sterile triticale can be seeded from fall to early spring, while peas should be seeded in spring. Tillage radish and sunflowers can be seeded in spring to break up compaction but are not suitable options for soil stability. A cover crop will stabilize soils and suppress noxious weed infestations to reduce erosion and facilitate revegetation of desired plant species.

Following the completion of each construction phase, permanent disturbance areas will be reseeded with a mix of native or non-invasive, non-native grasses and forbs as appropriate based on disturbance level and actual site conditions (see Section 4.4). All seeds will be obtained from a reputable supplier in compliance with the Oregon Seed Law (OAR 603-056). The final seed mix for permanent disturbance areas will include low growing grasses and pollinator-friendly forbs compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Table 3 in Section 4.7 includes an example of low-growing seed mix for permanent disturbance areas.

4.5 Revegetation of Temporary Disturbance Areas

4.5.1 Agricultural Lands

Temporarily disturbed agricultural lands will be reseeded with the appropriate crop or maintained as fallow in consultation with the landowner or farm operator. The Certificate Holder will consult with the landowner or farm operator to determine the seed mix, application methods, and rates for seed and fertilizer. Success of cropland revegetation will have been achieved when production of the revegetated area is comparable to that of adjacent, non-disturbed croplands of the same type.

Agricultural lands will be reseeded to match the timing of the crop rotation on adjacent cropland to facilitate easy harvest and re-establish the appropriate crop rotation. Agricultural lands that will be seeded in the year that construction is complete can be temporarily hydromulched or otherwise stabilized until seeding can occur in the fall; agricultural lands that will be fallow for a year (i.e., fallow rather than reseeded the year construction is complete) will be planted with a cover crop (dependent on timing of construction closeout) or have continued stabilization with hydromulch, straw mulch crimping, or other best management practices through the fallow year.

Soil compaction as a result of construction activity is a concern for restoring agricultural soils to their pre-construction productivity. Within temporary disturbance areas, the Certificate Holder will excavate and store topsoil separately from subsoil, so that topsoil is replaced and restored appropriately. During post-construction revegetation of temporary disturbance to agricultural lands, the Certificate Holder will loosen agricultural soil by mechanical scarification (tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction. Soil amendment, by addition of organic matter (e.g., compost), may also be necessary to alleviate compaction.

Success determination will involve consultation with the landowner or farm operator, and the Certificate Holder will report to ODOE on the success of agricultural land revegetation efforts. Noxious weed control is necessary for successful revegetation of agricultural lands and will be implemented per the methods described in the Draft Noxious Weed Control Plan (Exhibit P, Attachment P-3; updated for RFA 1, see Attachment 6).

4.5.2 Wildlife Habitat

There is no temporary disturbance to wildlife habitat because no wildlife habitat will be disturbed by Facility construction. Revegetation of wildlife habitat is not discussed in this Plan.

4.6 Seeding Methods

The seeding method and timing of planting will be appropriate to the seed mixes (see Section 4.7), weather conditions (e.g., precipitation, wind speed, temperature, etc.), and site conditions (including area size, slope, and erosion potential) based upon consultation with ODOE, ODA, ODFW, the Morrow County Weed Department, and the seed supplier. Seeding from late September to March is typically recommended; however, the Certificate Holder will consult with ODOE, ODFW,

ODA, Morrow County Weed Department, and/or the seed supplier to determine the optimal timing for seed application based on climatic conditions of the particular year when construction and revegetation efforts are implemented.

Common seed application methods that may be used for revegetation are broadcast seeding, drill seeding, imprint seeding, and hydroseeding; each of these are discussed further below. Other seeding methods may be proposed for review and approval prior to revegetation efforts.

4.6.1 Broadcast Seeding

Broadcast seeding is the application of seed directly to the ground surface. This method may be chosen for areas with shallow and rocky soils, and the type of broadcast spreader would depend on the size of the area to be seeded and the terrain. Broadcast seeding may be completed before or after panel and fence installation.

In this method, the seed mix is typically broadcast at a rate of 20 to 24 pounds pure live seed per acre, or twice the recommended rate for drill seeding; this rate may be adjusted depending on the recommendation of the actual seed supplier and agencies. When feasible, due to the seasonality of when planting can occur, the entire area will be seeded after grading is complete but before placement of Facility components, providing more flexibility in seed application. In those instances where seeding occurs prior to installation of components, follow-up seeding will occur in areas temporarily disturbed by installation and any areas that are deficient in vegetation from the first round of seeding. Immediately following seed application, hydromulch or certified weed-free straw would be applied. Broadcast seeding will not be employed if winds exceed 5 miles per hour. If certified weed-free straw is unavailable, the Certificate Holder or a designated construction contractor will identify a local source of straw. The local source of the straw will be approved by the county weed master and ODFW prior to purchase. This straw will either be crimped into the ground or applied with a tackifier.

4.6.2 Drill Seeding

Drill seeding can be used for larger areas with deeper soils and moderate to gentle terrain to accommodate mechanical equipment. This method provides the advantage of planting the seed at a uniform depth and may provide better soil to seed contact. Drill seeding plants seeds using an agricultural or range seed drill at a rate of 12 to 14 pounds pure live seed per acre, per discussions with a seed supplier and ODFW. The rate may be adjusted depending on the recommendations of the actual seed supplier. Drill seeding will be difficult after Facility components have been installed so it will primarily be used if seeding occurs after grading is complete but before components are installed or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.3 Imprint Seeding

Imprint seeding is a no-till drill seeding method used to restore grasslands in areas with low annual precipitation. Seeds will be sown at 20 to 24 pounds pure live seed per acre or according to application rates recommended by the seed supplier. The seeder consists of a heavy metal drum roller with V-shaped, angled teeth and a seed agitator box. The teeth create V-shaped troughs with a depth of 4-7 inches to collect rainwater. The rolling drum presses the seed into the soil, insuring good seed-to-soil contact. The troughs collect rainwater for seed germination and seedling growth. Imprint seeders can be used on steep slopes and generally do not require seed bed preparation before seeding. Seeding can occur on soils with light to moderate vegetative cover, with vegetation acting as a mulch to prevent soil erosion until seedlings are established. Imprint seeders do not work well in areas with shrubs or heavy vegetation cover. Heavily compacted soils may need to be ripped or de-compacted before seeding. Imprint seeding will be difficult after solar components have been installed, so it will primarily be used if seeding occurs after grading is complete but before components are installed, or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.4 Hydroseeding

Hydroseeding is a method of hydraulically applying seeds, stabilizers, and soil amendments to the surface of the soil. Hydroseeding is most applicable for areas where drill or broadcast seeding machinery cannot access; this usually includes steeper sloped or narrow terrain but can be used in all terrains. Hydroseeding is feasible after panel installation but before the Facility is fenced. Soil bed preparation is also crucial for growth success and frequently includes tracking perpendicular to the slope to create micro conditions for seed. Flat grading and compaction are not recommended. Seeding rates increase by 30 to 50 percent of broadcast seeding rates (i.e., 30 pounds pure live seed per acre) per consultation with the seed supplier and ODFW. Prior to hydroseeding the tackifier and fertilizer, if included, will be reviewed and approved in consultation with ODOE. Fertilizer should not be used when hydroseeding wildlife habitat.

4.7 Seed Mixes

Two seed mixes are proposed for revegetation efforts: one for revegetation of temporary disturbance areas outside the solar array fence, and one for revegetation of permanent disturbance areas within the solar array fence. Tables 2 and 3 present example seed mixes that would be considered for revegetation. However, the number of seed mixes and composition of final seed mixes will be determined in consultation with ODOE and ODFW and will be based on pre-construction conditions and availability of seed at the time of procurement.

Grassland Seed Mix #1 would be appropriate for revegetation of temporarily disturbed areas outside the solar array fence, with the exception of areas that would be returned to agricultural production following construction (as noted in Section 4.5.1). The example seed mix is presented in Table 2 and contains a mixture of native grasses and native, pollinator-friendly forbs. This seed mix includes a mixture of deep-rooted grasses and flowering plants as these types of species can

capture and filter stormwater, build topsoil, and provide food sources and for native insects (Davis 2021). Forbs included in this seed mix were also chosen based on their bloom period. Including plants that flower throughout the growing season provides a continuous source of nectar and pollen and can attract a variety of pollinators (NRCS 2011).

Table 2. Example Grassland Seed Mix #1

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Bluebunch wheatgrass[1]	*Pseudoroegneria spicata*	35
	Sandberg's bluegrass[2]	*Poa secunda* ssp. *secunda*	15
	Bottlebrush squirreltail	*Elymus elymoides*	10
	Needle-and-thread grass[3]	*Hesperostipa comata*	10
Forbs	Low gumweed	*Grindelia nana*	5
	Hoary aster	*Dieteria* (*Machaeranthera*) *canescens*	5
	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Munro's globemallow[4]	*Sphaeralcea munroana*	5
	Western blue flax	*Linum lewisii*	5
	Yarrow	*Achillea millefolium*	5

1. An alternative to bluebunch wheatgrass is Snake River wheatgrass (*Elymus wawawaiensis*; also sold as "Secar" bluebunch wheatgrass).
2. An alternative to Sandberg's bluegrass is big bluegrass (*Poa secunda* subsp. *juncifolia*; also sold as *P. ampla*).
3. Alternatives to needle-and-thread grass include the non-native bunchgrasses crested wheatgrass (*Agropyron cristatum*) and sheep/hard fescue (*Festuca ovina/F. trachyphylla*).
4. An alternative to Munro's globemallow is blanketflower (*Gaillardia aristata*)

A second grassland seed mix, Grassland Seed Mix #2, is suggested for post-construction revegetation within the solar array fence, including areas that previously consisted of agricultural lands. The example seed mix presented in Table 3 contains a mixture of low-growing native and non-native grasses and native and non-native pollinator friendly forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Similar to Grassland Seed Mix #1, this seed mix includes a mixture of deep-rooted grasses and flowering plants that flower throughout the growing season.

Table 3. Example Grassland Seed Mix #2

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Sandberg's bluegrass	*Poa secunda* ssp. *secunda*	35
	Bottlebrush squirreltail, common squirreltail	*Elymus elymoides* ssp. *elymoides*	15
	Desert fescue[1]	*Vulpia microstachys*	10
	Thurber's needlegrass	*Eriocoma (Achnatherum) thurberianum*	10

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Forbs	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Bigseed bisuitroot[2]	*Lomatium macrocarpum*	5
	Erigeron/fleabane	*Erigeron filifolius, E. linearis,* or *E. pumilus*	5
	Oregon sunshine	*Eriophyllum lanatum*	5
	Snow buckwheat	*Eriogonum niveum*	5
	Wollypod milkvetch	*Astragalus purshii*	5

1. Alternatives to desert fescue are sixweeks fescue (*Vulpia octoflora*) or sheep/hard fescue (*Festuca ovina*/*F. trachyphylla*).

2. An alternative to bigseed biscuitroot is longleaf phlox (*Phlox longifolia*).

4.8 Revegetation Methods by Disturbance Level

Revegetation methods for each disturbance level were developed to tailor revegetation to specific conditions (Table 4). Revegetation should follow soil reclamation, site preparation, and seeding methods described in Sections 4.2 through 4.7.

Table 4. Revegetation Methods by Disturbance Level

Disturbance Level	Soil Reclamation	Site Preparation	Seeding
1 – Mowing	Ensure vegetation remains intact.	Retain existing vegetation root systems to prevent erosion. Control weeds.	Seed if necessary to achieve success criteria
2 – Overland Drive and Crush	Measure soil compaction in areas of high vehicle traffic.	Retain existing vegetation root systems and/or mulch to prevent erosion. Decompact soil in areas of high vehicle traffic if necessary. Control weeds.	Seed if necessary to achieve success criteria
3 – Clear and Cut	Measure soil compaction.	Mulch to prevent erosion. Decompact soil if necessary. Control weeds.	Required
4 – Clear and Cut with Soil Removal	Measure soil compaction. Stockpile topsoil separately. from subsoil and stabilize during construction.	Mulch to prevent erosion. Decompact soil. Regrade and replace subsoil then topsoil prior to seeding. Control weeds.	Required

5.0 Revegetation Documentation

Records will be kept of revegetation efforts in all temporary and permanent disturbance areas. Records will include:

- Date construction phase was completed;
- Acreage of each disturbance level;
- Description and photos of the affected area;
- Date revegetation was initiated;
- Description of the revegetation effort, including methods and timing;
- Supporting figures representing the location, acres affected, and pre-disturbance condition of the revegetation area; and
- Confirmation from the landowner that temporary disturbance in cropland have been satisfactorily restored.

The Certificate Holder will meet with ODOE at least 14 days prior to initiation of revegetation efforts. The Certificate Holder will update ODOE with these records monthly as revegetation work occurs and will provide ODOE with copies of these records along with submission of the monitoring report that is required by the Site Certificate.

6.0 Monitoring

6.1 Monitoring of Permanent Disturbance Areas

In accordance with the Certificate Holder's anticipated NPDES 1200-C permit all areas within the solar array fence must be revegetated to stabilize soils for the purposes of erosion and dust pollution control. Pursuant to OAR 345-022-0022, construction and operation of the Facility must not result in significant adverse impacts to soils, including but not limited to, erosion. Pursuant to MCZO 3.010.K.3.f.(3), construction or maintenance activities shall not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. Therefore, monitoring is required to demonstrate compliance with the above site stabilization and weed control requirements. The Certificate Holder will monitor permanent disturbance areas to assess the following:

- Dominant species composition;
- Relative cover of desirable and undesirable forbs and grasses;
- Percent cover of bare soil;
- Degree of erosion;
- Presence noxious weeds; and
- Qualitative assessment of overall vigor of vegetation within revegetated areas.

Monitoring will be conducted by a qualified botanist or revegetation specialist and will begin within 60 days of the completion of initial site revegetation. Permanent disturbance areas will be monitored using a meander survey. During the meander survey, the surveyor will walk within the solar array fence and document the assessment items listed above using photos and spatial data collection. Areas of erosion and significant patches of bare soil will be mapped and photographed. The surveyor will record dominant species, overall percent cover of forbs and grasses, and general notes about plant vigor.

Monitoring will be conducted at least once per season during the first year following construction. After the first complete year of monitoring, the Certificate Holder will consult with ODOE to determine if the monitoring cycle can be reduced based on revegetation progress. After five years of monitoring, the Certificate Holder will design a long-term monitoring plan in consultation with ODOE.

6.1.1 Success Criteria

Success criteria outlined below will demonstrate compliance with the soil protection standard (OAR 345-022-0022); NPDES 1200-C permit requirements; and the requirements of MCZO 3.010.K.3.f.(4):

- Establish uniform (i.e., evenly distributed, without large bare areas) perennial, non-invasive vegetation that provides 70 percent or more cover on all exposed areas.

Requirements of the soil protection standard and MCZO 3.010.K.3.f.(4) apply to the construction and operation of the Facility. Therefore, the Certificate Holder shall maintain compliance with revegetation success criteria for all areas within the solar array fence for the life of the Facility. In each monitoring report, the Certificate Holder will include an assessment of whether the area within the solar array fence is meeting or trending toward meeting the revegetation success criteria. Final determination of whether the Certificate Holder is in compliance with the revegetation obligations will be made by ODOE. Remedial actions and/or additional monitoring for areas may be required in areas that have been determined by ODOE not to have met the success criteria.

6.1.2 Reporting

Monitoring reports will be prepared and submitted to ODOE once per season during the first year following construction. After the first year of monitoring is complete, the reporting cycle will be modified to align with the new monitoring cycle determined in consultation with ODOE. The first monitoring report will include a detailed description and timeline of revegetation methods that were implemented including species, amounts, and locations of seed applications and dates revegetation work was performed.

Each monitoring report will include:

- GIS maps of revegetation areas and disturbance levels;
- Monitoring methods;
- Local climatic data (i.e., precipitation, temperature) for the monitoring month and year and percent deviation from the historical average;

- Results of monitoring efforts;
- The investigator's assessment of whether the revegetated areas are trending toward meeting the success criteria;
- Assessments of factors impacting the ability of revegetated area to trend towards meeting the success criteria; and
- Recommendations for adaptive management, if any.

6.2 Monitoring of Temporary Disturbance Areas

Per ODFW recommendations on other projects, temporary disturbance monitoring is not required for temporary disturbance areas less than 0.5 acres or when the area is not sufficiently large to accommodate a monitoring site. Because there are no non-agricultural habitat types with temporary disturbance areas greater than 0.5 acres, no monitoring or reference sites will be established for this Facility.

6.3 Adaptive Management

After each revegetation monitoring visit in either temporary or permanent disturbance areas, the Certificate Holder's qualified investigator will report to the Certificate Holder regarding the revegetation progress of each revegetation area. If applicable, the investigator will make recommendations to the Certificate Holder for reseeding, weed control, or other remedial measures for areas that are not showing progress toward achieving revegetation success. The investigator will provide a description of factors that may be contributing to the lack of revegetation success. The Certificate Holder will include the investigator's recommendations for adaptive management and the measures taken in the next monitoring report. ODOE may require reseeding or other remedial measures in cases where success criteria have not been met.

If a revegetation area is damaged by wildfire during the first 5 years following initial seeding, the Certificate Holder will amend this Plan, subject to ODOE approval, to restore the damaged area. The Certificate Holder will continue to monitor and report on revegetation progress during the remainder of the 5-year period. The Certificate Holder will report to ODOE and ODFW the area impacted by the fire (with a map or figure) within 72 hours of discovery.

6.4 Soil Reclamation Monitoring

Soil measurements conducted per Section 4.2 shall be evaluated to determine whether soils within disturbance areas have compaction readings of greater than 300 psi. If results show soils have compaction readings of greater than 300 psi, then remediation activities must be completed before revegetation can begin. Prior to initiation of revegetation, the Certificate Holder will provide the results of soil compaction testing to ODOE.

7.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

8.0 References

Davis, R. 2021. Global buzz for solar with pollinators and beekeeping. Fresh Energy, Center for Pollinators in Energy. Available at: https://fresh-energy.org/solar-beekeeping-goes-global

Mosley, J. 2018. Targeted Livestock Grazing to Suppress Cheatgrass. Department of Animal and Range Sciences, Montana State University. November. Available at: https://www.montana.edu/extension/sanders/Prescription%20for%20Cheatgrass%20November%2025%202018.pdf

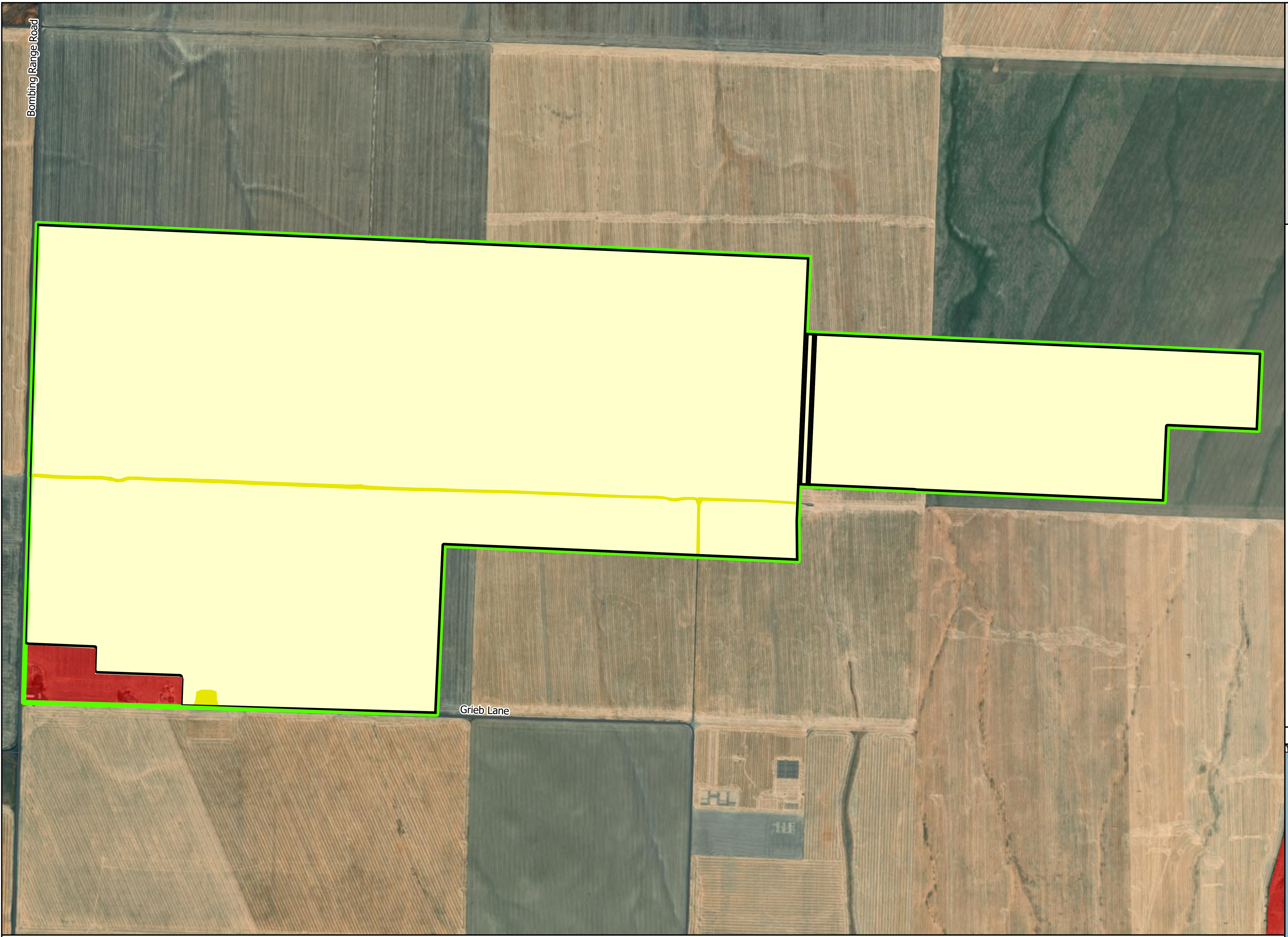
NRCS (Natural Resources Conservation Service). 2011. Plants for Pollinators in the Inland Northwest. U.S.D.A Natural Resources Conservation Service, Spokane, Washington – Boise, Idaho.

Figure

Sunstone Solar Project

Figure 1
Sunstone Solar Project 3

MORROW COUNTY, OR



- 🟩 SS 3 Site Boundary
- ▭ Permitted Fenceline
- 🟥 Excluded from Development
- — Local Roads

Habitat Subtypes by Category

Category 6

- ▭ Orchards, Vineyards, Wheat Fields, Other Row Crop
- 🟨 Urban and Mixed Environs

TETRA TECH PINEGATE RENEWABLES

Reference Map

1:13,000 WGS 1984 UTM Zone 11N 0 0.25 0.5 Miles NOT FOR CONSTRUCTION

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Sunstone Solar Project 3
Draft Wildlife Monitoring Plan

Prepared for

PINEGATE RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 3, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

Table of Contents

1.0 Introduction

Sunstone Solar 3, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 3 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities and the anticipated phasing of construction are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Wildlife Monitoring Plan (WMP) describes wildlife monitoring the Certificate Holder will conduct during operation of the Facility. This WMP has the following components:

1. Raptor nest surveys
2. Washington ground squirrel (WAGS; *Urocitellus washingtoni)* monitoring
3. Wildlife Reporting and Handling System (WRHS)
4. Data reporting

This WMP will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE) and the Oregon Department of Fish and Wildlife (ODFW) and will be updated as needed to reflect the final layout of the Facility.

2.0 Raptor Nest Surveys

The objectives of raptor nest surveys are: (1) to count raptor nests on the ground or above ground at the Facility; and (2) to determine whether there are noticeable changes in nesting activity in the local populations of raptor species, with particular focus on Swainson's hawks (*Buteo swainsoni*), the only state sensitive raptor species documented nesting during baseline surveys.

The Certificate Holder will conduct long-term ground-based monitoring of nests identified during the baseline raptor nest surveys, as well as any other nests identified subsequently. The ground-based surveys will be used to evaluate nest success by gathering data on nest occupancy. The Certificate Holder will employ qualified personnel to perform raptor nest surveys.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

2.1 Initial Monitoring

The first monitoring season will be in the first full raptor nesting season after the commercial operating date. During the first monitoring season, the surveyor will conduct one ground survey for raptor nests in late May or early June and additional surveys as described in this section. The ground surveys will be conducted within the site boundary to determine nest occupancy.

All nests discovered during the anticipated pre-construction surveys and any nests discovered during post-construction surveys, whether active or inactive, will be given identification numbers. Global Positioning System (GPS) coordinates will be recorded for each nest. Locations of inactive nests will be recorded because they could become occupied during future years.

After the first monitoring season, the surveyor will analyze this one year of data compared to the baseline data. The Certificate Holder will provide a summary of the first-year results in the monitoring report described in Section 5.0.

2.2 Long-Term Monitoring

The surveyor will conduct raptor nest surveys at 5-year intervals for the life of the Facility.[2] The surveyor will conduct long-term raptor nest surveys following the methods described in Section 2.3 every 5 years after the first monitoring season in years divisible by 5. This may result in a greater than 5-year period between the initial monitoring season and the first long-term monitoring season (e.g., if the initial monitoring season is 2028, the first long-term monitoring season would be 2035 rather than 2033). During each long-term monitoring event biologists will visit all previously identified nest locations in addition to searching the survey area for new nest sites.

In conducting long-term surveys, the surveyor will follow the same survey protocols as the initial survey (Section 2.3), unless the Certificate Holder proposes alternative protocols that are approved by ODOE. In developing an alternative protocol, the Certificate Holder will consult with ODFW and ODOE and will take into consideration other raptor nest monitoring conducted in adjacent or overlapping areas.

The Certificate Holder will analyze the data to identify any trends in the number of raptor breeding attempts the Facility supports and the success of those attempts. The Certificate Holder will submit a report after each year of long-term raptor nest surveys.

2.3 Monitoring Protocol

Qualifications of surveyors: Surveys and nest monitoring will be conducted by professional, qualified biologists with a relevant academic background and sufficient field experience pertaining to avian biology and species identification.

Survey period: Occupancy surveys will be conducted between March 1 and May 31. The survey period may be extended in consultation with ODFW and ODOE.

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[2] As used in this plan, "life of the Facility" means continuously until the Facility is restored and the site certificate is terminated in accordance with OAR 345-027-0110.

Survey area: The survey area will be limited to leased parcels within the Site Boundary, where surveyor access is granted. Surveys will be performed from public roads and project roads, or from participating landowner parcels only, as site conditions safely permit (e.g. snow, mud).

Survey protocol: Biologists will conduct a ground-based search for raptor nest activity using binoculars and/or spotting scopes to search potential nest sites. Previously identified nests will be surveyed to determine the occupancy status of nests. New nests that are discovered will also be surveyed and visited in future monitoring years. A log will be kept to track nest occupancy status on all nests. ArcGIS Online or similar GIS program will be used to locate and track the nests.

Data collection: Data collected during the survey will include, at a minimum, the location, occupancy status, occupying species, activity observed, and condition of each nest.

<u>Nest Location:</u> Nest/Burrow Identification Number: Existing IDs will be used where possible in addition to corresponding GPS waypoint numbers.

<u>Occupying Species:</u> Using four-letter American Ornithologists' Union codes (e.g., SWHA = Swainson's hawk).

<u>Raptor Activity:</u>
- Adult Present: Proximity of the adult to the nest (e.g., on nest, nearby, or unknown).
- Eggs or Young: Number of eggs or young observed.
- Nest Substrate: Structure in which nest was located (e.g., broadleaf tree, cut bank, transmission pole, etc.).
- Nest Height: Height relative to the structure it is on (e.g., on top of transmission pole, 3/4 of height of tree).

<u>Nest Condition:</u> To assess nest condition the following criteria will be used:
- No Longer Present: For nests that are no longer present.
- Unknown: The nest cannot be found, was not surveyed, or the nest is present, but because of its location a determination cannot be made.
- Excellent: Defined cup or nest bowl with a well-maintained rim; adult or young present.
- Good: Nest bowl intact and rim defined; minor repair needed for nest to be used; margins of nest in loose configuration, minor slumping occurring.
- Fair: Nest bowl intact and nest not dilapidated; but needs significant repair in order to be used; material is slumping or sliding.
- Poor: Loose structure of nest bowl still present; nest walls and side falling out; nest is in need of major repair to be used.
- Remnant: Nest bowl not defined; scant material remaining and not usable unless fully rebuilt.

Determination of active nests: Nest occupancy status will be determined using the definitions below.

<u>Active:</u> Defined by the presence of one or more eggs, dependent young, or adults on the nest in the past 10 days during the breeding season, including the period when adults are displaying courtship behaviors and are building or adding to the nest in preparation for egg-laying.

Potentially Active: There is not observable activity during the visit, but active status cannot be confirmed.

Inactive: The inactive status will only be determined if the nest is observed for at least one hour each time over the course of two consecutive visits separated by at least one day.

3.0 Washington Ground Squirrel Monitoring

No WAGS were detected during baseline surveys, but any new colonies that are detected incidentally during other surveys, such as raptor nest monitoring, will be documented and the extent of those colonies delineated and included in future WAGS monitoring and reporting activities.

If any incidental WAGS are detected, the Certificate Holder will employ qualified personnel to monitor these locations every 5 years thereafter in years divisible by five for the life of the Facility (i.e., on the same monitoring schedule as the raptor nest surveys). The survey area will include the colonies (i.e., groups of active burrows) and a buffer of 785 feet in suitable habitat, if accessible. The surveyors will walk linear transects spaced 165 to 230 feet (50 to 70 meters) apart two times between February 15 and May 31. Surveys of each location will be spaced at least 2 weeks apart. Surveyors will record locations of activity centers and colony boundaries using a sub-meter accuracy GPS unit; approximate number of burrows; and representative photographs of burrows and scat. Surveyors will describe habitat characteristics at each location and note any noticeable land use or habitat changes that may have occurred since detection.

After each survey, the Certificate Holder will report the results to ODFW and ODOE and will include maps of the areas surveyed and detection locations. WAGS surveys will not be conducted if there are barriers to WAGS dispersal (i.e., active agriculture fields, highways, perennial waterbodies) or no suitable habitat.

4.0 Wildlife Reporting and Handling System

The Certificate Holder will document fatalities found during routine maintenance activities and any other incidentally detected fatalities. However, systematic post-construction fatality monitoring studies are not likely to produce significant findings or provide meaningful data on impacts based on the attributes of this Facility (especially relative to the costs that they incur to implement) as described below, and therefore no systematic post-construction fatality monitoring study is proposed for the Facility nor is one needed to meet the standards under Oregon Administrative Rule (OAR) 345-022-0060. In a December 2023 meeting with the Certificate Holder and ODOE, ODFW stated they are not requesting a post-construction fatality monitoring study for the Facility. If evidence of significant fatality events is detected by operations and maintenance (O&M) staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring and adaptive management.

Although mortality at the Facility due to collision with infrastructure is possible, as it is with most human development (e.g., buildings), the available literature on avian mortality at utility-scale photovoltaic solar energy sites suggests that mortality at these facilities is comparatively low (Walston et al. 2016, Loss et al. 2014, Kosciuch et al. 2020, Smith et al. 2021). In Oregon, results of a fatality study at a 56-MW photovoltaic facility near Prineville detected only three bird fatalities, only two of which were native birds (i.e., a horned lark [*Eremophila alpestris*] and a dark-eyed junco [*Junco hyemalis*]), during 1 year of standardized searches (ODOE 2020). These results suggest that large fatality events are unlikely at photovoltaic solar facilities in the region but that low numbers of fatalities of common ground-dwelling bird species could be detected at the Facility (ODOE 2020), and may be similar to background mortality levels. Post-construction fatality monitoring studies conducted at utility-scale photovoltaic solar facilities to date have reported lower fatality rates compared to other human development types, with fatalities in general primarily composed of resident ground-nesting birds.

In contrast to wind energy development, impacts to wildlife from photovoltaic solar development are primarily associated with habitat loss rather than direct mortality from collisions. The Facility is located almost entirely on wheat fields, and impacts to wildlife habitat will be minimal, restricted primarily to small tracts of disturbed grasslands. This habitat will be mitigated in accordance with ODFW's Habitat Mitigation Policy (OAR 635-415-0025), as described in the Facility's Exhibit P and Habitat Mitigation Plan (Attachment P-2 to Exhibit P; updated for RFA 1, see Attachment 6). The Certificate Holder will adhere to standard best management practices including following Avian Powerline Interaction Committee guidelines for minimizing avian collisions and electrocutions (APLIC 2006, 2012), primarily burying the medium voltage collector line system, and implementing down-shield lighting for permanent lighting at the substations and O&M buildings, and identifying a licensed local wildlife rehabilitator capable of responding to the Facility in the event of injured wildlife. Based on coordination with ODFW, the Certificate Holder will additionally install flight diverters on the overhead collector line that crosses Sand Hollow. The Certificate Holder will use wildlife-friendly fencing that does not include a top strand. Thus, the Facility has already minimized the risk of avian collision fatalities, based on known risk factors such as lighting (Gehring et al. 2009; Kerlinger et al. 2010; USFWS 2012, 2013).

Additionally, post-construction fatality monitoring is not necessary for the Certificate Holder to meet the standards under OAR 345-022-0060 (i.e., that the design, construction and operation of the facility, taking into account mitigation, are consistent with the general fish and wildlife habitat mitigation goals and standards of OAR 635-415-0025, ODFW's Fish and Wildlife Habitat Mitigation Policy) because the mitigation goals and standards relate to fish and wildlife habitat quality and quantity rather than fatalities of fish and wildlife individuals. OAR 635-415-0025 goals and standards for impacts to Category 2, 3, 4, and 5 habitat (i.e., the habitat categories addressed in the Facility's Habitat Mitigation Plan) include avoidance and, where impacts are unavoidable, mitigation to achieve the goal of no net loss of either habitat quantity or quality (Category 2, 3 and 4 habitat) and/or a net benefit in habitat quantity or quality (Category 2 and 5 habitat). Fatality monitoring, in itself, does not improve or maintain habitat quantity or quality, nor would the results of monitoring affect the habitat mitigation ratios or the size of the mitigation need described in the

Facility's Habitat Mitigation Plan attached to Exhibit P and Attachment 6 for RFA 1. Therefore, a systematic post-construction fatality monitoring study is not necessary for the Energy Facility Siting Council (EFSC) to determine that the Facility is consistent with OAR 635-415-0025

Although standardized fatality searches will not be implemented, all incidentally detected fatalities will be reported in the WRHS. The WRHS is a program for O&M staff to report wildlife (including bird and bat) casualties found during operation of the Facility. O&M staff will be trained in the methods needed to carry out this program. This monitoring program includes the initial response, handling, and reporting of bird and bat carcasses discovered incidental to maintenance operations ("incidental finds"). Approximately 10 permanent O&M staff are anticipated to be on-site for Facility operations and be responsible for WRHS program implementation. If a battery energy storage system is installed, additional workers will be on-site, but they will likely be contract employees and will not be included in WRHS program implementation. As part of routine O&M activities, O&M staff will visit each inverter pad approximately every 6 months to visually inspect equipment. If evidence of significant fatality events is detected by O&M staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring.

All carcasses discovered by O&M staff will be photographed and recorded. If O&M staff find a carcass at the Facility, they will notify qualified personnel who will identify the carcass. If the qualified personnel determines that a carcass is a state or federally threatened or endangered or otherwise protected species, agency reporting procedures and timelines specified in Section 5.0 shall be followed. Information recorded for each carcass and reported to ODFW and ODOE will include the location, date of discovery, species if known, as well as any evidence that might assist in determination of cause of death, such as evidence of electrocution, vehicular strike, wire strike, predation, or disease. Based on coordination with ODFW, feather spots[3] will be documented if found as well, consistent with industry standards; however, feather spots will not necessarily be attributed to a Facility-caused fatality (personal communication with J. Thompson, ODFW, December 13, 2023). Fatalities documented by O&M staff will be reported to ODOE and ODFW annually, as described in Section 5.0.

Prior to construction, the Certificate Holder will develop and implement a protocol for handling injured birds. Any injured native birds found at the Facility may be carefully captured by trained qualified personnel and transported to a qualified rehabilitation specialist approved by ODOE. Alternatively, the Certificate Holder may contact a qualified rehabilitation specialist approved by ODOE to respond to injured wildlife. Blue Mountain Wildlife (https://bluemountainwildlife.org/, 541.278.0215), located in Pendleton, Oregon, has confirmed the ability to respond to injured native wildlife, especially migratory birds, at the Facility (Lynn Tompkins, personal communication, April 11, 2023). The Certificate Holder will pay costs, if any, charged for time and expenses related to care and rehabilitation of injured native birds found on the site, unless the cause of injury is clearly demonstrated to be unrelated to Facility operations.

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[3] Feather spots are defined as at least 5 tail feathers, or 2 primary feathers, or a total of at least 10 feathers with no attached bone or tissue, within 5 meters of each other (CEC and CDFG 2007).

5.0 Data Reporting

The Certificate Holder will report wildlife monitoring methods, data, and data analysis to ODOE for each calendar year in which wildlife monitoring occurs. Monitoring data include raptor nest survey data, WAGS monitoring data (if applicable), and WRHS data. The Certificate Holder may include the reporting of wildlife monitoring data and analysis in the annual report required under OAR 345-026-0080 or submit this information as a separate document at the same time the annual report is submitted. In addition, the Certificate Holder will provide to ODOE data or records generated in carrying out this WMP upon request by ODOE.

The Certificate Holder will notify the U.S. Fish and Wildlife Service and ODFW if any federal or state endangered or threatened species are killed or injured at the Facility within 24 hours of species identification.

6.0 Plan Amendment

This WMP may be amended from time to time by agreement of the Certificate Holder and EFSC. Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this WMP. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

7.0 References

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ODOE (Oregon Department of Energy). 2020. Montague Wind Power Facility - Final Order on Request for Amendment 5. September 25, 2020.

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USFWS. 2013. Revised Voluntary Guidelines for Communication Tower Design, Siting, Construction, Operation, Retrofitting, and Decommissioning. September 27, 2013.

Walston, Leroy J., Katherine E. Rollins, Kirk E. LaGory, Karen P. Smith, Stephanie A. Meyers. 2016. A preliminary assessment of avian mortality at utility-scale solar energy facilities in the United States. *Renewable Energy* 92: 405–414, https://doi.org/10.1016/j.renene.2016.02.041

Inadvertent Discovery Plan

Sunstone Solar Project 3

Morrow County, Oregon

October 2025

Author:
Lara Rooke, MA, RPA

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

130 Roberts Street
Asheville, NC 28801

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1.0 INTRODUCTION

Pine Gate Renewables (PGR) proposes to construct and operate the approved Sunstone Solar Project 3 (Facility), a solar energy generation facility with related or supporting facilities including an energy storage system on private lands in Morrow County, Oregon. PGR seeks a Site Certificate through the Oregon Department of Energy (ODOE), Oregon Energy Facility Siting Council (EFSC or Council) for the Facility. The Facility will include an up to 200-megawatt (MW) solar project, battery energy storage system, and related or supporting facilities in Morrow County, Oregon. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1). The approved solar facility siting area (Facility site boundary) is located on privately owned agricultural land with areas of sage brush near the drainages and along Sand Hollow Canyon.

To meet the requirements for site certification, PGR must develop an Inadvertent Discovery Plan (IDP) for monitoring construction activities and responding to the discovery of archaeological resources or buried human remains.

2.0 CULTURAL RESOURCES IN THE PROJECT AREA

The entirety of the Facility site boundary and a 2-mile viewshed was surveyed for cultural resources, including pedestrian surveys along with subsurface shovel probing within the Facility site boundary. A single archaeological site was identified in the Facility site boundary. It has been recommended as not eligible for listing on the National Register of Historic Places (NRHP). In addition, one historic site is identified in the Facility site boundary. The historic site is eligible for listing on the NRHP.

Prior to construction, PGR will develop a Monitoring Plan that incorporates this IDP and includes necessary staff, agency, and tribal contact information once determined. This plan should include monitoring protocols and staffing roles and incorporate input from the CTUIR.

3.0 PROCEDURES FOR THE DISCOVERY OF ARCHAEOLOGICAL RESOURCES

If any staff, contractors, or subcontractors, including archaeological and/or tribal monitors, believe that they have encountered cultural or archaeological remains of any kind, all work at and adjacent to the discovery shall immediately cease. The area of work stoppage will be adequate to provide for the security, protection, and integrity of the archaeological discovery. A cultural resource discovery may be pre-contact period or historic period in age and consist of (but not limited to):

- Areas of charcoal or charcoal-stained soil and stones;
- Stone tools or waste flakes (i.e., an arrowhead or stone chips);
- Bone, burned rock, or shell, whether or not seen in association with stone tools or chips;

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

- Clusters of tin cans, ceramics, flat glass, or bottles; and
- Concentrations of brick, railway tracks, or logging or agricultural equipment.

In the event unrecorded archaeological resources are identified during the construction or operation of the Sunstone Solar Project 3, work within 100 feet of the find shall be halted and directed away from the discovery until a Qualified Archaeologist[2] assesses the resource and its significance for inclusion on the NRHP. This assessment will include coordination with the CTUIR. (A wider avoidance area will be required for human remains; see below.) The archaeologist, in coordination with ODOE, the SHPO, Facility personnel, CTUIR, and the landowner, shall make the necessary plans for treatment of the finds and for the evaluation and mitigation of impacts if the finds are found to be eligible for listing on the NRHP.

A Qualified Archaeologist will determine if the resources are archaeological and greater than 50 years old. If the archaeologist believes that the discovery is a cultural resource, he or she in coordination with the PGR Construction Manager will establish a 100-foot avoidance buffer to protect the discovery site where construction activities will be suspended until treatment of the discovery can be determined. Vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery site or avoidance area. Any newly discovered archaeological resource will be considered eligible to the NRHP until determined otherwise. Work in the immediate area will not resume until treatment of the discovery has been completed.

If archaeological artifacts are observed during construction, the Qualified Archaeologist will ensure proper documentation and assessment of any discovered cultural resources. All precontact and historic cultural material discovered during project construction will be recorded by the archaeologist in SHPO's online archaeological site form database. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/sediment descriptions will be prepared for subsurface exposure. Discovery locations will be documented on scaled site plans and site location maps.

If the Qualified Archaeologist in consultation with the SHPO and CTUIR determines that the discovery is an NRHP-eligible cultural resource, they will consult to determine appropriate treatment to be presented and agreed upon in a Memorandum of Agreement (MOA) or other appropriate documentation. Mitigation measures will be developed in consultation with PGR, ODOE, SHPO, CTUIR, and the landowner, and could include avoidance through redesign, conducting data recovery, and/or relocating materials. Treatment measures performed may include protecting in place or data recovery such as mapping, photography, limited probing, and sample collection, or other activity deemed appropriate through an MOA or other appropriate documentation.

If human remains are inadvertently discovered, ODOE, SHPO, the Legislative Commission on Indian Services (LCIS), and CTUIR will decide when construction may continue at the discovery location.

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[2] *Qualified Archaeologist* - means a person with qualifications meeting the federal secretary of the interior's standards for a Professional Archaeologist . An individual who has: (A) A post-graduate degree in archaeology, anthropology, history, classics or other germane discipline with a specialization in archaeology, or a documented equivalency of such a degree; (B) Twelve weeks of supervised experience in basic archaeological field research, including both survey and excavation and four weeks of laboratory analysis or curating; and (C) Has designed and executed an archaeological study, as evidenced by a Master of Arts or Master of Science thesis, or report equivalent in scope and quality, dealing with archaeological field research.

Where cultural resources are encountered during construction, but additional project effects to the resources are not anticipated, Facility construction may continue while documentation and assessment of the cultural resources proceed. If continued construction is likely to cause additional impacts to such resources, Facility activities within a radius of 100 feet of the discovery will cease until the Qualified Archaeologist has documented the site, evaluated its significance in consultation with CTUIR, and assessed potential effects to the site.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the discovery of the cultural resource, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 100 foot buffer—work may continue outside of this buffer.
3) Notify PGR Project Manager and ODOE (see Attachment A).
4) Construction Manager will need to contact a Qualified Archaeologist to assess the find.
5) If archaeologist determines the find is an archaeological site or object, contact SHPO. If it is determined to *not* be archaeological, you may continue work.

4.0 PROCEDURES FOR THE DISCOVERY OF HUMAN REMAINS

If human remains and/or associated grave goods are inadvertently encountered during Project activities, the Oregon State legislature protocol[3] for inadvertent discovery of human remains will be followed (Oregon State Legislature 2025). All activity that may cause further disturbance to the remains shall cease and the area secured and protected from further disturbance. A 200-foot avoidance buffer will be utilized for human remains and associated grave goods until appropriate treatment is completed. The presence of skeletal remains will be immediately reported to the County Medical Examiner, Oregon State Police, SHPO, and LCIS. The remains will not be touched, moved, or further disturbed. The County Medical Examiner or LCIS State Physical Anthropologist will assume jurisdiction over the human skeletal remains and determine whether those remains are forensic or non-forensic. If the remains are non-forensic, then they will report that finding to SHPO and the State Physical Anthropologist with the LCIS, who will then take jurisdiction over the remains and will notify CTUIR.

Although excavation work in the immediate area of a human remains find will not resume until assessment has been completed, excavation work may continue in other parts of the Facility that have been surveyed for cultural resources. Due to the sensitive nature of such a find, human remains

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[3] https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

should never be left unattended. No work will resume in the area of a human remains discovery until written authorization has been received from the LCIS and SHPO.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the inadvertent discovery, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 60-meter/200-foot buffer, then work may continue outside of this buffer with caution.
3) Cover remains from view and protect them from damage or exposure, restrict access, and leave in place until directed otherwise. Do not take photographs. Do not speak to the media.
4) Notify (refer to Attachment A for contact information):
    - PGR Project Manager
    - ODOE
    - Oregon State Police **DO NOT CALL 911**
    - SHPO
    - LCIS State Physical Anthropologist
    - CTUIR and other appropriate Native American Tribes determined by LCIS

5) If the site is determined not to be a crime scene by the Oregon State Police, do not move anything! The remains will continue to be secured in place along with any associated funerary objects, and protected from weather, water runoff, and shielded from view.
6) Do not resume any work in the buffered area until a plan is developed and carried out between ODOE, SHPO, LCIS, and appropriate Native American Tribes and you are directed that work may proceed.

5.0 CONFIDENTIALITY

The Facility and employees shall make their best efforts, in accordance with federal and state law, to ensure that its personnel and contractors keep the discovery confidential. The media, or any third-party member or members of the public are not to be contacted or have information regarding the discovery, and any public or media inquiry is to be reported to ODOE. Prior to any release, the responsible agencies and Tribes shall concur on the amount of information, if any, to be released to the public.

To protect fragile, vulnerable, or threatened sites, the National Historic Preservation Act, as amended (Section 304 [16 U.S.C. 470s-3]), and Oregon State law (Oregon Revised Statute 192.501(11)) establishes that the location of archaeological sites, both on land and underwater, shall be confidential.

6.0 REFERENCES

Oregon State Legislature

2025 Electronic document accessed July 2025, https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

ATTACHMENT A: CONTACTS

1. Pine Gate Renewables

Project Manager	To be determined prior to construction

2. Cultural Resource Contacts

Qualified Archaeologist	Lara Rooke, Tetra Tech (425) 217 7625 (Cell)
Oregon SHPO State Archaeologist	John Pouley (503) 480-9164
State Physical Anthropologist, LCIS	Dr. Elissa Bullion (971) 707-1372 or (503) 986-1067

3. Agency Contacts

ODOE	Christopher Clark (503) 871-7254
Oregon State Police	Craig Heuberger (503) 731-0079 or (503) 731-3030 (dispatch)
Morrow County Medical Examiner	(541) 676-5421

4. Tribal Contacts

CTUIR	Teara Farrow Ferman (Human Remains) (541) 429-7230 or (541) 377-2959 (cell) Ashley Morton (Archaeological Resources) (541) 429-7214

Sunstone Solar Project 3

Draft Construction Wildfire Mitigation Plan

Sunstone Solar Project 3
October 2025

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 3, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

Table of Contents

List of Tables

Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 3, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
EMP	Emergency Management Plan
Facility	Sunstone Solar Project 3
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 3, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 3 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) is attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described in this plan, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final Construction WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During construction, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to construction of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115, if significantly different from Final Order on ASC and the Request for Amendment 1.

4.0 Inspection and Management

> *OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;*

4.1 Vegetation Management

The Certificate Holder and contractor(s) will maintain vegetation within the Site Boundary and will also maintain a defensible space clearance along Facility features. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

The following best management practices to minimize fire risk from vehicle travel and fueling activities would be implemented at the site during construction:

- The movement of vehicles will be planned and managed to minimize fire risk.
- The contractor(s) will be responsible for identifying and marking paths for all off-road vehicle travel. All off-road vehicle travel will be required to stay on the identified paths. No off-road vehicle travel will be permitted while working alone. Travel off road or parking in vegetated areas will be restricted during fire season.
- Areas with grass that are as tall or taller than the exhaust system of a vehicle must be wetted before vehicles travel through it.
- Workers will be instructed to shut off the engine of any vehicle that gets stuck, and periodically inspect the area adjacent to the exhaust system for evidence of ignition of vegetation. Stuck vehicles will be pulled out rather than “rocked” free and the area will be inspected again after the vehicle has been moved.
- All combustion engines (including but not limited to off road vehicles, chainsaws, and generators) will be equipped with a spark arrester that meets U.S. Forest Service Standard 5100-1.
- The contractor(s) will designate a location for field fueling operations at the temporary construction yards. Any fueling of generators, pumps, etc. shall take place at this location only.
- Fuel containers, if used, shall remain in a vehicle or equipment trailer, parked at a designated location alongside a county right-of-way. No fuel containers shall be in the vehicles that exit the right-of-way except the five-gallon container that is required for the water truck pump.
- Smoking shall only be allowed in designated smoking areas at the Facility.

5.0 Preventative and Minimization Actions for Wildfire Risk

OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;

5.1 Preventative Actions

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads[3]. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present. See Exhibit U[4] for additional discussion of Project fire prevention measures and coordination with local emergency responders.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during construction of the Facility, as applicable.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

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[3] Complete Application for Site Certificate, Exhibit D, May 16, 2024.

[4] Complete Application for Site Certificate, Exhibit U, May 16, 2024.

5.2.2 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fore spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high risk locations, designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.3 Emergency Management Plan

The EMP will be prepared prior to construction by the Certificate Holder and construction contractor and will contain policies and procedures for preparing for and responding to a range of potential emergencies, including fires. Implementation of the EMP will ensure risks to public health and safety and risks to emergency responders are minimized. Any potential fires inside the solar array will be controlled by trained staff who will be able to access the Facility around the clock. These measures will help keep external fires out or internal fires in. The EMP will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The plan will also specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, a construction kickoff meeting to discuss emergency planning, and invitations to observe any emergency drill conducted at the Facility.

In addition to the emergency responses to be stipulated in the EMP, personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

Another safety mitigation measure is to have available on site during construction is a water truck, water buffalo, or tank with minimum 500 gallon capacity.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

The Certificate Holder will track the industry groups and applicable design standards outlined in Table 2 to identify future technologies or best practices that could be implemented at the Facility.

Table 2: Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the O&M building and the substation enclosure.	Remodeling to the O&M and enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

Reference	Description	Method
1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/. 2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf. 3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.		

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Sunstone Solar Project 3
Draft Operational Wildfire Mitigation Plan

Sunstone Solar Project 3
October 2025

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 3, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

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Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 3, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
EMP	Emergency Management Plan
Facility	Sunstone Solar Project 3
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 3, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 3 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) was attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described above, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers, (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire, (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs, battery components, and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During operation, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires and how to safely respond to fires involving BESS components. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment Update

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to operation of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115.

4.0 Inspection and Management

OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;

4.1 Facility Inspections

Facility components will be inspected quarterly. The supervisory, control, and data acquisition (SCADA) system collects operating and performance data from the Facility as a whole and allows remote operation. The Certificate Holder will monitor the Facility components, such as the substation and solar arrays, 24 hours a day, 7 days a week including shutdown capabilities. These operational monitoring and maintenance measures are also discussed in Section 4.0.

The battery energy storage system may consist of either zinc-based batteries or lithium-ion (Li-ion) batteries and will be stored in completely contained, leak-proof modules. The modules will be stored on a concrete pad to capture any leaks that may occur. Operations and maintenance (O&M) employees will conduct inspections of the battery energy storage systems according to the manufacturer's recommendations, which are assumed to be monthly inspections.

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Section 2.7.1 of Exhibit B summarizes the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected.

Table 2 below provides draft operational inspections for electrical facility components from similar types of facilities. As part of finalizing the final operational WMP, the Certificate Holder may update this table as applicable to facility equipment, standards, and inspections.

Table 2: Draft Operational Inspections for Electrical Components

Inspection	Procedure	Standard	Time frame
Solar Inverter	Visual inspection of inverter and surrounding area.	SPCC Plan[1] Manufacturer's maintenance recommendations	Monthly SPCC Bi-annual Preventative Maintenance
Substation	Visual inspection of MPT, Avian Power Line Interaction Committee (APLIC) measures, and surrounding area.	Manufacturer's maintenance recommendations APLIC[2]	Monthly Yearly (APLIC)
BESS	Visual inspection of BESS, PCS, and surrounding areas	SPCC Plan Manufacturer's maintenance recommendations	Monthly

Inspection	Procedure	Standard	Time frame
Overhead electrical lines	Visual inspection of components, grounding, APLIC measures, vertical clearance distance between conductor and vegetation.	National Energy reliability Corporation (NERC)3 APLIC	Bi-annual
1. The Operational Spill Prevention, Control, and Countermeasure Plan for the facility will require these components to be inspected monthly for spills. During these inspections, Operational Staff will also visually inspect the component and surrounding area. 2. The Certificate Holder will develop an inspection checklist and program of electrical equipment based on manufacturer's recommendations for individual components. 3. Vegetation maintenance standard FAC-003-0 .			

4.2 Vegetation Management

Vegetation within areas temporarily disturbed during construction of the Facility, as well as revegetation of areas within the solar array fence line area, will be revegetated as outlined in the Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4[3]; updated for RFA 1, see Attachment 6). As noted in the Revegetation and Reclamation Plan, areas within the solar array fence line area will be revegetated with a mixture of low-growing grasses and forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). In addition, vegetation within the solar array fence line area will be managed as needed to reduce fuels for fire. This would include mowing vegetation under solar panels periodically, if required. The Certificate Holder will also maintain a 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

A physical vegetation survey assessment of the fenced area will be completed at least twice a year to monitor for vegetation clearances, maintain fire breaks, as applicable, and monitor for wildfire hazards. One of the vegetation survey assessments will occur in May or June, prior to the start of the dry season, a time when wildfire risk begins to become heightened. The survey will be conducted by the Site Operations Manager and will be used to assess the frequency of any upcoming vegetation maintenance required and identify areas that may need additional attention. The Site Operations Manager will visually assess and document vegetation height, abundance, and areas where vegetation should not be present such as crushed rock bed around collector substations. The vegetation survey assessment will determine that clearances and fire breaks (vegetative clearance areas and areas determined to remain clear to act as permanent fire breaks or areas where temporary fire breaks may be deployed in the event of a fire) are satisfactory, and if not, the mitigation procedures will be implemented (e.g., vegetation management) to ensure clearances and fire breaks are satisfactory The vegetation survey will document::

- Location of observations

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[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

- Species
- Estimated growth rate
- Abundance
- Clearance / Setbacks
- Risk of fire hazard

Additional vegetation surveys may be required throughout the season based on seasonally heightened fire risk. Vegetation Maintenance procedures and BMPs will be followed during operation of the Facility to ensure that vegetation does not grow in a manner that blocks or reduces solar radiation reaching the solar panels and reduce the risk of starting a fire. Vegetation control will employ best management practices (BMPs) and techniques that are most appropriate for the local environment. BMPs may include physical vegetation control such as mowing. Noxious weeds within the site boundary will be controlled in accordance with the Noxious Weed Control Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). Efforts will be made to minimize the use of herbicides and only herbicides approved for use by the U.S. Environmental Protection Agency and Oregon Department of Agriculture will be used. Herbicides used for vegetation management of the site will be selected and used in a manner that fully complies with all applicable laws and regulations.

Vegetation within the fence line and below the solar arrays will be maintained to a height of 18 inches and provide a minimum of 24-inch clear distance to any exposed electrical cables. Exposed electrical wires should be running under the solar panels at the midpoint or higher than the center of the panel. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present.

Ongoing vegetation management to ensure that vegetation does not grow in these graveled areas is outlined in Table 3.

Table 3. Vegetation Management Procedures by Facility Component

Vegetation Management	Procedure	Standard	Time Frame
Solar Inverter	Herbicide application on gravel pad around inverter to prevent vegetation growth.	Institute of Electrical and Electronics Engineers (IEEE) 80[1] National Electrical Code (NEC) 70[2]	Yearly, depending on vegetation condition.
Substation	Herbicide application on substation gravel pad. Highly compacted gravel foundations of substation are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.

Vegetation Management	Procedure	Standard	Time Frame
Battery energy storage system	Herbicide application on gravel pad surrounding the battery energy storage system. Highly compacted gravel foundations of the battery energy storage system are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.
Overhead electrical lines	Mow vegetation to achieve clearance requirements between conductor and ground.	North American Electric Reliability Corporation (NERC)[3]	Yearly, depending on vegetation condition.
1. IEEE (2015) 2. NFPA (2023) 3. NERC (2009)			

5.0 Preventative and Minimization Actions for Wildfire Risk

> *OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;*

5.1 Preventative Actions and Design Features

The Certificate Holder will minimize risk of operation of the facility causing wildfire by implementing a number of systems and procedures. During O&M activities, these will include requirements to conduct welding or metal cutting only in areas cleared of vegetation, and maintaining emergency firefighting equipment on-site. Employees will keep vehicles on roads and off dry grassland when feasible during the dry months of the year, unless such activities are required for emergency purposes, in which case fire precautions will be observed. Fire extinguishers and shovels will be kept in all vehicles. On-site employees will also receive training on fire prevention and response and have on-site fire extinguishers to respond to small fires. In the event of a large fire, emergency responders will be dispatched.

The Certificate Holder will minimize risk of Facility components causing wildfire through preventative actions. In the design of the Facility, the Certificate Holder will implement the design considerations and best practices outlined in Table 4 to minimize electrical fire risk from facility components.

Table 4. Design Considerations for Fire Safety by Facility Component

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Electrical connections by qualified electricians	X	X	X	X
Inspections for mechanical integrity prior to energizations	X	X	X	X

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Lighting protection	X	X	X	X
Corrosion protection	X	X	X	X
Strain relief of connecting cabling	X	X	X	X
Protection against moisture	X	X	X	X
Grounding systems	X	X	X	X
Safety setback from structures	X[1]	X[1]	X[1]	X[2]
Technology specific design standards	X[3]	X[4]	X[5]	X[3]

1. Graveled inside structure's perimeter fence with additional 3-foot gravel setback outside of structure's perimeter fence
2. Vertical and horizontal clearances from structures depends on voltage of conductor.
3. NFPA 70 (.NFPA 2023).
4. IEEE 979 (IEEE 2012).
5. NFPA 1, Chapter 52 (NFPA 2021).

During Facility operations, the areas within the site boundary that are subject to a heightened risk of wildfire include the solar array areas. The solar array areas will have low-growing vegetation maintained below the solar arrays during the operational period of the Facility. Measures for reducing the risk of fire ignition and reducing the risk of equipment damage were a wildfire to occur are discussed further in Section 3.0, including the Facility's vegetation management program (see Section 3.2), and through the emergency response procedures that will be described in the Emergency Management Plan (EMP). The EMP will be developed for the Facility and is outlined below in Section 4.2.5. The collector substation area, transformer pads, and the permanent, fenced parking and storage area will have reduced risk for fire due to the fact that these areas will have a gravel base with no vegetation within a 10-foot perimeter to reduce fire risk.

The Facility components will meet National Electrical Code and Institute of Electrical and Electronics Engineers standards and will not pose a significant fire risk. The solar array will have shielded electrical cabling, as required by applicable code, to prevent electrical fires. In addition, the collector system and substation will have redundant surge arrestors to deactivate the Facility during unusual operational events that could start fires. The collector substation will have also sufficient spacing between equipment to prevent the spread of fire.

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. A 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary will be maintained. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present. See Exhibit U for additional discussion of Project fire prevention measures and

coordination with local emergency responders. Vegetation free areas such as gravel pads or base and facility perimeter and interior roads act as a permanent fire break which could minimize the spread of fires on site or impacts from an external wildfire.

Smoke/fire detectors will be placed around the site that will be tied to the SCADA system and will contact local firefighting services. This communication system allows each solar string, battery energy storage system, and substation to be monitored by a SCADA system, accessed through both the SCADA control room in the substations or remotely. This system monitors these components for variables such as meteorological conditions, critical operating parameters, and power output. The solar array is controlled and monitored via the SCADA system and can be controlled remotely. SCADA software is tuned specifically to the needs of each project by the solar module manufacturer or a third-party SCADA vendor. This system will be monitored 24/7 by a remote operations center.

The Certificate Holder proposes to construct either a direct current–coupled distributed battery energy storage system (located throughout the solar array fence line area at the inverter and transformer sites) or alternating current–coupled battery energy storage system (concentrated in a single location within the solar array fence). The system as a whole will use a series of self-contained containers located within the solar array fence line area. The containers may have their own additional fencing, to be determined prior to construction. Each container will be placed on a concrete foundation. Regardless of the battery technology selected, the containers are estimated to require up to 0.2 to 0.4 acre each with a total of 2,491 containers. Each container is rated for outdoor environments and holds the batteries and a battery management system.

The Facility will use either Li-ion batteries or zinc batteries to store up to 200 MW alternating current of power over a 6-hour discharge duration (1,200 megawatt-hours alternating current) (ASC Exhibit C, Figure C-2[4]).

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Additionally, zinc batteries will have fans and a heating unit for climate control.

The following paragraphs summarize the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected. The chemicals used in Li-ion batteries are generally nontoxic but do present a flammability hazard. Li-ion systems would also include a fire prevention system and cooling units placed either on top of the containers or along the side. Li-ion batteries are susceptible to overheating and typically require cooling systems dedicated to each battery energy storage system enclosure, especially at the utility scale (Jeevarajan et al. 2022). The gas released by an overheating Li-ion cell is mainly carbon dioxide but may also include carbon monoxide, methane, ethylene, and propylene (Jeevarajan et al. 2022).

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[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

The Certificate Holder will implement the following fire prevention and control methods to minimize fire and safety risks for the Li-ion batteries proposed for the battery energy storage system:

- The batteries will be stored in completely contained, leak-proof modules.
- Ample working space will be provided around the battery energy storage system for maintenance and safety purposes.
- Off-site, 24-hour monitoring of the battery energy storage system will be implemented and will include shutdown capabilities.
- Transportation of Li-ion batteries is subject to 49 Code of Federal Regulations (CFR) 173.185 – Department of Transportation Pipeline and Hazardous Material Administration. This regulation contains requirements for prevention of a dangerous evolution of heat; prevention of short circuits; prevention of damage to the terminals; and prevention of batteries coming into contact with other batteries or conductive materials. Adherence to the requirements and regulations, personnel training, safe interim storage, and segregation from other potential waste streams will minimize any public hazard related to transport, use, or disposal of batteries.
- Design of the battery energy storage system will be in accordance with applicable Underwriters Laboratories (UL; specifically, 1642, 1741, 1973, 9540A), National Electric Code, and National Fire Protection Association (specifically 855) standards, which require rigorous industry testing and certification related to fire safety and/or other regulatory requirements applicable to battery storage at the time of construction.
- Additionally, the Certificate Holder will employ the following design practices, as applicable to the available technology and design at time of construction:
    - Use of Li-ion phosphate battery chemistry that does not release oxygen when it decomposes due to temperature;
    - Employment of an advanced and proven battery management system;
    - Qualification testing of battery systems in accordance with UL 9540A (UL Solutions 2025);
    - Employment of Fike fire control panels with 24-hour battery backup at every battery container;
    - Installation of fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems in every battery container;
    - Installation of doors that are equipped with a contact that will shut down the battery container if opened;
    - Installation of fire extinguishing and thermal insulation sheets between each individual battery cell;

  - Implementation of locks and fencing to prevent entry of unauthorized personnel;
  - Installation of remote power disconnect switches; and
  - Clear and visible signs to identify remote power disconnect switches.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during operations of the Facility.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

5.2.2 Electrical Safety Program

All operational workers will be trained in electrical safety and the specific hazards of the Facility. This training will address:

- Minimum experience requirements to work on different types of electrical components;
- Electrical equipment testing and troubleshooting;
- Switching system;
- Provisions for entering high voltage areas (e.g., substation);
- Minimum approach distances; and
- Required personal protective equipment.

5.2.3 Lock Out/Tag Out Program

During maintenance activities, electrical equipment will be de-energized and physically locked or tagged in the de-energized positions to inadvertent events that could result in arc flash.

5.2.4 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fire spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high-risk locations, as designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.5 Emergency Management Plan

Emergency Management will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The final WMP will specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, annual meetings to discuss emergency planning, protocols for how to respond to electrical fires and safely respond to a fire involving BESS components, and invitations to observe any emergency drill conducted at the Facility.

At the beginning of Facility operations, a copy of the site plan indicating the arrangement of the Facility structures, access points, and fire breaks will be provided to the local fire district.

Personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

During times of heightened wildfire risk, a water truck, water buffalo, or tank with minimum 500 gallon capacity will be stationed at the site during operations and maintenance activities.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the amended site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

This Plan will be updated by the Certificate Holder every 5 years. Updates to this Plan will account for changes in local fire protection agency personnel and changes in best practices for minimizing and mitigating fire risk. It is recommended to consult with Morrow County, the local fire department, and the Morrow County Emergency Manager.

After each 5-year review, a copy of the updated plans will be provided to the Oregon Department of Energy with the annual compliance report required under OAR 345-026-008(2).

Every 5 years, the Certificate Holder will review wildfire risk and update this Plan for the site boundary. Evaluation of wildfire risk will be consistent with the requirements of OAR 345-022-0115(1) using current data from reputable sources.

The Certificate Holder may consider revisions to this Plan at its sole discretion to incorporate future best practices or emerging technology depending on whether the new technology is cost effective and suitable for the site conditions. The Certificate Holder will track the industry groups and applicable design standards outlined in Table 5 to identify future technologies or best practices that could be implemented at the Facility.

Table 5. Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].

Reference	Description	Method
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the O&M building and the substation enclosure.	Remodeling to the O&M and enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/.
2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf.
3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.

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Sunstone Solar Project 4

Sunstone Solar Project 4
Draft Fugitive Dust Control Plan

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 4, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

Table of Contents

List of Attachments

1.0 Introduction

This Fugitive Dust Control Plan (Plan) has been developed by Sunstone Solar 4, LLC (Certificate Holder), a subsidiary of Pine Gate Renewables, LLC, for the approved Sunstone Solar Project 4 (Facility) in Morrow County, Oregon. The purpose of this Plan is to reduce fugitive dust emissions associated with construction-related activities of a photovoltaic energy generation facility with up to 200 megawatts (MW) alternating current and related or supporting facilities, as well as a 1,200 MW-hour distributed battery energy storage system. The majority of the site consists of a mix of fallow fields and fields in small grain production, primarily dryland wheat; no farmlands within the site boundary receive irrigation (the application of water to land for purposes of growing agricultural products; Sunstone Solar 2024). This Plan summarizes the sources of and regulatory issues that relate to fugitive dust emissions; identifies responsibilities, monitoring, and training; and provides reasonable available control methods for fugitive dust in a table for easy reference in the field (Attachment 1).

This is an owner-imposed Plan that is expected to be implemented, maintained, and adaptively managed by the selected contractor throughout all phases of construction. The performance criteria and suggested measures identified in this Plan are minimums, and the contractor is expected to identify and implement additional measures as needed to fully meet all regulatory and public safety performance criteria. As identified in this Plan, the contractor may propose alternative approaches for consideration by the owner.

1.1 Fugitive Dust Sources

The Natural Resources Conservation Service (NRCS) Web Soil Survey identified five major soil types within the project area (NRCS 2025). Approximately 98 percent of the site is composed of Warden silt loam, which is moderately or severely susceptible to erosion from ground disturbance, wind, and vehicle traffic on unpaved roads due to its composition of hemic organic soil materials and very fine sand (NRCS 2025, NRCS 2011). Due to their composition, the retention of moisture in these sediments is thus restricted. Furthermore, these sediment particles have a low resistance to dust propagation and would be transported or drift to adjacent lands due to the lack of water through irrigation; thus, these soils are considered at high risk for fugitive dust.

Fugitive dust can arise from a variety of construction and operational activities associated with solar development. The sources can be grouped into three general categories: dust created from ground-disturbing activities such as clearing and grading, dust created from wind action on bare soils and stockpiles such as those not fully stabilized post-construction with either vegetation or a tackifier, and dust created from traffic on unpaved roads. Sediment is the basis for fugitive dust, meaning that sediment particles can become fugitive dust if they are windborne. Therefore, the thresholds for treating sediment and erosion on the site will be similar if not the same as the thresholds for treating fugitive dust. Maintaining existing vegetation and root systems is the single most effective method for avoiding fugitive dust and sediment. Where existing vegetation and root systems are disturbed, quickly reestablishing vegetation is critical.

1.2 Regulatory Compliance

Fugitive dust is a source of particulate matter with a mean diameter less than 10 microns (PM_{10}) which is one of the seven air pollutants the U.S. Environmental Protection Agency (EPA) regulates under the National Ambient Air Quality Standards (NAAQS). To a lesser extent, fugitive dust is a source of particulate matter with a mean diameter less than 2.5 microns ($PM_{2.5}$), which has proposed regulations pending under NAAQS. These soil particles are very small, can remain suspended in the air for long periods of time, and are easily inhaled into the lungs. Increased risks of death and disease have been linked to periods of high outdoor PM_{10} and $PM_{2.5}$ concentrations. These fine particles can potentially be lifted thousands of feet into the atmosphere and transported across continents and oceans creating global health, ecological, and climate change impacts.

The EPA shares responsibility with the Oregon Department of Environmental Quality (ODEQ) for the implementation of Clean Air Act (CAA) criteria in Oregon. ODEQ implements the CAA rules under the EPA-approved Oregon Administrative Rules (Chapter 340, Division 21 General Emission Standards for Particulate Matter). Fugitive dust is the primary concern related to the CAA at the Project. Fugitive dust is defined by ODEQ as dust that visibly leaves the project site for a period of more than **18 seconds in a 6-minute period,** determined by the attached EPA Method 22 (ODEQ 2019) at the downwind property boundary (Oregon Administrative Rules [OAR] 340-208-0210 (2)-a and -b).

The ODEQ Rule 340-208-0210 contains the following requirements for fugitive dust:

- Reasonable precautions must be taken to prevent particulate matter from becoming airborne. This includes, but is not limited to, the use of water or other chemicals to control dust during construction, on unpaved roads, and during the transport of materials; enclosure of materials stockpiles and covering of open-body trucks; and prompt removal from paved streets of earth or other material.
- If fugitive dust is discovered, ODEQ may require the Facility to cease work until the fugitive dust emissions are controlled. Emissions are considered controlled when fugitive dust is no longer leaving the Facility site for more than 18 seconds in a 6-minute period.

Further, ODEQ Rule 340-208-0300 specifies that it is prohibited to cause or allow any air contaminants (e.g., fugitive dust) to create a nuisance. If ODEQ determines that a nuisance has been created, the agency may pursue informal or formal enforcement actions to abate the nuisance.

A National Pollutant Discharge Elimination System Construction Stormwater Discharge Permit (Oregon 1200-C Construction Stormwater Permit), pursuant to Oregon Revised Statutes 468.050 and Section 402 of the federal Clean Water Act, will be obtained from ODEQ. This permit requires the permit holder to "Prevent wind-blown soil and dust from areas with exposed soil through the appropriate application of water or other dust suppression techniques to control the generation of pollutants that could be discharged in stormwater from the site" (Section 2.2.9) and requires permit holders to implement measures including monitoring, record keeping, reporting of exceedances, and installation, maintenance, and adaptive management of best management practices (BMPs) to control both stormwater and fugitive dust discharges. Implementation of these measures is intended to reduce fugitive dust to a negligible impact and ensure compliance with applicable air quality regulations.

The Morrow County Code regulates nuisances through the Oregon State Statute Chapter 203. Controlling fugitive dust emissions is required to avoid creating a public nuisance, which is defined as "any thing, substance, or act that is a threat to the public health, safety or welfare" (Morrow County Code Enforcement Ordinance ORD-2021-4).

2.0 Fugitive Dust Control Plan

2.1 Responsibility

The expectation is that the Contractor will implement and adaptively manage this Plan, controlling fugitive dust emissions and meeting all regulatory and public safety performance criteria throughout construction. As described in Section 1.2 above, the holder of the Oregon 1200-C permit is required to control fugitive dust emissions, including ensuring compliance by all subcontractors and outside service providers.

If the Certificate Holder identifies that the regulatory and public safety performance criteria are not being met, the Certificate Holder will implement enforcement measures, including but not limited to:

- Issuance of a Non-Conformance and/or Non-Compliance Report.
- Contractor to prepare and submit a corrective action plan.
- Contractor to document corrective actions taken and performance criteria met.
- Partial or full stoppage of work on site through activation of shut-down clause in contract.
- At the Certificate Holder's sole discretion, an outside contractor may be contracted to implement corrective actions, to be reimbursed by the Contractor.

Additionally, the Certificate Holder may establish a Community Action Council to create an open and ongoing pathway for communication with stakeholders for the Project, including controlling fugitive dust emissions and avoiding the creation of nuisances. The Community Action Council could include representatives from the Morrow County Commissioners' Office, Morrow County Planning Department, Oregon Department of Transportation, and neighboring landowners. The Contractor will work with the Certificate Holder to determine whether this Community Action Council will be established, and if so, the details of its establishment.

2.2 Monitoring

As required by the 1200-C permit, the permit holder will perform visual monitoring and recordkeeping by a Certified Erosion and Sediment Control or Storm Water Quality Inspector (inspector). The Contractor's construction site manager and inspector will be responsible for ensuring that the measures in this Plan are implemented, monitored, and adaptively managed, and that any exceedances are immediately reported to the Certificate Holder.

The visual monitoring required by the 1200-C permit must occur at least once every 14 calendar days. However, because OAR 340-208-0210 restricts visible fugitive emissions on a continuous standard to a maximum of 18 seconds in a given 6-minute period, and because fugitive dust emissions may provide an immediate public safety concern in this location, this Plan requires that fugitive dust be monitored and controlled on an ongoing basis.

Monitoring for fugitive dust emissions shall include:

- Use of EPA Method 22 (ODEQ 2019; see Attachment 2) as specified in OAR 340-208-0210, at least once a day.
- The observation shall be performed during times of peak construction activity at the downwind property boundary.
- Recording of observations in a fugitive dust inspection log that is kept on site and shall be available digitally to the Certificate Holder. This log shall include all information required in EPA Method 22 and shall also include photos and/or video taken during the observation period to document conditions.
- Installation and operation of a weather station, recording (at a minimum) wind speed and direction.

Triggers for additional, more frequent monitoring will include:

- Observation of visible fugitive dust emissions by Contractor, agency, or the Certificate Holder staff.
- Request by a member of the Community Action Council established by the Certificate Holder.
- Wind speeds greater than 15 miles per hour.
- Receipt of complaints or concerns through the Project Dust Control Hotline.

2.3 Training

EPA Method 22 (ODEQ 2019) does not require a specific certification, but it is necessary that the person responsible for observations completed for this method be knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in the references cited in Method 22 (EPA 2019) or from the lecture portion of the EPA Method 9 certification course. The Contractor shall document in the inspection log how the person responsible for observations meets this requirement.

Construction workers will attend a Worker Environmental Awareness Program training prior to conducting construction activities. This training will include a summary of fugitive dust control measures included in this Plan and the responsibilities of personnel working on the Facility related to fugitive dust control.

2.4 Fugitive Dust Prevention and Management

This document and the attached table are intended to provide guidance to construction personnel on measures intended to minimize impacts and control fugitive dust emissions during construction. It is the responsibility of the Contractor to monitor and adaptively manage the site to maintain compliance with all local, state, and federal requirements. Additionally, this Plan is supplemental to the Contractor's Erosion and Sediment Control Plan and does not substitute for any requirements of ODEQ or other agencies.

This Plan is performance-based. As shown in the flow chart in Figure 1, if fugitive dust emissions in excess of the ODEQ criteria of **18 seconds in a 6-minute period** occur, the Contractor shall:

- Implement adaptive management actions, including altering work operations and/or pause work until the fugitive dust emissions are controlled.
- Document that fugitive dust emissions have been controlled, including monitoring with EPA Method 22.
- In addition to any reporting requirements required in the 1200-C permit, report noncompliance incidents and adaptive management actions taken by the Certificate Holder within 24 hours of occurrence.

The Contractor shall maintain and implement this Plan during all phases of construction. The table in Attachment 1 provides suggested Reasonable Available Control Measures (RACMs) for anticipated fugitive dust sources based on industry-standard BMPs and reasonable precautions specified in the Oregon 1200-C permit, ODEQ's Construction Stormwater Best Management Practices Manual (Manual) (ODEQ 2021), and OAR 340-208-0210. Supplemental RACMs are identified in the table in case initial RACMs are not effective in controlling fugitive dust or are not feasible to implement (Attachment 1).

The Contractor shall identify and implement additional RACMs as needed to control fugitive dust emissions. Additionally, the Contractor may propose alternative approaches and RACMs for controlling fugitive dust. This proposal shall be made in writing and is subject to the approval of the Certificate Holder.

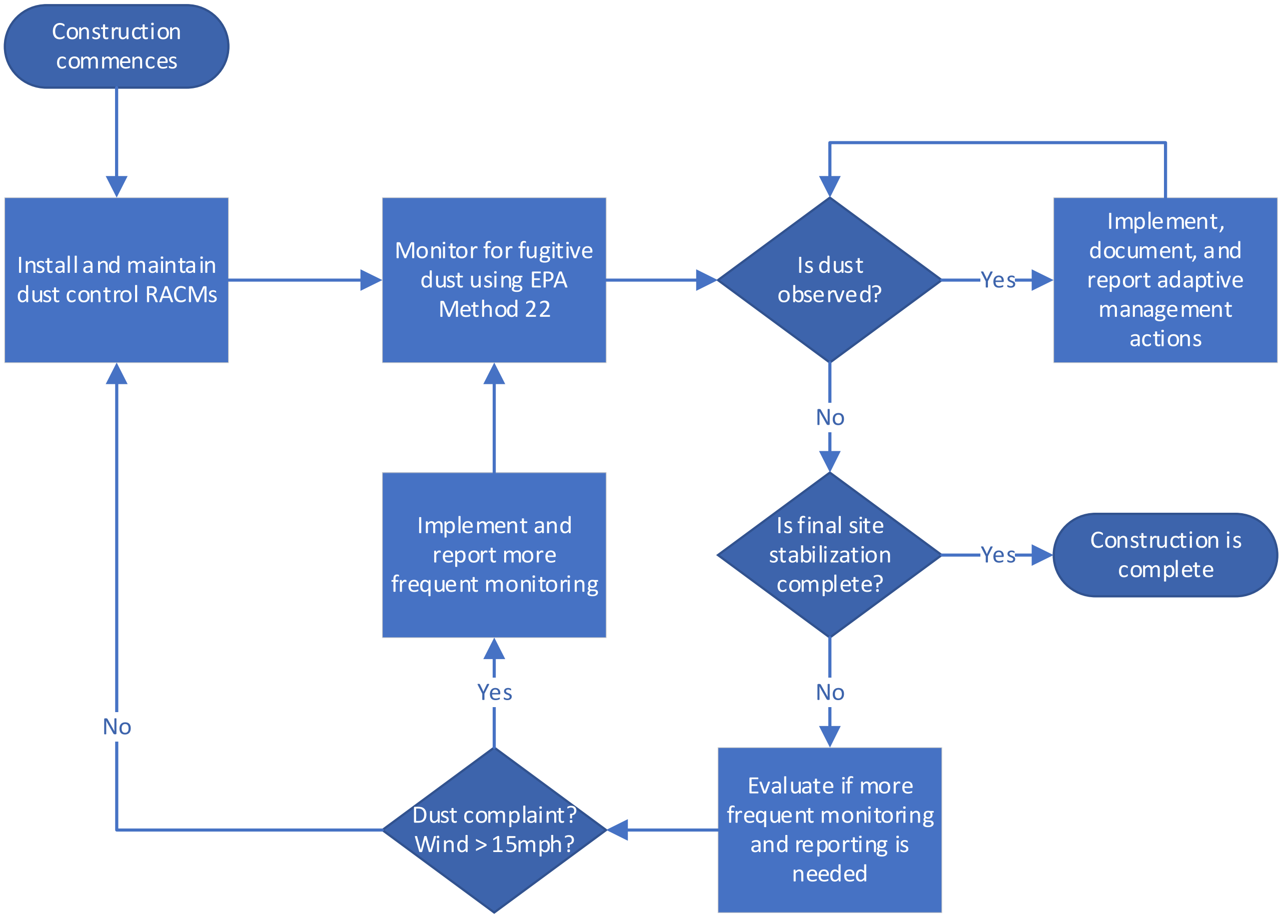

Figure 1. Dust Control Plan Flow Chart

3.0 References

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Attachment 1: Fugitive Dust Sources and Reasonable Available Control Measures

Fugitive Dust Sources and Reasonable Available Control Measures

Construction Phase	RACM(s)	Supplemental RACM(s)
All Phases of Construction	Daily fugitive dust monitoring and record keeping.	Increase frequency of monitoring.
	Prominent display of Dust Control Hotline signs, providing direct access to the Contractor's site manager or inspector.	If established, proactive engagement with Community Action Council.
	If established, Worker Environmental Awareness Program training for all construction employees.	Additional trainings and refreshers for employees.
	Maintain stockpile of BMPs on site, including sufficient palliatives for a single treatment of all site access roads and sufficient palliatives, mulch, and/or hydromulch for a minimum of 25 percent of the total disturbed area, and machinery for application.	Increase stockpile of palliatives, mulch, and/or hydromulch and add additional BMPs.
	Documentation and reporting of adaptive management actions.	Development and submittal of revised Fugitive Dust Control Plan.
Site Access	Install and maintain stabilized construction entrances at ingress/egress locations and restrict traffic to these locations.	Add additional construction entrance BMPs (e.g., wheel wash).
	Daily sweeping up of sediment from paved surfaces utilizing vacuum sweeper with HEPA filtration.	Increase sweeper frequency.
	Access roads shall be graveled.	Road maintenance and reapplication of gravel.
	Access roads will be stabilized with water or palliative sufficient to eliminate visible and sustained dust from vehicular travel and wind erosion. Reapply stabilization as necessary to maintain dust-free condition.	If water is unavailable or ineffective, or if water use is limited by any agency or regulation, access roads will be stabilized with longer-lasting palliatives.
	Restrict construction traffic to established and stabilized access routes.	Install fencing or barricades to prevent traffic outside of established routes.
	Limit traffic speeds to 15 miles per hour on stabilized unpaved roads within the site as long as such speeds do not create significant visible dust emissions. Traffic speed signs shall be displayed prominently at all site entrances and exits.	Limit traffic speeds within the site to 5 or 10 miles per hour.

Construction Phase	RACM(s)	Supplemental RACM(s)
Clearing, Grading, and Unstable Surfaces	Maintain the natural topography and vegetation of the site to the extent possible, including by limited grading and limited establishment of temporary access roads.	Reduce area being actively worked and stabilize unworked areas.
	Phase construction to expose the minimum amount of soil necessary.	Increase construction phasing to further minimize exposed soil.
	Leave existing vegetation intact to the extent possible.	Utilize mowing and rolling techniques to maintain plant root systems for soil stabilization.
	Minimize disturbance areas and soil exposure to the maximum extent feasible.	Limit work to a portion of the disturbed area until all disturbed areas receive temporary or final stabilization.
	When wind speeds exceed 15 miles per hour, minimize new disturbances to the extent possible and/or mobilize additional water trucks or palliatives to minimize fugitive dust from exposed surfaces.	Stop all ground disturbing activities and apply additional dust control measures until measures are effective or wind speeds slow and fugitive emissions stop.
	Separate and cover topsoil.	Increase maintenance frequency for topsoil cover. Combine methods, such as mulch plus tackifier.
	Stabilize exposed soils within the timeframes established in the 1200-C permit. Stabilize exposed soils in stages based on site conditions and weather.	Stabilize exposed soils more frequently, even if additional work is anticipated within the timeframe established in the 1200-C permit. Reapply stabilization measures following any additional disturbances.
	Temporarily stabilize exposed surfaces to prohibit significant and sustained visible fugitive dust from wind erosion. Utilize BMPs such as mulch, hydromulch with or without seeds, tackifier, spreading stone or gravel, and trackwalking.	Combine stabilization methods, such as mulch plus tackifier, or trackwalking plus hydromulch. Increase frequency of maintenance of stabilization.
	Seed exposed surfaces during the appropriate season with approved temporary or permanent seed mixes.	Reapply seed to newly disturbed areas or areas with poor germination. Use temporary seeding even if additional work is anticipated before final stabilization. Use irrigation to enhance seeding success.
	Gate seals should be tight on dump trucks. Soil load shall be kept below 6 inches of the freeboard of the truck. Drop heights shall be minimized when loaders dump soil into trucks.	Cover haul trucks with a tarp or other suitable cover.

Attachment 2: EPA Method 22

State of Oregon Department of Environmental Quality

OAR 340-208-0210

EPA Method 22

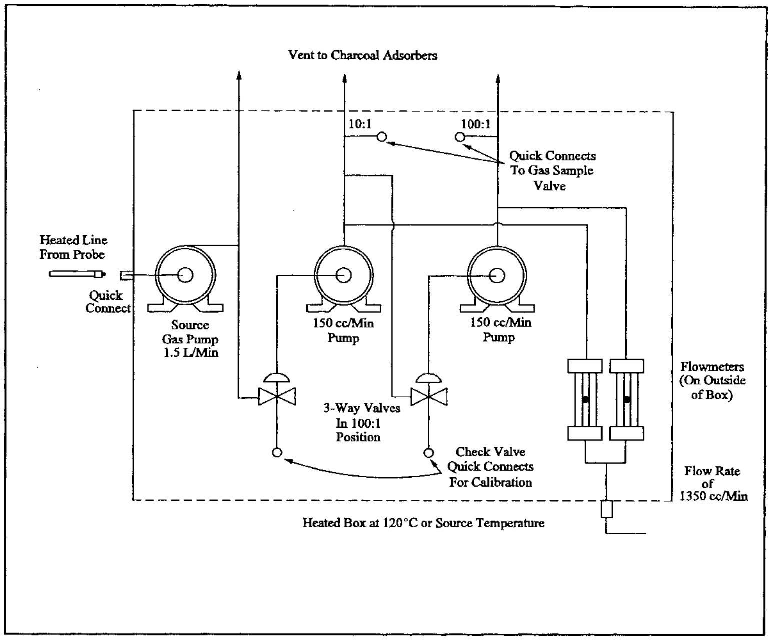


Figure 18-13. Schematic Diagram of the Heated Box Required for Dilution of Sample Gas.

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST

[Respond with initials or number as appropriate]

1. Presurvey data:
   - A. Grab sample collected ☐ ______
     - B. Grab sample analyzed for composition ☐ ______
     - Method GC ☐ ______
       - GC/MS ☐ ______
       - Other ☐ ______
   - C. GC-FID analysis performed ☐ ______
2. Laboratory calibration data:
   - A. Calibration curves prepared ☐ ______
     - Number of components ☐ ______
     - Number of concentrations/component (3 required). ☐ ______
   - B. Audit samples (optional):
   - Analysis completed ☐ ______
   - Verified for concentration ☐ ______
   - OK obtained for field work ☐ ______
3. Sampling procedures:
   - A. Method:
     - Bag sample ☐ ______
     - Direct interface ☐ ______
     - Dilution interface ☐ ______
   - B. Number of samples collected ☐ ______
4. Field Analysis:
   - A. Total hydrocarbon analysis performed ☐ ______
   - B. Calibration curve prepared ☐ ______
     - Number of components ☐ ______
     - Number of concentrations per component (3 required). ☐ ______

Gaseous Organic Sampling and Analysis Data

Plant ____________________

Date ____________________

Location ____________________

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST (RESPOND WITH INITIALS OR NUMBER AS APPROPRIATE)

1. Pre-survey data	Date
A. Grab sample collected	________
B. Grab sample analyzed for composition	________
Method GC	________
GC/MS	________
Other____________________	________
C. GC–FID analysis performed	________
2. Laboratory calibration curves prepared	________
A. Number of components	________
B. Number of concentrations per component (3 required)	________
C. OK obtained for field work	________
3. Sampling procedures.	
A. Method.	
Bag sample	________
Direct interface	________
Dilution interface	________
B. Number of samples collected	________
4. Field Analysis.	
A. Total hydrocarbon analysis performed	________
B. Calibration curve prepared	________
Number of components	________
Number of concentrations per component (3 required)	________

Figure 18–14. Sampling and Analysis Sheet

[36 FR 24877, Dec. 23, 1971]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting appendix A–6 to part 60, see the List of CFR sections Affected, which appears in the Finding Aids section of the printed volume and at *www.fdsys.gov*.

APPENDIX A–7 TO PART 60—TEST METHODS 19 THROUGH 25E

Method 19—Determination of sulfur dioxide removal efficiency and particulate, sulfur dioxide and nitrogen oxides emission rates

Method 20—Determination of nitrogen oxides, sulfur dioxide, and diluent emissions from stationary gas turbines

Method 21—Determination of volatile organic compound leaks

Method 22—Visual determination of fugitive emissions from material sources and smoke emissions from flares

Method 23—Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans From Stationary Sources

Method 24—Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

Method 24A—Determination of volatile matter content and density of printing inks and related coatings

Method 25—Determination of total gaseous nonmethane organic emissions as carbon

Method 25A—Determination of total gaseous organic concentration using a flame ionization analyzer

Method 25B—Determination of total gaseous organic concentration using a nondispersive infrared analyzer

Method 25C—Determination of nonmethane organic compounds (NMOC) in MSW landfill gases

Method 25D—Determination of the Volatile Organic Concentration of Waste Samples

Method 25E—Determination of Vapor Phase Organic Concentration in Waste Samples

The test methods in this appendix are referred to in §60.8 (Performance Tests) and §60.11 (Compliance With Standards and Maintenance Requirements) of 40 CFR part 60, subpart A (General Provisions). Specific uses of these test methods are described in the standards of performance contained in the subparts, beginning with Subpart D.

Within each standard of performance, a section title ‘‘Test Methods and Procedures’’ is provided to: (1) Identify the test methods to be used as reference methods to the facility subject to the respective standard and (2) identify any special instructions or conditions to be followed when applying a method to the respective facility. Such instructions (for example, establish sampling rates, volumes, or temperatures) are to be used either in addition to, or as a substitute for procedures in a test method. Similarly, for sources subject to emission monitoring requirements, specific instructions pertaining to any use of a test method as a reference method are provided in the subpart or in Appendix B.

Inclusion of methods in this appendix is not intended as an endorsement or denial of their applicability to sources that are not subject to standards of performance. The methods are potentially applicable to other sources; however, applicability should be confirmed by careful and appropriate evaluation of the conditions prevalent at such sources.

The approach followed in the formulation of the test methods involves specifications for equipment, procedures, and performance. In concept, a performance specification approach would be preferable in all methods because this allows the greatest flexibility to the user. In practice, however, this approach is impractical in most cases because performance specifications cannot be established. Most of the methods described herein, therefore, involve specific equipment specifications and procedures, and only a few methods in this appendix rely on performance criteria.

Minor changes in the test methods should not necessarily affect the validity of the results and it is recognized that alternative and equivalent methods exist. section 60.8 provides authority for the Administrator to specify or approve (1) equivalent methods, (2) alternative methods, and (3) minor changes in the methodology of the test methods. It should be clearly understood that unless otherwise identified all such methods and changes must have prior approval of the Administrator. An owner employing such methods or deviations from the test methods without obtaining prior approval does so at the risk of subsequent disapproval and retesting with approved methods.

Within the test methods, certain specific equipment or procedures are recognized as being acceptable or potentially acceptable and are specifically identified in the methods. The items identified as acceptable options may be used without approval but must be identified in the test report. The potentially approvable options are cited as ‘‘subject to the approval of the Administrator’’ or as ‘‘or equivalent.’’ Such potentially approvable techniques or alternatives may be used at the discretion of the owner without prior approval. However, detailed descriptions for applying these potentially approvable techniques or alternatives are not provided in the test methods. Also, the potentially approvable options are not necessarily acceptable in all applications. Therefore, an owner electing to use such potentially approvable techniques or alternatives is responsible for: (1) assuring that the techniques or alternatives are in fact applicable and are properly executed; (2) including a written description of the alternative method in the test report (the written method must be clear and must be capable of being performed without additional instruction, and the degree of detail should be similar to the detail contained in the test methods); and (3) providing any rationale or supporting data necessary to show the validity of the alternative in the particular application. Failure to meet these requirements can result in the Administrator’s disapproval of the alternative.

Method 19—Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates

1.0 Scope and Application

1.1 Analytes. This method provides data reduction procedures relating to the following pollutants, but does not include any sample collection or analysis procedures.

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X), including:		
Nitric oxide (NO)	10102–43–9	N/A
Nitrogen dioxide (NO_2)	10102–44–0.	
Particulate matter (PM)	None assigned	N/A
Sulfur dioxide (SO_2)	7499–09–05	N/A

1.2 Applicability. Where specified by an applicable subpart of the regulations, this method is applicable for the determination of (a) PM, SO_2, and NO_X emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions.

2.0 Summary of Method

2.1 Emission Rates. Oxygen (O_2) or carbon dioxide (CO_2) concentrations and appropriate F factors (ratios of combustion gas volumes to heat inputs) are used to calculate pollutant emission rates from pollutant concentrations.

2.2 Sulfur Reduction Efficiency and SO_2 Removal Efficiency. An overall SO_2 emission reduction efficiency is computed from the efficiency of fuel pretreatment systems, where applicable, and the efficiency of SO_2 control devices.

2.2.1 The sulfur removal efficiency of a fuel pretreatment system is determined by fuel sampling and analysis of the sulfur and heat contents of the fuel before and after the pretreatment system.

2.2.2 The SO_2 removal efficiency of a control device is determined by measuring the SO_2 rates before and after the control device.

2.2.2.1 The inlet rates to SO_2 control systems (or, when SO_2 control systems are not used, SO_2 emission rates to the atmosphere) are determined by fuel sampling and analysis.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety [Reserved]

6.0 Equipment and Supplies [Reserved]

7.0 Reagents and Standards [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transport [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedures [Reserved]

12.0 Data Analysis and Calculations

12.1 Nomenclature

B_{wa} = Moisture fraction of ambient air, percent.

B_{ws} = Moisture fraction of effluent gas, percent.

%C = Concentration of carbon from an ultimate analysis of fuel, weight percent.

C_d = Pollutant concentration, dry basis, ng/scm (lb/scf)

$\%CO_{2d}$,$\%CO_{2w}$ = Concentration of carbon dioxide on a dry and wet basis, respectively, percent.

C_w = Pollutant concentration, wet basis, ng/scm (lb/scf).

D = Number of sampling periods during the performance test period.

E = Pollutant emission rate, ng/J (lb/million Btu).

E_a = Average pollutant rate for the specified performance test period, ng/J (lb/million Btu).

E_{ao}, E_{ai} = Average pollutant rate of the control device, outlet and inlet, respectively, for the performance test period, ng/J (lb/million Btu).

E_{bi} = Pollutant rate from the steam generating unit, ng/J (lb/million Btu)

E_{bo} = Pollutant emission rate from the steam generating unit, ng/J (lb/million Btu).

E_{ci} = Pollutant rate in combined effluent, ng/J (lb/million Btu).

E_{co} = Pollutant emission rate in combined effluent, ng/J (lb/million Btu).

E_d = Average pollutant rate for each sampling period (*e.g.*, 24-hr Method 6B sample or 24-hr fuel sample) or for each fuel lot (*e.g.*, amount of fuel bunkered), ng/J (lb/million Btu).

E_{di} = Average inlet SO_2 rate for each sampling period d, ng/J (lb/million Btu)

E_g = Pollutant rate from gas turbine, ng/J (lb/million Btu).

E_{ga} = Daily geometric average pollutant rate, ng/J (lbs/million Btu) or ppm corrected to 7 percent O_2.

E_{jo},E_{ji} = Matched pair hourly arithmetic average pollutant rate, outlet and inlet, respectively, ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

E_h = Hourly average pollutant, ng/J (lb/million Btu).

E_{hj} = Hourly arithmetic average pollutant rate for hour ''j,'' ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

EXP = Natural logarithmic base (2.718) raised to the value enclosed by brackets.

F_d, F_w, F_c = Volumes of combustion components per unit of heat content, scm/J (scf/million Btu).

GCV = Gross calorific value of the fuel consistent with the ultimate analysis, kJ/kg (Btu/lb).

GCV_p, GCV_r = Gross calorific value for the product and raw fuel lots, respectively, dry basis, kJ/kg (Btu/lb).

%H = Concentration of hydrogen from an ultimate analysis of fuel, weight percent.

H = Total number of operating hours for which pollutant rates are determined in the performance test period.

H_b = Heat input rate to the steam generating unit from fuels fired in the steam generating unit, J/hr (million Btu/hr).

H_g = Heat input rate to gas turbine from all fuels fired in the gas turbine, J/hr (million Btu/hr).

$\%H_2O$ = Concentration of water from an ultimate analysis of fuel, weight percent.

H_r = Total numbers of hours in the performance test period (*e.g.*, 720 hours for 30-day performance test period).

K = Conversion factor, 10^{-5} (kJ/J)/(%) [10^6 Btu/million Btu].

K_c = (9.57 scm/kg)/% [(1.53 scf/lb)/%].

K_{cc} = (2.0 scm/kg)/% [(0.321 scf/lb)/%].

K_{hd} = (22.7 scm/kg)/% [(3.64 scf/lb)/%].

K_{hw} = (34.74 scm/kg)/% [(5.57 scf/lb)/%].

K_n = (0.86 scm/kg)/% [(0.14 scf/lb)/%].

K_o = (2.85 scm/kg)/% [(0.46 scf/lb)/%].

K_s = (3.54 scm/kg)/% [(0.57 scf/lb)/%].

K_w = (1.30 scm/kg)/% [(0.21 scf/lb)/%].

ln = Natural log of indicated value.

L_p,L_r = Weight of the product and raw fuel lots, respectively, metric ton (ton).

%N = Concentration of nitrogen from an ultimate analysis of fuel, weight percent.

N = Number of fuel lots during the averaging period.

n = Number of fuels being burned in combination.

n_d = Number of operating hours of the affected facility within the performance test period for each E_d determined.

n_t = Total number of hourly averages for which paired inlet and outlet pollutant rates are available within the 24-hr midnight to midnight daily period.

%O = Concentration of oxygen from an ultimate analysis of fuel, weight percent.

$\%O_{2d}$, $\%O_{2w}$ = Concentration of oxygen on a dry and wet basis, respectively, percent.

P_s = Potential SO_2 emissions, percent.

$\%R_f$ = SO_2 removal efficiency from fuel pretreatment, percent.

$\%R_g$ = SO_2 removal efficiency of the control device, percent.

$\%R_{ga}$ = Daily geometric average percent reduction.

$\%R_o$ = Overall SO_2 reduction, percent.

%S = Sulfur content of as-fired fuel lot, dry basis, weight percent.

S_e = Standard deviation of the hourly average pollutant rates for each performance test period, ng/J (lb/million Btu).

$\%S_f$ = Concentration of sulfur from an ultimate analysis of fuel, weight percent.

S_i = Standard deviation of the hourly average inlet pollutant rates for each performance test period, ng/J (lb/million Btu).

S_o = Standard deviation of the hourly average emission rates for each performance test period, ng/J (lb/million Btu).

$\%S_p$, $\%S_r$ = Sulfur content of the product and raw fuel lots respectively, dry basis, weight percent.

$t_{0.95}$ = Values shown in Table 19–3 for the indicated number of data points n.

X_k = Fraction of total heat input from each type of fuel k.

12.2 Emission Rates of PM, SO_2, and NO_X. Select from the following sections the applicable procedure to compute the PM, S_{O2}, or NO_X emission rate (E) in ng/J (lb/million Btu). The pollutant concentration must be in ng/scm (lb/scf) and the F factor must be in scm/J (scf/million Btu). If the pollutant concentration (C) is not in the appropriate units, use Table 19–1 in section 17.0 to make the proper conversion. An F factor is the ratio of the gas volume of the products of combustion to the heat content of the fuel. The dry F factor (F_d) includes all components of combustion less water, the wet F factor (F_w) includes all components of combustion, and the carbon F factor (F_c) includes only carbon dioxide.

NOTE: Since F_w factors include water resulting only from the combustion of hydrogen in the fuel, the procedures using F_w factors are not applicable for computing E from steam generating units with wet scrubbers or with other processes that add water (*e.g.*, steam injection).

12.2.1 Oxygen-Based F Factor, Dry Basis. When measurements are on a dry basis for both O ($\%O_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_d \frac{20.9}{\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-1}$$

12.2.2 Oxygen-Based F Factor, Wet Basis. When measurements are on a wet basis for both O_2 ($\%O_{2w}$) and pollutant (C_w) concentrations, use either of the following:

12.2.2.1 If the moisture fraction of ambient air (B_{wa}) is measured:

$$E = C_w F_w \frac{20.9}{\left[20.9\left(1 - B_{wa}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-2}$$

Instead of actual measurement, B_{wa} may be estimated according to the procedure below.

NOTE: The estimates are selected to ensure that negative errors will not be larger than −1.5 percent. However, positive errors, or over-estimation of emissions by as much as 5 percent may be introduced depending upon the geographic location of the facility and the associated range of ambient moisture.

12.2.2.1.1 B_{wa} = 0.027. This value may be used at any location at all times.

12.2.2.1.2 B_{wa} = Highest monthly average of B_{wa} that occurred within the previous calendar year at the nearest Weather Service Station. This value shall be determined annually and may be used as an estimate for the entire current calendar year.

12.2.2.1.3 B_{wa} = Highest daily average of Bwa that occurred within a calendar month at the nearest Weather Service Station, calculated from the data from the past 3 years. This value shall be computed for each month and may be used as an estimate for the current respective calendar month.

12.2.2.2 If the moisture fraction (B_{ws}) of the effluent gas is measured:

$$E = C_w F_d \frac{20.9}{\left[20.9\left(1-B_{ws}\right)-\%O_{2w}\right]} \qquad \text{Eq. 19-3}$$

12.2.3 Oxygen-Based F Factor, Dry/Wet Basis.

12.2.3.1 When the pollutant concentration is measured on a wet basis (C_w) and O_2 concentration is measured on a dry basis ($\%O_{2d}$), use the following equation:

$$E = \frac{\left(C_w F_d\right)(20.9)}{\left(1-B_{ws}\right)\left(20.9-\%O_{2d}\right)} \qquad \text{Eq. 19-4}$$

12.2.3.2 When the pollutant concentration is measured on a dry basis (C_d) and the O_2 concentration is measured on a wet basis ($\%O_{2w}$), use the following equation:

$$E = \frac{C_d F_d 20.9}{\dfrac{\left(20.9-\%O_{2w}\right)}{\left(1-B_{ws}\right)}} \qquad \text{Eq. 19-5}$$

12.2.4 Carbon Dioxide-Based F Factor, Dry Basis. When measurements are on a dry basis for both CO_2 ($\%CO_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_c \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-6}$$

12.2.5 Carbon Dioxide-Based F Factor, Wet Basis. When measurements are on a wet basis for both CO_2 ($\%CO_{2w}$) and pollutant (C_w) concentrations, use the following equation:

$$E = C_w F_c \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-7}$$

12.2.6 Carbon Dioxide-Based F Factor, Dry/Wet Basis.

12.2.6.1 When the pollutant concentration is measured on a wet basis (C_w) and CO_2 concentration is measured on a dry basis ($\%CO_{2d}$), use the following equation:

$$E = \frac{C_w F_c}{\left(1-B_{ws}\right)} \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-8}$$

12.2.6.2 When the pollutant concentration is measured on a dry basis (C_d) and CO_2 concentration is measured on a wet basis ($\%CO_{2w}$), use the following equation:

$$E = C_d F_c \left(1-B_{ws}\right) \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-9}$$

12.2.7 Direct-Fired Reheat Fuel Burning. The effect of direct-fired reheat fuel burning (for the purpose of raising the temperature of the exhaust effluent from wet scrubbers to above the moisture dew-point) on emission rates will be less than 1.0 percent and, therefore, may be ignored.

12.2.8 Combined Cycle-Gas Turbine Systems. For gas turbine-steam generator combined cycle systems, determine the emissions from the steam generating unit or the percent reduction in potential SO_2 emissions as follows:

12.2.8.1 Compute the emission rate from the steam generating unit using the following equation:

$$E_{bo} = E_{co} + \frac{H_g}{H_b}\left(E_{co} - E_g\right) \qquad \text{Eq. 19-10}$$

12.2.8.1.1 Use the test methods and procedures section of 40 CFR Part 60, Subpart GG to obtain E_{co} and E_g. Do not use F_w factors for determining E_g or E_{co}. If an SO_2 control device is used, measure E_{co} after the control device.

12.2.8.1.2 Suitable methods shall be used to determine the heat input rates to the steam generating units (H_b) and the gas turbine (H_g).

12.2.8.2 If a control device is used, compute the percent of potential SO_2 emissions (P_s) using the following equations:

$$E_{bi} = E_{ci} - \frac{H_g}{H_b}\left(E_{ci} - E_g\right) \qquad \text{Eq. 19-11}$$

$$P_s = 100\left(1 - \frac{E_{bo}}{E_{bi}}\right) \qquad \text{Eq. 19-12}$$

NOTE: Use the test methods and procedures section of Subpart GG to obtain E_{ci} and E_g. Do not use F_w factors for determining E_g or E_{ci}.

12.3 F Factors. Use an average F factor according to section 12.3.1 or determine an applicable F factor according to section 12.3.2. If combined fuels are fired, prorate the applicable F factors using the procedure in section 12.3.3.

12.3.1 Average F Factors. Average F factors (F_d, F_w, or F_c) from Table 19–2 in section 17.0 may be used.

12.3.2 Determined F Factors. If the fuel burned is not listed in Table 19–2 or if the owner or operator chooses to determine an F factor rather than use the values in Table 19–2, use the procedure below:

12.3.2.1 Equations. Use the equations below, as appropriate, to compute the F factors:

$$F_d = \frac{K\left(K_{hd}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O\right)}{GCV} \qquad \text{Eq. 19-13}$$

$$F_w = \frac{K\left[K_{hw}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O + K_w\%H_2O\right]}{GCV_w} \qquad \text{Eq. 19-14}$$

$$F_c = \frac{K\left(K_{cc}\%C\right)}{GCV} \qquad \text{Eq. 19-15}$$

NOTE: Omit the $\%H_2O$ term in the equations for F_w if %H and %O include the unavailable hydrogen and oxygen in the form of H_2O.)

12.3.2.2 Use applicable sampling procedures in section 12.5.2.1 or 12.5.2.2 to obtain samples for analyses.

12.3.2.3 Use ASTM D 3176–74 or 89 (all cited ASTM standards are incorporated by reference—see §60.17) for ultimate analysis of the fuel.

12.3.2.4 Use applicable methods in section 12.5.2.1 or 12.5.2.2 to determine the heat content of solid or liquid fuels. For gaseous fuels, use ASTM D 1826–77 or 94 (incorporated by reference—see §60.17) to determine the heat content.

12.3.3 F Factors for Combination of Fuels. If combinations of fuels are burned, use the following equations, as applicable unless otherwise specified in an applicable subpart:

$$F_d = \sum_{k=1}^{n}\left(X_k F_{dk}\right) \qquad \text{Eq. 19-16}$$

$$F_w = \sum_{k=1}^{n}\left(X_k F_{wk}\right) \qquad \text{Eq. 19-17}$$

$$F_c = \sum_{k=1}^{n}\left(X_k F_{ck}\right) \qquad \text{Eq. 19-18}$$

12.4 Determination of Average Pollutant Rates.

12.4.1 Average Pollutant Rates from Hourly Values. When hourly average pollutant rates (E_h), inlet or outlet, are obtained (*e.g.*, CEMS values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{1}{H}\sum_{j=1}^{n} E_{hj} \qquad \text{Eq. 19-19}$$

12.4.2 Average Pollutant Rates from Other than Hourly Averages. When pollutant rates are determined from measured values representing longer than 1-hour periods (*e.g.*, daily fuel sampling and analyses or Method 6B values), or when pollutant rates are determined from combinations of 1-hour and longer than 1-hour periods (*e.g.*, CEMS and Method 6B values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{\sum_{j=1}^{D}\left(n_d E_d\right)_j}{\sum_{j=1}^{D} n_{dj}} \qquad \text{Eq. 19-20}$$

12.4.3 Daily Geometric Average Pollutant Rates from Hourly Values. The geometric average pollutant rate (E_{ga}) is computed using the following equation:

$$E_{ga} = \exp\left[\frac{1}{n_t}\sum_{j=1}^{n_t}\left[\ln\left(E_{hj}\right)\right]\right] \qquad \text{Eq. 19-21}$$

12.5 Determination of Overall Reduction in Potential Sulfur Dioxide Emission.

12.5.1 Overall Percent Reduction. Compute the overall percent SO_2 reduction ($\%R_o$) using the following equation:

$$\%R_o = 100\left[1.0 - \left(1.0 - \frac{\%R_f}{100}\right)\left(1.0 - \frac{\%R_g}{100}\right)\right] \qquad \text{Eq. 19-22}$$

12.5.2 Pretreatment Removal Efficiency (Optional). Compute the SO_2 removal efficiency from fuel pretreatment ($\%R_f$) for the averaging period (*e.g.*, 90 days) as specified in the applicable regulation using the following equation:

$$\%R_f = 100\left[1.0 - \frac{\sum_{j=1}^{N}\left(\frac{\%S_{pj}}{GCV_{pj}}\right)L_{pj}}{\sum_{j=1}^{N}\left(\frac{\%S_{rj}}{GCV_{rj}}\right)L_{rj}}\right] \qquad \text{Eq. 19-23}$$

NOTE: In calculating $\%R_f$, include %S and GCV values for all fuel lots that are not pretreated and are used during the averaging period.

12.5.2.1 Solid Fossil (Including Waste) Fuel/Sampling and Analysis.

NOTE: For the purposes of this method, raw fuel (coal or oil) is the fuel delivered to the desulfurization (pretreatment) facility. For oil, the input oil to the oil desulfurization process (*e.g.*, hydrotreatment) is considered to be the raw fuel.

12.5.2.1.1 Sample Increment Collection. Use ASTM D 2234–76, 96, 97a, or 98 (incorporated by reference—see §60.17), Type I, Conditions A, B, or C, and systematic spacing. As used in this method, systematic spacing is intended to include evenly spaced increments in time or increments based on equal weights of coal passing the collection area. As a minimum, determine the number and weight of increments required per gross sample representing each coal lot according to Table 2 or Paragraph 7.1.5.2 of ASTM D 2234. Collect one gross sample for each lot of raw coal and one gross sample for each lot of product coal.

12.5.2.1.2 ASTM Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of product coal is the weight of product coal from one type of raw coal. The lot size of raw coal is the weight of raw coal used to produce one lot of product coal. Typically, the lot size is the weight of coal processed in a 1-day (24-hour) period. If more than one type of coal is treated and produced in 1 day, then gross samples must be collected and analyzed for each type of coal. A coal lot size equaling the 90-day quarterly fuel quantity for a steam generating unit may be used if representative sampling can be conducted for each raw coal and product coal.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.1.3 Gross Sample Analysis. Use ASTM D 2013–72 or 86 to prepare the sample, ASTM D 3177–75 or 89 or ASTM D 4239–85, 94, or 97 to determine sulfur content (%S), ASTM D 3173–73 or 87 to determine moisture content, and ASTM D 2015–77 (Reapproved 1978) or 96, D 3286–85 or 96, or D 5865–98 or 10 to determine gross calorific value (GCV) (all standards cited are incorporated by reference—see §60.17 for acceptable versions of the standards) on a dry basis for each gross sample.

12.5.2.2 Liquid Fossil Fuel-Sampling and Analysis. See Note under section 12.5.2.1.

12.5.2.2.1 Sample Collection. Follow the procedures for continuous sampling in ASTM D 270 or D 4177–95 (incorporated by reference—see §60.17) for each gross sample from each fuel lot.

12.5.2.2.2 Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of a product oil is the weight of product oil from one pretreatment facility and intended as one shipment (ship load, barge load, etc.). The lot size of raw oil is the weight of each crude liquid fuel type used to produce a lot of product oil.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.2.3 Sample Analysis. Use ASTM D 129–64, 78, or 95, ASTM D 1552–83 or 95, or ASTM D 4057–81 or 95 to determine the sulfur content (%S) and ASTM D 240–76 or 92 (all standards cited are incorporated by reference—see §60.17) to determine the GCV of each gross sample. These values may be assumed to be on a dry basis. The owner or operator of an affected facility may elect to determine the GCV by sampling the oil combusted on the first steam generating unit operating day of each calendar month and then using the lowest GCV value of the three GCV values per quarter for the GCV of all oil combusted in that calendar quarter.

12.5.2.3 Use appropriate procedures, subject to the approval of the Administrator, to determine the fraction of total mass input derived from each type of fuel.

12.5.3 Control Device Removal Efficiency. Compute the percent removal efficiency ($\%R_g$) of the control device using the following equation:

$$\%R_g = 100\left(1.0 - \frac{E_{ao}}{E_{ai}}\right) \qquad \text{Eq. 19-24}$$

12.5.3.1 Use continuous emission monitoring systems or test methods, as appropriate, to determine the outlet SO_2 rates and, if appropriate, the inlet SO_2 rates. The rates may be determined as hourly (E_h) or other sampling period averages (E_d). Then, compute the average pollutant rates for the performance test period (E_{ao} and E_{ai}) using the procedures in section 12.4.

12.5.3.2 As an alternative, as-fired fuel sampling and analysis may be used to determine inlet SO_2 rates as follows:

12.5.3.2.1 Compute the average inlet SO_2 rate (E_{di}) for each sampling period using the following equation:

$$E_{di} = K\frac{\%S}{GCV} \qquad \text{Eq. 19-25}$$

Where:

$$K = 2\times10^7\left(\frac{\text{ng } SO_2}{\%S}\right)\left(\frac{(\text{kJ})}{\text{J}}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^4\left(\frac{\text{lb } SO_2}{\%S}\right)\left(\frac{\text{Btu}}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4 to determine the average inlet SO_2 rate for the performance test period (E_{ai}).

12.5.3.2.2 Collect the fuel samples from a location in the fuel handling system that provides a sample representative of the fuel bunkered or consumed during a steam generating unit operating day. For the purpose of as-fired fuel sampling under section 12.5.3.2 or section 12.6, the lot size for coal is the weight of coal bunkered or consumed during each steam generating unit operating day. The lot size for oil is the weight of oil supplied to the ‘‘day’’ tank or consumed during each steam generating unit operating day. For reporting and calculation purposes, the gross sample shall be identified with the calendar day on which sampling began. For steam generating unit operating days when a coal-fired steam generating unit is operated without coal being added to the bunkers, the coal analysis from the previous ‘‘as bunkered’’ coal sample shall be used until coal is bunkered again. For steam generating unit operating days when an oil-fired steam generating unit is operated without oil being added to the oil ‘‘day’’ tank, the oil analysis from the previous day shall be used until the ‘‘day’’ tank is filled again. Alternative definitions of fuel lot size may be used, subject to prior approval of the Administrator.

12.5.3.2.3 Use ASTM procedures specified in section 12.5.2.1 or 12.5.2.2 to determine %S and GCV.

12.5.4 Daily Geometric Average Percent Reduction from Hourly Values. The geometric average percent reduction ($\%R_{ga}$) is computed using the following equation:

$$\%R_{ga} = 100\left[1 - \text{EXP}\left(\frac{1}{n_t}\sum_{j=1}^{n_t} 1\text{n}\frac{E_{jo}}{E_{ji}}\right)\right] \qquad \text{Eq. 19-26}$$

NOTE: The calculation includes only paired data sets (hourly average) for the inlet and outlet pollutant measurements.

12.6 Sulfur Retention Credit for Compliance Fuel. If fuel sampling and analysis procedures in section 12.5.2.1 are being used to determine average SO_2 emission rates (E_{as}) to the atmosphere from a coal-fired steam generating unit when there is no SO_2 control device, the following equation may be used to adjust the emission rate for sulfur retention credits (no credits are allowed for oil-fired systems) (E_{di}) for each sampling period using the following equation:

$$E_{di} = 0.97K\ \frac{\%S}{GDV} \qquad \text{Eq. 19-27}$$

Where:

$$K = 2\times10^{7}\left(\frac{\text{ng SO}_2}{\%S}\right)\left(\frac{kJ}{J}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^{4}\left(\frac{\text{lb SO}_2}{\%S}\right)\left(\frac{Btu}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4.2 to determine the average SO_2 emission rate to the atmosphere for the performance test period (E_{ao}).

12.7 Determination of Compliance When Minimum Data Requirement Is Not Met.

12.7.1 Adjusted Emission Rates and Control Device Removal Efficiency. When the minimum data requirement is not met, the Administrator may use the following adjusted emission rates or control device removal efficiencies to determine compliance with the applicable standards.

12.7.1.1 Emission Rate. Compliance with the emission rate standard may be determined by using the lower confidence limit of the emission rate (E_{ao}*) as follows:

$$E_{ao}^{*} = E_{ao} - t_{0.95} S_o \qquad \text{Eq. 19-28}$$

12.7.1.2 Control Device Removal Efficiency. Compliance with the overall emission reduction ($\%R_o$) may be determined by using the lower confidence limit of the emission rate (E_{ao}*) and the upper confidence limit of the inlet pollutant rate (E_{ai}*) in calculating the control device removal efficiency ($\%R_g$) as follows:

$$\%R_g = 100\left(1.0 - \frac{E_{ao}^{*}}{E_{ai}^{*}}\right) \qquad \text{Eq. 19-29}$$

$$E_{ai}^{*} = E_{ai} + t_{0.95} S_i \qquad \text{Eq. 19-30}$$

12.7.2 Standard Deviation of Hourly Average Pollutant Rates. Compute the standard deviation (S_e) of the hourly average pollutant rates using the following equation:

$$S_e = \sqrt{\frac{1}{H} - \frac{1}{H_r}}\ \sqrt{\frac{\sum_{j=1}^{H}\left(E_{hj} - E_a\right)^2}{H-1}} \qquad \text{Eq. 19-31}$$

Equation 19–19 through 19–31 may be used to compute the standard deviation for both the outlet (S_o) and, if applicable, inlet (S_i) pollutant rates.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References [Reserved]

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION

From	To	Multiply by
g/scm	ng/scm	10^9
mg/scm	ng/scm	10^6
lb/scf	ng/scm	1.602×10^{13}

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION—Continued

From	To	Multiply by
ppm SO_2	ng/scm	2.66×10^6
ppm NO_X	ng/scm	1.912×10^6
ppm SO_2	lb/scf	1.660×10^{-7}
ppm NO_X	lb/scf	1.194×10^{-7}

TABLE 19–2—F FACTORS FOR VARIOUS FUELS[1]

Fuel Type	F_d		F_w		F_c	
	dscm/J	dscf/10^6 Btu	wscm/J	wscf/10^6 Btu	scm/J	scf/10^6 Btu
Coal:						
Anthracite[2]	2.71×10^{-7}	10,100	2.83×10^{-7}	10,540	0.530×10^{-7}	1,970
Bituminus[2]	2.63×10^{-7}	9,780	2.86×10^{-7}	10,640	0.484×10^{-7}	1,800
Lignite	2.65×10^{-7}	9,860	3.21×10^{-7}	11,950	0.513×10^{-7}	1,910
Oil[3]	2.47×10^{-7}	9,190	2.77×10^{-7}	10,320	0.383×10^{-7}	1,420
Gas:.						
Natural	2.34×10^{-7}	8,710	2.85×10^{-7}	10,610	0.287×10^{-7}	1,040
Propane	2.34×10^{-7}	8,710	2.74×10^{-7}	10,200	0.321×10^{-7}	1,190
Butane	2.34×10^{-7}	8,710	2.79×10^{-7}	10,390	0.337×10^{-7}	1,250
Wood	2.48×10^{-7}	9,240			0.492×10^{-7}	1,830
Wood Bark	2.58×10^{-7}	9,600			0.516×10^{-7}	1,920
Municipal	2.57×10^{-7}	9,570			0.488×10^{-7}	1,820
Solid Waste						

[1] Determined at standard conditions: 20 °C (68 °F) and 760 mm Hg (29.92 in Hg)

[2] As classified according to ASTM D 388.

[3] Crude, residual, or distillate.

TABLE 19–3—VALUES FOR $T_{0.95}$*

n[1]	$t_{0.95}$	n[1]	$t_{0.95}$	n[1]	$t_{0.95}$
2	6.31	8	1.89	22–26	1.71
3	2.42	9	1.86	27–31	1.70
4	2.35	10	1.83	32–51	1.68
5	2.13	11	1.81	52–91	1.67
6	2.02	12–16	1.77	92–151	1.66
7	1.94	17–21	1.73	152 or more	1.65

[1] The values of this table are corrected for n-1 degrees of freedom. Use n equal to the number (H) of hourly average data points.

METHOD 20—DETERMINATION OF NITROGEN OXIDES, SULFUR DIOXIDE, AND DILUENT EMISSIONS FROM STATIONARY GAS TURBINES

1.0 Scope and Application

What is Method 20?

Method 20 contains the details you must follow when using an instrumental analyzer to determine concentrations of nitrogen oxides, oxygen, carbon dioxide, and sulfur dioxide in the emissions from stationary gas turbines. This method follows the specific instructions for equipment and performance requirements, supplies, sample collection and analysis, calculations, and data analysis in the methods listed in section 2.0.

1.1 Analytes. What does this method determine?

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X) as nitrogen dioxide:	10102–43–9	Typically <2% of Calibration Span.
Nitric oxide (NO)	10102–44–0	
Nitrogen dioxide NO_2.		
Diluent oxygen (O_2) or carbon dioxide (CO_2)		Typically <2% of Calibration Span.
Sulfur dioxide (SO_X)	7446–09–5	Typically <2% of Calibration Span.

1.2 Applicability. When is this method required? The use of Method 20 may be required by specific New Source Performance Standards, Clean Air Marketing rules, and State Implementation Plans and permits where

measuring SO_2, NO_X, CO_2, and/or O_2 concentrations in stationary gas turbines emissions are required. Other regulations may also require its use.

1.3 Data Quality Objectives. How good must my collected data be? Refer to section 1.3 of Method 7E.

2.0 Summary of Method

In this method, NO_X, O_2 (or CO_2), and SO_X are measured using the following methods found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 3A—Determination of Oxygen and Carbon Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(c) Method 6C—Determination of Sulfur Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(d) Method 7E—Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(e) Method 19—Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates.

3.0 Definitions

Refer to section 3.0 of Method 7E for the applicable definitions.

4.0 Interferences

Refer to section 4.0 of Methods 3A, 6C, and 7E as applicable.

5.0 Safety

Refer to section 5.0 of Method 7E.

6.0 Equipment and Supplies

The measurement system design is shown in Figure 7E–1 of Method 7E. Refer to the appropriate methods listed in section 2.0 for equipment and supplies.

7.0 Reagents and Standards

Refer to the appropriate methods listed in section 2.0 for reagents and standards.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling Site and Sampling Points. Follow the procedures of section 8.1 of Method 7E. For the stratification test in section 8.1.2, determine the diluent-corrected pollutant concentration at each traverse point.

8.2 Initial Measurement System Performance Tests. You must refer to the appropriate methods listed in section 2.0 for the measurement system performance tests as applicable.

8.3 Interference Check. You must follow the procedures in section 8.3 of Method 3A or 6C, or section 8.2.7 of Method 7E (as appropriate).

8.4 Sample Collection. You must follow the procedures of section 8.4 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

8.5 Post-Run System Bias Check, Drift Assessment, and Alternative Dynamic Spike Procedure. You must follow the procedures of sections 8.5 and 8.6 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

9.0 Quality Control

Follow quality control procedures in section 9.0 of Method 7E.

10.0 Calibration and Standardization

Follow the procedures for calibration and standardization in section 10.0 of Method 7E.

11.0 Analytical Procedures

Because sample collection and analysis are performed together (see section 8), additional discussion of the analytical procedure is not necessary.

12.0 Calculations and Data Analysis

You must follow the procedures for calculations and data analysis in section 12.0 of the appropriate method listed in section 2.0. Follow the procedures in section 12.0 of Method 19 for calculating fuel-specific F factors, diluent-corrected pollutant concentrations, and emission rates.

13.0 Method Performance

The specifications for the applicable performance checks are the same as in section 13.0 of Method 7E.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures

Refer to section 16.0 of the appropriate method listed in section 2.0 for alternative procedures.

17.0 References

Refer to section 17.0 of the appropriate method listed in section 2.0 for references.

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Refer to section 18.0 of the appropriate method listed in section 2.0 for tables, diagrams, flowcharts, and validation data.

METHOD 21—DETERMINATION OF VOLATILE ORGANIC COMPOUND LEAKS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile Organic Compounds (VOC).	No CAS number assigned.

1.2 Scope. This method is applicable for the determination of VOC leaks from process equipment. These sources include, but are not limited to, valves, flanges and other connections, pumps and compressors, pressure relief devices, process drains, open-ended valves, pump and compressor seal system degassing vents, accumulator vessel vents, agitator seals, and access door seals.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A portable instrument is used to detect VOC leaks from individual sources. The instrument detector type is not specified, but it must meet the specifications and performance criteria contained in section 6.0. A leak definition concentration based on a reference compound is specified in each applicable regulation. This method is intended to locate and classify leaks only, and is not to be used as a direct measure of mass emission rate from individual sources.

3.0 Definitions

3.1 *Calibration gas* means the VOC compound used to adjust the instrument meter reading to a known value. The calibration gas is usually the reference compound at a known concentration approximately equal to the leak definition concentration.

3.2 *Calibration precision* means the degree of agreement between measurements of the same known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration.

3.3 *Leak definition concentration* means the local VOC concentration at the surface of a leak source that indicates that a VOC emission (leak) is present. The leak definition is an instrument meter reading based on a reference compound.

3.4 *No detectable emission* means a local VOC concentration at the surface of a leak source, adjusted for local VOC ambient concentration, that is less than 2.5 percent of the specified leak definition concentration. that indicates that a VOC emission (leak) is not present.

3.5 *Reference compound* means the VOC species selected as the instrument calibration basis for specification of the leak definition concentration. (For example, if a leak definition concentration is 10,000 ppm as methane, then any source emission that results in a local concentration that yields a meter reading of 10,000 on an instrument meter calibrated with methane would be classified as a leak. In this example, the leak definition concentration is 10,000 ppm and the reference compound is methane.)

3.6 *Response factor* means the ratio of the known concentration of a VOC compound to the observed meter reading when measured using an instrument calibrated with the reference compound specified in the applicable regulation.

3.7 *Response time* means the time interval from a step change in VOC concentration at the input of the sampling system to the time at which 90 percent of the corresponding final value is reached as displayed on the instrument readout meter.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Pollutants. Several of the compounds, leaks of which may be determined by this method, may be irritating or corrosive to tissues (*e.g.*, heptane) or may be toxic (*e.g.*, benzene, methyl alcohol). Nearly all are fire hazards. Compounds in emissions should be determined through familiarity with the source. Appropriate precautions can be found in reference documents, such as reference No. 4 in section 16.0.

6.0 Equipment and Supplies

A VOC monitoring instrument meeting the following specifications is required:

6.1 The VOC instrument detector shall respond to the compounds being processed. Detector types that may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption, and photoionization.

6.2 The instrument shall be capable of measuring the leak definition concentration specified in the regulation.

6.3 The scale of the instrument meter shall be readable to ±2.5 percent of the specified leak definition concentration.

6.4 The instrument shall be equipped with an electrically driven pump to ensure that a sample is provided to the detector at a constant flow rate. The nominal sample flow rate, as measured at the sample probe tip, shall be 0.10 to 3.0 l/min (0.004 to 0.1 ft^3/min) when the probe is fitted with a glass wool plug or filter that may be used to prevent plugging of the instrument.

6.5 The instrument shall be equipped with a probe or probe extension or sampling not to exceed 6.4 mm (¼ in) in outside diameter,

with a single end opening for admission of sample.

6.6 The instrument shall be intrinsically safe for operation in explosive atmospheres as defined by the National Electrical Code by the National Fire Prevention Association or other applicable regulatory code for operation in any explosive atmospheres that may be encountered in its use. The instrument shall, at a minimum, be intrinsically safe for Class 1, Division 1 conditions, and/or Class 2, Division 1 conditions, as appropriate, as defined by the example code. The instrument shall not be operated with any safety device, such as an exhaust flame arrestor, removed.

7.0 Reagents and Standards

7.1 Two gas mixtures are required for instrument calibration and performance evaluation:

7.1.1 Zero Gas. Air, less than 10 parts per million by volume (ppmv) VOC.

7.1.2 Calibration Gas. For each organic species that is to be measured during individual source surveys, obtain or prepare a known standard in air at a concentration approximately equal to the applicable leak definition specified in the regulation.

7.2 Cylinder Gases. If cylinder calibration gas mixtures are used, they must be analyzed and certified by the manufacturer to be within 2 percent accuracy, and a shelf life must be specified. Cylinder standards must be either reanalyzed or replaced at the end of the specified shelf life.

7.3 Prepared Gases. Calibration gases may be prepared by the user according to any accepted gaseous preparation procedure that will yield a mixture accurate to within 2 percent. Prepared standards must be replaced each day of use unless it is demonstrated that degradation does not occur during storage.

7.4 Mixtures with non-Reference Compound Gases. Calibrations may be performed using a compound other than the reference compound. In this case, a conversion factor must be determined for the alternative compound such that the resulting meter readings during source surveys can be converted to reference compound results.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Instrument Performance Evaluation. Assemble and start up the instrument according to the manufacturer's instructions for recommended warmup period and preliminary adjustments.

8.1.1 Response Factor. A response factor must be determined for each compound that is to be measured, either by testing or from reference sources. The response factor tests are required before placing the analyzer into service, but do not have to be repeated at subsequent intervals.

8.1.1.1 Calibrate the instrument with the reference compound as specified in the applicable regulation. Introduce the calibration gas mixture to the analyzer and record the observed meter reading. Introduce zero gas until a stable reading is obtained. Make a total of three measurements by alternating between the calibration gas and zero gas. Calculate the response factor for each repetition and the average response factor.

8.1.1.2 The instrument response factors for each of the individual VOC to be measured shall be less than 10 unless otherwise specified in the applicable regulation. When no instrument is available that meets this specification when calibrated with the reference VOC specified in the applicable regulation, the available instrument may be calibrated with one of the VOC to be measured, or any other VOC, so long as the instrument then has a response factor of less than 10 for each of the individual VOC to be measured.

8.1.1.3 Alternatively, if response factors have been published for the compounds of interest for the instrument or detector type, the response factor determination is not required, and existing results may be referenced. Examples of published response factors for flame ionization and catalytic oxidation detectors are included in References 1–3 of section 17.0.

8.1.2 Calibration Precision. The calibration precision test must be completed prior to placing the analyzer into service and at subsequent 3-month intervals or at the next use, whichever is later.

8.1.2.1 Make a total of three measurements by alternately using zero gas and the specified calibration gas. Record the meter readings. Calculate the average algebraic difference between the meter readings and the known value. Divide this average difference by the known calibration value and multiply by 100 to express the resulting calibration precision as a percentage.

8.1.2.2 The calibration precision shall be equal to or less than 10 percent of the calibration gas value.

8.1.3 Response Time. The response time test is required before placing the instrument into service. If a modification to the sample pumping system or flow configuration is made that would change the response time, a new test is required before further use.

8.1.3.1 Introduce zero gas into the instrument sample probe. When the meter reading has stabilized, switch quickly to the specified calibration gas. After switching, measure the time required to attain 90 percent of the final stable reading. Perform this test sequence three times and record the results. Calculate the average response time.

8.1.3.2 The instrument response time shall be equal to or less than 30 seconds. The instrument pump, dilution probe (if any), sample probe, and probe filter that will be used

during testing shall all be in place during the response time determination.

8.2 Instrument Calibration. Calibrate the VOC monitoring instrument according to section 10.0.

8.3 Individual Source Surveys.

8.3.1 Type I—Leak Definition Based on Concentration. Place the probe inlet at the surface of the component interface where leakage could occur. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained. Leave the probe inlet at this maximum reading location for approximately two times the instrument response time. If the maximum observed meter reading is greater than the leak definition in the applicable regulation, record and report the results as specified in the regulation reporting requirements. Examples of the application of this general technique to specific equipment types are:

8.3.1.1 Valves. The most common source of leaks from valves is the seal between the stem and housing. Place the probe at the interface where the stem exits the packing gland and sample the stem circumference. Also, place the probe at the interface of the packing gland take-up flange seat and sample the periphery. In addition, survey valve housings of multipart assembly at the surface of all interfaces where a leak could occur.

8.3.1.2 Flanges and Other Connections. For welded flanges, place the probe at the outer edge of the flange-gasket interface and sample the circumference of the flange. Sample other types of nonpermanent joints (such as threaded connections) with a similar traverse.

8.3.1.3 Pumps and Compressors. Conduct a circumferential traverse at the outer surface of the pump or compressor shaft and seal interface. If the source is a rotating shaft, position the probe inlet within 1 cm of the shaft-seal interface for the survey. If the housing configuration prevents a complete traverse of the shaft periphery, sample all accessible portions. Sample all other joints on the pump or compressor housing where leakage could occur.

8.3.1.4 Pressure Relief Devices. The configuration of most pressure relief devices prevents sampling at the sealing seat interface. For those devices equipped with an enclosed extension, or horn, place the probe inlet at approximately the center of the exhaust area to the atmosphere.

8.3.1.5 Process Drains. For open drains, place the probe inlet at approximately the center of the area open to the atmosphere. For covered drains, place the probe at the surface of the cover interface and conduct a peripheral traverse.

8.3.1.6 Open-ended Lines or Valves. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.7 Seal System Degassing Vents and Accumulator Vents. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.8 Access door seals. Place the probe inlet at the surface of the door seal interface and conduct a peripheral traverse.

8.3.2 Type II—''No Detectable Emission''. Determine the local ambient VOC concentration around the source by moving the probe randomly upwind and downwind at a distance of one to two meters from the source. If an interference exists with this determination due to a nearby emission or leak, the local ambient concentration may be determined at distances closer to the source, but in no case shall the distance be less than 25 centimeters. Then move the probe inlet to the surface of the source and determine the concentration as outlined in section 8.3.1. The difference between these concentrations determines whether there are no detectable emissions. Record and report the results as specified by the regulation. For those cases where the regulation requires a specific device installation, or that specified vents be ducted or piped to a control device, the existence of these conditions shall be visually confirmed. When the regulation also requires that no detectable emissions exist, visual observations and sampling surveys are required. Examples of this technique are:

8.3.2.1 Pump or Compressor Seals. If applicable, determine the type of shaft seal. Perform a survey of the local area ambient VOC concentration and determine if detectable emissions exist as described in section 8.3.2.

8.3.2.2 Seal System Degassing Vents, Accumulator Vessel Vents, Pressure Relief Devices. If applicable, observe whether or not the applicable ducting or piping exists. Also, determine if any sources exist in the ducting or piping where emissions could occur upstream of the control device. If the required ducting or piping exists and there are no sources where the emissions could be vented to the atmosphere upstream of the control device, then it is presumed that no detectable emissions are present. If there are sources in the ducting or piping where emissions could be vented or sources where leaks could occur, the sampling surveys described in section 8.3.2 shall be used to determine if detectable emissions exist.

8.3.3 Alternative Screening Procedure.

8.3.3.1 A screening procedure based on the formation of bubbles in a soap solution that is sprayed on a potential leak source may be used for those sources that do not have continuously moving parts, that do not have surface temperatures greater than the boiling point or less than the freezing point of the soap solution, that do not have open

areas to the atmosphere that the soap solution cannot bridge, or that do not exhibit evidence of liquid leakage. Sources that have these conditions present must be surveyed using the instrument technique of section 8.3.1 or 8.3.2.

8.3.3.2 Spray a soap solution over all potential leak sources. The soap solution may be a commercially available leak detection solution or may be prepared using concentrated detergent and water. A pressure sprayer or squeeze bottle may be used to dispense the solution. Observe the potential leak sites to determine if any bubbles are formed. If no bubbles are observed, the source is presumed to have no detectable emissions or leaks as applicable. If any bubbles are observed, the instrument techniques of section 8.3.1 or 8.3.2 shall be used to determine if a leak exists, or if the source has detectable emissions, as applicable.

9.0 Quality Control

Section	Quality control measure	Effect
8.1.2	Instrument calibration precision check	Ensure precision and accuracy, respectively, of instrument response to standard.
10.0	Instrument calibration.	

10.0 Calibration and Standardization

10.1 Calibrate the VOC monitoring instrument as follows. After the appropriate warmup period and zero internal calibration procedure, introduce the calibration gas into the instrument sample probe. Adjust the instrument meter readout to correspond to the calibration gas value.

NOTE: If the meter readout cannot be adjusted to the proper value, a malfunction of the analyzer is indicated and corrective actions are necessary before use.

11.0 Analytical Procedures [Reserved]

12.0 Data Analyses and Calculations [Reserved]

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Dubose, D.A., and G.E. Harris. Response Factors of VOC Analyzers at a Meter Reading of 10,000 ppmv for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81051. September 1981.

2. Brown, G.E., *et al.* Response Factors of VOC Analyzers Calibrated with Methane for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–022. May 1981.

3. DuBose, D.A. *et al.* Response of Portable VOC Analyzers to Chemical Mixtures. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–110. September 1981.

4. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 22—VISUAL DETERMINATION OF FUGITIVE EMISSIONS FROM MATERIAL SOURCES AND SMOKE EMISSIONS FROM FLARES

NOTE: This method is not inclusive with respect to observer certification. Some material is incorporated by reference from Method 9.

1.0 Scope and Application

This method is applicable for the determination of the frequency of fugitive emissions from stationary sources, only as specified in an applicable subpart of the regulations. This method also is applicable for the determination of the frequency of visible smoke emissions from flares.

2.0 Summary of Method

2.1 Fugitive emissions produced during material processing, handling, and transfer operations or smoke emissions from flares are visually determined by an observer without the aid of instruments.

2.2 This method is used also to determine visible smoke emissions from flares used for combustion of waste process materials.

2.3 This method determines the amount of time that visible emissions occur during the observation period (*i.e.*, the accumulated emission time). This method does not require that the opacity of emissions be determined. Since this procedure requires only the determination of whether visible emissions occur and does not require the determination of opacity levels, observer certification according to the procedures of Method 9 is not required. However, it is necessary that the observer is knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative

to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in References 1 and 2 or from the lecture portion of the Method 9 certification course.

3.0 Definitions

3.1 *Emission frequency* means the percentage of time that emissions are visible during the observation period.

3.2 *Emission time* means the accumulated amount of time that emissions are visible during the observation period.

3.3 *Fugitive emissions* means emissions generated by an affected facility which is not collected by a capture system and is released to the atmosphere. This includes emissions that (1) escape capture by process equipment exhaust hoods; (2) are emitted during material transfer; (3) are emitted from buildings housing material processing or handling equipment; or (4) are emitted directly from process equipment.

3.4 *Observation period* means the accumulated time period during which observations are conducted, not to be less than the period specified in the applicable regulation.

3.5 *Smoke emissions* means a pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission.

4.0 Interferences

4.1 Occasionally, fugitive emissions from sources other than the affected facility (*e.g.*, road dust) may prevent a clear view of the affected facility. This may particularly be a problem during periods of high wind. If the view of the potential emission points is obscured to such a degree that the observer questions the validity of continuing observations, then the observations shall be terminated, and the observer shall clearly note this fact on the data form.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment

6.1 Stopwatches (two). Accumulative type with unit divisions of at least 0.5 seconds.

6.2 Light Meter. Light meter capable of measuring illuminance in the 50 to 200 lux range, required for indoor observations only.

7.0 Reagents and Supplies [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transfer [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

11.1 Selection of Observation Location. Survey the affected facility, or the building or structure housing the process to be observed, and determine the locations of potential emissions. If the affected facility is located inside a building, determine an observation location that is consistent with the requirements of the applicable regulation (*i.e.*, outside observation of emissions escaping the building/structure or inside observation of emissions directly emitted from the affected facility process unit). Then select a position that enables a clear view of the potential emission point(s) of the affected facility or of the building or structure housing the affected facility, as appropriate for the applicable subpart. A position at least 4.6 m (15 feet), but not more than 400 m (0.25 miles), from the emission source is recommended. For outdoor locations, select a position where the sunlight is not shining directly in the observer's eyes.

11.2 Field Records.

11.2.1 Outdoor Location. Record the following information on the field data sheet (Figure 22–1): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record also the estimated wind speed, wind direction, and sky condition. Sketch the process unit being observed, and note the observer location relative to the source and the sun. Indicate the potential and actual emission points on the sketch.

11.2.2 Indoor Location. Record the following information on the field data sheet (Figure 22–2): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record as appropriate the type, location, and intensity of lighting on the data sheet. Sketch the process unit being observed, and note the observer location relative to the source. Indicate the potential and actual fugitive emission points on the sketch.

11.3 Indoor Lighting Requirements. For indoor locations, use a light meter to measure the level of illumination at a location as close to the emission source(s) as is feasible. An illumination of greater than 100 lux (10 foot candles) is considered necessary for proper application of this method.

11.4 Observations.

11.4.1 Procedure. Record the clock time when observations begin. Use one stopwatch to monitor the duration of the observation

period. Start this stopwatch when the observation period begins. If the observation period is divided into two or more segments by process shutdowns or observer rest breaks (see section 11.4.3), stop the stopwatch when a break begins and restart the stopwatch without resetting it when the break ends. Stop the stopwatch at the end of the observation period. The accumulated time indicated by this stopwatch is the duration of observation period. When the observation period is completed, record the clock time. During the observation period, continuously watch the emission source. Upon observing an emission (condensed water vapor is not considered an emission), start the second accumulative stopwatch; stop the watch when the emission stops. Continue this procedure for the entire observation period. The accumulated elapsed time on this stopwatch is the total time emissions were visible during the observation period (*i.e.,* the emission time.)

11.4.2 Observation Period. Choose an observation period of sufficient length to meet the requirements for determining compliance with the emission standard in the applicable subpart of the regulations. When the length of the observation period is specifically stated in the applicable subpart, it may not be necessary to observe the source for this entire period if the emission time required to indicate noncompliance (based on the specified observation period) is observed in a shorter time period. In other words, if the regulation prohibits emissions for more than 6 minutes in any hour, then observations may (optional) be stopped after an emission time of 6 minutes is exceeded. Similarly, when the regulation is expressed as an emission frequency and the regulation prohibits emissions for greater than 10 percent of the time in any hour, then observations may (optional) be terminated after 6 minutes of emission are observed since 6 minutes is 10 percent of an hour. In any case, the observation period shall not be less than 6 minutes in duration. In some cases, the process operation may be intermittent or cyclic. In such cases, it may be convenient for the observation period to coincide with the length of the process cycle.

11.4.3 Observer Rest Breaks. Do not observe emissions continuously for a period of more than 15 to 20 minutes without taking a rest break. For sources requiring observation periods of greater than 20 minutes, the observer shall take a break of not less than 5 minutes and not more than 10 minutes after every 15 to 20 minutes of observation. If continuous observations are desired for extended time periods, two observers can alternate between making observations and taking breaks.

11.5 Recording Observations. Record the accumulated time of the observation period on the data sheet as the observation period duration. Record the accumulated time emissions were observed on the data sheet as the emission time. Record the clock time the observation period began and ended, as well as the clock time any observer breaks began and ended.

12.0 Data Analysis and Calculations

If the applicable subpart requires that the emission rate be expressed as an emission frequency (in percent), determine this value as follows: Divide the accumulated emission time (in seconds) by the duration of the observation period (in seconds) or by any minimum observation period required in the applicable subpart, if the actual observation period is less than the required period, and multiply this quotient by 100.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

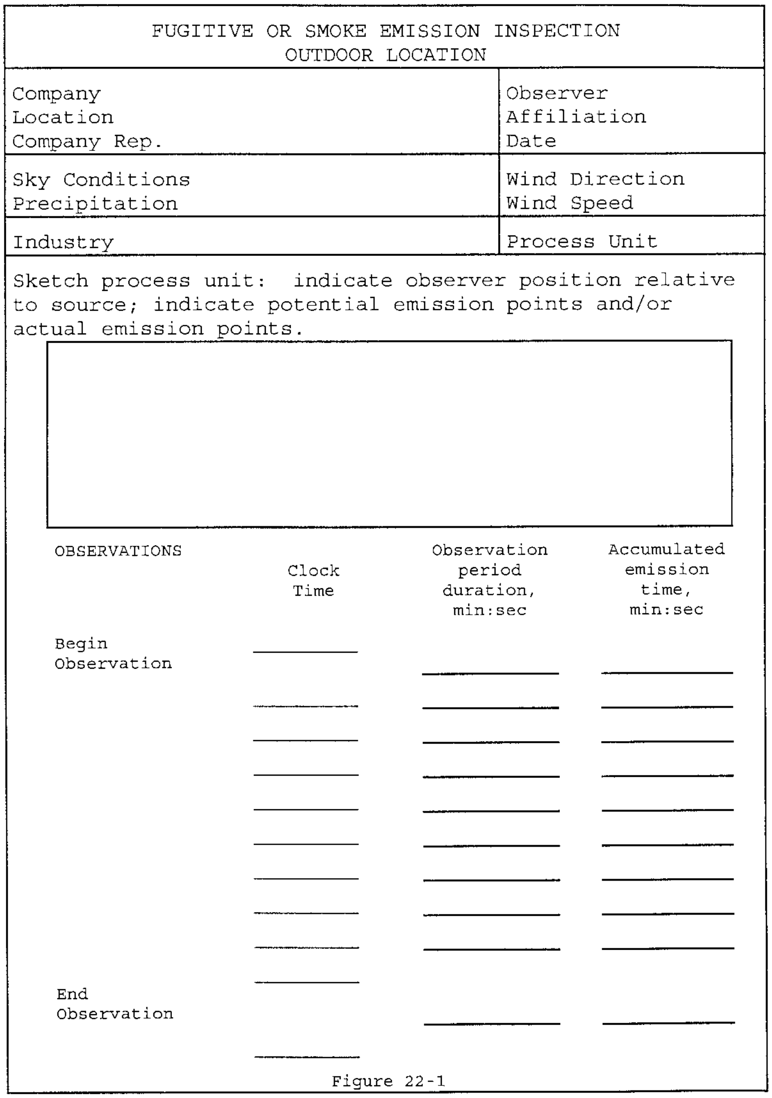
15.0 Waste Management [Reserved]

16.0 References

1. Missan, R., and A. Stein. Guidelines for Evaluation of Visible Emissions Certification, Field Procedures, Legal Aspects, and Background Material. EPA Publication No. EPA–340/1–75–007. April 1975.

2. Wohlschlegel, P., and D.E. Wagoner. Guideline for Development of a Quality Assurance Program: Volume IX—Visual Determination of Opacity Emissions from Stationary Sources. EPA Publication No. EPA–650/4–74–005i. November 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data



FUGITIVE OR SMOKE EMISSION INSPECTION
OUTDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Sky Conditions Precipitation	Wind Direction Wind Speed
Industry	Process Unit

Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin Observation	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______	______	______
	______		
End Observation		______	______
	______		

Figure 22-1

FUGITIVE OR SMOKE EMISSION INSPECTION
INDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Industry	Process Unit

Light type (fluorescent, incandescent, natural)
Light location (overhead, behind observer, etc.)
Illuminance (lux or footcandles)
Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin			
End Observation			

Figure 22-2

Method 23—Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans From Stationary Sources

1. Applicability and Principle

1.1 Applicability. This method is applicable to the determination of polychlorinated dibenzo-p-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) from stationary sources.

1.2 Principle. A sample is withdrawn from the gas stream isokinetically and collected in the sample probe, on a glass fiber filter, and on a packed column of adsorbent material. The sample cannot be separated into a particle vapor fraction. The PCDD's and

PCDF's are extracted from the sample, separated by high resolution gas chromatography, and measured by high resolution mass spectrometry.

2. Apparatus

2.1 Sampling. A schematic of the sampling train used in this method is shown in Figure 23–1. Sealing greases may not be used in assembling the train. The train is identical to that described in section 2.1 of Method 5 of this appendix with the following additions:

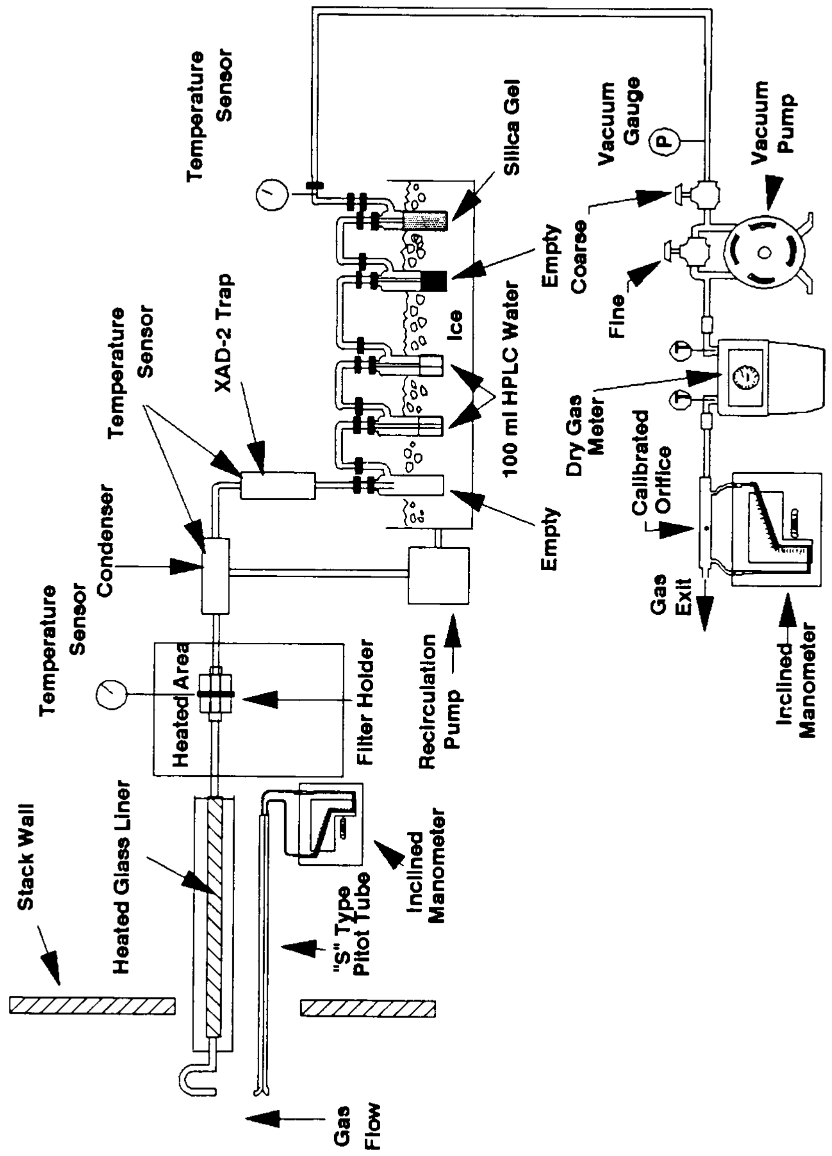


Figure 23.1 Sampling train

2.1.1 Nozzle. The nozzle shall be made of nickel, nickel-plated stainless steel, quartz, or borosilicate glass.

2.1.2 Sample Transfer Lines. The sample transfer lines, if needed, shall be heat traced, heavy walled TFE (½ in. OD with ⅛ in. wall) with connecting fittings that are capable of forming leak-free, vacuum-tight connections without using sealing greases. The line shall be as short as possible and must be maintained at 120 °C.

2.1.1 Filter Support. Teflon or Teflon-coated wire.

2.1.2 Condenser. Glass, coil type with compatible fittings. A schematic diagram is shown in Figure 23–2.

2.1.3 Water Bath. Thermostatically controlled to maintain the gas temperature exiting the condenser at <20 °C (68 °F).

2.1.4 Adsorbent Module. Glass container to hold the solid adsorbent. A shematic diagram is shown in Figure 23–2. Other physical configurations of the resin trap/condenser assembly are acceptable. The connecting fittings shall form leak-free, vacuum tight seals. No sealant greases shall be used in the sampling train. A coarse glass frit is included to retain the adsorbent.

2.2 Sample Recovery.

2.2.1 Fitting Caps. Ground glass, Teflon tape, or aluminum foil (Section 2.2.6) to cap off the sample exposed sections of the train.

2.2.2 Wash Bottles. Teflon, 500-ml.

2.2.3 Probe-Liner Probe-Nozzle, and Filter-Holder Brushes. Inert bristle brushes with precleaned stainless steel or Teflon handles. The probe brush shall have extensions of stainless steel or Teflon, at least as long as the probe. The brushes shall be properly sized and shaped to brush out the nozzle, probe liner, and transfer line, if used.

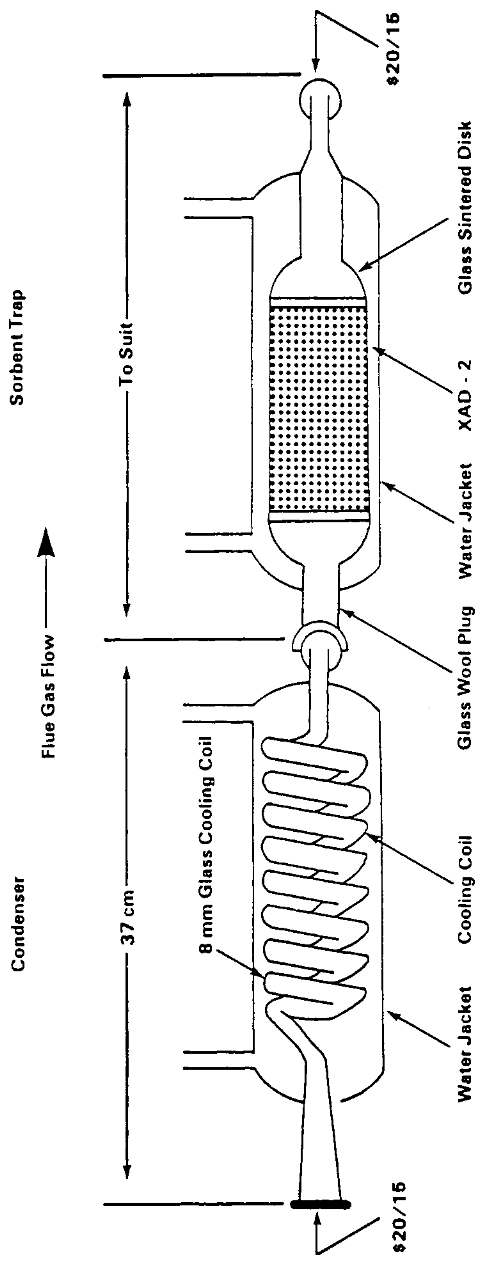


Figure 23.2. Condenser and adsorbent trap

2.2.4 Filter Storage Container. Sealed filter holder, wide-mouth amber glass jar with Teflon-lined cap, or glass petri dish.

2.2.5 Balance. Triple beam.

2.2.6 Aluminum Foil. Heavy duty, hexane-rinsed.

2.2.7 Storage Container. Air-tight container to store silica gel.

2.2.8 Graduated Cylinder. Glass, 250-ml with 2-ml graduation.

2.2.9 Glass Sample Storage Container. Amber glass bottle for sample glassware washes, 500- or 1000-ml, with leak free Teflon-lined caps.

2.3 Analysis.

2.3.1 Sample Container. 125- and 250-ml flint glass bottles with Teflon-lined caps.

2.3.2 Test Tube. Glass.

2.3.3 Soxhlet Extraction Apparatus. Capable of holding 43 × 123 mm extraction thimbles.

2.3.4 Extraction Thimble. Glass, precleaned cellulosic, or glass fiber.

2.3.5 Pasteur Pipettes. For preparing liquid chromatographic columns.

2.3.6 Reacti-vials. Amber glass, 2-ml, silanized prior to use.

2.3.7 Rotary Evaporator. Buchi/Brinkman RF–121 or equivalent.

2.3.8 Nitrogen Evaporative Concentrator. N-Evap Analytical Evaporator Model III or equivalent.

2.3.9 Separatory Funnels. Glass, 2-liter.

2.3.10 Gas Chromatograph. Consisting of the following components:

2.3.10.1 Oven. Capable of maintaining the separation column at the proper operating temperature ±°C and performing programmed increases in temperature at rates of at least 40 °C/min.

2.3.10.2 Temperature Gauge. To monitor column oven, detector, and exhaust temperatures ±1 °C.

2.3.10.3 Flow System. Gas metering system to measure sample, fuel, combustion gas, and carrier gas flows.

2.3.10.4 Capillary Columns. A fused silica column, 60 × 0.25 mm inside diameter (ID), coated with DB–5 and a fused silica column, 30 m × 0.25 mm ID coated with DB–225. Other column systems may be used provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

2.3.11 Mass Spectrometer. Capable of routine operation at a resolution of 1:10000 with a stability of ±5 ppm.

2.3.12 Data System. Compatible with the mass spectrometer and capable of monitoring at least five groups of 25 ions.

2.3.13 Analytical Balance. To measure within 0.1 mg.

3. Reagents

3.1 Sampling.

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Standard Method D 2986–71 (Reapproved 1978) (incorporated by reference—see § 60.17).

3.1.1.1 Precleaning. All filters shall be cleaned before their initial use. Place a glass extraction thimble and 1 g of silica gel and a plug of glass wool into a Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Place no more than 50 filters in the thimble onto the silica gel bed and top with the cleaned glass wool. Charge the Soxhlet with toluene and reflux for 16 hours. After extraction, allow the Soxhlet to cool, remove the filters, and dry them under a clean N_2 stream. Store the filters in a glass petri dish sealed with Teflon tape.

3.1.2 Adsorbent Resin. Amberlite XAD–2 resin. Thoroughly cleaned before initial use.

3.1.2.1 Cleaning Procedure. This procedure may be carried out in a giant Soxhlet extractor. An all-glass filter thimble containing an extra-course frit is used for extraction of XAD–2. The frit is recessed 10–15 mm above a crenelated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass wool plug and a stainless steel ring because it floats on methylene chloride. This process involves sequential extraction in the following order.

Solvent	Procedure
Water	Initial rinse: Place resin in a beaker, rinse once with water, and discard. Fill with water a second time, let stand overnight, and discard.
Water	Extract with water for 8 hours.
Methanol	Extract for 22 hours.
Methylene Chloride	Extract for 22 hours.
Toluene	Extract for 22 hours.

3.1.2.2 Drying.

3.1.2.2.1 Drying Column. Pyrex pipe, 10.2 cm ID by 0.6 m long, with suitable retainers.

3.1.2.2.2 Procedure. The adsorbent must be dried with clean inert gas. Liquid nitrogen from a standard commercial liquid nitrogen cylinder has proven to be a reliable source of large volumes of gas free from organic contaminants. Connect the liquid nitrogen cylinder to the column by a length of cleaned copper tubing, 0.95 cm ID, coiled to pass through a heat source. A convenient heat source is a water-bath heated from a steam line. The final nitrogen temperature should only be warm to the touch and not over 40 °C. Continue flowing nitrogen through the adsorbent until all the residual solvent is removed. The flow rate should be sufficient to gently agitate the particles but not so excessive as the cause the particles to fracture.

3.1.2.3 Quality Control Check. The adsorbent must be checked for residual toluene.

3.1.2.3.1 Extraction. Weigh 1.0 g sample of dried resin into a small vial, add 3 ml of toluene, cap the vial, and shake it well.

3.1.2.3.2 Analysis. Inject a 2 µl sample of the extract into a gas chromatograph operated under the following conditions:

Column: 6 ft × ⅛ in stainless steel containing 10 percent OV–101 on 100/120 Supelcoport.
Carrier Gas: Helium at a rate of 30 ml/min.
Detector: Flame ionization detector operated at a sensitivity of 4×10^{-11} A/mV.
Injection Port Temperature: 250 °C.
Detector Temperature: 305 °C.
Oven Temperature: 30 °C for 4 min; programmed to rise at 40 °C/min until it reaches 250 °C; return to 30 °C after 17 minutes.

Compare the results of the analysis to the results from the reference solution. Prepare the reference solution by injection 2.5 µl of methylene chloride into 100 ml of toluene. This corresponds to 100 µg of methylene chloride per g of adsorbent. The maximum acceptable concentration is 1000 µg/g of adsorbent. If the adsorbent exceeds this level, drying must be continued until the excess methylene chloride is removed.

3.1.2.4 Storage. The adsorbent must be used within 4 weeks of cleaning. After cleaning, it may be stored in a wide mouth amber glass container with a Teflon-lined cap or placed in one of the glass adsorbent modules tightly sealed with glass stoppers. If precleaned adsorbent is purchased in sealed containers, it must be used within 4 weeks after the seal is broken.

3.1.3 Glass Wool. Cleaned by sequential immersion in three aliquots of methylene chloride, dried in a 110 °C oven, and stored in a methylene chloride-washed glass jar with a Teflon-lined screw cap.

3.1.4 Water. Deionized distilled and stored in a methylene chloride-rinsed glass container with a Teflon-lined screw cap.

3.1.5 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175 °C (350 °F) for two hours. New silica gel may be used as received. Alternately other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.6 Chromic Acid Cleaning Solution. Dissolve 20 g of sodium dichromate in 15 ml of water, and then carefully add 400 ml of concentrated sulfuric acid.

3.2 Sample Recovery.

3.2.2 Acetone. Pesticide quality.

3.2.2 Methylene Chloride. Pesticide qualtity.

3.2.3 Toluene. Pesticide quality.

3.3 Analysis.

3.3.1 Potassium Hydroxide. ACS grade, 2-percent (weight/volume) in water.

3.3.2 Sodium Sulfate. Granulated, reagent grade. Purify prior to use by rinsing with methylene chloride and oven drying. Store the cleaned material in a glass container with a Teflon-lined screw cap.

3.3.3 Sulfuric Acid. Reagent grade.

3.3.4 Sodium Hydroxide. 1.0 N. Weigh 40 g of sodium hydroxide into a 1-liter volumetric flask. Dilute to 1 liter with water.

3.3.5 Hexane. Pesticide grade.

3.3.6 Methylene Chloride. Pesticide grade.

3.3.7 Benzene. Pesticide Grade.

3.3.8 Ethyl Acetate.

3.3.9 Methanol. Pesticide Grade.

3.3.10 Toluene. Pesticide Grade.

3.3.11 Nonane. Pesticide Grade.

3.3.12 Cyclohexane. Pesticide Grade.

3.3.13 Basic Alumina. Activity grade 1, 100–200 mesh. Prior to use, activate the alumina by heating for 16 hours at 130 °C before use. Store in a desiccator. Pre-activated alumina may be purchased from a supplier and may be used as received.

3.3.14 Silica Gel. Bio-Sil A, 100–200 mesh. Prior to use, activate the silica gel by heating for at least 30 minutes at 180 °C. After cooling, rinse the silica gel sequentially with methanol and methylene chloride. Heat the rinsed silica gel at 50 °C for 10 minutes, then increase the temperature gradually to 180 °C over 25 minutes and maintain it at this temperature for 90 minutes. Cool at room temperature and store in a glass container with a Teflon-lined screw cap.

3.3.15 Silica Gel Impregnated with Sulfuric Acid. Combine 100 g of silica gel with 44 g of concentrated sulfuric acid in a screw capped glass bottle and agitate thoroughly. Disperse the solids with a stirring rod until a uniform mixture is obtained. Store the mixture in a glass container with a Teflon-lined screw cap.

3.3.16 Silica Gel Impregnated with Sodium Hydroxide. Combine 39 g of 1 N sodium hydroxide with 100 g of silica gel in a screw capped glass bottle and agitate thoroughly. Disperse solids with a stirring rod until a uniform mixture is obtained. Store the mixture in glass container with a Teflon-lined screw cap.

3.3.17 Carbon/Celite. Combine 10.7 g of AX–21 carbon with 124 g of Celite 545 in a 250-ml glass bottle with a Teflon-lined screw cap. Agitate the mixture thoroughly until a uniform mixture is obtained. Store in the glass container.

3.3.18 Nitrogen. Ultra high purity.

3.3.19 Hydrogen. Ultra high purity.

3.3.20 Internal Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Internal Standards'' in 10 ml of nonane.

3.3.21 Surrogate Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Surrogate Standards'' in 10 ml of nonane.

3.3.22 Recovery Standard Solution. Prepare a stock standard solution containing the

isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Recovery Standards'' in 10 ml of nonane.

4. Procedure

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation.

4.1.1.1 Cleaning Glassware. All glass components of the train upstream of and including the adsorbent module, shall be cleaned as described in section 3A of the ''Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.'' Special care shall be devoted to the removal of residual silicone grease sealants on ground glass connections of used glassware. Any residue shall be removed by soaking the glassware for several hours in a chromic acid cleaning solution prior to cleaning as described above.

4.1.1.2 Adsorbent Trap. The traps must be loaded in a clean area to avoid contamination. They may not be loaded in the field. Fill a trap with 20 to 40 g of XAD–2. Follow the XAD–2 with glass wool and tightly cap both ends of the trap. Add 100 µl of the surrogate standard solution (section 3.3.21) to each trap.

4.1.1.3 Sample Train. It is suggested that all components be maintained according to the procedure described in APTD–0576. Alternative mercury-free thermometers may be used if the thermometers are, at a minimum, equivalent in terms of performance or suitably effective for the specific temperature measurement application.

4.1.1.4 Silica Gel. Weigh several 200 to 300 g portions of silica gel in an air tight container to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel may be weighed directly in its impinger or sampling holder just prior to sampling.

4.1.1.5 Filter. Check each filter against light for irregularities and flaws or pinhole leaks. Pack the filters flat in a clean glass container.

4.1.2 Preliminary Determinations. Same as section 4.1.2 of Method 5.

4.1.3 Preparation of Collection Train.

4.1.3.1 During preparation and assembly of the sampling train, keep all train openings where contamination can enter, sealed until just prior to assembly or until sampling is about to begin.

NOTE: Do not use sealant grease in assembling the train.

4.1.3.2 Place approximately 100 ml of water in the second and third impingers, leave the first and fourth impingers empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fifth impinger.

4.1.3.3 Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

4.1.3.4 Assemble the train as shown in Figure 23–1.

4.1.3.5 Turn on the adsorbent module and condenser coil recirculating pump and begin monitoring the adsorbent module gas entry temperature. Ensure proper sorbent temperature gas entry temperature before proceeding and before sampling is initiated. It is extremely important that the XAD–2 adsorbent resin temperature never exceed 50 °C because thermal decomposition will occur. During testing, the XAD–2 temperature must not exceed 20 °C for efficient capture of the PCDD's and PCDF's.

4.1.4 Leak-Check Procedure. Same as Method 5, section 4.1.4.

4.1.5 Sample Train Operation. Same as Method 5, section 4.1.5.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Seal the nozzle end of the sampling probe with Teflon tape or aluminum foil.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe. Remove the probe from the train and close off both ends with aluminum foil. Seal off the inlet to the train with Teflon tape, a ground glass cap, or aluminum foil.

Transfer the probe and impinger assembly to the cleanup area. This area shall be clean and enclosed so that the chances of losing or contaminating the sample are minimized. Smoking, which could contaminate the sample, shall not be allowed in the cleanup area.

Inspect the train prior to and during disassembly and note any abnormal conditions, e.g., broken filters, colored impinger liquid, etc. Treat the samples as follows:

4.2.1 Container No. 1. Either seal the filter holder or carefully remove the filter from the filter holder and place it in its identified container. Use a pair of cleaned tweezers to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the container any particulate matter and filter fibers which adhere to the filter holder gasket, by using a dry inert bristle brush and a sharp-edged blade. Seal the container.

4.2.2 Adsorbent Module. Remove the module from the train, tightly cap both ends, label it, cover with aluminum foil, and store it on ice for transport to the laboratory.

4.2.3 Container No. 2. Quantitatively recover material deposited in the nozzle, probe transfer lines, the front half of the filter holder, and the cyclone, if used, first, by

brushing while rinsing three times each with acetone and then, by rinsing the probe three times with methylene chloride. Collect all the rinses in Container No. 2.

Rinse the back half of the filter holder three times with acetone. Rinse the connecting line between the filter and the condenser three times with acetone. Soak the connecting line with three separate portions of methylene chloride for 5 minutes each. If using a separate condenser and adsorbent trap, rinse the condenser in the same manner as the connecting line. Collect all the rinses in Container No. 2 and mark the level of the liquid on the container.

4.2.4 Container No. 3. Repeat the methylene chloride-rinsing described in section 4.2.3 using toluene as the rinse solvent. Collect the rinses in Container No. 3 and mark the level of the liquid on the container.

4.2.5 Impinger Water. Measure the liquid in the first three impingers to within ±1 ml by using a graduated cylinder or by weighing it to within ±0.5 g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

Discard the liquid after measuring and recording the volume or weight.

4.2.7 Silica Gel. Note the color of the indicating silica gel to determine if it has been completely spent and make a mention of its condition. Transfer the silica gel from the fifth impinger to its original container and seal. If a moisture determination is made, follow the applicable procedures in sections 8.7.6.3 and 11.2.3 of Method 5 to handle and weigh the silica gel. If moisture is not measured, the silica gel may be disposed.

5. Analysis

All glassware shall be cleaned as described in section 3A of the ‘‘Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.’’ All samples must be extracted within 30 days of collection and analyzed within 45 days of extraction.

5.1 Sample Extraction.

5.1.1 Extraction System. Place an extraction thimble (section 2.3.4), 1 g of silica gel, and a plug of glass wool into the Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Remove the extraction thimble from the extraction system and place it in a glass beaker to catch the solvent rinses.

5.1.2 Container No. 1 (Filter). Transfer the contents directly to the glass thimble of the extraction system and extract them simultaneously with the XAD–2 resin.

5.1.3 Adsorbent Cartridge. Suspend the adsorbent module directly over the extraction thimble in the beaker (See section 5.1.1). The glass frit of the module should be in the up position. Using a Teflon squeeze bottle containing toluene, flush the XAD–2 into the thimble onto the bed of cleaned silica gel. Thoroughly rinse the glass module catching the rinsings in the beaker containing the thimble. If the resin is wet, effective extraction can be accomplished by loosely packing the resin in the thimble. Add the XAD–2 glass wool plug into the thimble.

5.1.4 Container No. 2 (Acetone and Methylene Chloride). Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus, at a temperature of less than 37 °C. Rinse the sample container three times with small portions of methylene chloride and add these to the concentrated solution and concentrate further to near dryness. This residue contains particulate matter removed in the rinse of the train probe and nozzle. Add the concentrate to the filter and the XAD–2 resin in the Soxhlet apparatus described in section 5.1.1.

5.1.5 Extraction. Add 100 µl of the internal standard solution (Section 3.3.20) to the extraction thimble containing the contents of the adsorbent cartridge, the contents of Container No. 1, and the concentrate from section 5.1.4. Cover the contents of the extraction thimble with the cleaned glass wool plug to prevent the XAD–2 resin from floating into the solvent reservoir of the extractor. Place the thimble in the extractor, and add the toluene contained in the beaker to the solvent reservoir. Pour additional toluene to fill the reservoir approximately ⅔ full. Add Teflon boiling chips and assemble the apparatus. Adjust the heat source to cause the extractor to cycle three times per hour. Extract the sample for 16 hours. After extraction, allow the Soxhlet to cool. Transfer the toluene extract and three 10-ml rinses to the rotary evaporator. Concentrate the extract to approximately 10 ml. At this point the analyst may choose to split the sample in half. If so, split the sample, store one half for future use, and analyze the other according to the procedures in sections 5.2 and 5.3. In either case, use a nitrogen evaporative concentrator to reduce the volume of the sample being analyzed to near dryness. Dissolve the residue in 5 ml of hexane.

5.1.6 Container No. 3 (Toluene Rinse). Add 100 µl of the Internal Standard solution (section 3.3.2) to the contents of the container. Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus at a temperature of less than 37 °C. Rinse the sample container apparatus at a temperature of less than 37 °C. Rinse the sample container three times with small portions of toluene and add these to the concentrated solution and concentrate further to near dryness. Analyze the extract separately according to the procedures in sections 5.2 and 5.3, but concentrate the solution in a rotary evaporator apparatus rather than a nitrogen evaporative concentrator.

5.2 Sample Cleanup and Fractionation.

5.2.1 Silica Gel Column. Pack one end of a glass column, 20 mm × 230 mm, with glass wool. Add in sequence, 1 g silica gel, 2 g of sodium hydroxide impregnated silica gel, 1 g silica gel, 4 g of acid-modified silica gel, and 1 g of silica gel. Wash the column with 30 ml of hexane and discard it. Add the sample extract, dissolved in 5 ml of hexane to the column with two additional 5-ml rinses. Elute the column with an additional 90 ml of hexane and retain the entire eluate. Concentrate this solution to a volume of about 1 ml using the nitrogen evaporative concentrator (section 2.3.7).

5.2.2 Basic Alumina Column. Shorten a 25-ml disposable Pasteur pipette to about 16 ml. Pack the lower section with glass wool and 12 g of basic alumina. Transfer the concentrated extract from the silica gel column to the top of the basic alumina column and elute the column sequentially with 120 ml of 0.5 percent methylene chloride in hexane followed by 120 ml of 35 percent methylene chloride in hexane. Discard the first 120 ml of eluate. Collect the second 120 ml of eluate and concentrate it to about 0.5 ml using the nitrogen evaporative concentrator.

5.2.3 AX–21 Carbon/Celite 545 Column. Remove the botton 0.5 in. from the tip of a 9-ml disposable Pasteur pipette. Insert a glass fiber filter disk in the top of the pipette 2.5 cm from the constriction. Add sufficient carbon/celite mixture to form a 2 cm column. Top with a glass wool plug. In some cases AX–21 carbon fines may wash through the glass wool plug and enter the sample. This may be prevented by adding a celite plug to the exit end of the column. Rinse the column in sequence with 2 ml of 50 percent benzene in ethyl acetate, 1 ml of 50 percent methylene chloride in cyclohexane, and 2 ml of hexane. Discard these rinses. Transfer the concentrate in 1 ml of hexane from the basic alumina column to the carbon/celite column along with 1 ml of hexane rinse. Elute the column sequentially with 2 ml of 50 percent methylene chloride in hexane and 2 ml of 50 percent benzene in ethyl acetate and discard these eluates. Invert the column and elute in the reverse direction with 13 ml of toluene. Collect this eluate. Concentrate the eluate in a rotary evaporator at 50 °C to about 1 ml. Transfer the concentrate to a Reacti-vial using a toluene rinse and concentrate to a volume of 200 µl using a stream of N_2. Store extracts at room temperature, shielded from light, until the analysis is performed.

5.3 Analysis. Analyze the sample with a gas chromatograph coupled to a mass spectrometer (GC/MS) using the instrumental parameters in sections 5.3.1 and 5.3.2. Immediately prior to analysis, add a 20 µl aliquot of the Recovery Standard solution from Table 1 to each sample. A 2 µl aliquot of the extract is injected into the GC. Sample extracts are first analyzed using the DB–5 capillary column to determine the concentration of each isomer of PCDD's and PCDF's (tetra-through octa-). If tetra-chlorinated dibenzofurans are detected in this analysis, then analyze another aliquot of the sample in a separate run, using the DB–225 column to measure the 2,3,7,8 tetra-chloro dibenzofuran isomer. Other column systems may be used, provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

5.3.1 Gas Chromatograph Operating Conditions.

5.3.1.1 Injector. Configured for capillary column, splitless, 250 °C.

5.3.1.2 Carrier Gas. Helium, 1–2 ml/min.

5.3.1.3 Oven. Initially at 150 °C. Raise by at least 40 °C/min to 190 °C and then at 3 °C/min up to 300 °C.

5.3.2 High Resolution Mass Spectrometer.

5.3.2.1 Resolution. 10000 m/e.

5.3.2.2 Ionization Mode. Electron impact.

5.3.2.3 Source Temperature 250 °C.

5.3.2.4 Monitoring Mode. Selected ion monitoring. A list of the various ions to be monitored is summarized in Table 3.

5.3.2.5 Identification Criteria. The following identification criteria shall be used for the characterization of polychlorinated dibenzodioxins and dibenzofurans.

1. The integrated ion-abundance ratio (M/M + 2 or M + 2/M + 4) shall be within 15 percent of the theoretical value. The acceptable ion-abundance ratio ranges for the identification of chlorine-containing compounds are given in Table 4.

2. The retention time for the analytes must be within 3 seconds of the corresponding ^{13}C-labeled internal standard, surrogate or alternate standard.

3. The monitored ions, shown in Table 3 for a given analyte, shall reach their maximum within 2 seconds of each other.

4. The identification of specific isomers that do not have corresponding ^{13}C-labeled standards is done by comparison of the relative retention time (RRT) of the analyte to the nearest internal standard retention time with reference (i.e., within 0.005 RRT units) to the comparable RRT's found in the continuing calibration.

5. The signal to noise ratio for all monitored ions must be greater than 2.5.

6. The confirmation of 2, 3, 7, 8–TCDD and 2, 3, 7, 8–TCDF shall satisfy all of the above identification criteria.

7. For the identification of PCDF's, no signal may be found in the corresponding PCDPE channels.

5.3.2.6 Quantification. The peak areas for the two ions monitored for each analyte are summed to yield the total response for each analyte. Each internal standard is used to quantify the indigenous PCDD's or PCDF's in its homologous series. For example, the $^{13}C_{12}$–2,3,7,8-tetra chlorinated dibenzodioxin is used to calculate the concentrations of all

other tetra chlorinated isomers. Recoveries of the tetra- and penta- internal standards are calculated using the $^{13}C_{12}$–1,2,3,4–TCDD. Recoveries of the hexa- through octa- internal standards are calculated using $^{13}C_{12}$–1,2,3,7,8,9–HxCDD. Recoveries of the surrogate standards are calculated using the corresponding homolog from the internal standard.

6. Calibration

Same as Method 5 with the following additions.

6.1 GC/MS System.

6.1.1 Initial Calibration. Calibrate the GC/MS system using the set of five standards shown in Table 2. The relative standard deviation for the mean response factor from each of the unlabeled analytes (Table 2) and of the internal, surrogate, and alternate standards shall be less than or equal to the values in Table 5. The signal to noise ratio for the GC signal present in every selected ion current profile shall be greater than or equal to 2.5. The ion abundance ratios shall be within the control limits in Table 4.

6.1.2 Daily Performance Check.

6.1.2.1 Calibration Check. Inject on µl of solution Number 3 from Table 2. Calculate the relative response factor (RRF) for each compound and compare each RRF to the corresponding mean RRF obtained during the initial calibration. The analyzer performance is acceptable if the measured RRF's for the labeled and unlabeled compounds for the daily run are within the limits of the mean values shown in Table 5. In addition, the ion-abundance ratios shall be within the allowable control limits shown in Table 4.

6.1.2.2 Column Separation Check. Inject a solution of a mixture of PCDD's and PCDF's that documents resolution between 2,3,7,8–TCDD and other TCDD isomers. Resolution is defined as a valley between peaks that is less than 25 percent of the lower of the two peaks. Identify and record the retention time windows for each homologous series.

Perform a similar resolution check on the confirmation column to document the resolution between 2,3,7,8 TCDF and other TCDF isomers.

6.2 Lock Channels. Set mass spectrometer lock channels as specified in Table 3. Monitor the quality control check channels specified in Table 3 to verify instrument stability during the analysis.

7. Quality Control

7.1 Sampling Train Collection Efficiency Check. Add 100 µl of the surrogate standards in Table 1 to the absorbent cartridge of each train before collecting the field samples.

7.2 Internal Standard Percent Recoveries. A group of nine carbon labeled PCDD's and PCDF's representing, the tetra-through octachlorinated homologues, is added to every sample prior to extraction. The role of the internal standards is to quantify the native PCDD's and PCDF's present in the sample as well as to determine the overall method efficiency. Recoveries of the internal standards must be between 40 to 130 percent for the tetra-through hexachlorinated compounds while the range is 25 to 130 percent for the higher hepta- and octachlorinated homologues.

7.3 Surrogate Recoveries. The five surrogate compounds in Table 2 are added to the resin in the adsorbent sampling cartridge before the sample is collected. The surrogate recoveries are measured relative to the internal standards and are a measure of collection efficiency. They are not used to measure native PCDD's and PCDF's. All recoveries shall be between 70 and 130 percent. Poor recoveries for all the surrogates may be an indication of breakthrough in the sampling train. If the recovery of all standards is below 70 percent, the sampling runs must be repeated. As an alternative, the sampling runs do not have to be repeated if the final results are divided by the fraction of surrogate recovery. Poor recoveries of isolated surrogate compounds should not be grounds for rejecting an entire set of the samples.

7.4 Toluene QA Rinse. Report the results of the toluene QA rinse separately from the total sample catch. Do not add it to the total sample.

8.0 [Reserved]

9. Calculations

Same as Method 5, section 6 with the following additions.

9.1 Nomenclature.

A_{ai} = Integrated ion current of the noise at the retention time of the analyte.

A^*_{ci} = Integrated ion current of the two ions characteristic of the internal standard i in the calibration standard.

A_{cij} = Integrated ion current of the two ions characteristic of compound i in the jth calibration standard.

A^*_{cij} = Integrated ion current of the two ions characteristic of the internal standard i in the jth calibration standard.

A_{csi} = Integrated ion current of the two ions characteristic of surrogate compound i in the calibration standard.

A_i = Integrated ion current of the two ions characteristic of compound i in the sample.

A^*_i = Integrated ion current of the two ions characteristic of internal standard i in the sample.

A_{rs} = Integrated ion current of the two ions characteristic of the recovery standard.

A_{si} = Integrated ion current of the two ions characteristic of surrogate compound i in the sample.

C_i = Concentration of PCDD or PCDF i in the sample, pg/M^3.

C_T = Total concentration of PCDD's or PCDF's in the sample, pg/M^3.
m_{ci} = Mass of compound i in the calibration standard injected into the analyzer, pg.
m_{rs} = Mass of recovery standard in the calibration standard injected into the analyzer, pg.
m_{si} = Mass of surrogate compound in the calibration standard, pg.
RRF_i = Relative response factor.
RRF_{rs} = Recovery standard response factor.
RRF_s = Surrogate compound response factor.

9.2 Average Relative Response Factor.

$$RRF_i = \frac{1}{n}\sum_{j=1}^{n}\frac{A_{cij}\, m^*_{ci}}{A^*_{cij}\, m_{ci}} \qquad \text{Eq. 23-1}$$

9.3 Concentration of the PCDD's and PCDF's.

$$C_i = \frac{m_i{}^* A_i}{A_i{}^* RRF_i V_{mstd}} \qquad \text{Eq. 23-2}$$

9.4 Recovery Standard Response Factor.

$$RRF_{rs} = \frac{A_{ci}{}^* m_{rs}}{A_{rs} m_{ci}{}^*} \qquad \text{Eq. 23-3}$$

9.5 Recovery of Internal Standards (R*).

$$R^* = \frac{A_i{}^* m_{rs}}{A_{rs} RF_{rs} m_i{}^*} \times 100\% \qquad \text{Eq. 23-4}$$

9.6 Surrogate Compound Response Factor.

$$RRF_s = \frac{A_{ci}{}^* m_s}{A_{cis} m_{ci}{}^*} \qquad \text{Eq. 23-5}$$

9.7 Recovery of Surrogate Compounds (R_s).

$$R_s = \frac{A_s m_i{}^*}{A_i{}^* RRF_s m_s} \times 100\% \qquad \text{Eq. 23-6}$$

9.8 Minimum Detectable Limit (MDL).

$$MDL = \frac{2.5\ A_{ai} m_i{}^*}{A_{ci}{}^* RRF_i} \qquad \text{Eq. 23-7}$$

9.9 Total Concentration of PCDD's and PCDF's in the Sample.

$$C_{Tr} = \sum_{i=1}^{n} C_i \qquad \text{Eq. 23-8}$$

Any PCDD's or PCDF's that are reported as nondetected (below the MDL) shall be counted as zero for the purpose of calculating the total concentration of PCDD's and PCDF's in the sample.

10. Bibliography

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3. Thompson, J. R. (ed.). Analysis of Pesticide Residues in Human and Environmental Samples. U.S. Environmental Protection Agency. Research Triangle Park, NC. 1974.

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TABLE 1—COMPOSITION OF THE SAMPLE FORTIFICATION AND RECOVERY STANDARDS SOLUTIONS

Analyte	Concentration (pg/μl)
Internal Standards:	
$^{13}C_{12}$-2,3,7,8-TCDD	100
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100
$^{13}C_{12}$-OCDD	100
$^{13}C_{12}$-2,3,7,8-TCDF	100
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100
Surrogate Standards:	
$^{37}Cl_4$-2,3,7,8-TCDD	100
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	100
$^{13}C_{12}$-2,3,4,7,8-PeCDF	100
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	100
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	100
Recovery Standards:	
$^{13}C_{12}$-1,2,3,4-TCDD	500
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS

Compound	Concentrations (pg/μL)				
	Solution No.				
	1	2	3	4	5
Alternate Standard:					
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	2.5	5	25	250	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS—Continued

Compound	Concentrations (pg/μL)				
	Solution No.				
	1	2	3	4	5
Recovery Standards:					
$^{13}C_{12}$-1,2,3,4-TCDD ..	100	100	100	100	100
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100

TABLE 3—ELEMENTAL COMPOSITIONS AND EXACT MASSES OF THE IONS MONITORED BY HIGH RESOLUTION MASS SPECTROMETRY FOR PCDD'S AND PCDF'S

Descriptor No.	Accurate mass	Ion type	Elemental composition	Analyte
2	292.9825	LOCK	C_7F_{11}	PFK
	303.9016	M	$C_{12}H_4{}^{35}Cl_4O$	TCDF
	305.8987	M + 2	$C_{12}H_4{}^{35}Cl^{37}O$	TCDF
	315.9419	M	$^{13}C_{12}H_4{}^{35}Cl_4O$	TCDF (S)
	317.9389	M + 2	$^{13}C_{12}H_4{}^{35}Cl_3{}^{37}ClO$	TCDF (S)
	319.8965	M	$C_{12}H_4{}^{35}ClO_2$	TCDD
	321.8936	M + 2	$C_{12}H_4{}^{35}Cl_3{}^{37}ClO_2$	TCDD
	327.8847	M	$C_{12}H_4{}^{37}Cl_4O_2$	TCDD (S)
	330.9792	QC	C_7F_{13}	PFK
	331.9368	M	$^{13}C_{12}H_4{}^{35}Cl_4O_2$	TCDD (S)
	333.9339	M + 2	$^{13}C_{12}H_4{}^{35}Cl^{37}ClO_2$	TCDD (S)
	339.8597	M + 2	$C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PECDF
	341.8567	M + 4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O$	PeCDF
	351.9000	M + 2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF (S)
	353.8970	M + 4	$^{13}C_{12}H_3{}^{35}Cl^{3537}Cl_2O$	PeCDF (S)
	355.8546	M + 2	$C_{12}H_3{}^{35}Cl_3 37ClO_2$	PeCDD
	357.8516	M + 4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O_2$	PeCDD
	367.8949	M + 2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO_2$	PeCDD (S)
	369.8919	M + 4	$^{13}C_{12}H_3{}^{35}Cl_3{}^{37}\ Cl_2O_2$	PeCDD (S)
	375.8364	M + 2	$C_{12}H_4{}^{35}Cl_5{}^{37}ClO$	HxCDPE
	409.7974	M + 2	$C_{12}H_3{}^{35}Cl_6{}^{37}ClO$	HpCPDE
3	373.8208	M + 2	$C_{12}H_2 35Cl_5{}^{37}ClO$	HxCDF
	375.8178	M + 4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDF
	383.8639	M	$^{13}C_{12}H_2{}^{35}Cl_6O$	HxCDF (S)
	385.8610	M + 2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO$	HxCDF (S)
	389.8157	M + 2	$C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD
	391.8127	M + 4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O_2$	HxCDD
	392.9760	LOCK	C_9F_{15}	PFK
	401.8559	M + 2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD (S)
	403.8529	M + 4	$^{13}C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDD (S)
	445.7555	M + 4	$C_{12}H_2{}^{35}Cl_6{}^{37}Cl_2O$	OCDPE
	430.9729	QC	C_9F_{17}	PFK
4	407.7818	M + 2	$C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF
	409.7789	M + 4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O$	HpCDF
	417.8253	M	$^{13}C_{12}H^{35}Cl_7O$	HpCDF (S)
	419.8220	M + 2	$^{13}C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF (S)
	423.7766	M + 2	$C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD
	425.7737	M + 4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD
	435.8169	M + 2	$^{13}C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD (S)
	437.8140	M + 4	$^{13}C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD (S)
	479.7165	M + 4	$C_{12}H^{35}Cl_7{}^{37}Cl_2O$	NCPDE
	430.9729	LOCK	C_9F_{17}	PFK
	441.7428	M + 2	$C_{12}{}^{35}Cl_7{}^{37}ClO$	OCDF
	443.7399	M + 4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O$	OCDF
	457.7377	M + 2	$C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD
	459.7348	M + 4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD
	469.7779	M + 2	$^{13}C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD (S)
	471.7750	M + 4	$^{13}C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD (S)
	513.6775	M + 4	$C_{12}{}^{35}Cl_8{}^{37}Cl_2O_2$	DCDPE
	442.9728	QC	$C_{10}F_{17}$	PFK

(a) The following nuclidic masses were used:
H = 1.007825
C = 12.000000
^{13}C = 13.003355
F = 18.9984
O = 15.994915
^{35}Cl = 34.968853
^{37}Cl = 36.965903

S = Labeled Standard
QC = Ion selected for monitoring instrument stability during the GC/MS analysis.

TABLE 4—ACCEPTABLE RANGES FOR ION-ABUNDANCE RATIOS OF PCDD'S AND PCDF'S

No. of chlorine atoms	Ion type	Theoretical ratio	Control limits	
			Lower	Upper
4	M/M + 2	0.77	0.65	0.89
5	M + 2/M + 4	1.55	1.32	1.78
6	M + 2/M + 4	1.24	1.05	1.43
6[a]	M/M + 2	0.51	0.43	0.59
7[b]	M/M + 2	0.44	0.37	0.51
7	M + 2/M + 4	1.04	0.88	1.20
8	M + 2/M + 4	0.89	0.76	1.02

[a] Used only for ^{13}C-HxCDF.
[b] Used only for ^{13}C-HpCDF.

TABLE 5—MINIMUM REQUIREMENTS FOR INITIAL AND DAILY CALIBRATION RESPONSE FACTORS

Compound	Relative response factors	
	Initial calibration RSD	Daily calibration % difference
Unlabeled Analytes:		
2,3,7,8-TCDD	25	25
2,3,7,8-TCDF	25	25
1,2,3,7,8-PeCDD	25	25
1,2,3,7,8-PeCDF	25	25
2,3,4,7,8-PeCDF	25	25
1,2,4,5,7,8-HxCDD	25	25
1,2,3,6,7,8-HxCDD	25	25
1,2,3,7,8,9-HxCDD	25	25
1,2,3,4,7,8-HxCDF	25	25
1,2,3,6,7,8-HxCDF	25	25
1,2,3,7,8,9-HxCDF	25	25
2,3,4,6,7,8-HxCDF	25	25
1,2,3,4,6,7,8-HpCDD	25	25
1,2,3,4,6,7,8-HpCDF	25	25
OCDD	25	25
OCDF	30	30
Internal Standards:		
$^{13}C_{12}$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-1,2,3,7,8-PeCDD	30	30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	25	25
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	30	30
$^{13}C_{12}$-OCDD	30	30
$^{13}C_{12}$-2,3,7,8-TCDF	30	30
$^{13}C_{12}$-1,2,3,7,8-PeCDF	30	30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	30	30
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	30	30
Surrogate Standards:		
$^{37}Cl_4$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-2,3,4,7,8-PeCDF	25	25
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	25	25
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	25	25
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	25	25
Alternate Standard:		
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	25	25

METHOD 24—DETERMINATION OF VOLATILE MATTER CONTENT, WATER CONTENT, DENSITY, VOLUME SOLIDS, AND WEIGHT SOLIDS OF SURFACE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds	No CAS Number assigned
Water.	7732–18–5

1.2 Applicability. This method is applicable for the determination of volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

1.3 Precision and Bias. Intra-and inter-laboratory analytical precision statements are presented in section 13.1. No bias has been identified.

2.0 Summary of Method

2.1 Standard methods are used to determine the volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

3.0 Definitions

3.1 *Waterborne coating* means any coating which contains more than 5 percent water by weight in its volatile fraction.

3.2 *Multicomponent coatings* are coatings that are packaged in two or more parts, which are combined before application. Upon combination a coreactant from one part of the coating chemically reacts, at ambient conditions, with a coreactant from another part of the coating.

3.3 *Ultraviolet (UV) radiation-cured coatings* are coatings which contain unreacted monomers that are polymerized by exposure to ultraviolet light.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Several of the compounds that may be contained in the coatings analyzed by this method may be irritating or corrosive to tissues (e.g., heptane) or may be toxic (e.g., benzene, methyl alcohol). Nearly all are fire hazards.

Appropriate precautions can be found in reference documents, such as Reference 3 of section 16.0.

6.0 Equipment and Supplies

The equipment and supplies specified in the ASTM methods listed in sections 6.1 through 6.6 (incorporated by reference—see § 60.17 for acceptable versions of the methods) are required:

6.1 ASTM D 1475–60, 80, or 90, Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products.

6.2 ASTM D 2369–81, 87, 90, 92, 93, or 95, Standard Test Method for Volatile Content of Coatings.

6.3 ASTM D 3792–79 or 91, Standard Test Method for Water Content of Water Reducible Paints by Direct Injection into a Gas Chromatograph.

6.4 ASTM D 4017–81, 90, or 96a, Standard Test Method for Water in Paints and Paint Materials by the Karl Fischer Titration Method.

6.5 ASTM 4457–85 91, Standard Test Method for Determination of Dichloromethane and 1,1,1-Trichloroethane in Paints and Coatings by Direct Injection into a Gas Chromatograph.

6.6 ASTM D 5403–93, Standard Test Methods for Volatile Content of Radiation Curable Materials.

6.7 ASTM D 6419–00, Test Method for Volatile Content of Sheet-Fed and Coldset Web Offset Printing Inks.

7.0 Reagents and Standards

7.1 The reagents and standards specified in the ASTM methods listed in sections 6.1 through 6.6 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 1 of section 16.0.

9.0 Quality Control

9.1 Reproducibility

NOTE: Not applicable to UV radiation-cured coatings). The variety of coatings that may be subject to analysis makes it necessary to verify the ability of the analyst and the analytical procedures to obtain reproducible results for the coatings tested. Verification is accomplished by running duplicate analyses on each sample tested (Sections 11.2 through 11.4) and comparing the results with the intra-laboratory precision statements (Section 13.1) for each parameter.

9.2 Confidence Limits for Waterborne Coatings. Because of the inherent increased imprecision in the determination of the VOC content of waterborne coatings as the weight percent of water increases, measured parameters for waterborne coatings are replaced with appropriate confidence limits (Section 12.6). These confidence limits are based on measured parameters and inter-laboratory precision statements.

10.0 Calibration and Standardization

10.1 Perform the calibration and standardization procedures specified in the ASTM methods listed in sections 6.1 through 6.6.

11.0 Analytical Procedure

Additional guidance can be found in Reference 2 of section 16.0.

11.1 Non Thin-film Ultraviolet Radiation-cured (UV radiation-cured) Coatings.

11.1.1 Volatile Content. Use the procedure in ASTM D 5403 to determine the volatile matter content of the coating except the curing test described in NOTE 2 of ASTM D 5403 is required.

11.1.2 Water Content. To determine water content, follow section 11.3.2.

11.1.3 Coating Density. To determine coating density, follow section 11.3.3.

11.1.4 Solids Content. To determine solids content, follow section 11.3.4.

11.1.5 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the equation in section 12.2. If C is less than 0.2 g and A is greater than or equal to 225 cm^2 (35 in^2) then the coating or ink is considered a thin-film UV radiation-cured coating and ASTM D 5403 is not applicable.

NOTE: As noted in section 1.4 of ASTM D 5403, this method may not be applicable to radiation curable materials wherein the volatile material is water.

11.2 Multi-component Coatings.

11.2.1 Sample Preparation.

11.2.1.1 Prepare about 100 ml of sample by mixing the components in a storage container, such as a glass jar with a screw top or a metal can with a cap. The storage container should be just large enough to hold the mixture. Combine the components (by weight or volume) in the ratio recommended by the manufacturer. Tightly close the container between additions and during mixing to prevent loss of volatile materials. However, most manufacturers mixing instructions are by volume. Because of possible error caused by expansion of the liquid when measuring the volume, it is recommended that the components be combined by weight. When weight is used to combine the components and the manufacturer's recommended ratio is by volume, the density must be determined by section 11.3.3.

11.2.1.2 Immediately after mixing, take aliquots from this 100 ml sample for determination of the total volatile content, water content, and density.

11.2.2 Volatile Content. To determine total volatile content, use the apparatus and

reagents described in ASTM D2369 (incorporated by reference; see §60.17 for the approved versions of the standard), respectively, and use the following procedures:

11.2.2.1 Weigh and record the weight of an aluminum foil weighing dish. Add 3 ±1 ml of suitable solvent as specified in ASTM D2369 to the weighing dish. Using a syringe as specified in ASTM D2369, weigh to 1 mg, by difference, a sample of coating into the weighing dish. For coatings believed to have a volatile content less than 40 weight percent, a suitable size is 0.3 + 0.10 g, but for coatings believed to have a volatile content greater than 40 weight percent, a suitable size is 0.5 ±0.1 g.

NOTE: If the volatile content determined pursuant to section 12.4 is not in the range corresponding to the sample size chosen repeat the test with the appropriate sample size. Add the specimen dropwise, shaking (swirling) the dish to disperse the specimen completely in the solvent. If the material forms a lump that cannot be dispersed, discard the specimen and prepare a new one. Similarly, prepare a duplicate. The sample shall stand for a minimum of 1 hour, but no more than 24 hours prior to being oven cured at 110 ±5 °C (230 ±9 °F) for 1 hour.

11.2.2.2 Heat the aluminum foil dishes containing the dispersed specimens in the forced draft oven for 60 min at 110 ±5 °C (230 ±9 °F). Caution—provide adequate ventilation, consistent with accepted laboratory practice, to prevent solvent vapors from accumulating to a dangerous level.

11.2.2.3 Remove the dishes from the oven, place immediately in a desiccator, cool to ambient temperature, and weigh to within 1 mg.

11.2.2.4 Run analyses in pairs (duplicate sets) for each coating mixture until the criterion in section 11.4 is met. Calculate W_V following Equation 24–2 and record the arithmetic average.

11.2.3 Water Content. To determine water content, follow section 11.3.2.

11.2.4 Coating Density. To determine coating density, follow section 11.3.3.

11.2.5 Solids Content. To determine solids content, follow section 11.3.4.

11.2.6 Exempt Solvent Content. To determine the exempt solvent content, follow section 11.3.5.

NOTE: For all other coatings (*i.e.*, water-or solvent-borne coatings) not covered by multicomponent or UV radiation-cured coatings, analyze as shown below:

11.3 Water-or Solvent-borne coatings.

11.3.1 Volatile Content. Use the procedure in ASTM D 2369 to determine the volatile matter content (may include water) of the coating.

11.3.1.1 Record the following information:

W_1 = weight of dish and sample before heating, g

W_2 = weight of dish and sample after heating, g

W_3 = sample weight, g.

11.3.1.2 Calculate the weight fraction of the volatile matter (W_v) for each analysis as shown in section 12.3.

11.3.1.3 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.1.4 Record the arithmetic average (W_v).

11.3.2 Water Content. For waterborne coatings only, determine the weight fraction of water (W_w) using either ASTM D 3792 or ASTM D 4017.

11.3.2.1 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.2.2 Record the arithmetic average (w_w).

11.3.3 Coating Density. Determine the density (Dc, kg/l) of the surface coating using the procedure in ASTM D 1475.

11.3.3.1 Run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement in section 13.1.

11.3.3.2 Record the arithmetic average (D_c).

11.3.4 Solids Content. Determine the volume fraction (V_s) solids of the coating by calculation using the manufacturer's formulation.

11.3.5 Exempt Solvent Content. Determine the weight fraction of exempt solvents (W_E) by using ASTM Method D4457. Run a duplicate set of determinations and record the arithmetic average (W_E).

11.4 Sample Analysis Criteria. For W_v and W_w, run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement for that parameter. For D_c, run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement. If, after several attempts, it is concluded that the ASTM procedures cannot be used for the specific coating with the established intra-laboratory precision (excluding UV radiation-cured coatings), the U.S. Environmental Protection Agency (EPA) will assume responsibility for providing the necessary procedures for revising the method or precision statements upon written request to: Director, Emissions, Monitoring, and Analysis Division, MD–14, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

12.0 Calculations and Data Analysis

12.1 Nomenclature.

A = Area of substrate, cm^2, (in^2).

C = Amount of coating or ink added to the substrate, g.

D_c = Density of coating or ink, g/cm^3 (g/in^3).

F = Manufacturer's recommended film thickness, cm (in).

W_o = Weight fraction of nonaqueous volatile matter, g/g.

W_s = Weight fraction of solids, g/g.

W_v = Weight fraction of the volatile matter, g/g.

W_w = Weight fraction of the water, g/g.

12.2 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the following equation:

$$C = F\,A\,D_c \qquad \text{Eq. 24-1}$$

12.3 Calculate W_v for each analysis as shown below:

$$W_v = \frac{W_1 - W_2}{W_3} \qquad \text{Eq. 24-2}$$

12.4 Nonaqueous Volatile Matter.

12.4.1 Solvent-borne Coatings.

$$W_o = W_v \qquad \text{Eq. 24-3}$$

12.4.2 Waterborne Coatings.

$$W_o = W_v - W_w \qquad \text{Eq. 24-4}$$

12.4.3 Coatings Containing Exempt Solvents.

$$W_o = W_v - W_E - W_w \qquad \text{Eq. 24-5}$$

12.5 Weight Fraction Solids.

$$W_s = 1 - W_v \qquad \text{Eq. 24-6}$$

12.6 Confidence Limit Calculations for Waterborne Coatings. To calculate the lower confidence limit, subtract the appropriate inter-laboratory precision value from the measured mean value for that parameter. To calculate the upper confidence limit, add the appropriate inter-laboratory precision value to the measured mean value for that parameter. For W_v and D_c, use the lower confidence limits; for W_w, use the upper confidence limit. Because W_s is calculated, there is no adjustment for this parameter.

13.0 Method Performance

13.1 Analytical Precision Statements. The intra-and inter-laboratory precision statements are given in Table 24–1 in section 17.0.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as specified in section 6.0, with the addition of the following:

1. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

2. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A.

EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

3. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 24–1—ANALYTICAL PRECISION STATEMENTS

	Intra-laboratory	Inter-laboratory
Volatile matter content, W_v	±0.015 $\overline{W}_v$	±0.047 $\overline{W}_v$
Water content, W_w	±0.029 $\overline{W}_w$	±0.075 $\overline{W}_w$
Density, D_c	±0.001 kg/l	±0.002 kg/l

METHOD 24A—DETERMINATION OF VOLATILE MATTER CONTENT AND DENSITY OF PUBLICATION ROTOGRAVURE INKS AND RELATED PUBLICATION ROTOGRAVURE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds (VOC).	No CAS number assigned.

1.2 Applicability. This method is applicable for the determination of the VOC content and density of solvent-borne (solvent-reducible) publication rotogravure inks and related publication rotogravure coatings.

2.0 Summary of Method

2.1 Separate procedures are used to determine the VOC weight fraction and density of the ink or related coating and the density of the solvent in the ink or related coating. The VOC weight fraction is determined by measuring the weight loss of a known sample quantity which has been heated for a specified length of time at a specified temperature. The density of both the ink or related coating and solvent are measured by a standard procedure. From this information, the VOC volume fraction is calculated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Some of the compounds that may be contained in the inks or related coatings analyzed by this method may be irritating or corrosive to tissues or may be toxic. Nearly all are fire hazards. Appropriate precautions can be found in reference documents, such as Reference 6 of section 16.0.

6.0 Equipment and Supplies

The following equipment and supplies are required for sample analysis:

6.1 Weighing Dishes. Aluminum foil, 58 mm (2.3 in.) in diameter by 18 mm (0.7 in.) high, with a flat bottom. There must be at least three weighing dishes per sample.

6.2 Disposable Syringe. 5 ml.

6.3 Analytical Balance. To measure to within 0.1 mg.

6.4 Oven. Vacuum oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) and an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) for 4 hours. Alternatively, a forced draft oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) for 24 hours.

6.5 The equipment and supplies specified in ASTM D 1475–60, 80, or 90 (incorporated by reference—see § 60.17).

7.0 Reagents and Standards

7.1 The reagents and standards specified in ASTM D 1475–60, 80, or 90 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 4 of section 16.0.

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

Additional guidance can be found in Reference 5 of section 16.0.

11.1 VOC Weight Fraction. Shake or mix the ink or related coating sample thoroughly to assure that all the solids are completely suspended. Label and weigh to the nearest 0.1 mg a weighing dish and record this weight (M_{x1}). Using a 5 ml syringe, without a needle, extract an aliquot from the ink or related coating sample. Weigh the syringe and aliquot to the nearest 0.1 mg and record this weight (M_{cy1}). Transfer 1 to 3 g of the aliquot to the tared weighing dish. Reweigh the syringe and remaining aliquot to the nearest 0.1 mg and record this weight (M_{cy2}). Heat the weighing dish with the transferred aliquot in a vacuum oven at an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) and a temperature of 120 ±2 °C (248 ±4 °F) for 4 hours. Alternatively, heat the weighing dish with the transferred aliquot in a forced draft oven at a temperature of 120 ±2 °C for 24 hours. After the weighing dish has cooled, reweigh it to the nearest 0.1 mg and record the weight (M_{x2}). Repeat this procedure two times for each ink or related coating sample, for a total of three samples.

11.2 Ink or Related Coating Density. Determine the density of the ink or related coating (D_c) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the ink or related coating density as the arithmetic average (D_c) of the three determinations.

11.3 Solvent Density. Determine the density of the solvent (D_o) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the solvent density as the arithmetic average (D_o) of the three determinations.

12.0 Calculations and Data Analysis

12.1 VOC Weight Fraction. For each determination, calculate the volatile organic content weight fraction (W_o) using the following equation:

$$W_o = \frac{M_{x1} + M_{cy1} - M_{cy2} - M_{x2}}{M_{cy1} - M_{cy2}} \qquad \text{Eq. 24A-1}$$

Make a total of three determinations. Report the VOC weight fraction as the arithmetic average ($\bar{W}_o$) of the three determinations.

12.2 VOC Volume Fraction. Calculate the volume fraction volatile organic content (V_o) using the following equation:

$$V_o = \frac{\overline{W}_o \overline{D}_c}{\overline{D}_o} \qquad \text{Eq. 24A-2}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. ASTM Designation D 1475.

2. Teleconversation. Wright, Chuck, Inmont Corporation with Reich, R., A., Radian Corporation. September 25, 1979, Gravure Ink Analysis.

3. Teleconversation. Oppenheimer, Robert, Gravure Research Institute with Burt, Rick, Radian Corporation, November 5, 1979, Gravure Ink Analysis.

4. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

5. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A. EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

6. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25—DETERMINATION OF TOTAL GASEOUS NONMETHANE ORGANIC EMISSIONS AS CARBON

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total gaseous nonmethane organic compounds (TGNMO)	N/A	Dependent upon analytical equipment.

1.2 Applicability.

1.2.1 This method is applicable for the determination of volatile organic compounds (VOC) (measured as total gaseous nonmethane organics (TGNMO) and reported as carbon) in stationary source emissions. This method is not applicable for the determination of organic particulate matter.

1.2.2 This method is not the only method that applies to the measurement of VOC. Costs, logistics, and other practicalities of source testing may make other test methods more desirable for measuring VOC contents of certain effluent streams. Proper judgment is required in determining the most applicable VOC test method. For example, depending upon the molecular composition of the organics in the effluent stream, a totally automated semicontinuous nonmethane organics (NMO) analyzer interfaced directly to the source may yield accurate results. This approach has the advantage of providing emission data semicontinuously over an extended time period.

1.2.3 Direct measurement of an effluent with a flame ionization detector (FID) analyzer may be appropriate with prior characterization of the gas stream and knowledge that the detector responds predictably to the organic compounds in the stream. If present, methane (CH_4) will, of course, also be measured. The FID can be used under any of the following limited conditions: (1) Where only one compound is known to exist; (2) when the organic compounds consist of only hydrogen and carbon; (3) where the relative percentages of the compounds are known or can be determined, and the FID responses to the compounds are known; (4) where a consistent mixture of the compounds exists before and after emission control and only the relative concentrations are to be assessed; or (5) where the FID can be calibrated against mass standards of the compounds emitted (solvent emissions, for example).

1.2.4 Another example of the use of a direct FID is as a screening method. If there is enough information available to provide a rough estimate of the analyzer accuracy, the FID analyzer can be used to determine the VOC content of an uncharacterized gas stream. With a sufficient buffer to account for possible inaccuracies, the direct FID can be a useful tool to obtain the desired results without costly exact determination.

1.2.5 In situations where a qualitative/quantitative analysis of an effluent stream is desired or required, a gas chromatographic FID system may apply. However, for sources emitting numerous organics, the time and expense of this approach will be formidable.

2.0 Summary of Method

2.1 An emission sample is withdrawn from the stack at a constant rate through a heated filter and a chilled condensate trap by means of an evacuated sample tank. After sampling is completed, the TGNMO are determined by independently analyzing the condensate trap and sample tank fractions and combining the analytical results. The organic content of the condensate trap fraction is determined by oxidizing the NMO to carbon dioxide (CO_2) and quantitatively collecting in the effluent in an evacuated vessel; then a portion of the CO_2 is reduced to CH_4 and measured by an FID. The organic content of the sample tank fraction is measured by injecting a portion of the sample into a gas chromatographic column to separate the NMO from carbon monoxide (CO), CO_2, and CH_4; the NMO are oxidized to CO_2, reduced to CH_4, and measured by an FID. In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 Carbon Dioxide and Water Vapor. When carbon dioxide (CO_2) and water vapor are present together in the stack, they can produce a positive bias in the sample. The magnitude of the bias depends on the concentrations of CO_2 and water vapor. As a guideline, multiply the CO_2 concentration, expressed as volume percent, times the water vapor concentration. If this product does not exceed 100, the bias can be considered insignificant. For example, the bias is not significant for a source having 10 percent CO_2 and 10 percent water vapor, but it might be significant for a source having 10 percent CO_2 and 20 percent water vapor.

4.2. Particulate Matter. Collection of organic particulate matter in the condensate trap would produce a positive bias. A filter is included in the sampling equipment to minimize this bias.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

6.1 Sample Collection. The sampling system consists of a heated probe, heated filter, condensate trap, flow control system, and sample tank (see Figure 25–1). The TGNMO sampling equipment can be constructed from commercially available components and components fabricated in a machine shop. The following equipment is required:

6.1.1 Heated Probe. 6.4-mm (¼-in.) OD stainless steel tubing with a heating system capable of maintaining a gas temperature at the exit end of at least 129 °C (265 °F). The probe shall be equipped with a temperature sensor at the exit end to monitor the gas temperature. A suitable probe is shown in Figure 25–1. The nozzle is an elbow fitting attached to the front end of the probe while the temperature sensor is inserted in the side arm of a tee fitting attached to the rear of the probe. The probe is wrapped with a suitable length of high temperature heating tape, and then covered with two layers of glass cloth insulation and one layer of aluminum foil or an equivalent wrapping.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.2 Filter Holder. 25-mm (15⁄16-in.) ID Gelman filter holder with 303 stainless steel body and 316 stainless steel support screen with the Viton O-ring replaced by a Teflon O-ring.

6.1.3 Filter Heating System.

6.1.3.1 A metal box consisting of an inner and an outer shell separated by insulating material with a heating element in the inner shell capable of maintaining a gas temperature at the filter of 121 ±3 °C (250 ±5 °F). The heating box shall include temperature sensors to monitor the gas temperature immediately upstream and immediately downstream of the filter.

6.1.3.2 A suitable heating box is shown in Figure 25–2. The outer shell is a metal box that measures 102 mm × 280 mm × 292 mm (4 in. × 11 in. × 11½ in.), while the inner shell is a metal box measuring 76 mm × 229 mm × 241 mm (3 in. × 9 in. × 9½ in.). The inner box is supported by 13-mm (½-in.) phenolic rods. The void space between the boxes is filled with ceramic fiber insulation which is sealed in place by means of a silicon rubber bead around the upper sides of the box. A removable lid made in a similar manner, with a 25-mm (1-in.) gap between the parts is used to cover the heating chamber. The inner box is heated with a 250-watt cartridge heater, shielded by a stainless steel shroud. The heater is regulated by a thermostatic temperature controller which is set to maintain a gas temperature of 121 °C (250 °F) as measured by the temperature sensor upstream of the filter.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.4 Condensate Trap. 9.5-mm (⅜-in.) OD 316 stainless steel tubing bent into a U-shape. Exact dimensions are shown in Figure

25–3. The tubing shall be packed with coarse quartz wool, to a density of approximately 0.11 g/cm^3 before bending. While the condensate trap is packed with dry ice in the Dewar, an ice bridge may form between the arms of the condensate trap making it difficult to remove the condensate trap. This problem can be prevented by attaching a steel plate between the arms of the condensate trap in the same plane as the arms to completely fill the intervening space.

6.1.5 Valve. Stainless steel control valve for starting and stopping sample flow.

6.1.6 Metering Valve. Stainless steel valve for regulating the sample flow rate through the sample train.

6.1.7 Rate Meter. Rotameter, or equivalent, capable of measuring sample flow in the range of 60 to 100 cm^3/min (0.13 to 0.21 ft^3/hr).

6.1.8 Sample Tank. Stainless steel or aluminum tank with a minimum volume of 4 liters (0.14 ft^3).

NOTE: Sample volumes greater than 4 liters may be required for sources with low organic concentrations.

6.1.9 Mercury Manometer. U-tube manometer or absolute pressure gauge capable of measuring pressure to within 1 mm Hg in the range of 0 to 900 mm.

6.1.10 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

6.2 Condensate Recovery. The system for the recovery of the organics captured in the condensate trap consists of a heat source, an oxidation catalyst, a nondispersive infrared (NDIR) analyzer, and an intermediate collection vessel (ICV). Figure 25–4 is a schematic of a typical system. The system shall be capable of proper oxidation and recovery, as specified in section 10.1.1. The following major components are required:

6.2.1 Heat Source. Sufficient to heat the condensate trap (including probe) to a temperature of 200 °C (390 °F). A system using both a heat gun and an electric tube furnace is recommended.

6.2.2 Heat Tape. Sufficient to heat the connecting tubing between the water trap and the oxidation catalyst to 100 °C (212 °F).

6.2.3 Oxidation Catalyst. A suitable length of 9.5 mm (3⁄8-in.) OD Inconel 600 tubing packed with 15 cm (6 in.) of 3.2 mm (3⁄8-in.) diameter 19 percent chromia on alumina pellets. The catalyst material is packed in the center of the catalyst tube with quartz wool packed on either end to hold it in place.

6.2.4 Water Trap. Leak-proof, capable of removing moisture from the gas stream.

6.2.5 Syringe Port. A 6.4-mm (1⁄4-in.) OD stainless steel tee fitting with a rubber septum placed in the side arm.

6.2.6 NDIR Detector. Capable of indicating CO_2 concentration in the range of zero to 5 percent, to monitor the progress of combustion of the organic compounds from the condensate trap.

6.2.7 Flow-Control Valve. Stainless steel, to maintain the trap conditioning system near atmospheric pressure.

6.2.8 Intermediate Collection Vessel. Stainless steel or aluminum, equipped with a female quick connect. Tanks with nominal volumes of at least 6 liters (0.2 ft^3) are recommended.

6.2.9 Mercury Manometer. Same as described in section 6.1.9.

6.2.10 Syringe. 10-ml gas-tight glass syringe equipped with an appropriate needle.

6.2.11 Syringes. 10-μl and 50-μl liquid injection syringes.

6.2.12 Liquid Sample Injection Unit. 316 Stainless steel U-tube fitted with an injection septum (see Figure 25–7).

6.3 Analysis.

6.3.1 NMO Analyzer. The NMO analyzer is a gas chromatograph (GC) with backflush capability for NMO analysis and is equipped with an oxidation catalyst, reduction catalyst, and FID. Figures 25–5 and 25–6 are schematics of a typical NMO analyzer. This semicontinuous GC/FID analyzer shall be capable of: (1) Separating CO, CO_2, and CH_4 from NMO, (2) reducing the CO_2 to CH_4 and quantifying as CH_4, and (3) oxidizing the NMO to CO_2, reducing the CO_2 to CH_4 and quantifying as CH_4, according to section 10.1.2. The analyzer consists of the following major components:

6.3.1.1 Oxidation Catalyst. A suitable length of 9.5-mm (3⁄8-in.) OD Inconel 600 tubing packed with 5.1 cm (2 in.) of 19 percent chromia on 3.2-mm (1⁄8-in.) alumina pellets. The catalyst material is packed in the center of the tube supported on either side by quartz wool. The catalyst tube must be mounted vertically in a 650 °C (1200 °F) furnace. Longer catalysts mounted horizontally may be used, provided they can meet the specifications of section 10.1.2.1.

6.3.1.2 Reduction Catalyst. A 7.6-cm (3-in.) length of 6.4-mm (1⁄4-in.) OD Inconel tubing fully packed with 100-mesh pure nickel powder. The catalyst tube must be mounted vertically in a 400 °C (750 °F) furnace.

6.3.1.3 Separation Column(s). A 30-cm (1-ft) length of 3.2-mm (1⁄8-in.) OD stainless steel tubing packed with 60/80 mesh Unibeads 1S followed by a 61-cm (2-ft) length of 3.2-mm (1⁄8-in.) OD stainless steel tubing packed with 60/80 mesh Carbosieve G. The Carbosieve and Unibeads columns must be baked separately at 200 °C (390 °F) with carrier gas flowing through them for 24 hours before initial use.

6.3.1.4 Sample Injection System. A single 10-port GC sample injection valve or a group of valves with sufficient ports fitted with a sample loop properly sized to interface with the NMO analyzer (1-cc loop recommended).

6.3.1.5 FID. An FID meeting the following specifications is required:

6.3.1.5.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.2.3.

6.3.1.5.2 Range. A full scale range of 10 to 50,000 ppm CH_4. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.3.1.6 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the analytical results.

6.3.2 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 1 mm Hg.

6.3.3 Temperature Sensor. Capable of measuring the laboratory temperature within 1 °C (2 °F).

6.3.4 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

7.0 Reagents and Standards

7.1 Sample Collection. The following reagents are required for sample collection:

7.1.1 Dry Ice. Solid CO2, crushed.

7.1.2 Coarse Quartz Wool. 8 to 15 um.

7.1.3 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Method D2986–71, 78, or 95a (incorporated by reference—see § 60.17). Test data from the supplier's quality control program are sufficient for this purpose.

7.2 NMO Analysis. The following gases are required for NMO analysis:

7.2.1 Carrier Gases. Helium (He) and oxygen (O_2) containing less than 1 ppm CO_2 and less than 0.1 ppm hydrocarbon.

7.2.2 Fuel Gas. Hydrogen (H_2), at least 99.999 percent pure.

7.2.3 Combustion Gas. Either air (less than 0.1 ppm total hydrocarbon content) or O_2 (purity 99.99 percent or greater), as required by the detector.

7.3 Condensate Analysis. The following are required for condensate analysis:

7.3.1 Gases. Containing less than 1 ppm carbon.

7.3.1.1 Air.

7.3.1.2 Oxygen.

7.3.2 Liquids. To conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society.

7.3.2.1 Hexane.

7.3.2.2 Decane.

7.4 Calibration. For all calibration gases, the manufacturer must recommend a maximum shelf life for each cylinder (i.e., the length of time the gas concentration is not expected to change more than ±5 percent from its certified value). The date of gas cylinder preparation, certified organic concentration, and recommended maximum shelf life must be affixed to each cylinder before shipment from the gas manufacturer to the buyer. The following calibration gases are required:

7.4.1 Oxidation Catalyst Efficiency Check Calibration Gas. Gas mixture standard with nominal concentration of 1 percent methane in air.

7.4.2 FID Linearity and NMO Calibration Gases. Three gas mixture standards with nominal propane concentrations of 20 ppm, 200 ppm, and 3000 ppm, in air.

7.4.3 CO_2 Calibration Gases. Three gas mixture standards with nominal CO_2 concentrations of 50 ppm, 500 ppm, and 1 percent, in air.

NOTE: Total NMO less than 1 ppm required for 1 percent mixture.

7.4.4 NMO Analyzer System Check Calibration Gases. Four calibration gases are needed as follows:

7.4.4.1 Propane Mixture. Gas mixture standard containing (nominal) 50 ppm CO, 50 ppm CH_4, 1 percent CO_2, and 20 ppm C_3H_8, prepared in air.

7.4.4.2 Hexane. Gas mixture standard containing (nominal) 50 ppm hexane in air.

7.4.4.3 Toluene. Gas mixture standard containing (nominal) 20 ppm toluene in air.

7.4.4.4 Methanol. Gas mixture standard containing (nominal) 100 ppm methanol in air.

8.0 Sample Collection, Preservation, Transport, and Storage

8.1 Sampling Equipment Preparation.

8.1.1 Condensate Trap Cleaning. Before its initial use and after each use, a condensate trap should be thoroughly cleaned and checked to ensure that it is not contaminated. Both cleaning and checking can be accomplished by installing the trap in the condensate recovery system and treating it as if it were a sample. The trap should be heated as described in section 11.1.3. A trap may be considered clean when the CO_2 concentration in its effluent gas drops below 10 ppm. This check is optional for traps that most recently have been used to collect samples which were then recovered according to the procedure in section 11.1.3.

8.1.2 Sample Tank Evacuation and Leak-Check. Evacuate the sample tank to 10 mm Hg absolute pressure or less. Then close the sample tank valve, and allow the tank to sit for 60 minutes. The tank is acceptable if a change in tank vacuum of less than 1 mm Hg is noted. The evacuation and leak-check may be conducted either in the laboratory or the field.

8.1.3 Sampling Train Assembly. Just before assembly, measure the tank vacuum using a mercury manometer. Record this vacuum, the ambient temperature, and the barometric pressure at this time. Close the sample tank valve and assemble the sampling

system as shown in Figure 25–1. Immerse the condensate trap body in dry ice at least 30 minutes before commencing sampling to improve collection efficiency. The point where the inlet tube joins the trap body should be 2.5 to 5 cm (1 to 2 in.) above the top of the dry ice.

8.1.4 Pretest Leak-Check. A pretest leak-check is required. Calculate or measure the approximate volume of the sampling train from the probe tip to the sample tank valve. After assembling the sampling train, plug the probe tip, and make certain that the sample tank valve is closed. Turn on the vacuum pump, and evacuate the sampling system from the probe tip to the sample tank valve to an absolute pressure of 10 mm Hg or less. Close the purge valve, turn off the pump, wait a minimum period of 10 minutes, and recheck the indicated vacuum. Calculate the maximum allowable pressure change based on a leak rate of 1 percent of the sampling rate using Equation 25–1, section 12.2. If the measured pressure change exceeds the allowable, correct the problem and repeat the leak-check before beginning sampling.

8.2 Sample Collection.

8.2.1 Unplug the probe tip, and place the probe into the stack such that the probe is perpendicular to the duct or stack axis; locate the probe tip at a single preselected point of average velocity facing away from the direction of gas flow. For stacks having a negative static pressure, seal the sample port sufficiently to prevent air in-leakage around the probe. Set the probe temperature controller to 129 °C (265 °F) and the filter temperature controller to 121 °C (250 °F). Allow the probe and filter to heat for about 30 minutes before purging the sample train.

8.2.2 Close the sample valve, open the purge valve, and start the vacuum pump. Set the flow rate between 60 and 100 cm^3/min (0.13 and 0.21 ft^3/hr), and purge the train with stack gas for at least 10 minutes.

8.2.3 When the temperatures at the exit ends of the probe and filter are within the corresponding specified ranges, check the dry ice level around the condensate trap, and add dry ice if necessary. Record the clock time. To begin sampling, close the purge valve and stop the pump. Open the sample valve and the sample tank valve. Using the flow control valve, set the flow through the sample train to the proper rate. Adjust the flow rate as necessary to maintain a constant rate (±10 percent) throughout the duration of the sampling period. Record the sample tank vacuum and flowmeter setting at 5-minute intervals. (See Figure 25–8.) Select a total sample time greater than or equal to the minimum sampling time specified in the applicable subpart of the regulations; end the sampling when this time period is reached or when a constant flow rate can no longer be maintained because of reduced sample tank vacuum.

NOTE: If sampling had to be stopped before obtaining the minimum sampling time (specified in the applicable subpart) because a constant flow rate could not be maintained, proceed as follows: After closing the sample tank valve, remove the used sample tank from the sampling train (without disconnecting other portions of the sampling train). Take another evacuated and leak-checked sample tank, measure and record the tank vacuum, and attach the new tank to the sampling train. After the new tank is attached to the sample train, proceed with the sampling until the required minimum sampling time has been exceeded.

8.3 Sample Recovery. After sampling is completed, close the flow control valve, and record the final tank vacuum; then record the tank temperature and barometric pressure. Close the sample tank valve, and disconnect the sample tank from the sample system. Disconnect the condensate trap at the inlet to the rate meter, and tightly seal both ends of the condensate trap. Do not include the probe from the stack to the filter as part of the condensate sample.

8.4 Sample Storage and Transport. Keep the trap packed in dry ice until the samples are returned to the laboratory for analysis. Ensure that run numbers are identified on the condensate trap and the sample tank(s).

9.0 Quality Control

Section	Quality control measure	Effect
10.1.1	Initial performance check of condensate recovery apparatus.	Ensure acceptable condensate recovery efficiency.
10.1.2, 10.2	NMO analyzer initial and daily performance checks.	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial Performance Checks.

10.1.1 Condensate Recovery Apparatus. Perform these tests before the system is first placed in operation, after any shutdown of 6 months or more, and after any major modification of the system, or at the frequency recommended by the manufacturer.

10.1.1.1 Carrier Gas and Auxiliary O_2 Blank Check. Analyze each new tank of carrier gas or auxiliary O_2 with the NMO analyzer to

check for contamination. Treat the gas cylinders as noncondensible gas samples, and analyze according to the procedure in section 11.2.3. Add together any measured CH_4, CO, CO_2, or NMO. The total concentration must be less than 5 ppm.

10.1.1.2 Oxidation Catalyst Efficiency Check.

10.1.1.2.1 With a clean condensate trap installed in the recovery system or a ⅛″ stainless steel connector tube, replace the carrier gas cylinder with the high level methane standard gas cylinder (Section 7.4.1). Set the four-port valve to the recovery position, and attach an ICV to the recovery system. With the sample recovery valve in vent position and the flow-control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

10.1.1.2.2 After the NDIR response has stabilized, switch the sample recovery valve from vent to collect. When the manometer or pressure gauge begins to register a slight positive pressure, open the flow-control valve. Keep the flow adjusted such that the pressure in the system is maintained within 10 percent of atmospheric pressure. Continue collecting the sample in a normal manner until the ICV is filled to a nominal gauge pressure of 300 mm Hg. Close the ICV valve, and remove the ICV from the system. Place the sample recovery valve in the vent position, and return the recovery system to its normal carrier gas and normal operating conditions. Analyze the ICV for CO_2 using the NMO analyzer; the catalyst efficiency is acceptable if the CO_2 concentration is within 2 percent of the methane standard concentration.

10.1.1.3 System Performance Check. Construct a liquid sample injection unit similar in design to the unit shown in Figure 25–7. Insert this unit into the condensate recovery and conditioning system in place of a condensate trap, and set the carrier gas and auxiliary O_2 flow rates to normal operating levels. Attach an evacuated ICV to the system, and switch from system vent to collect. With the carrier gas routed through the injection unit and the oxidation catalyst, inject a liquid sample (see sections 10.1.1.3.1 to 10.1.1.3.4) into the injection port. Operate the trap recovery system as described in section 11.1.3. Measure the final ICV pressure, and then analyze the vessel to determine the CO_2 concentration. For each injection, calculate the percent recovery according to section 12.7. Calculate the relative standard deviation for each set of triplicate injections according to section 12.8. The performance test is acceptable if the average percent recovery is 100 ±5 percent and the relative standard deviation is less than 2 percent for each set of triplicate injections.

10.1.1.3.1 50 μl hexane.

10.1.1.3.2 10 μl hexane.

10.1.1.3.3 50 μl decane.

10.1.1.3.4 10 μl decane.

10.1.2 NMO Analyzer. Perform these tests before the system is first placed in operation, after any shutdown longer than 6 months, and after any major modification of the system.

10.1.2.1 Oxidation Catalyst Efficiency Check. Turn off or bypass the NMO analyzer reduction catalyst. Make triplicate injections of the high level methane standard (Section 7.4.1). The oxidation catalyst operation is acceptable if the FID response is less than 1 percent of the injected methane concentration.

10.1.2.2 Reduction Catalyst Efficiency Check. With the oxidation catalyst unheated or bypassed and the heated reduction catalyst bypassed, make triplicate injections of the high level methane standard (Section 7.4.1). Repeat this procedure with both catalysts operative. The reduction catalyst operation is acceptable if the responses under both conditions agree within 5 percent of their average.

10.1.2.3 NMO Analyzer Linearity Check Calibration. While operating both the oxidation and reduction catalysts, conduct a linearity check of the analyzer using the propane standards specified in section 7.4.2. Make triplicate injections of each calibration gas. For each gas (*i.e.*, each set of triplicate injections), calculate the average response factor (area/ppm C) for each gas, as well as and the relative standard deviation (according to section 12.8). Then calculate the overall mean of the response factor values. The instrument linearity is acceptable if the average response factor of each calibration gas is within 2.5 percent of the overall mean value and if the relative standard deviation gas is less than 2 percent of the overall mean value. Record the overall mean of the propane response factor values as the NMO calibration response factor (RF_{NMO}). Repeat the linearity check using the CO_2 standards specified in section 7.4.3. Make triplicate injections of each gas, and then calculate the average response factor (area/ppm C) for each gas, as well as the overall mean of the response factor values. Record the overall mean of the response factor values as the CO_2 calibration response factor (RF_{CO2}). The RF_{CO2} must be within 10 percent of the RF_{NMO}.

10.1.2.4 System Performance Check. Check the column separation and overall performance of the analyzer by making triplicate injections of the calibration gases listed in section 7.4.4. The analyzer performance is acceptable if the measured NMO value for each gas (average of triplicate injections) is within 5 percent of the expected value.

10.2 NMO Analyzer Daily Calibration. The following calibration procedures shall be performed before and immediately after the

analysis of each set of samples, or on a daily basis, whichever is more stringent:

10.2.1 CO_2 Response Factor. Inject triplicate samples of the high level CO_2 calibration gas (Section 7.4.3), and calculate the average response factor. The system operation is adequate if the calculated response factor is within 5 percent of the RF_{CO2} calculated during the initial performance test (Section 10.1.2.3). Use the daily response factor (DRF_{CO2}) for analyzer calibration and the calculation of measured CO_2 concentrations in the ICV samples.

10.2.2 NMO Response Factors. Inject triplicate samples of the mixed propane calibration cylinder gas (Section 7.4.4.1), and calculate the average NMO response factor. The system operation is adequate if the calculated response factor is within 10 percent of the RF_{NMO} calculated during the initial performance test (Section 10.1.2.4). Use the daily response factor (DRF_{NMO}) for analyzer calibration and calculation of NMO concentrations in the sample tanks.

10.3 Sample Tank and ICV Volume. The volume of the gas sampling tanks used must be determined. Determine the tank and ICV volumes by weighing them empty and then filled with deionized distilled water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedure

11.1 Condensate Recovery. See Figure 25–9. Set the carrier gas flow rate, and heat the catalyst to its operating temperature to condition the apparatus.

11.1.1 Daily Performance Checks. Each day before analyzing any samples, perform the following tests:

11.1.1.1 Leak-Check. With the carrier gas inlets and the sample recovery valve closed, install a clean condensate trap in the system, and evacuate the system to 10 mm Hg absolute pressure or less. Monitor the system pressure for 10 minutes. The system is acceptable if the pressure change is less than 2 mm Hg.

11.1.1.2 System Background Test. Adjust the carrier gas and auxiliary oxygen flow rate to their normal values of 100 cc/min and 150 cc/min, respectively, with the sample recovery valve in vent position. Using a 10-ml syringe, withdraw a sample from the system effluent through the syringe port. Inject this sample into the NMO analyzer, and measure the CO_2 content. The system background is acceptable if the CO_2 concentration is less than 10 ppm.

11.1.1.3 Oxidation Catalyst Efficiency Check. Conduct a catalyst efficiency test as specified in section 10.1.1.2. If the criterion of this test cannot be met, make the necessary repairs to the system before proceeding.

11.1.2 Condensate Trap CO_2 Purge and Sample Tank Pressurization.

11.1.2.1 After sampling is completed, the condensate trap will contain condensed water and organics and a small volume of sampled gas. This gas from the stack may contain a significant amount of CO_2 which must be removed from the condensate trap before the sample is recovered. This is accomplished by purging the condensate trap with zero air and collecting the purged gas in the original sample tank.

11.1.2.2 Begin with the sample tank and condensate trap from the test run to be analyzed. Set the four-port valve of the condensate recovery system in the CO_2 purge position as shown in Figure 25–9. With the sample tank valve closed, attach the sample tank to the sample recovery system. With the sample recovery valve in the vent position and the flow control valve fully open, evacuate the manometer or pressure gauge to the vacuum of the sample tank. Next, close the vacuum pump valve, open the sample tank valve, and record the tank pressure.

11.1.2.3 Attach the dry ice-cooled condensate trap to the recovery system, and initiate the purge by switching the sample recovery valve from vent to collect position. Adjust the flow control valve to maintain atmospheric pressure in the recovery system. Continue the purge until the CO_2 concentration of the trap effluent is less than 5 ppm. CO_2 concentration in the trap effluent should be measured by extracting syringe samples from the recovery system and analyzing the samples with the NMO analyzer. This procedure should be used only after the NDIR response has reached a minimum level. Using a 10-ml syringe, extract a sample from the syringe port prior to the NDIR, and inject this sample into the NMO analyzer.

11.1.2.4 After the completion of the CO_2 purge, use the carrier gas bypass valve to pressurize the sample tank to approximately 1,060 mm Hg absolute pressure with zero air.

11.1.3 Recovery of the Condensate Trap Sample (See Figure 25–10).

11.1.3.1 Attach the ICV to the sample recovery system. With the sample recovery valve in a closed position, between vent and collect, and the flow control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

11.1.3.2 Begin auxiliary oxygen flow to the oxidation catalyst at a rate of 150 cc/min, then switch the four-way valve to the trap recovery position and the sample recovery valve to collect position. The system should now be set up to operate as indicated in Figure 25–10. After the manometer or pressure gauge begins to register a slight positive pressure, open the flow control valve. Adjust the flow-control valve to maintain atmospheric pressure in the system within 10 percent.

11.1.3.3 Remove the condensate trap from the dry ice, and allow it to warm to ambient temperature while monitoring the NDIR response. If, after 5 minutes, the CO_2 concentration of the catalyst effluent is below 10,000 ppm, discontinue the auxiliary oxygen flow to the oxidation catalyst. Begin heating the trap by placing it in a furnace preheated to 200 °C (390 °F). Once heating has begun, carefully monitor the NDIR response to ensure that the catalyst effluent concentration does not exceed 50,000 ppm. Whenever the CO_2 concentration exceeds 50,000 ppm, supply auxiliary oxygen to the catalyst at the rate of 150 cc/min. Begin heating the tubing that connected the heated sample box to the condensate trap only after the CO_2 concentration falls below 10,000 ppm. This tubing may be heated in the same oven as the condensate trap or with an auxiliary heat source such as a heat gun. Heating temperature must not exceed 200 °C (390 °F). If a heat gun is used, heat the tubing slowly along its entire length from the upstream end to the downstream end, and repeat the pattern for a total of three times. Continue the recovery until the CO_2 concentration drops to less than 10 ppm as determined by syringe injection as described under the condensate trap CO_2 purge procedure (Section 11.1.2).

11.1.3.4 After the sample recovery is completed, use the carrier gas bypass valve to pressurize the ICV to approximately 1060 mm Hg absolute pressure with zero air.

11.2 Analysis. Once the initial performance test of the NMO analyzer has been successfully completed (see section 10.1.2) and the daily CO_2 and NMO response factors have been determined (see section 10.2), proceed with sample analysis as follows:

11.2.1 Operating Conditions. The carrier gas flow rate is 29.5 cc/min He and 2.2 cc/min O_2. The column oven is heated to 85 °C (185 °F). The order of elution for the sample from the column is CO, CH_4, CO_2, and NMO.

11.2.2 Analysis of Recovered Condensate Sample. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (380 °F) as rapidly as possible. A rate of 30 °C/min (90 °F) has been shown to be adequate. Record the value obtained for the condensible organic material (C_{cm}) measured as CO_2 and any measured NMO. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average C_{cm}.

11.2.3 Analysis of Sample Tank. Perform the analysis as described in section 11.2.2, but record only the value measured for NMO (C_{tm}).

12.0 Data Analysis and Calculations

Carry out the calculations, retaining at least one extra significant figure beyond that of the acquired data. Round off figures after final calculations. All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature.

C = TGNMO concentration of the effluent, ppm C equivalent.
C_c = Calculated condensible organic (condensate trap) concentration of the effluent, ppm C equivalent.
C_{cm} = Measured concentration (NMO analyzer) for the condensate trap ICV, ppm CO_2.
C_t = Calculated noncondensible organic concentration (sample tank) of the effluent, ppm C equivalent.
C_{tm} = Measured concentration (NMO analyzer) for the sample tank, ppm NMO.
F = Sampling flow rate, cc/min.
L = Volume of liquid injected, µl.
M = Molecular weight of the liquid injected, g/g-mole.
M_c = TGNMO mass concentration of the effluent, mg C/dsm^3.
N = Carbon number of the liquid compound injected (N = 12 for decane, N = 6 for hexane).
n = Number of data points.
P_f = Final pressure of the intermediate collection vessel, mm Hg absolute.
P_b = Barometric pressure, cm Hg.
P_{ti} = Gas sample tank pressure before sampling, mm Hg absolute.
P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.
P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.
q = Total number of analyzer injections of intermediate collection vessel during analysis (where k = injection number, 1 * * * q).
r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 * * * r).
r = Density of liquid injected, g/cc.
T_f = Final temperature of intermediate collection vessel, °K.
T_{ti} = Sample tank temperature before sampling, °K.
T_t = Sample tank temperature at completion of sampling, °K.
T_{tf} = Sample tank temperature after pressurizing, °K.
V = Sample tank volume, m^3.
V_t = Sample train volume, cc.
V_v = Intermediate collection vessel volume, m^3.
V_s = Gas volume sampled, dsm^3.
x_i = Individual measurements.
$\bar{x}$ = Mean value.

ΔP = Allowable pressure change, cm Hg.
Θ = Leak-check period, min.

12.2 Allowable Pressure Change. For the pretest leak-check, calculate the allowable pressure change using Equation 25–1:

$$\Delta P = 0.01 \frac{FP_b\Theta}{V_t} \qquad \text{Eq. 25-1}$$

12.3 Sample Volume. For each test run, calculate the gas volume sampled using Equation 25–2:

$$V_s = 0.3857\, V\left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}\right) \qquad \text{Eq. 25-2}$$

12.4 Noncondensible Organics. For each sample tank, determine the concentration of nonmethane organics (ppm C) using Equation 25–3:

$$C_t = \left(\frac{\dfrac{P_{tf}}{T_{tf}}}{\dfrac{P_t}{T_t} - \dfrac{P_{ti}}{T_{ti}}}\right)\left(\frac{1}{r}\sum_{j=1}^{r} C_{tm_j}\right) \qquad \text{Eq. 25-3}$$

12.5 Condensible Organics. For each condensate trap determine the concentration of organics (ppm C) using Equation 25–4:

$$C_c = 0.3857 \frac{V_v P_f}{V_s T_f}\left(\frac{1}{q}\sum_{k=1}^{q} C_{cm_k}\right) \qquad \text{Eq. 25-4}$$

12.6 TGNMO Mass Concentration. Determine the TGNMO mass concentration as carbon for each test run, using Equation 25–5:

$$M_c = 0.4993\left(C_t + C_c\right) \qquad \text{Eq. 25-5}$$

12.7 Percent Recovery. Calculate the percent recovery for the liquid injections to the condensate recovery and conditioning system using Equation 25–6:

$$\text{Percent Recovery} = K\,\frac{M\,V_v P_t C_{cm}}{L\,P\,T_f N} \qquad \text{Eq. 25-6}$$

where K = 1.604 (°K)(g-mole)(%)/(mm Hg)(ml)(m^3)(ppm).

12.8 Relative Standard Deviation. Use Equation 25–7 to calculate the relative standard deviation (RSD) of percent recovery and analyzer linearity.

$$\text{RSD} = \frac{100}{\bar{x}}\left[\frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}{n-1}\right]^{\frac{1}{2}} \qquad \text{Eq. 25-7}$$

13.0 Method Performance

13.1 Range. The minimum detectable limit of the method has been determined to be 50 parts per million by volume (ppm). No upper limit has been established.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, A.E., S. Witz, and R.D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, MA. June 15–20, 1975.) 14 p.

2. Salo, A.E., W.L. Oaks, and R.D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, CO. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

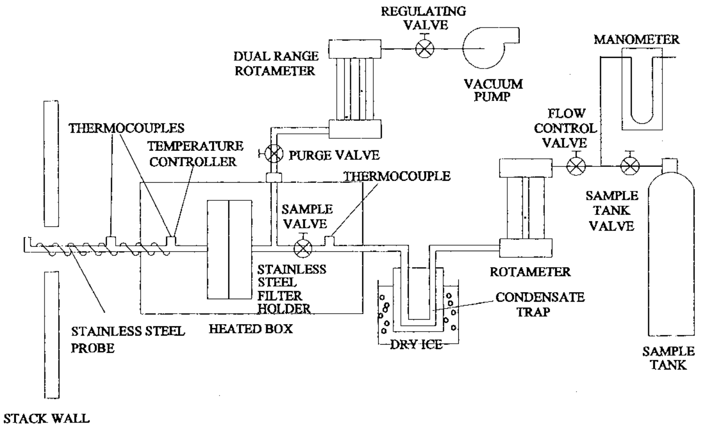


Figure 25-1. Sampling Train

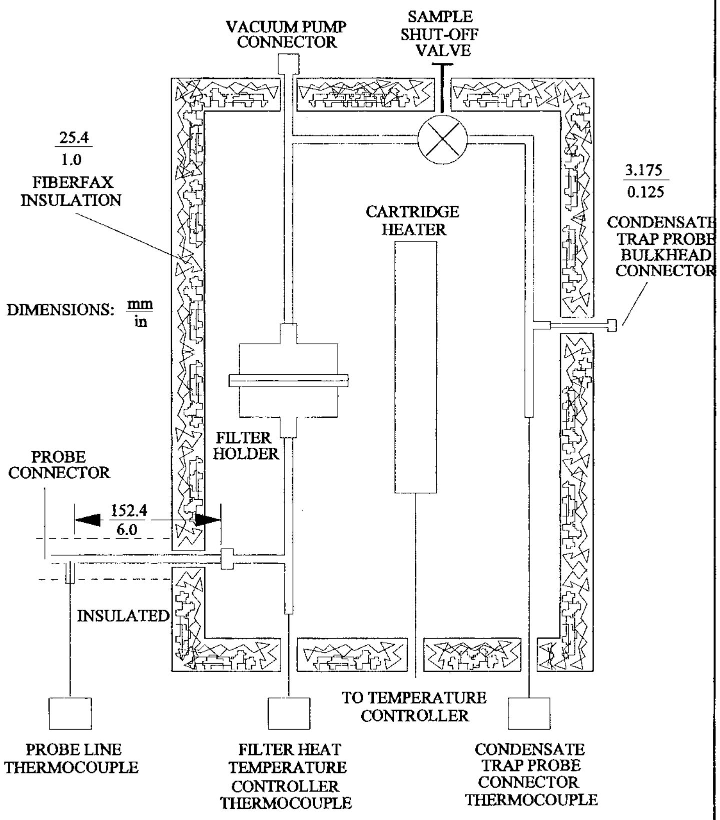


Figure 25-2. Out-of-stack Filter Box

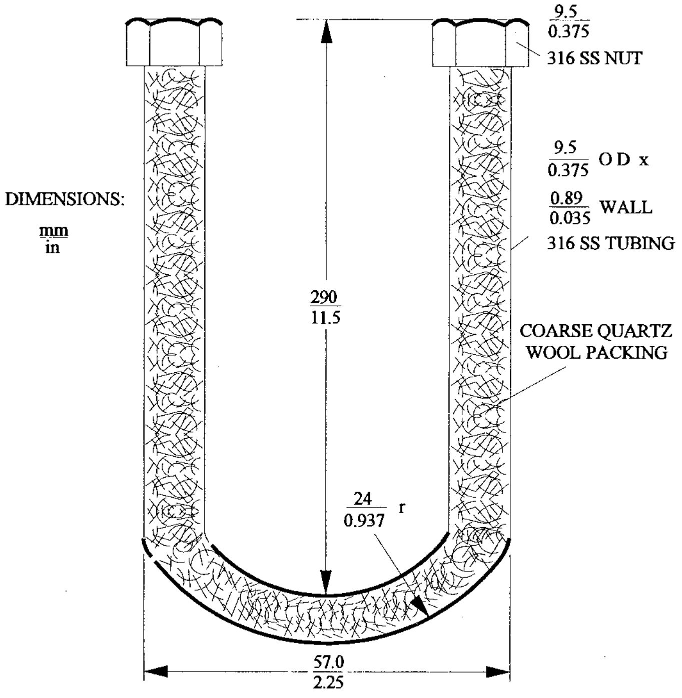


Figure 25-3. Condensate Trap

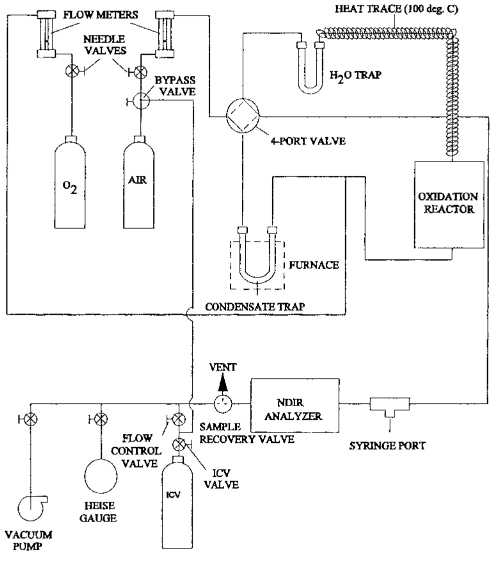


Figure 25-4. Condensate Recovery System

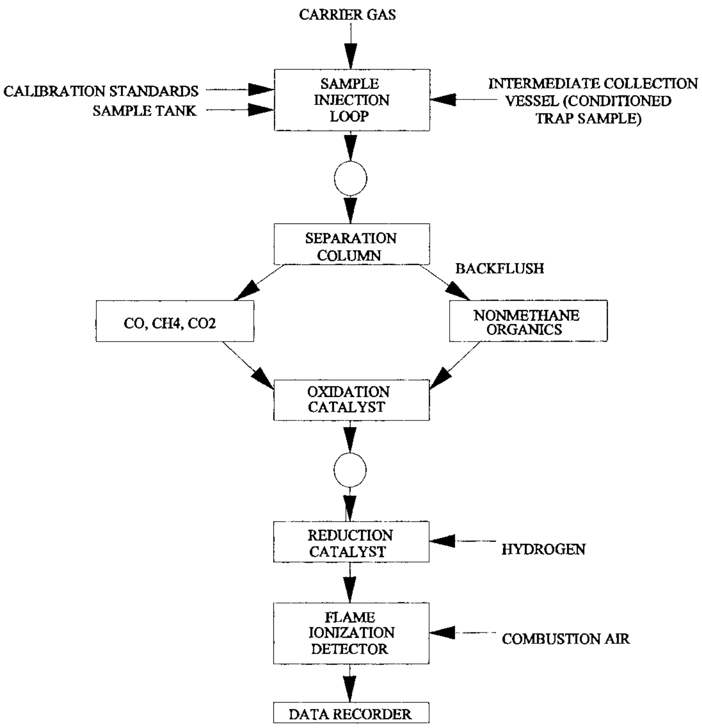


Figure 25-5. Simplified Schematic of Nonmethane Organic (NMO) Analyzer

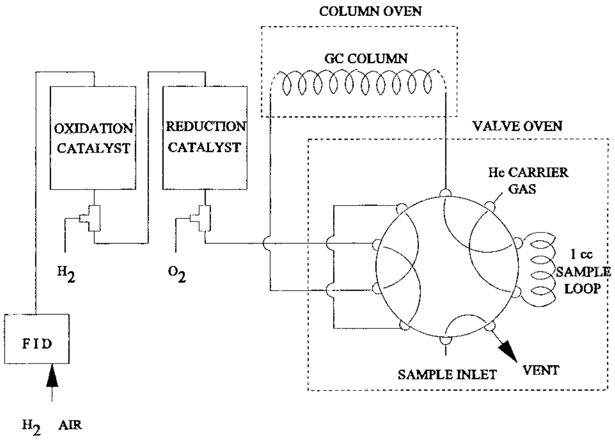


Figure 25-6. Nonmethane Organic Analyzer (NMO)

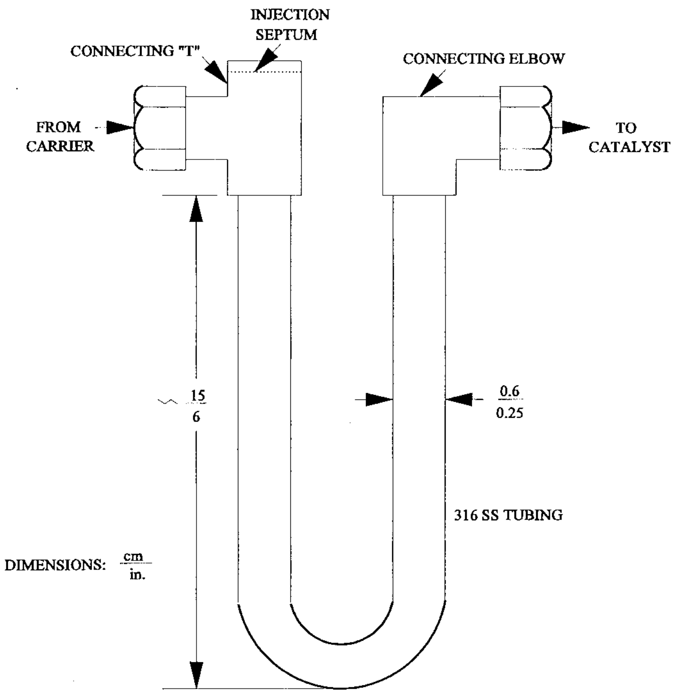
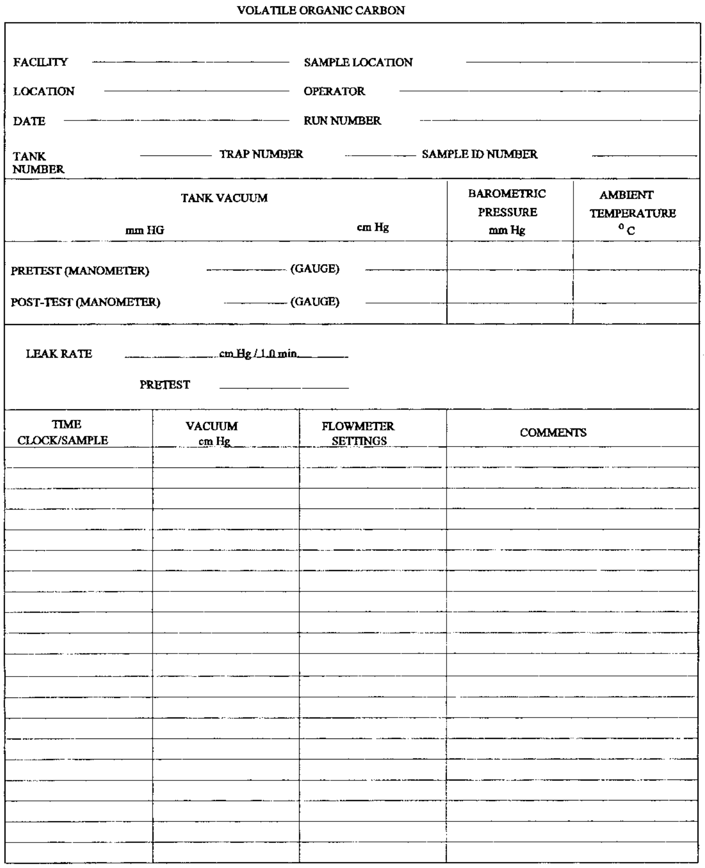


Figure 25-7. Liquid Sample Injection Unit



VOLATILE ORGANIC CARBON

FACILITY ________ SAMPLE LOCATION ________

LOCATION ________ OPERATOR ________

DATE ________ RUN NUMBER ________

TANK NUMBER ________ TRAP NUMBER ________ SAMPLE ID NUMBER ________

TANK VACUUM mm HG	cm Hg	BAROMETRIC PRESSURE mm Hg	AMBIENT TEMPERATURE °C
PRETEST (MANOMETER) ______	(GAUGE) ______		
POST-TEST (MANOMETER) ______	(GAUGE) ______		

LEAK RATE ______ cm Hg / 1.0 min. ______

PRETEST ______

TIME CLOCK/SAMPLE	VACUUM cm Hg	FLOWMETER SETTINGS	COMMENTS

Figure 25-8. Example Field Data Form

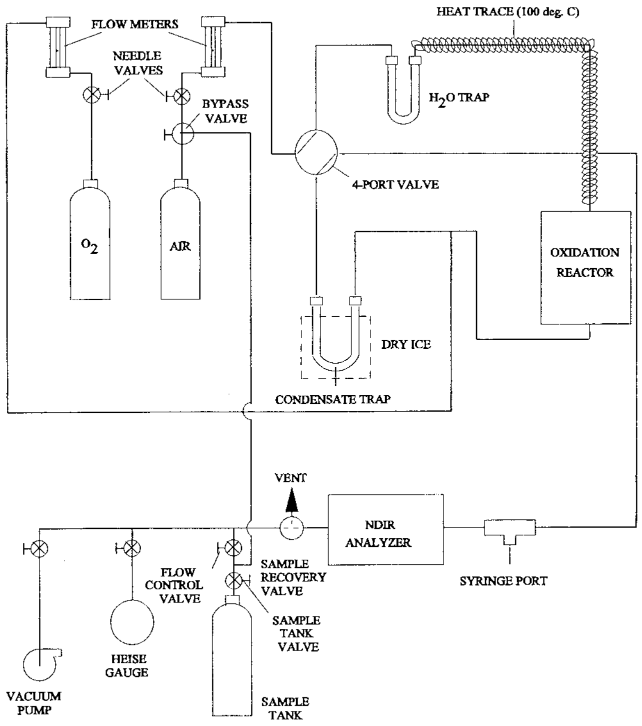


Figure 25-9. Condensate Recovery System, CO2 Purge

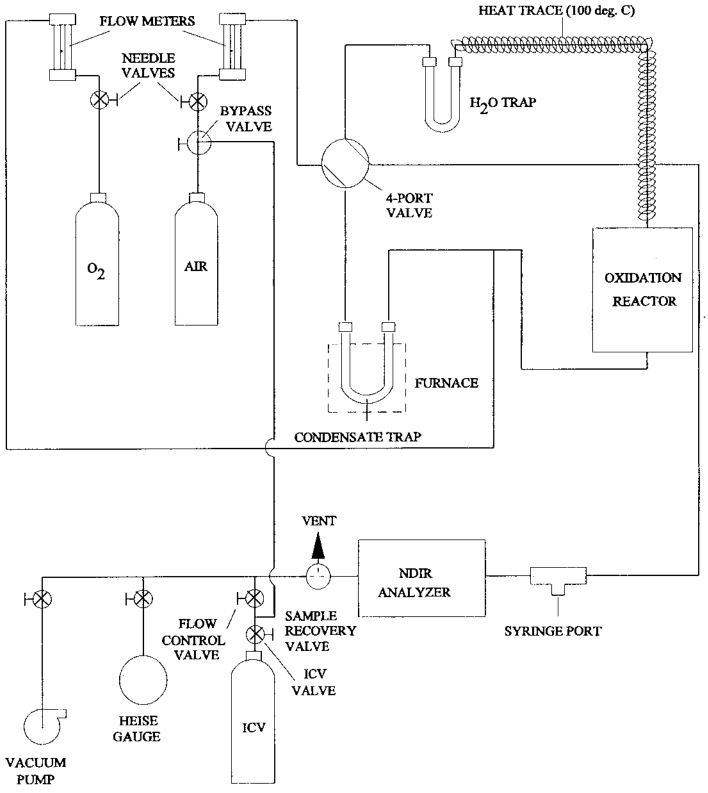


Figure 25-10. Condensate Recovery System, Collection of Trap Organics

METHOD 25A—DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A FLAME IONIZATION ANALYZER

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A gas sample is extracted from the source through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

3.1 *Calibration drift* means the difference in the measurement system response to a mid-level calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

3.2 *Calibration error* means the difference between the gas concentration indicated by the measurement system and the know concentration of the calibration gas.

3.3 *Calibration gas* means a known concentration of a gas in an appropriate diluent gas.

3.4 *Measurement system* means the total equipment required for the determination of the gas concentration. The system consists of the following major subsystems:

3.4.1 *Sample interface* means that portion of a system used for one or more of the following: sample acquisition, sample transportation, sample conditioning, or protection of the analyzer(s) from the effects of the stack effluent.

3.4.2 *Organic analyzer* means that portion of the measurement system that senses the gas to be measured and generates an output proportional to its concentration.

3.5 *Response time* means the time interval from a step change in pollutant concentration at the inlet to the emission measurement system to the time at which 95 percent of the corresponding final value is reached as displayed on the recorder.

3.6 *Span Value* means the upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the applicable emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected concentration. For convenience, the span value should correspond to 100 percent of the recorder scale.

3.7 *Zero drift* means the difference in the measurement system response to a zero level calibration gas before or after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

6.1 Measurement System. Any measurement system for total organic concentration that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 25A–1. All sampling components leading to the analyzer shall be heated ≥110 °C (220 °F) throughout the sampling period, unless safety reasons are cited (Section 5.2) The essential components of the measurement system are described below:

6.1.1 Organic Concentration Analyzer. A flame ionization analyzer (FIA) capable of meeting or exceeding the specifications of this method. The flame ionization detector block shall be heated >120 °C (250 °F).

6.1.2 Sample Probe. Stainless steel, or equivalent, three-hole rake type. Sample holes shall be 4 mm (0.16-in.) in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

6.1.3 Heated Sample Line. Stainless steel or Teflon'' tubing to transport the sample gas

to the analyzer. The sample line should be heated (≥110 °C) to prevent any condensation.

6.1.4 Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are applicable.

6.1.5 Particulate Filter. An in-stack or an out-of-stack glass fiber filter is recommended if exhaust gas particulate loading is significant. An out-of-stack filter should be heated to prevent any condensation.

6.1.6 Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

7.0 Reagents and Standards

7.1 Calibration Gases. The calibration gases for the gas analyzer shall be propane in air or propane in nitrogen. Alternatively, organic compounds other than propane can be used; the appropriate corrections for response factor must be made. Calibration gases shall be prepared in accordance with the procedure listed in Citation 2 of section 16. Additionally, the manufacturer of the cylinder should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change more than ±2 percent from the certified value. For calibration gas values not generally available (*i.e.*, organics between 1 and 10 percent by volume), alternative methods for preparing calibration gas mixtures, such as dilution systems (Test Method 205, 40 CFR Part 51, Appendix M), may be used with prior approval of the Administrator.

7.1.1 Fuel. A 40 percent H_2/60 percent N_2 gas mixture is recommended to avoid an oxygen synergism effect that reportedly occurs when oxygen concentration varies significantly from a mean value.

7.1.2 Zero Gas. High purity air with less than 0.1 part per million by volume (ppmv) of organic material (propane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

7.1.3 Low-level Calibration Gas. An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value.

7.1.4 Mid-level Calibration Gas. An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value.

7.1.5 High-level Calibration Gas. An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Selection of Sampling Site. The location of the sampling site is generally specified by the applicable regulation or purpose of the test (*i.e.*, exhaust stack, inlet line, etc.). The sample port shall be located to meet the testing requirements of Method 1.

8.2 Location of Sample Probe. Install the sample probe so that the probe is centrally located in the stack, pipe, or duct and is sealed tightly at the stack port connection.

8.3 Measurement System Preparation. Prior to the emission test, assemble the measurement system by following the manufacturer's written instructions for preparing sample interface and the organic analyzer. Make the system operable (Section 10.1).

8.4 Calibration Error Test. Immediately prior to the test series (within 2 hours of the start of the test), introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then introduce low-level and mid-level calibration gases successively to the measurement system. Record the analyzer responses for low-level and mid-level calibration gases and determine the differences between the measurement system responses and the predicted responses. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and must be replaced or repaired prior to testing. No adjustments to the measurement system shall be conducted after the calibration and before the drift check (Section 8.6.2). If adjustments are necessary before the completion of the test series, perform the drift checks prior to the required adjustments and repeat the calibration following the adjustments. If multiple electronic ranges are to be used, each additional range must be checked with a mid-level calibration gas to verify the multiplication factor.

8.5 Response Time Test. Introduce zero gas into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. Record the time from the concentration change to the measurement system response equivalent to 95 percent of the step change. Repeat the test three times and average the results.

8.6 Emission Measurement Test Procedure.

8.6.1 Organic Measurement. Begin sampling at the start of the test period, recording time and any required process information as appropriate. In particulate, note on the recording chart, periods of process interruption or cyclic operation.

8.6.2 Drift Determination. Immediately following the completion of the test period and hourly during the test period, reintroduce the zero and mid-level calibration gases, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until both the zero and calibration drift checks are made.) Record the analyzer response. If the drift values exceed the specified limits, invalidate the test results preceding the check and repeat the test following corrections to the measurement system. Alternatively, recalibrate the test measurement system as in section 8.4 and report the results using both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

NOTE: Note on the recording chart periods of process interruption or cyclic operation.

9.0 Quality Control

Method section	Quality control measure	Effect
8.4	Zero and calibration drift tests	Ensures that bias introduced by drift in the measurement system output during the run is no greater than 3 percent of span.

10.0 Calibration and Standardization

10.1 FIA equipment can be calibrated for almost any range of total organic concentrations. For high concentrations of organics (>1.0 percent by volume as propane), modifications to most commonly available analyzers are necessary. One accepted method of equipment modification is to decrease the size of the sample to the analyzer through the use of a smaller diameter sample capillary. Direct and continuous measurement of organic concentration is a necessary consideration when determining any modification design.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

12.1 Determine the average organic concentration in terms of ppmv as propane or other calibration gas. The average shall be determined by integration of the output recording over the period specified in the applicable regulation. If results are required in terms of ppmv as carbon, adjust measured concentrations using Equation 25A–1.

$$C_c = K\,C_{meas} \qquad \text{Eq. 25A-1}$$

Where:

C_c = Organic concentration as carbon, ppmv.

C_{meas} = Organic concentration as measured, ppmv.

K = Carbon equivalent correction factor.

= 2 for ethane.

= 3 for propane.

= 4 for butane.

= Appropriate response factor for other organic calibration gases.

13.0 Method Performance

13.1 Measurement System Performance Specifications.

13.1.1 Zero Drift. Less than ±3 percent of the span value.

13.1.2 Calibration Drift. Less than ±3 percent of span value.

13.1.3 Calibration Error. Less than ±5 percent of the calibration gas value.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Measurement of Volatile Organic Compounds—Guideline Series. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA–450/2–78–041. June 1978. p. 46–54.

2. EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards. U.S. Environmental Protection Agency, Quality Assurance and Technical Support Division. Research Triangle Park, N.C. September 1993.

3. Gasoline Vapor Emission Laboratory Evaluation—Part 2. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. EMB Report No. 75–GAS–6. August 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

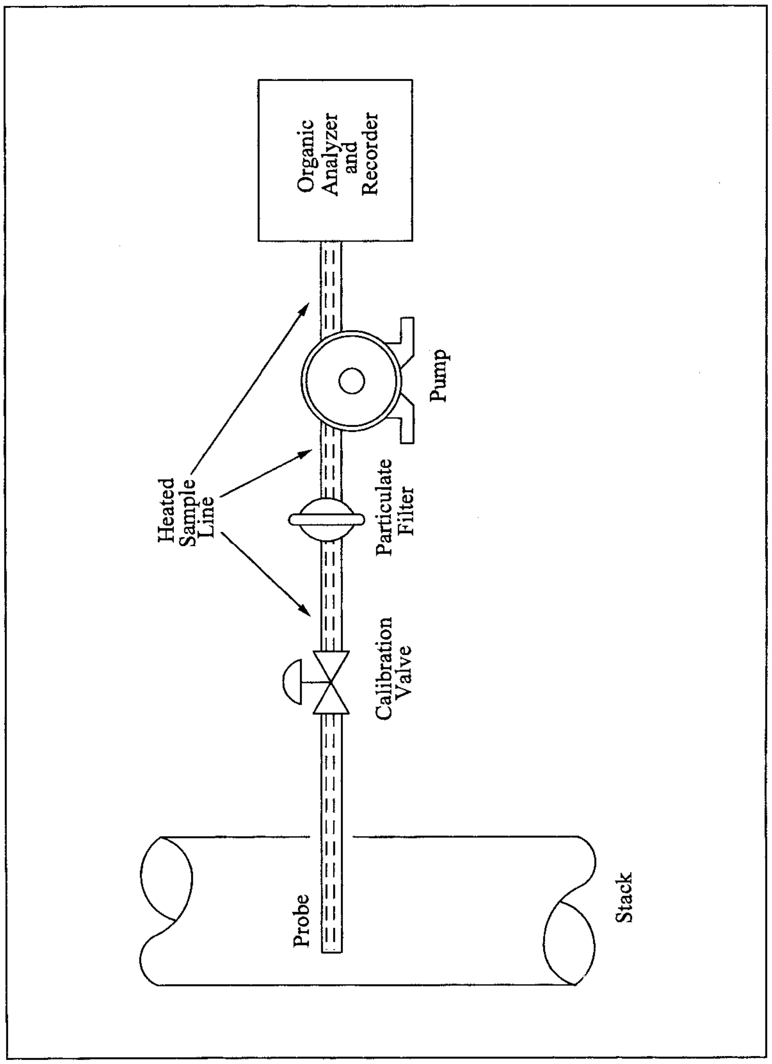


Figure 25A-1. Organic Concentration Measurement System.

Method 25B—Determination of Total Gaseous Organic Concentration Using a Nondispersive Infrared Analyzer

Note: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 1, Method 6C, and Method 25A.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes. Other organic materials may be measured using the general procedure in this method, the appropriate calibration gas, and an analyzer set to the appropriate absorption band.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a nondispersive infrared analyzer (NDIR). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

Same as Method 25A, section 3.0.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

Same as Method 25A, section 6.0, with the exception of the following:

6.1 Organic Concentration Analyzer. A nondispersive infrared analyzer designed to measure alkane organics and capable of meeting or exceeding the specifications in this method.

7.0 Reagents and Standards

Same as Method 25A, section 7.1. No fuel gas is required for an NDIR.

8.0 Sample Collection, Preservation, Storage, and Transport

Same as Method 25A, section 8.0.

9.0 Quality Control

Same as Method 25A, section 9.0.

10.0 Calibration and Standardization

Same as Method 25A, section 10.0.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

Same as Method 25A, section 12.0.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as Method 25A, section 16.0.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25C—DETERMINATION OF NONMETHANE ORGANIC COMPOUNDS (NMOC) IN LANDFILL GASES

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling and analytical) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should also have a thorough knowledge of EPA Method 25.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Nonmethane organic compounds (NMOC).	No CAS number assigned.

1.2 Applicability. This method is applicable to the sampling and measurement of NMOC as carbon in landfill gases (LFG).

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A sample probe that has been perforated at one end is driven or augured to a depth of 0.9 m (3 ft) below the bottom of the landfill cover. A sample of the landfill gas is extracted with an evacuated cylinder. The NMOC content of the gas is determined by

injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4); the NMOC are oxidized to CO_2, reduced to CH_4, and measured by a flame ionization detector (FID). In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Since this method is complex, only experienced personnel should perform this test. LFG contains methane, therefore explosive mixtures may exist on or near the landfill. It is advisable to take appropriate safety precautions when testing landfills, such as refraining from smoking and installing explosion-proof equipment.

6.0 Equipment and Supplies

6.1 Sample Probe. Stainless steel, with the bottom third perforated. Teflon probe liners and sampling lines are also allowed. Non-perforated probes are allowed as long as they are withdrawn to create a gap equivalent to having the bottom third perforated. The sample probe must be capped at the bottom and must have a threaded cap with a sampling attachment at the top. The sample probe must be long enough to go through and extend no less than 0.9 m (3 ft) below the landfill cover. If the sample probe is to be driven into the landfill, the bottom cap should be designed to facilitate driving the probe into the landfill.

6.2 Sampling Train.

6.2.1 Rotameter with Flow Control Valve. Capable of measuring a sample flow rate of 100 ±10 ml/min. The control valve must be made of stainless steel.

6.2.2 Sampling Valve. Stainless steel.

6.2.3 Pressure Gauge. U-tube mercury manometer, or equivalent, capable of measuring pressure to within 1 mm Hg (0.5 in H_2O) in the range of 0 to 1,100 mm Hg (0 to 590 in H_2O).

6.2.4 Sample Tank. Stainless steel or aluminum cylinder, equipped with a stainless steel sample tank valve.

6.3 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg (5.4 in H_2O).

6.4 Purging Pump. Portable, explosion proof, and suitable for sampling NMOC.

6.5 Pilot Probe Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.1.

6.5.1 Pilot Probe. Tubing of sufficient strength to withstand being driven into the landfill by a post driver and an outside diameter of at least 6 mm (0.25 in.) smaller than the sample probe. The pilot probe shall be capped on both ends and long enough to go through the landfill cover and extend no less than 0.9 m (3 ft) into the landfill.

6.5.2 Post Driver and Compressor. Capable of driving the pilot probe and the sampling probe into the landfill. The Kitty Hawk portable post driver has been found to be acceptable.

6.6 Auger Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.2.

6.6.1 Auger. Capable of drilling through the landfill cover and to a depth of no less than 0.9 m (3 ft) into the landfill.

6.6.2 Pea Gravel.

6.6.3 Bentonite.

6.7 NMOC Analyzer, Barometer, Thermometer, and Syringes. Same as in sections 6.3.1, 6.3.2, 6.33, and 6.2.10, respectively, of Method 25.

7.0 Reagents and Standards

7.1 NMOC Analysis. Same as in Method 25, section 7.2.

7.2 Calibration. Same as in Method 25, section 7.4, except omit section 7.4.3.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sample Tank Evacuation and Leak-Check. Conduct the sample tank evacuation and leak-check either in the laboratory or the field. Connect the pressure gauge and sampling valve to the sample tank. Evacuate the sample tank to 10 mm Hg (5.4 in H_2O) absolute pressure or less. Close the sampling valve, and allow the tank to sit for 30 minutes. The tank is acceptable if no change more than ±2 mm is noted. Include the results of the leak-check in the test report.

8.2 Sample Probe Installation. The tester may use the procedure in section 8.2.1 or 8.2.2.

8.2.1 Pilot Probe Procedure. Use the post driver to drive the pilot probe at least 0.9 m (3 ft) below the landfill cover. Alternative procedures to drive the probe into the landfill may be used subject to the approval of the Administrator's designated representative.

8.2.1.1 Remove the pilot probe and drive the sample probe into the hole left by the pilot probe. The sample probe shall extend at least 0.9 m (3 ft) below the landfill cover and shall protrude about 0.3 m (1 ft) above the landfill cover. Seal around the sampling probe with bentonite and cap the sampling probe with the sampling probe cap.

8.2.2 Auger Procedure. Use an auger to drill a hole to at least 0.9 m (3 ft) below the landfill cover. Place the sample probe in the hole and backfill with pea gravel to a level 0.6 m (2 ft) from the surface. The sample probe shall protrude at least 0.3 m (1 ft) above the landfill cover. Seal the remaining area around the probe with bentonite. Allow 24

hours for the landfill gases to equilibrate inside the augured probe before sampling.

8.2.3 Driven Probes. Closed-point probes may be driven directly into the landfill in a single step. This method may not require backfilling if the probe is adequately sealed by its insertion. Unperforated probes that are inserted in this manner and withdrawn at a distance from a detachable tip to create an open space are also acceptable.

8.3 Sample Train Assembly. Just before assembling the sample train, measure the sample tank vacuum using the pressure gauge. Record the vacuum, the ambient temperature, and the barometric pressure at this time. Assemble the sampling probe purging system as shown in Figure 25C–1.

8.4 Sampling Procedure. Open the sampling valve and use the purge pump and the flow control valve to evacuate at least two sample probe volumes from the system at a flow rate of 500 ml/min or less. Close the sampling valve and replace the purge pump with the sample tank apparatus as shown in Figure 25C–2. Open the sampling valve and the sample tank valve and, using the flow control valve, sample at a flow rate of 500 ml/min or less until either a constant flow rate can no longer be maintained because of reduced sample tank vacuum or the appropriate composite volume is attained. Disconnect the sampling tank apparatus and pressurize the sample cylinder to approximately 1,060 mm Hg (567 in. H_2O) absolute pressure with helium, and record the final pressure. Alternatively, the sample tank may be pressurized in the lab.

8.4.1 The following restrictions apply to compositing samples from different probe sites into a single cylinder: (1) Individual composite samples per cylinder must be of equal volume; this must be verified by recording the flow rate, sampling time, vacuum readings, or other appropriate volume measuring data, (2) individual composite samples must have a minimum volume of 1 liter unless data is provided showing smaller volumes can be accurately measured, and (3) composite samples must not be collected using the final cylinder vacuum as it diminishes to ambient pressure.

8.4.2 Use Method 3C to determine the percent N_2 in each cylinder. The presence of N_2 indicates either infiltration of ambient air into the landfill gas sample or an inappropriate testing site has been chosen where anaerobic decomposition has not begun. The landfill gas sample is acceptable if the concentration of N_2 is less than 20 percent. Alternatively, Method 3C may be used to determine the oxygen content of each cylinder as an air infiltration test. With this option, the oxygen content of each cylinder must be less than 5 percent.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
8.4.2	Verify that landfill gas sample contains less than 20 percent N_2 or 5 percent O_2.	Ensures that ambient air was not drawn into the landfill gas sample and gas was sampled from an appropriate location.
10.1, 10.2	NMOC analyzer initial and daily performance checks.	Ensures precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial NMOC Analyzer Performance Test. Same as in Method 25, section 10.1, except omit the linearity checks for CO_2 standards.

10.2 NMOC Analyzer Daily Calibration.

10.2.1 NMOC Response Factors. Same as in Method 25, section 10.2.2.

10.3 Sample Tank Volume. The volume of the gas sampling tanks must be determined. Determine the tank volumes by weighing them empty and then filled with deionized water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedures

11.1 The oxidation, reduction, and measurement of NMOC's is similar to Method 25. Before putting the NMOC analyzer into routine operation, conduct an initial performance test. Start the analyzer, and perform all the necessary functions in order to put the analyzer into proper working order. Conduct the performance test according to the procedures established in section 10.1. Once the performance test has been successfully completed and the NMOC calibration response factor has been determined, proceed with sample analysis as follows:

11.1.1 Daily Operations and Calibration Checks. Before and immediately after the analysis of each set of samples or on a daily basis (whichever occurs first), conduct a calibration test according to the procedures established in section 10.2. If the criteria of the daily calibration test cannot be met, repeat

the NMOC analyzer performance test (Section 10.1) before proceeding.

11.1.2 Operating Conditions. Same as in Method 25, section 11.2.1.

11.1.3 Analysis of Sample Tank. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (383 °F) as rapidly as possible. A rate of 30 °C/min (54 °F/min) has been shown to be adequate. Record the value obtained for any measured NMOC. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average as C_{tm}.

12.0 Data Analysis and Calculations

NOTE: All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature

B_w = Moisture content in the sample, fraction.

C_{N2} = N_2 concentration in the diluted sample gas.

C_{mN2} = Measured N_2 concentration, fraction in landfill gas.

C_{mOx} = Measured Oxygen concentration, fraction in landfill gas.

C_{Ox} = Oxygen concentration in the diluted sample gas.

C_t = Calculated NMOC concentration, ppmv C equivalent.

C_{tm} = Measured NMOC concentration, ppmv C equivalent.

P_b = Barometric pressure, mm Hg.

P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.

P_{ti} = Gas sample tank pressure after evacuation, mm Hg absolute.

P_w = Vapor pressure of H_2O (from Table 25C–1), mm Hg.

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 . . . r).

T_t = Sample tank temperature at completion of sampling, °K.

T_{ti} = Sample tank temperature before sampling, °K.

T_{tf} = Sample tank temperature after pressuring, °K.

12.2 Water Correction. Use Table 25C–1 (Section 17.0), the LFG temperature, and barometric pressure at the sampling site to calculate B_w.

$$B_w = \frac{P_w}{P_b} \qquad \text{Eq. 25C-1}$$

12.3 Nitrogen Concentration in the landfill gas. Use equation 25C–2 to calculate the measured concentration of nitrogen in the original landfill gas.

$$C_{N2} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right]C_{mN2} \qquad \text{Eq.25C-2}$$

12.4 Oxygen Concentration in the landfill gas. Use equation 25C–3 to calculate the measured concentration of oxygen in the original landfill gas.

$$C_{Ox} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right]C_{mOx} \qquad \text{Eq.25C-3}$$

12.5 You must correct the NMOC Concentration for the concentration of nitrogen or oxygen based on which gas or gases passes the requirements in section 9.1.

12.5.1 NMOC Concentration with nitrogen correction. Use Equation 25C–4 to calculate the concentration of NMOC for each sample tank when the nitrogen concentration is less than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t}-\frac{P_{ti}}{T_{ti}}\right)\left(1-\frac{99}{78}C_{N2}\right)-B_w}\frac{1}{r}\sum_{j=1}^{r} C_{tm(j)} \qquad \text{Eq.25C-4}$$

12.5.2 NMOC Concentration with oxygen correction. Use Equation 25C–5 to calculate the concentration of NMOC for each sample tank if the landfill gas oxygen is less than 5 percent and the landfill gas nitrogen concentration is greater than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t}-\frac{P_{ti}}{T_{ti}}\right)\left(1-\frac{99}{21}C_{Ox}\right)-B_w}\frac{1}{r}\sum_{j=1}^{r} C_{tm(j)} \qquad \text{Eq.25C-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts. June 15–20, 1975.) 14 p.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

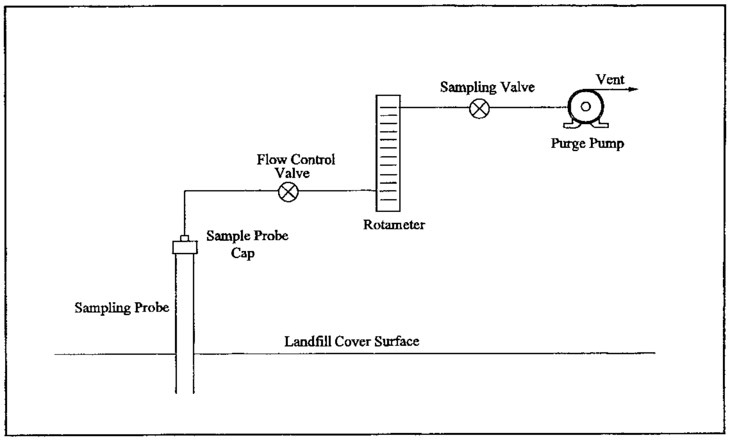


Figure 25C-1. Schematic of Sampling Probe Purging System

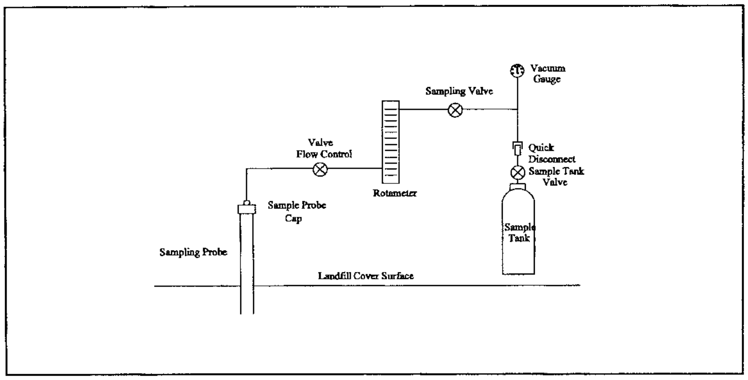


Figure 25C-2. Schematic of Sampling Train.

TABLE 25C–1—MOISTURE CORRECTION

Temperature, °C	Vapor Pressure of H_2O, mm Hg	Tempera-ture, °C	Vapor Pressure of H_2O, mm Hg
4	6.1	18	15.5
6	7.0	20	17.5
8	8.0	22	19.8
10	9.2	24	22.4
12	10.5	26	25.2
14	12.0	28	28.3
16	13.6	30	31.8

METHOD 25D—DETERMINATION OF THE VOLATILE ORGANIC CONCENTRATION OF WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) or an electrolytic conductivity detector (ELCD) because knowledge beyond the scope of this presentation is required.

1.0 Scope and Application

1.1 Analyte. Volatile Organic Compounds. No CAS No. assigned.

1.2 Applicability. This method is applicable for determining the volatile organic (VO) concentration of a waste sample.

2.0 Summary of Method

2.1 Principle. A sample of waste is obtained at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). The sample is suspended in an organic/aqueous matrix, then heated and purged with nitrogen for 30 min. in order to separate certain organic compounds. Part of the sample is analyzed for carbon concentration, as methane, with an FID, and part of the sample is analyzed for chlorine concentration, as chloride, with an ELCD. The VO concentration is the sum of the carbon and chlorine content of the sample.

3.0 Definitions

3.1 *Well-mixed* in the context of this method refers to turbulent flow which results in multiple-phase waste in effect behaving as single-phase waste due to good mixing.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1 Sampling. The following equipment is required:

6.1.1 Sampling Tube. Flexible Teflon, 0.25 in. ID (6.35 mm).

6.1.2 Sample Container. Borosilicate glass, 40-mL, and a Teflon-lined screw cap capable of forming an air tight seal.

6.1.3 Cooling Coil. Fabricated from 0.25 in (6.35 mm). ID 304 stainless steel tubing with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Purging Apparatus. For separating the VO from the waste sample. A schematic of the system is shown in Figure 25D–1. The purging apparatus consists of the following major components.

6.2.1.1 Purging Flask. A glass container to hold the sample while it is heated and purged with dry nitrogen. The cap of the purging flask is equipped with three fittings: one for a purging lance (fitting with the #7 Ace-thread), one for the Teflon exit tubing (side fitting, also a #7 Ace-thread), and a third (a 50-mm Ace-thread) to attach the base of the purging flask as shown in Figure 25D–2. The base of the purging flask is a 50-mm ID (2 in) cylindrical glass tube. One end of the tube is open while the other end is sealed. Exact dimensions are shown in Figure 25D–2.

6.2.1.2 Purging Lance. Glass tube, 6-mm OD (0.2 in) by 30 cm (12 in) long. The purging end of the tube is fitted with a four-arm bubbler with each tip drawn to an opening 1 mm (0.04 in) in diameter. Details and exact dimensions are shown in Figure 25D–2.

6.2.1.3 Coalescing Filter. Porous fritted disc incorporated into a container with the same dimensions as the purging flask. The details of the design are shown in Figure 25D–3.

6.2.1.4 Constant Temperature Chamber. A forced draft oven capable of maintaining a uniform temperature around the purging flask and coalescing filter of 75 ±2 °C (167 ±3.6 °F).

6.2.1.5 Three-way Valve. Manually operated, stainless steel. To introduce calibration gas into system.

6.2.1.6 Flow Controllers. Two, adjustable. One capable of maintaining a purge gas flow rate of 6 ±0.06 L/min (0.2 ±0.002 ft^3/min) The other capable of maintaining a calibration gas flow rate of 1–100 mL/min (0.00004–0.004 ft^3/min).

6.2.1.7 Rotameter. For monitoring the air flow through the purging system (0–10 L/min)(0–0.4 ft^3/min).

6.2.1.8 Sample Splitters. Two heated flow restrictors (placed inside oven or heated to 120 ±10 °C (248 ±18 °F)). At a purge rate of 6 L/min (0.2 ft^3/min), one will supply a constant flow to the first detector (the rest of the flow will be directed to the second sample splitter). The second splitter will split the analytical flow between the second detector and the flow restrictor. The approximate flow to the FID will be 40 mL/min (0.0014 ft^3/min) and to the ELCD will be 15 mL/min (0.0005 ft^3/min), but the exact flow must be adjusted to be compatible with the individual detector and to meet its linearity requirement. The two sample splitters will be connected to each other by 1/8′ OD (3.175 mm) stainless steel tubing.

6.2.1.9 Flow Restrictor. Stainless steel tubing, 1/8′ OD (3.175 mm), connecting the second sample splitter to the ice bath. Length is determined by the resulting pressure in the purging flask (as measured by the pressure gauge). The resulting pressure from the use of the flow restrictor shall be 6–7 psig.

6.2.1.10 Filter Flask. With one-hole stopper. Used to hold ice bath. Excess purge gas is vented through the flask to prevent condensation in the flowmeter and to trap volatile organic compounds.

6.2.1.11 Four-way Valve. Manually operated, stainless steel. Placed inside oven, used to bypass purging flask.

6.2.1.12 On/Off Valves. Two, stainless steel. One heat resistant up to 130 °C (266 °F) and placed between oven and ELCD. The other a toggle valve used to control purge gas flow.

6.2.1.13 Pressure Gauge. Range 0–40 psi. To monitor pressure in purging flask and coalescing filter.

6.2.1.14 Sample Lines. Teflon, 1/4′ OD (6.35 mm), used inside the oven to carry purge gas to and from purging chamber and to and from coalescing filter to four-way valve. Also used to carry sample from four-way valve to first sample splitter.

6.2.1.15 Detector Tubing. Stainless steel, 1/8′ OD (3.175 mm), heated to 120 ±10 °C (248 ±18 °F) . Used to carry sample gas from each sample splitter to a detector. Each piece of tubing must be wrapped with heat tape and insulating tape in order to insure that no cold spots exist. The tubing leading to the ELCD will also contain a heat-resistant on-off valve (Section 6.2.1.12) which shall also be wrapped with heat-tape and insulation.

6.2.2 Volatile Organic Measurement System. Consisting of an FID to measure the carbon concentration of the sample and an ELCD to measure the chlorine concentration.

6.2.2.1 FID. A heated FID meeting the following specifications is required.

6.2.2.1.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.1.

6.2.2.1.2 Range. A full scale range of 50 pg carbon/sec to 50 μg carbon/sec. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.1.3 Data Recording System. A digital integration system compatible with the FID for permanently recording the output of the detector. The recorder shall have the capability to start and stop integration at points selected by the operator or it shall be capable of the ‘‘integration by slices’’ technique (this technique involves breaking down the chromatogram into smaller increments, integrating the area under the curve for each portion, subtracting the background for each portion, and then adding all of the areas together for the final area count).

6.2.2.2 ELCD. An ELCD meeting the following specifications is required. 1-propanol must be used as the electrolyte. The electrolyte flow through the conductivity cell shall be 1 to 2 mL/min (0.00004 to 0.00007 ft^3/min).

NOTE: A ¼-in. ID (6.35 mm) quartz reactor tube is strongly recommended to reduce carbon buildup and the resulting detector maintenance.

6.2.2.2.1 Linearity. A linear response (±10 percent) over the response range as demonstrated by the procedures in section 10.1.2.

6.2.2.2.2 Range. A full scale range of 5.0 pg/sec to 500 ng/sec chloride. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.2.3 Data Recording System. A digital integration system compatible with the output voltage range of the ELCD. The recorder must have the capability to start and stop integration at points selected by the operator or it shall be capable of performing the ‘‘integration by slices’’ technique.

7.0 Reagents and Standards

7.1 Sampling.

7.1.1 Polyethylene Glycol (PEG). Ninety-eight percent pure with an average molecular weight of 400. Before using the PEG, remove any organic compounds that might be detected as volatile organics by heating it to 120 °C (248 °F) and purging it with nitrogen at a flow rate of 1 to 2 L/min (0.04 to 0.07 ft^3/min) for 2 hours. The cleaned PEG must be stored under a 1 to 2 L/min (0.04 to 0.07 ft^3/min) nitrogen purge until use. The purge apparatus is shown in Figure 25D–4.

7.2 Analysis.

7.2.1 Sample Separation. The following are required for the sample purging step.

7.2.1.1 PEG. Same as section 7.1.1.

7.2.1.2 Purge Gas. Zero grade nitrogen (N_2), containing less than 1 ppm carbon.

7.2.2 Volatile Organics Measurement. The following are required for measuring the VO concentration.

7.2.2.1 Hydrogen (H_2). Zero grade H_2, 99.999 percent pure.

7.2.2.2 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2.2.3 Calibration Gas. Pressurized gas cylinder containing 10 percent propane and 1 percent 1,1-dichloroethylene by volume in nitrogen.

7.2.2.4 Water. Deionized distilled water that conforms to American Society for Testing and Materials Specification D 1193–74, Type 3, is required for analysis. At the option of the analyst, the $KMnO_4$ test for oxidizable organic matter may be omitted when high concentrations are not expected to be present.

7.2.2.5 1-Propanol. ACS grade or better. Electrolyte Solution. For use in the ELCD.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling.

8.1.1 Sampling Plan Design and Development. Use the procedures in chapter nine of Reference 1 in section 16 as guidance in developing a sampling plan.

8.1.2 Single Phase or Well-mixed Waste.

8.1.2.1 Install a sampling tap to obtain the sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). Assemble the sampling apparatus as shown in Figure 25D–5.

8.1.2.2 Prepare the sampling containers as follows: Pour 30 mL of clean PEG into the container. PEG will reduce but not eliminate the loss of organics during sample collection. Weigh the sample container with the screw cap, the PEG, and any labels to the nearest 0.01 g and record the weight (m_{st}). Store the containers in an ice bath until 1 hour before sampling (PEG will solidify at ice bath temperatures; allow the containers to reach room temperature before sampling).

8.1.2.3 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.1.2.4 After purging, stop the sample flow and direct the sampling tube to a preweighed sample container, prepared as described in section 8.1.2.2. Keep the tip of the tube below the surface of the PEG during sampling to minimize contact with the atmosphere. Sample at a flow rate such that the temperature of the waste is less than 10 °C (50 °F). Fill the sample container and immediately cap it (within 5 seconds) so that a minimum headspace exists in the container. Store immediately in a cooler and cover with ice.

8.1.3 Multiple-phase Waste. Collect a 10 g sample of each phase of waste generated using the procedures described in section 8.1.2 or 8.1.5. Each phase of the waste shall be analyzed as a separate sample. Calculate the weighted average VO concentration of the waste using Equation 25D–13 (Section 12.14).

8.1.4 Solid waste. Add approximately 10 g of the solid waste to a container prepared in the manner described in section 8.1.2.2, minimizing headspace. Cap and chill immediately.

8.1.5 Alternative to Tap Installation. If tap installation is impractical or impossible, fill a large, clean, empty container by submerging the container into the waste below the surface of the waste. Immediately fill a container prepared in the manner described in section 8.1.2.2 with approximately 10 g of the waste collected in the large container. Minimize headspace, cap and chill immediately.

8.1.6 Alternative sampling techniques may be used upon the approval of the Administrator.

8.2 Sample Recovery.

8.2.1 Assemble the purging apparatus as shown in Figures 25D–1 and 25D–2. The oven shall be heated to 75 ±2 °C (167 ±3.6 °F). The sampling lines leading from the oven to the detectors shall be heated to 120 ±10 °C (248 ±18 °F) with no cold spots. The flame ionization detector shall be operated with a heated block. Adjust the purging lance so that it reaches the bottom of the chamber.

8.2.2 Remove the sample container from the cooler, and wipe the exterior of the container to remove any extraneous ice, water, or other debris. Reweigh the sample container to the nearest 0.01 g, and record the weight (m_{sf}). Pour the contents of the sample container into the purging flask, rinse the sample container three times with a total of 20 mL of PEG (since the sample container originally held 30 mL of PEG, the total volume of PEG added to the purging flask will be 50 mL), transferring the rinsings to the purging flask after each rinse. Cap purging flask between rinses. The total volume of PEG in the purging flask shall be 50 mL. Add 50 mL of water to the purging flask.

9.0 Quality Control

9.1 Quality Control Samples. If audit samples are not available, prepare and analyze the two types of quality control samples (QCS) listed in Sections 9.1.1 and 9.1.2. Before placing the system in operation, after a shutdown of greater than six months, and after any major modifications, analyze each QCS in triplicate. For each detector, calculate the percent recovery by dividing measured concentration by theoretical concentration and multiplying by 100. Determine the mean percent recovery for each detector for each QCS triplicate analysis. The RSD for any triplicate analysis shall be ≤10 percent. For QCS 1 (methylene chloride), the percent recovery shall be ≥90 percent for carbon as methane, and ≥55 percent for chlorine as chloride. For QCS 2 (1,3-dichloro-2-propanol), the percent recovery shall be ≤15 percent for carbon as methane, and ≤6 percent for chlorine as chloride. If the analytical system does not meet the above-mentioned criteria for both detectors, check the system parameters (temperature, system pressure, purge rate, etc.), correct the problem, and repeat the triplicate analysis of each QCS.

9.1.1 QCS 1, Methylene Chloride. Prepare a stock solution by weighing, to the nearest 0.1 mg, 55 µL of HPLC grade methylene chloride in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 µL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze

the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 3.777×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 1.670×10^{-2}.

9.1.2 QCS 2, 1,3-dichloro-2-propanol. Prepare a stock solution by weighing, to the nearest 0.1 mg, 60 μL of high purity grade 1,3-dichloro-2-propanol in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 μL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 7.461×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 1.099×10^{-2}.

9.1.3 Routine QCS Analysis. For each set of compliance samples (in this context, set is per facility, per compliance test), analyze one QCS 1 and one QCS 2 sample. The percent recovery for each sample for each detector shall be ±13 percent of the mean recovery established for the most recent set of QCS triplicate analysis (Section 9.4). If the sample does not meet this criteria, check the system components and analyze another QCS 1 and 2 until a single set of QCS meet the ±13 percent criteria.

10.0 Calibration and Standardization

10.1 Initial Performance Check of Purging System. Before placing the system in operation, after a shutdown of greater than six months, after any major modifications, and at least once per month during continuous operation, conduct the linearity checks described in sections 10.1.1 and 10.1.2. Install calibration gas at the three-way calibration gas valve. See Figure 25D–1.

10.1.1 Linearity Check Procedure. Using the calibration standard described in section 7.2.2.3 and by varying the injection time, it is possible to calibrate at multiple concentration levels. Use Equation 25D–3 to calculate three sets of calibration gas flow rates and run times needed to introduce a total mass of carbon, as methane, (m_c) of 1, 5, and 10 mg into the system (low, medium and high FID calibration, respectively). Use Equation 25D–4 to calculate three sets of calibration gas flow rates and run times needed to introduce a total chloride mass (m_{ch}) of 1, 5, and 10 mg into the system (low, medium and high ELCD calibration, respectively). With the system operating in standby mode, allow the FID and the ELCD to establish a stable baseline. Set the secondary pressure regulator of the calibration gas cylinder to the same pressure as the purge gas cylinder and set the proper flow rate with the calibration flow controller (see Figure 25D–1). The calibration gas flow rate can be measured with a flowmeter attached to the vent position of the calibration gas valve. Set the four-way bypass valve to standby position so that the calibration gas flows through the coalescing filter only. Inject the calibration gas by turning the calibration gas valve from vent position to inject position. Continue the calibration gas flow for the appropriate period of time before switching the calibration valve to vent position. Continue recording the response of the FID and the ELCD for 5 min after switching off calibration gas flow. Make triplicate injections of all six levels of calibration.

10.1.2 Linearity Criteria. Calculate the average response factor (Equations 25D–5 and 25D–6) and the relative standard deviation (RSD) (Equation 25D–10) at each level of the calibration curve for both detectors. Calculate the overall mean of the three response factor averages for each detector. The FID linearity is acceptable if each response factor is within 5 percent of the overall mean and if the RSD for each set of triplicate injections is less than 5 percent. The ELCD linearity is acceptable if each response factor is within 10 percent of the overall mean and if the RSD for each set of triplicate injections is less than 10 percent. Record the overall mean value of the response factors for the FID and the ELCD. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2 Daily Calibrations.

10.2.1 Daily Linearity Check. Follow the procedures outlined in section 10.1.1 to analyze the medium level calibration for both the FID and the ELCD in duplicate at the start of the day. Calculate the response factors and the RSDs for each detector. For the FID, the calibration is acceptable if the average response factor is within 5 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 5 percent. For the ELCD, the calibration is acceptable if the average response factor is within 10 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 10 percent. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2.2 Calibration Range Check.

10.2.2.1 If the waste concentration for either detector falls below the range of calibration for that detector, use the procedure outlined in section 10.1.1 to choose two calibration points that bracket the new target

concentration. Analyze each of these points in triplicate (as outlined in section 10.1.1) and use the criteria in section 10.1.2 to determine the linearity of the detector in this ''mini-calibration'' range.

10.2.2.2 After the initial linearity check of the mini-calibration curve, it is only necessary to test one of the points in duplicate for the daily calibration check (in addition to the points specified in section 10.2.1). The average daily mini-calibration point should fit the linearity criteria specified in section 10.2.1. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat the calibration procedure mentioned in the first paragraph of section 10.2.2. A mini-calibration curve for waste concentrations above the calibration curve for either detector is optional.

10.3 Analytical Balance. Calibrate against standard weights.

11.0 Analysis

11.1 Sample Analysis.

11.1.1 Turn on the constant temperature chamber and allow the temperature to equilibrate at 75 ±2 °C (167 ±3.6 °F). Turn the four-way valve so that the purge gas bypasses the purging flask, the purge gas flowing through the coalescing filter and to the detectors (standby mode). Turn on the purge gas. Allow both the FID and the ELCD to warm up until a stable baseline is achieved on each detector. Pack the filter flask with ice. Replace ice after each run and dispose of the waste water properly. When the temperature of the oven reaches 75 ±2 °C (167 ±3.6 °F), start both integrators and record baseline. After 1 min, turn the four-way valve so that the purge gas flows through the purging flask, to the coalescing filter and to the sample splitters (purge mode). Continue recording the response of the FID and the ELCD. Monitor the readings of the pressure gauge and the rotameter. If the readings fall below established setpoints, stop the purging, determine the source of the leak, and resolve the problem before resuming. Leaks detected during a sampling period invalidate that sample.

11.1.2 As the purging continues, monitor the output of the detectors to make certain that the analysis is proceeding correctly and that the results are being properly recorded. Every 10 minutes read and record the purge flow rate, the pressure and the chamber temperature. Continue the purging for 30 minutes.

11.1.3 For each detector output, integrate over the entire area of the peak starting at 1 minute and continuing until the end of the run. Subtract the established baseline area from the peak area. Record the corrected area of the peak. See Figure 25D–6 for an example integration.

11.2 Water Blank. A water blank shall be analyzed for each batch of cleaned PEG prepared. Transfer about 60 mL of water into the purging flask. Add 50 mL of the cleaned PEG to the purging flask. Treat the blank as described in sections 8.2 and 8.3, excluding section 8.2.2. Calculate the concentration of carbon and chlorine in the blank sample (assume 10 g of waste as the mass). A VO concentration equivalent to ≤10 percent of the applicable standard may be subtracted from the measured VO concentration of the waste samples. Include all blank results and documentation in the test report.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A_b = Area under the water blank response curve, counts.

A_c = Area under the calibration response curve, counts.

A_s = Area under the sample response curve, counts.

C = Concentration of volatile organics in the sample, ppmw.

C_c = Concentration of carbon, as methane, in the calibration gas, mg/L.

C_{ch} = Concentration of chloride in the calibration gas, mg/L.

C_j = VO concentration of phase j, ppmw.

DR_t = Average daily response factor of the FID, mg CH_4/counts.

Dr_{th} = Average daily response factor of the ELCD, mg Cl^-/counts.

F_j = Weight fraction of phase j present in the waste.

m_c = Mass of carbon, as methane, in a calibration run, mg.

m_{ch} = Mass of chloride in a calibration run, mg.

m_s = Mass of the waste sample, g.

m_{sc} = Mass of carbon, as methane, in the sample, mg.

m_{sf} = Mass of sample container and waste sample, g.

m_{sh} = Mass of chloride in the sample, mg.

m_{st} = Mass of sample container prior to sampling, g.

m_{VO} = Mass of volatile organics in the sample, mg.

n = Total number of phases present in the waste.

P_p = Percent propane in calibration gas (L/L).

P_{vc} = Percent 1,1-dichloroethylene in calibration gas (L/L).

Q_c = Flow rate of calibration gas, L/min.

t_c = Length of time standard gas is delivered to the analyzer, min.

W = Weighted average VO concentration, ppmw.

12.2 Concentration of Carbon, as Methane, in the Calibration Gas.

$$C_c = (19.681 \times P_p) + (13.121 \times P_{vc}) \quad \text{Eq. 25D-1}$$

12.3 Concentration of Chloride in the Calibration Gas.

$$C_{ch} = 28.998 \times P_{vc} \quad \text{Eq. 25D-2}$$

12.4 Mass of Carbon, as Methane, in a Calibration Run.

$$M_c = C_c \times Q_c \times t_c \quad \text{Eq. 25D-3}$$

12.5 Mass of Chloride in a Calibration Run.

$$m_{ch} = C_{ch} \times Q_c \times t_c \quad \text{Eq. 25D-4}$$

12.6 FID Response Factor, mg/counts.

$$DR_t = \frac{m_c}{A_c} \quad \text{Eq. 25D-5}$$

12.7 ELCD Response Factor, mg/counts.

$$DR_{th} = \frac{m_{ch}}{A_c} \quad \text{Eq. 25D-6}$$

12.8 Mass of Carbon in the Sample.

$$m_{sc} = DR_t(A_s - A_b) \quad \text{Eq. 25D-7}$$

12.9 Mass of Chloride in the Sample.

$$m_{sh} = DR_{th}(A_s - A_b) \quad \text{Eq. 25D-8}$$

12.10 Mass of Volatile Organics in the Sample.

$$m_{vo} = m_{sc} + m_{sh} \quad \text{Eq. 25D-9}$$

12.11 Relative Standard Deviation.

$$RSD = \frac{100}{\overline{x}} \sqrt{\frac{\sum_{i=1}^{n} (x_i - \overline{x})^2}{n-1}} \quad \text{Eq. 25D-10}$$

12.12 Mass of Sample.

$$m_s = m_{sf} - m_{st} \quad \text{Eq. 25D-11}$$

12.13 Concentration of Volatile Organics in Waste.

$$C = \frac{(m_{vo} \times 1000)}{m_s} \quad \text{Eq. 25D-12}$$

12.14 Weighted Average VO Concentration of Multi-phase Waste.

$$W = \sum_{j=1}^{n} F_j \, x \, \overline{C}_j \quad \text{Eq. 25D-13}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. ‘‘Test Methods for Evaluating Solid Waste, Physical/Chemistry Methods’’, U.S. Environmental Protection Agency. Publication SW–846, 3rd Edition, November 1986 as amended by Update I, November 1990.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

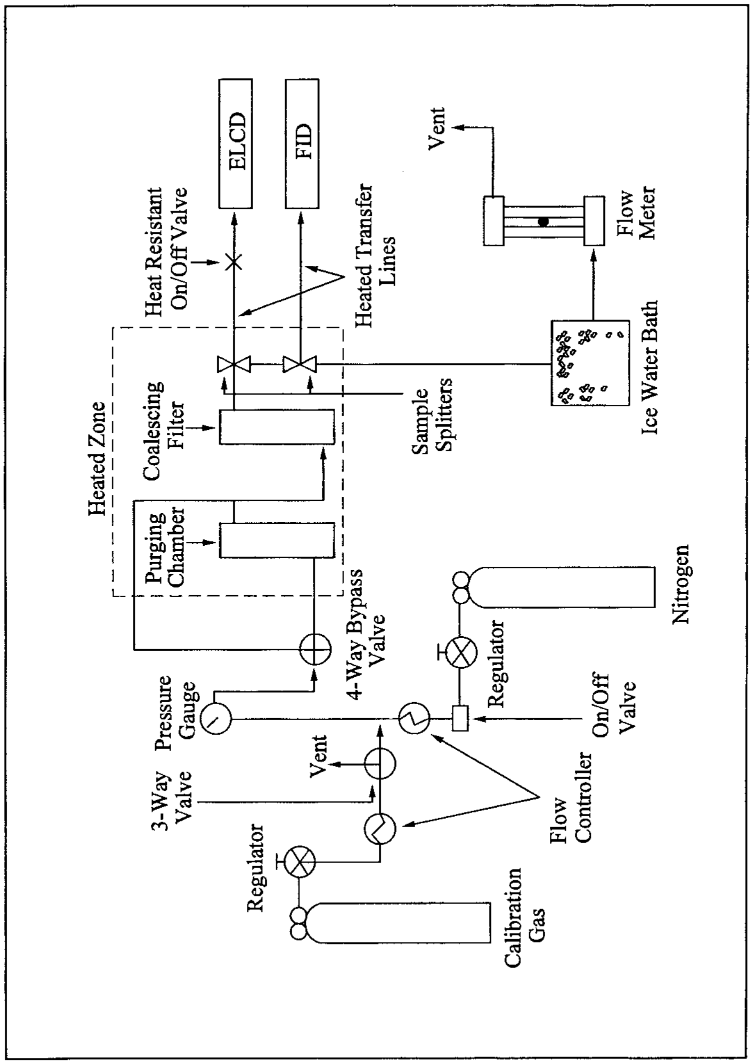


Figure 25D-1. Schematic of Purging Apparatus.

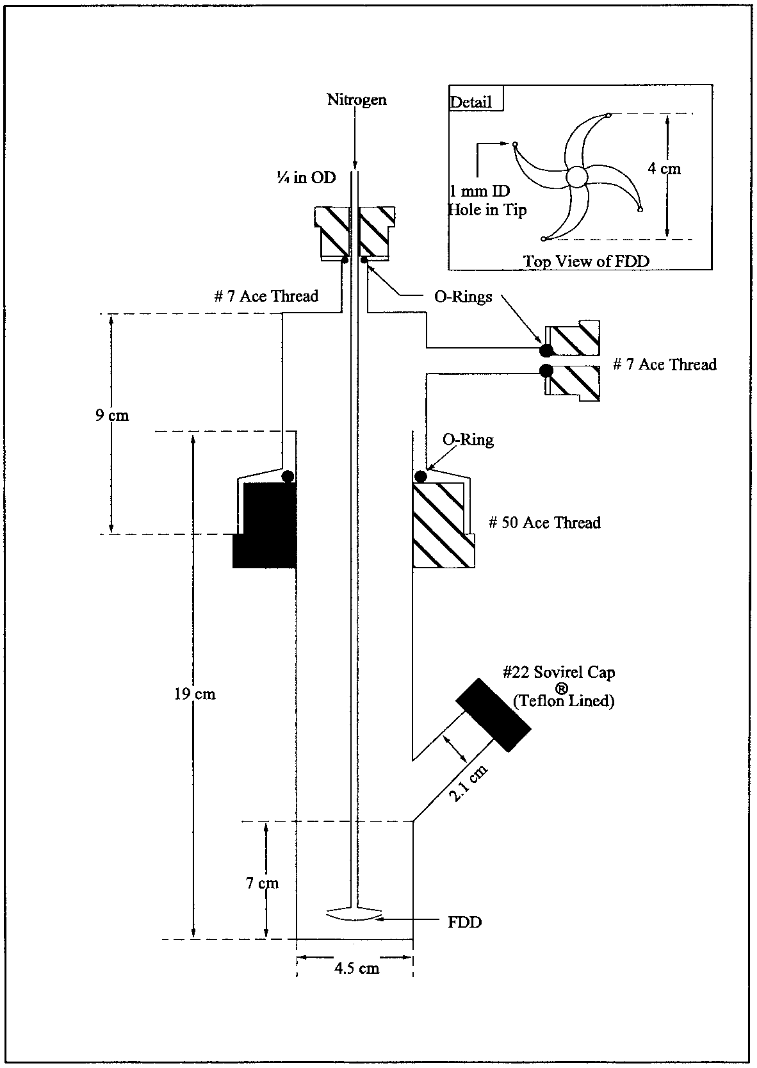
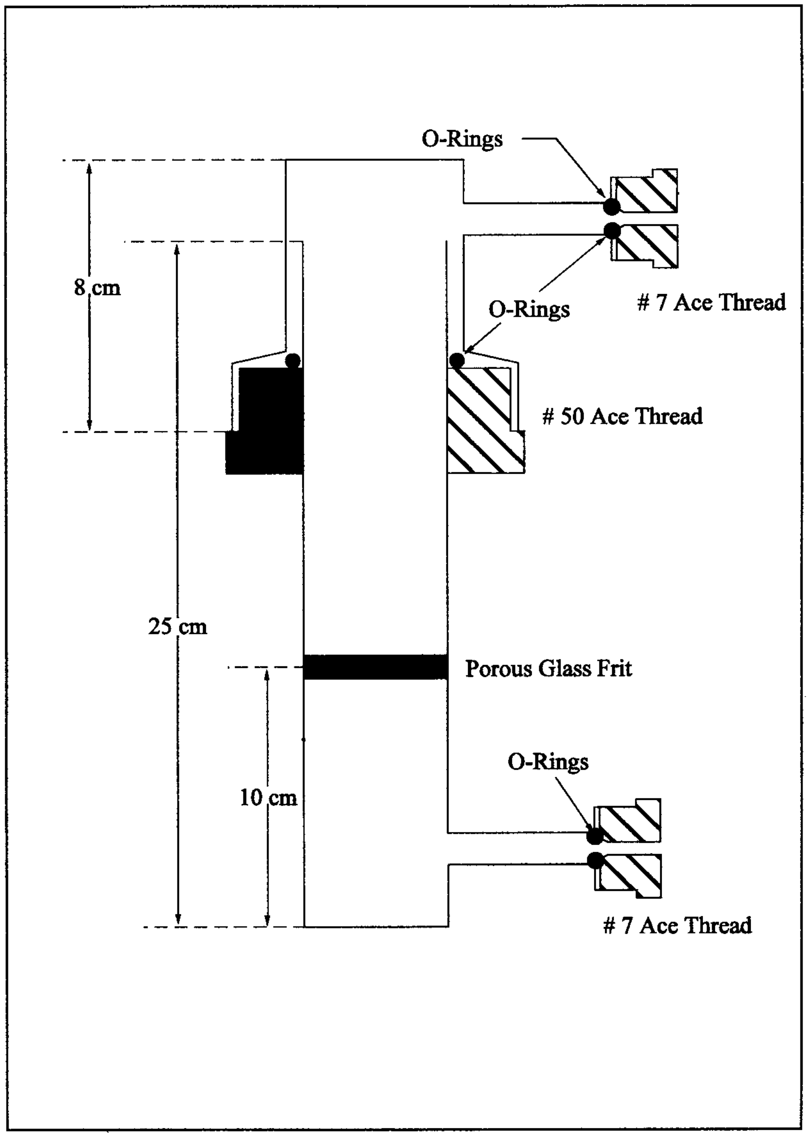


Figure 25D-2. Purging Lance.


O-Rings
8 cm
O-Rings
7 Ace Thread
50 Ace Thread
25 cm
Porous Glass Frit
O-Rings
10 cm
7 Ace Thread

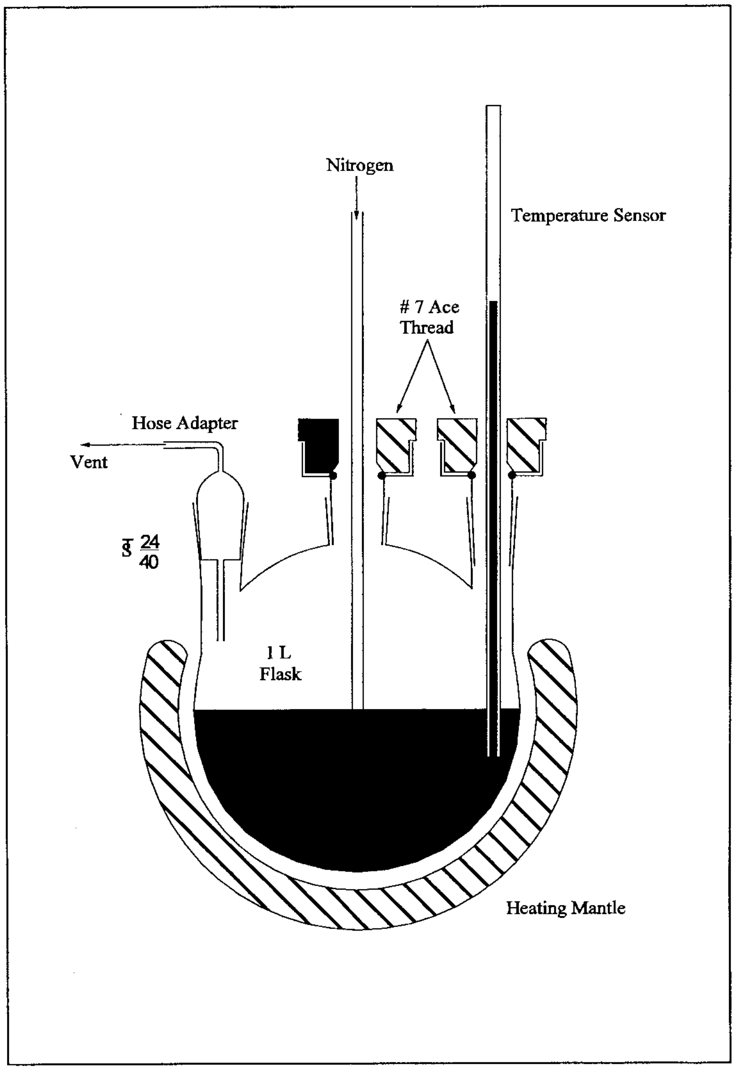


Figure 25D-4. Schematic of PEG Cleaning System.

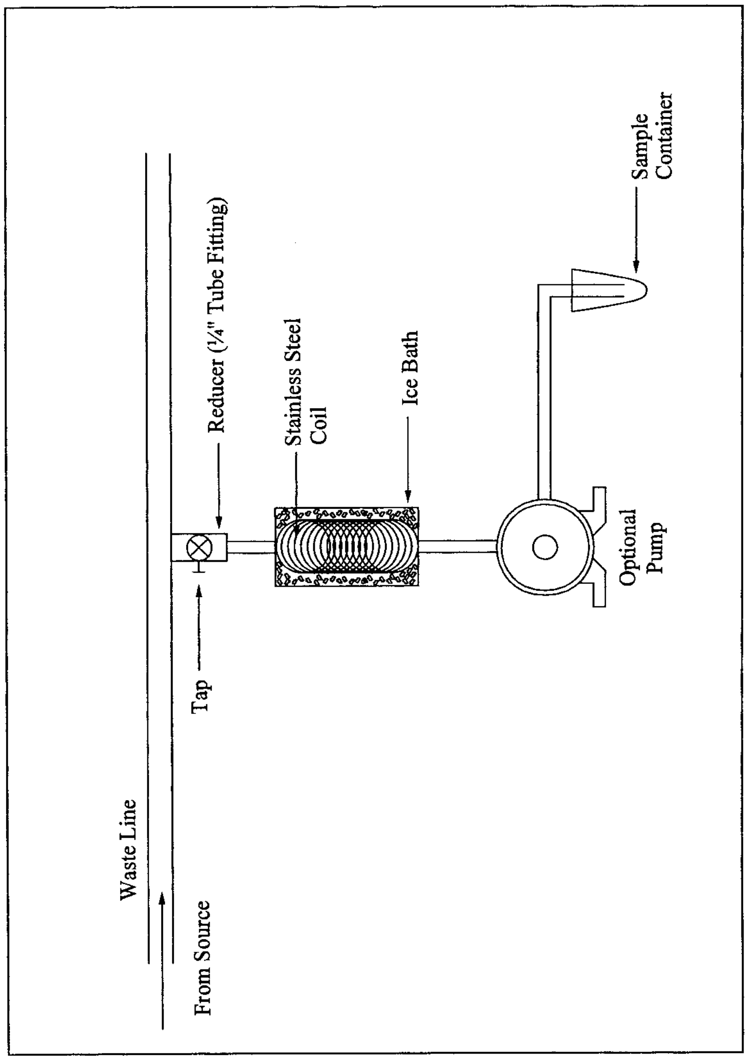


Figure 25D-5. Schematic of Sampling Apparatus.

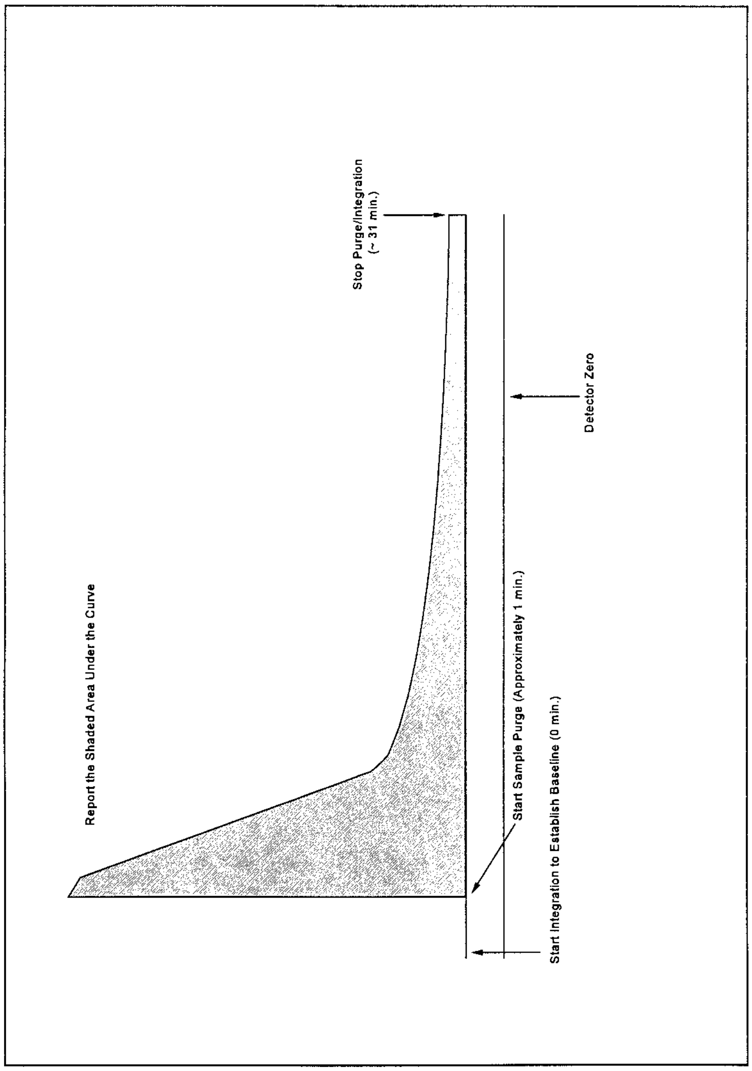


Figure 25D-6. Example Integration of Either Detector.

METHOD 25E—DETERMINATION OF VAPOR PHASE ORGANIC CONCENTRATION IN WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) nor by those who are unfamiliar with source sampling because knowledge beyond the scope of this presentation is required. This method is not inclusive with respect to specifications (*e.g.*, reagents and standards) and calibration procedures. Some material is incorporated by reference from other methods. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 106, part 61, Appendix B, and Method 18, part 60, Appendix A.

1.0 Scope and Application

1.1 Applicability. This method is applicable for determining the vapor pressure of waste cited by an applicable regulation.

1.2 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 The headspace vapor of the sample is analyzed for carbon content by a headspace analyzer, which uses an FID.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 The analyst shall select the operating parameters best suited to the requirements for a particular analysis. The analyst shall produce confirming data through an adequate supplemental analytical technique and have the data available for review by the Administrator.

5.0 Safety [Reserved]

6.0 Equipment and Supplies

6.1 Sampling. The following equipment is required:

6.1.1 Sample Containers. Vials, glass, with butyl rubber septa, Perkin-Elmer Corporation Numbers 0105–0129 (glass vials), B001–0728 (gray butyl rubber septum, plug style), 0105–0131 (butyl rubber septa), or equivalent. The seal must be made from butyl rubber. Silicone rubber seals are not acceptable.

6.1.2 Vial Sealer. Perkin-Elmer Number 105–0106, or equivalent.

6.1.3 Gas-Tight Syringe. Perkin-Elmer Number 00230117, or equivalent.

6.1.4 The following equipment is required for sampling.

6.1.4.1 Tap.

6.1.4.2 Tubing. Teflon, 0.25-in. ID.

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1.4.3 Cooling Coil. Stainless steel (304), 0.25 in.-ID, equipped with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Balanced Pressure Headspace Sampler. Perkin-Elmer HS–6, HS–100, or equivalent, equipped with a glass bead column instead of a chromatographic column.

6.2.2 FID. An FID meeting the following specifications is required.

6.2.2.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.2.

6.2.2.2 Range. A full scale range of 1 to 10,000 parts per million (ppm) propane (C_3H_8). Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.3 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the output of the detector.

6.2.4 Temperature Sensor. Capable of reading temperatures in the range of 30 to 60 °C (86 to 140 °F) with an accuracy of ±0.1 °C (±0.2 °F).

7.0 Reagents and Standards

7.1 Analysis. The following items are required for analysis.

7.1.1 Hydrogen (H_2). Zero grade hydrogen, as required by the FID.

7.1.2 Carrier Gas. Zero grade nitrogen, containing less than 1 ppm carbon (C) and less than 1 ppm carbon dioxide.

7.1.3 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2 Calibration and Linearity Check.

7.2.1 Stock Cylinder Gas Standard. 100 percent propane. The manufacturer shall: (a) Certify the gas composition to be accurate to ±3 percent or better (see section 7.2.1.1); (b) recommend a maximum shelf life over which the gas concentration does not change by greater than ±5 percent from the certified value; and (c) affix the date of gas cylinder preparation, certified propane concentration, and recommended maximum shelf life to the cylinder before shipment to the buyer.

7.2.1.1 Cylinder Standards Certification. The manufacturer shall certify the concentration of the calibration gas in the cylinder by (a) directly analyzing the cylinder and (b) calibrating his analytical procedure on the day of cylinder analysis. To calibrate his analytical procedure, the manufacturer shall use, as a minimum, a three-point calibration curve.

7.2.1.2 Verification of Manufacturer's Calibration Standards. Before using, the manufacturer shall verify each calibration standard by (a) comparing it to gas mixtures prepared in accordance with the procedure described in section 7.1 of Method 106 of Part 61, Appendix B, or by (b) calibrating it against Standard Reference Materials (SRM's) prepared by the National Bureau of Standards, if such SRM's are available. The agreement between the initially determined concentration value and the verification concentration value must be within ±5 percent. The manufacturer must reverify all calibration standards on a time interval consistent with the shelf life of the cylinder standards sold.

8.0 Sampling Collection, Preservation, Storage, and Transport

8.1 Install a sampling tap to obtain a sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to

the atmosphere). Assemble the sampling apparatus as shown in Figure 25E–1.

8.2 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.3 After purging, stop the sample flow and transfer the Teflon sampling tube to a sample container. Sample at a flow rate such that the temperature of the waste is <10 °C (<50 °F). Fill the sample container halfway (±5 percent) and cap it within 5 seconds. Store immediately in a cooler and cover with ice.

8.4 Alternative sampling techniques may be used upon the approval of the Administrator.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
10.2, 10.3	FID calibration and response check	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Use the procedures in sections 10.2 to calibrate the headspace analyzer and FID and check for linearity before the system is first placed in operation, after any shutdown longer than 6 months, and after any modification of the system.

10.2 Calibration and Linearity. Use the procedures in section 10 of Method 18 of Part 60, Appendix A, to prepare the standards and calibrate the flowmeters, using propane as the standard gas. Fill the calibration standard vials halfway (±5 percent) with deionized water. Purge and fill the airspace with calibration standard. Prepare a minimum of three concentrations of calibration standards in triplicate at concentrations that will bracket the applicable cutoff. For a cutoff of 5.2 kPa (0.75 psi), prepare nominal concentrations of 30,000, 50,000, and 70,000 ppm as propane. For a cutoff of 27.6 kPa (4.0 psi), prepare nominal concentrations of 200,000, 300,000, and 400,000 ppm as propane.

10.2.1 Use the procedures in section 11.3 to measure the FID response of each standard. Use a linear regression analysis to calculate the values for the slope (k) and the y-intercept (b). Use the procedures in sections 12.3 and 12.2 to test the calibration and the linearity.

10.3 Daily FID Calibration Check. Check the calibration at the beginning and at the end of the daily runs by using the following procedures. Prepare 2 calibration standards at the nominal cutoff concentration using the procedures in section 10.2. Place one at the beginning and one at the end of the daily run. Measure the FID response of the daily calibration standard and use the values for k and b from the most recent calibration to calculate the concentration of the daily standard. Use an equation similar to 25E–2 to calculate the percent difference between the daily standard and C_s. If the difference is within 5 percent, then the previous values for k and b can be used. Otherwise, use the procedures in section 10.2 to recalibrate the FID.

11.0 Analytical Procedures

11.1 Allow one hour for the headspace vials to equilibrate at the temperature specified in the regulation. Allow the FID to warm up until a stable baseline is achieved on the detector.

11.2 Check the calibration of the FID daily using the procedures in section 10.3.

11.3 Follow the manufacturer's recommended procedures for the normal operation of the headspace sampler and FID.

11.4 Use the procedures in sections 12.4 and 12.5 to calculate the vapor phase organic vapor pressure in the samples.

11.5 Monitor the output of the detector to make certain that the results are being properly recorded.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A = Measurement of the area under the response curve, counts.

b = y-intercept of the linear regression line.

C_a = Measured vapor phase organic concentration of sample, ppm as propane.

C_{ma} = Average measured vapor phase organic concentration of standard, ppm as propane.

C_m = Measured vapor phase organic concentration of standard, ppm as propane.

C_s = Calculated standard concentration, ppm as propane.

k = Slope of the linear regression line.

P_{bar} = Atmospheric pressure at analysis conditions, mm Hg (in. Hg).

P* = Organic vapor pressure in the sample, kPa (psi).

PD = Percent difference between the average measured vapor phase organic concentration (C_m) and the calculated standard concentration (C_s).

RSD = Relative standard deviation.

$\beta = 1.333 \times 10^{-7}$ kPa/[(mm Hg)(ppm)], (4.91×10^{-7} psi/[(in. Hg)(ppm)])

12.2 Linearity. Use the following equation to calculate the measured standard concentration for each standard vial.

$$C_m = kA + b \qquad \text{Eq. 25E-1}$$

12.2.1 Calculate the average measured standard concentration (C_{ma}) for each set of triplicate standards and use the following equation to calculate PD between C_{ma} and C_s. The instrument linearity is acceptable if the PD is within five for each standard.

$$PD = \frac{C_s - C_{ma}}{C_s} \times 100 \qquad \text{Eq. 25E-2}$$

12.3. Relative Standard Deviation (RSD). Use the following equation to calculate the RSD for each triplicate set of standards.

$$RSD = \frac{100}{C_{ma}} \sqrt{\frac{\sum \left(C_m - C_{ma}\right)^2}{2}} \qquad \text{Eq. 25E-3}$$

The calibration is acceptable if the RSD is within five for each standard concentration.

12.4 Concentration of organics in the headspace. Use the following equation to calculate the concentration of vapor phase organics in each sample.

$$C_a = kA + b \qquad \text{Eq. 25E-4}$$

12.5 Vapor Pressure of Organics in the Headspace Sample. Use the following equation to calculate the vapor pressure of organics in the sample.

$$P^* = \beta P_{bar} C_a \qquad \text{Eq. 25E-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. ‘‘Determination of Solvent Vapor Concentrations by Total Combustion Analysis: a Comparison of Infared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. ‘‘Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) p. 25.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

Sunstone Solar Project 4
Draft Noxious Weed Control Plan

Prepared for

PINEGATE RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 4, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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Appendices

1.0 Introduction

Sunstone Solar 4, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 4 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Noxious Weed Control Plan has been prepared to comply with Oregon Administrative Rule 660-033-0130 (38)(h)(D), which states, in regard to photovoltaic solar power generation facilities, that:

> "C*onstruction or maintenance activities will not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. This provision may be satisfied by the submittal and county approval of a weed control plan prepared by an adequately qualified individual that includes a long-term maintenance agreement. The approved plan shall be attached to the decision as a condition of approval*."

Noxious weeds are non-native, aggressive plants with the potential to cause significant damage to native ecosystems and/or cause significant economic losses. Noxious weeds are opportunistic plant species that readily flourish in disturbed areas, are difficult to control, and thereby can compete with and/or prevent native plant species from re-establishing. Notably, the likelihood of introduction or explosion of noxious weeds is correlated with new disturbances in a region, such as large-scale construction projects. In addition, noxious weed species can adversely affect the structure, composition, and success of revegetation efforts associated with construction-related temporary disturbances.

The intent of this Plan is to provide clear methods to prevent the introduction and spread of designated noxious weeds from the construction and operation of the Facility, control existing populations of noxious weeds within construction areas, and monitor the success of efforts to prevent and control noxious weeds. The Certificate Holder and its contractors will be responsible for implementing the methods detailed in this Plan.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

Prior to construction, the Certificate Holder shall finalize this plan by completing the following:

- Conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform pre-construction weed treatment.
- Develop final noxious weed monitoring methods in consultation with ODOE and incorporate as an amendment to this plan upon ODOE approval.
- Update Table 2 in consultation with ODOE and the Morrow County Weed Department.
- Provide records demonstrating all personnel have been trained on noxious weed control.
- Provide evidence that existing noxious weed infestations have been identified and treated in a manner consistent with Morrow County recommendations.
- Consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern.

2.0 Regulatory Framework

2.1 State of Oregon

In Oregon, a noxious weed is defined under Oregon Revised Statutes (ORS) 569.175 as "a terrestrial, aquatic, or marine plant designated by the State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.". Noxious weeds have been declared by ORS 569.350 as a menace to public welfare, and control of these plants is the responsibility of private landowners and operators, as well as county, state, and federal governments.

The Oregon State Weed Board (OSWB) was created by the Oregon Department of Agriculture (ODA) under ORS 569.600. OSWB provides recommendations for noxious weed control at the state-level and is responsible for updating the State Noxious Weed List. The OSWB and the ODA classify noxious weeds in Oregon in accordance with the ODA Noxious Weed Policy and Classification System (ODA 2024). There are three designations under the State's system:

- **A Listed Weed:** A weed of known economic importance that occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent.
    - **Recommended Action:** Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed:** A weed of economic importance that is regionally abundant but may have limited distribution in some counties.

  - **Recommended Action:** Limited to intensive control at the state, county, or regional level as determined on a site-specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.
- **T-Designated Weed:** A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

2.2 Morrow County

The Morrow County Code Enforcement Ordinance establishes procedures for enforcing Morrow County Code through the authority granted to general law counties by ORS Chapter 203. Section 11 of the county Code Enforcement Ordinance, updated on July 5, 2021, establishes Morrow County as a weed control district, defines what is considered a noxious weed or weed of economic importance, identifies the responsibility of private landowners to control weeds, and outlines the authority of the weed control district and Morrow County Weed Program Manager/Inspector to administer and enforce weed control in the ordinance (Morrow County 2021).

Morrow County has its own weed classification system that differs from the state. Morrow County defines two classifications of weeds (Morrow County 2025):

- **Noxious Weeds - “A List”:** Any plant that is determined by the weed advisory board and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land, or property under provisions of Oregon State Statute and thus mandated for control.
- **Weeds of Economic Importance - “B List”:** Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

2.3 State and County Weed Lists

The ODA lists 46 Class A species and 88 Class B species for the state of Oregon, 19 of which are T-designated (ODA 2024; Appendix A). Morrow County specifically recognizes 36 species of noxious weeds (Appendix B; Morrow County 2025). Although not all the Morrow County listed noxious weeds noted in Appendix B occur in the vicinity of the Facility, the Certificate Holder and its contractors should be aware of the entire list while monitoring and controlling weeds. Noxious weeds known to occur in the vicinity of the site boundary are discussed in Section 3.0.

3.0 Noxious Weeds Identified at the Facility

In June, 2022 Tetra Tech completed rare plant and habitat categorization surveys within and adjacent to the original Sunstone Solar Project site boundary[2]. During those surveys, four listed noxious weed species were documented, including three ODA-listed noxious weed species and four Morrow County listed species noxious weed species. Table 1 lists the noxious weed species observed, their noxious weed designation (i.e., status), and the frequency of observations. Locations of these noxious weeds documented during surveys are included in Exhibit P, Attachment P-1 of the ASC[3]. Three of the four noxious weed species observed were state and/or County “B” listed weeds (Table 1; Morrow County 2025, ODA 2024). One species, rush skeletonweed (*Chondrilla juncea*), is an “A” List Weed in Morrow County and a state “T”-designated weed, meaning that ODA has targeted this species for prevention and control (Morrow County 2025; ODA 2024). Note that none of these noxious weed species observations are located within the Sunstone Solar Project 4/Facility site boundary, however, due to the likelihood that these species could be found at the Facility in the future, they are retained for awareness and noxious weed prevention purposes.

Cereal rye (*Secale cereale*) was abundant in the previously disturbed areas outside of active crop fields and was generally found in previously disturbed ground. Rush skeletonweed was found in isolated small populations or single individuals on the hillside between active cropland and a gravel county road. Puncturevine (*Tribulus terrestris*) and jointed goatgrass (*Aegilops cylindrica*) were found in the highly disturbed border in between active cropland and roads. The Certificate Holder will conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform management actions. The Certificate Holder may coordinate with landowners regarding noxious weed presence. Identified noxious weed infestations will be treated prior to construction.

Table 1. Noxious Weeds Observed during Surveys in 2022

Scientific Name	Common Name	Oregon State Status[1]	Morrow County Status[1]	Frequency
Aegilops cylindrica	Jointed goatgrass	B	B	Few small patches.
Chondrilla juncea	Rush skeletonweed	B*, T	A	Occasional single plants.
Secale cereale	Cereal rye	Not listed	B	Scattered large-sized patches.
Tribulus terrestris	Puncturevine	B*	B	Few small to large-sized patches.
1. Definitions for state and county noxious weed status are provided in Sections 2.1 and 2.2, respectively. Species marked with a (*) are targeted for biocontrol (ODA 2024).				

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[2] Site Certificate for the Sunstone Solar Project, November 18, 2024.

[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

In addition to noxious weeds, cheatgrass, an invasive annual grass, was identified in grassland habitats within the site boundary. While this species is not listed as a noxious weed by the state or county, it and other invasive annual grasses can adversely impact habitat and can increase fire risk. To address these issues and maintain compliance with the requirements of the Revegetation Plan required under Condition PRE-FW-01, the certificate holder will monitor the spread of these species as explained in Section 4.3 and 4.4.

4.0 Noxious Weed Management

This section of this Plan describes the steps the Certificate Holder will take to prevent and control the establishment and spread of noxious weed species during both construction and operation of the Facility. Noxious weed control methods for the Facility described in this Plan have been developed utilizing information from the ODA Noxious Weed Control Program and the Morrow County Weed Department.

The management of noxious weeds will be considered throughout all stages of construction and operation of the Facility and will include:

- **Prevention:** Implementing measures to prevent the spread of noxious weeds during construction, operation, and maintenance activities.
- **Treatment:** Treating noxious weed populations with their appropriate control methods, at appropriate time intervals.
- **Monitoring:** Assessing noxious weed changes within the Facility site boundary over time and ensuring that legacy as well as new weed populations are not increasing their distributions.

The Certificate Holder's objective is to prevent the introduction of new noxious weed populations and the spread of existing noxious weed populations. The methods described below will be implemented to minimize the spread of noxious weeds during construction activities. New noxious weeds detected during post-construction revegetation will be considered a result of construction activities and will be controlled accordingly.

4.1 Prevention

Prior to the start of construction, all personnel will be trained on the importance of noxious weed control. As part of start-up activities, and to help facilitate the avoidance of existing infestations and identification of new infestations, the Certificate Holder or their construction contractor will provide information and training to all construction personnel regarding noxious weed identification and prevention strategies. Operations and maintenance personnel will be similarly informed. The importance of preventing the spread of noxious weeds in areas not currently infested and controlling the proliferation of noxious weeds already present within or near the Facility will be emphasized.

The Certificate Holder will implement the following best management practices to minimize the spread of noxious weeds during construction activities, revegetation efforts, and operation and maintenance activities. The following practices center around ensuring that noxious weed seeds or reproductive plant fragments are not unintentionally dispersed within or outside of the Facility boundaries by personnel or their vehicles. These practices allow for responsible movement around sites with noxious weeds already present, and ensure that new populations or species are not accidentally introduced into the Facility boundaries.

- Flagging and treating areas of noxious weed infestations prior to construction to alert construction personnel;
- Limiting vehicle access to designated routes, whether existing roads or newly constructed roads, and the outer limits of construction disturbances per the final design for the Facility;
- Limiting vehicle traffic in noxious weed-infested areas;
- Cleaning construction vehicles each time they enter or exit the Facility at a wash station located inside the Facility at vehicle ingress/egress points;
- Cleaning vehicles and equipment associated with ground disturbance and movement of topsoil utilizing a mobile wash station after performing work in noxious weed-infested areas and prior to performing work in non-infested areas;
- Where feasible, not moving topsoil and other soils from noxious weed infested areas outside of the infested areas and returning them to their previous location during reclamation activities;
- Treating soils from infested areas with a pre-emergent herbicide prior to initiation of revegetation efforts;
- Providing information regarding target noxious weed species at the operations and maintenance buildings;
- Treating noxious weeds via biological, mechanical or chemical control (see Section 4.2);
- Preventing conditions favorable for noxious weed germination and spread by revegetating temporarily disturbed areas as soon as practicable;
- Monitoring areas of disturbance for noxious weeds after construction (see Section 4.3), during the normal course of revegetation maintenance of temporary workspaces, and implementing control measures as appropriate;
- Revegetating the site with appropriate, local native seed or native plants; when these are not available, non-invasive, and non-persistent non-native species may be used; and
- Ensuring that seed and straw mulch used for site rehabilitation and revegetation are certified free of noxious weed seed and propagules.

4.2 Treatment

Control of noxious weeds and other invasive weed species will be implemented through biological, mechanical, chemical, or biological control measures. The control method used will depend on the

weed species and size of infestation, time of year, proximity to intact native habitats, and resources available (Tu et al. 2003). Generally, mechanical control is best suited for small infestations of tap-rooted weeds that can be hand pulled or large occurrences in areas where mowing or soil disturbance is acceptable. Chemical control is used for most occurrences of perennial weeds with rhizomes or stolons and large occurrences of any weed in areas where mowing or soil disturbance are not recommended. Successful noxious weed control programs typically combine mechanical and chemical treatment strategies (USEPA 2008).

The Certificate Holder will be responsible for hiring a qualified contractor to implement the treatment of noxious weeds. The Certificate Holder will ensure that noxious weed management actions will be conducted by specialists with the following qualifications:

- Experience in native plant, non-native and invasive plants, and noxious weed identification;
- Experience in noxious weed mapping;
- If chemical control is used, specialists must possess a Commercial or Public Pesticide Applicator License from the ODA or possess an Immediately Supervised Pesticide Trainee License and be supervised by a licensed applicator;
- Training in noxious weed management or Integrated Pest Management with an emphasis in noxious weeds;
- Experience in coordination with agencies and private landowners; and
- No recent (within one year) violations on the contractor’s record.

Existing noxious weed populations will be prevented from expanding in size and density and will not be spread to new sites. Existing populations of A listed noxious weeds will be eliminated. If it is determined that noxious weeds have invaded areas immediately adjacent to the Facility (e.g., areas visible just beyond the outer limits of construction disturbances associated with the Facility or along access roads) as a result of construction, the Certificate Holder will contact the landowner and seek approval to treat those noxious weed populations.

Long-term weed control methods will be described in a long-term monitoring plan as described in Section 4.3. The main factor in long-term weed control is successful revegetation with non-weedy species as described in the Draft Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). If feasible, long-term management of vegetation within the Facility solar array fence line may include prescriptive sheep and goat grazing by an authorized contractor, if approved by Morrow County, ODFW and ODOE. As noted above, short-term noxious weed control will be done through mechanical or chemical treatment. However, it will be important to ensure that the short-term treatment does not affect the establishment of the native perennial cover that will help provide the long-term control. Additionally, early detection and control of small noxious weed populations before they can expand into larger populations is extremely important for successful weed control efforts.

Noxious weed control will continue for the life of the Facility to meet the identified success criteria described in Section 4.3. Supplemental seeding of desirable species may be needed to meet and/or

maintain compliance with success criteria. Fertilizer application will be limited in areas treated for noxious weeds, as fertilizer can stimulate the growth of noxious weeds, and the timing of revegetation activities will need to be coordinated with noxious weed treatments.

4.2.1 Biological

Biological control involves the use of prescribed insects, fungi and livestock to control noxious weeds to achieve management objectives. Biological control methods are typically targeted to a specific species or plant to control its persistence. They are also used for maintenance in targeted areas for vegetation management control in height and density that includes mitigating fire risk and erosion. Biological control is environmentally friendly and should be the first consideration when applicable.

4.2.2 Mechanical Treatment

Mechanical treatment will be the preferred method of treatment for existing noxious weed populations where appropriate within the boundaries of the Facility. Mechanical control methods rely on removal of plants, seed heads, and/or cutting roots with a shovel or other hand tools or equipment that can be used to remove, mow, or disc noxious weed populations. Hand removal of plants is also included under this treatment method. Mechanical methods are useful for smaller, isolated populations of noxious weeds in areas of sensitive habitats. Additionally, hand removal of small infestations can minimize soil disturbance, allowing desirable species to remain and limiting conditions favorable for noxious weeds.

For some large noxious weed occurrences, mowing, tilling, discing, or other mechanical techniques may be used to reduce thatch prior to chemical application so that herbicide can more effectively make contact with the target species. However, some rhizomatous plants can spread by discing or tillage. In addition, rush skeletonweed, which was identified near the Facility (Section 3.0), can reproduce vegetatively from small segments of root, and discing or tilling can facilitate the spread of this species. As such, implementation of discing will be species-specific and avoided in areas where rush skeletonweed individuals have been found.

If tilling or discing is employed in areas that will be revegetated following construction, subsequent seeding will be conducted to re-establish desirable vegetative cover that will stabilize the soils and slow the potential re-invasion of noxious weeds. Discing, tilling, or other mechanical treatments that disturb the soil surface within native habitats will also be avoided in favor of herbicide application, which is an effective means of reducing the size of noxious weed populations as well as preventing the establishment of new infestations. Previously unbroken ground or fallow areas should not be tilled or rod-weeded to maintain native biocrusts and prevent exposing weed seeds.

4.2.3 Chemical Treatment

Chemical control can effectively remove noxious weeds through use of selective herbicide when mechanical control is not feasible. The specific herbicide used and the timing of application will be

chosen based on the specific noxious weed being treated, as appropriate herbicides differ between species and types of plants (i.e., dicots such as rush skeletonweed versus monocots such as jointed goatgrass). Example treatment methods, as well as the recommended timing of treatments for the four target noxious weeds identified within the Facility, are summarized in Table 2. The status of herbicide approval (e.g., confirming herbicides are approved for use by the U.S. Environmental Protection Agency [EPA] and ODA) will be checked annually.

Prior to construction and every fall season during facility operation, the Certificate Holder or its contractor will consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern, to allow for adaptive weed management given changes in weed control effectiveness from noxious weed species tolerance to herbicide treatment over time. Results of the consultation shall be reported in the Certificate Holder's annual monitoring report. Any alternative control methods can be proposed by the Certificate Holder or its contractors after consulting with the Morrow County Weed Department and included in the Certificate Holder's annual monitoring report.

Herbicides will be applied on identified, treatable, noxious weed infestations. The Certificate Holder or their contractors will coordinate with the Morrow County Weed Department to determine which populations are treatable and will notify landowners of proposed herbicide use on their lands prior to application. If a noxious weed population is deemed to be untreatable (e.g., too widespread and established in an area to successfully control), the Certificate Holder will implement the applicable prevention measures discussed in Section 4.1, except for treatment with herbicides.

Table 2. Example Treatment for Target Noxious Weed Species

Scientific Name	Common Name	Treatment Method and Timing
Aegilops cylindrica	Jointed goatgrass	**Glyphosate** – Apply to actively growing plants emerged before bolt stage (i.e., stage of growth where growth is focused on seed development versus leaf development). • Rate: 0.38 to 0.75 lb ae/a[1] **Imazapic –** Apply pre-emergence in fall. Due to the residual effect of this herbicide, it will not be used in areas to be revegetated. • Rate: 0.063 to 0.188 lb/a[1] **Sulfometuron** – Apply in fall or in late winter before jointed goatgrass is 3 inches tall. • Rate: 1 to 1.5 oz ai/a (1.33 to 2 oz/a)[1]
Chondrilla juncea	Rush skeletonweed	**2,4-D or MCPA –** Apply to rosettes in the spring immediately before or during bolting. • Rate: 2 lb ae/a[1] **Aminopyralid (Milestone) –** Spring or fall when rosettes are present. • Rate: 1.75 oz ae/a (7 fluid oz/a Milestone)[1] **Clopyralid –** Apply to rosettes in fall or up to early bolting in spring. • Rate: 0.25 to 0.375 lb ae/a (0.66 to 1 pint/a)[1]

Scientific Name	Common Name	Treatment Method and Timing
		Picloram – Apply from late fall to early spring. For best results, apply just before or during bolting. - Rate: 1 lb ae/a[1]
Secale cereale	Cereal rye	Postemergence, non-selective herbicides such as glyphosate can control cereal rye. Glyphosate does not provide residual weed control, so any plants that emerge after treatment will not be controlled. Other herbicides that have found to provide control include Clethodim, Hexazinone, Rimsulfuron, Sethoxydim, and Sulfometuron.
Tribulus terrestris	Puncturevine	**2,4-D amine or 2,4-D LV ester–** Apply every 3 weeks during growing season or when new seedlings appear. - Rate: 1 to 2 lb ae in 10 to 20 gal water for spot treatments **Bentazon (Basagran) + imazamox (Raptor)–** Apply to small, actively growing puncture vine - Rate: 0.75 to 1 lb ai/A bentazon + 0.031 lb ai/a imazamox (4 oz/A Raptor) **Bromacil + diuron–** Apply before weeds emerge. - Rate: 8 lb ai/A (10 lb/a)[1] **Chlorsulfuron–** Apply late fall or late winter preemergence to growth. Needs moisture to activate. - Rate: 1 oz ai/a (1.5 oz/a)[1] **Fomesafen –** Apply pre- and postemergence, depending on crop. - Rate: 1 to 2 pints/A (0.25 to 0.5 lb ai/a)[1] **Imazapic –** Apply early postemergence when plants are cracking. - Rate: 0.125 to 0.188 lb ai/a[1] **Indaziflam –** Apply at least several weeks prior to expected germination of puncture vine. Apply to dry soils when rain is not expected for at least 48 hours. Can be successfully applied several months in advance of weed germination. - Rate: Grazed areas 0.046 to 0.065 lb ai/a (3.5 to 5 oz/a Rejuvra); areas not grazed or cut for hay 0.046 to 0.09 lb ai/A (3.5 to 7 oz/a Rejuvra). Use lower rates only where weed pressure is light and shorter period of residual activity is desired. **Norflurazon –** Apply in fall to spring, before puncture vine emerges. - Rate: Refer to label. Adjust rates depending on soil texture and organic matter **Paraquat –** Apply as a postemergence spray to puncture vine foliage - Rate: 0.38 to 0.49 lb ai/a[1] -

Sources: DiTomaso e al. 2013; LCNWCB 2022; Prather and Peachey 2022.

[1] a = acre; ae = acid equivalent; ai = active ingredient; lb= pound; oz = ounces

4.2.3.1 Herbicide Application and Handling

Herbicide application will occur within the appropriate season and during the appropriate timeframe to achieve desired results, as approved by ODOE and the county weed departments. Herbicide application will adhere to EPA and ODA standards. Only those herbicides that are approved by the EPA and ODA will be used. In general, application of herbicides will not occur when the following conditions exists:

- Wind velocity exceeds 15 miles per hour for granular application, or exceeds 10 miles per hour for liquid applications;
- Snow or ice covers the foliage of target species; or
- Adverse weather conditions are forecasted within the next few days.

Hand application methods (e.g., backpack spraying) may be used in roadless areas or in rough terrain. Vehicle-mounted sprayers (e.g., handgun, boom, and injector) will be used mainly in open areas that are readily accessible by vehicle. Calibration checks of equipment will be conducted prior to spraying activities, as well as periodically throughout use, to ensure that appropriate application rates are achieved.

Herbicides will be transported to the Facility daily with the following stipulations:

- Only the quantity needed for that day's work will be transported.
- Concentrate will be transported in approved containers only, and in a manner that will prevent spilling, stored separately from food, clothing, and safety equipment.
- Mixing will be done off-site and at a distance greater than 200 feet from open or flowing water, wetlands, or other sensitive species' habitat. No herbicides will be applied at these areas unless authorized by the appropriate regulatory agencies.
- All herbicide equipment and containers will be inspected daily for leaks.
- Herbicides use will be in accordance with all manufacture's label recommendations and warnings.

4.2.3.2 Herbicide Spills and Cleanups

All appropriate precautions will be taken to avoid herbicide spills. In the event of a spill, cleanup will be immediate. Contractors will keep spill kits in their vehicles and in an appropriate storage shed to allow for quick and effective response to spills. Items included in the spill kit will be:

- Protective clothing and gloves;
- Adsorptive clay, "kitty litter," or other commercial adsorbent;
- Plastic bags and a bucket;
- A shovel;
- A fiber brush and screw-in handle;
- A dustpan;

- Caution tape;
- Highway flares (use on existing hard-top roads only); and
- Detergent.

Response to an herbicide spill will vary with the size and location of the spill, but general procedures include:

- Stopping the leak;
- Containing the spilled material;
- Traffic control;
- Dressing the clean-up team in protective clothing;
- Cleaning up and removing the spilled herbicide, as well as the contaminated adsorptive material and soil; and
- Transporting the spilled herbicide and contaminated material to an authorized disposal site.

4.2.3.3 Herbicide Spill Reporting

All herbicide contractors will have readily available copies of the appropriate material safety data sheets for the herbicides used at their disposal and will keep copies of the material safety data sheets in the application vehicle. If an herbicide spill of any size occurs, the appropriate agency and spill coordinators will be notified promptly. In case of a spill into wetlands and waterbodies, the appropriate federal, state, and county agencies will be notified immediately. All herbicide spills equal to or greater than 200 pounds or 25 gallons of pesticide residue will be reported to the Oregon Emergency Response System in accordance with applicable laws and requirements (OAR 340-142-0050; ODEQ 2024). The Certificate Holder will report all herbicide spills to ODOE by phone or email within 24 hours with follow up reporting as appropriate.

4.3 Monitoring

Weed inspections will occur across the entire Facility through visual inspection of the site while driving and/or walking. Final monitoring methods will be determined in consultation with ODOE prior to construction and will be incorporated as an amendment to this plan upon ODOE approval. Monitoring will be conducted by a qualified botanist or weed specialist and will begin in the first growing season after seeding. Monitoring for noxious weeds and other undesirable weed species will occur at least five times per year including in the spring, June, July, and August for summer annuals and in the fall during the first two years following construction to capture the different life cycles of noxious weed species. This will allow real-time assessment of weed growth and inform proactive weed control measures to prevent large scale infestations. Frequent checks during early revegetation efforts will enable the Certificate Holder to respond to new weed infestations in a timely manner and ensure the success of the site’s revegetation. These inspections will be used to inform ongoing weed control efforts.

The initial monitoring survey will be scheduled slightly before herbicide application, as applicable, to identify any noxious weed species within the areas to be treated, with a focus on target noxious weed species observed prior to construction (Table 1), or other populations of target noxious weeds not previously observed.

Monitoring will assess the success of noxious weed treatments and will document any new noxious weed infestations observed. During the first two years following construction, the Certificate Holder will meet with ODOE and the Morrow County Weed Department at least once per season to provide updates on weed infestations and control measures at the Facility. These results will also be summarized in annual monitoring reports that describe the treatments performed, treatment success, make recommendations to improve treatment success (if necessary), and note any new target noxious weed species or emergence. Reports will be submitted to the Oregon Department of Energy (ODOE), Oregon Department of Fish and Wildlife (ODFW), and Morrow County annually.

Based on the success of control efforts after the second year of monitoring, the Certificate Holder will consult with ODOE and ODFW to determine if the monitoring cycle can be reduced for years three to five. After five years of monitoring, the Certificate Holder will design a long-term weed control plan in consultation with ODOE and the Morrow County Weed Department. The Certificate Holder will maintain ongoing communication with individual landowners, the Morrow County Weed Department, and ODOE regarding noxious weeds within the Facility. Landowners may also contact the Certificate Holder directly to report the presence of noxious weeds related to Facility activity. The Certificate Holder will control the noxious weeds on a case-by-case basis and prepare a summary of measures taken for that landowner. During the operational period of the Facility, the Certificate Holder will control noxious weeds as described in the long-term weed control plan. The Certificate Holder will report the investigator’s findings and recommendations regarding weed control in the Facility’s annual report required per OAR 345-026-0080.

The following contact information for the Morrow County Weed Program Manager will be used and updated as needed:

Corey Sweeney, Weed Program Manager
Morrow County Public Works
365 West Highway 74
Lexington, OR 97839
(541) 989-9502
mcweed@co.morrow.or.us

4.4 Success Criteria

Success criteria outlined below are designed to demonstrate compliance with OAR 660-033-0130(38)(D) to prevent the introduction and spread of noxious weed species. In each annual monitoring report, the Certificate Holder will include an assessment of whether the Facility is meeting or trending toward meeting the noxious weed control success criteria. Compliance with the Facility Site Certificate will be demonstrated through documentation of meeting these success criteria for the life of the Facility.

- Class A and Class B noxious weed presence within the solar array fence line will not exceed 15 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Class T noxious weed presence within the solar array fence line will not exceed 5 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Invasive Annual Grasses and other Undesirable Species will not exceed more then 50 percent cover within any 1 acre area or more than 30 percent cover within the solar array fence line.
- During revegetation of temporary disturbance areas outside of the solar array fence line presence and cover of noxious weeds is 75 percent or less than that of the reference site.

5.0 Roles and Responsibilities

The Certificate Holder is the overall responsible party for construction and operation of the Facility and implementation of the noxious weed management activities described in this Plan. However, the Certificate Holder may use contractors to complete tasks associated with noxious weed management and monitoring. Example responsible parties and their roles may include:

Monitoring Contractor

- Perform site visits to document noxious weed occurrences.
- Provide summary memo after each visit to Certificate Holder's operations manager outlining findings and treatment recommendations.
- Communicate directly with Weed Management Contractor and provide maps, and photos of noxious weed species locations to Weed Management Contractor.
- Communicate with Morrow County Weed Program Manager, and ODA about noxious weed survey findings and treatment plans.
- Prepare annual report for the Facility describing noxious weed monitoring findings and treatments.
- Organize and attend quarterly calls with the Certificate Holder and Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Certificate Holder Site Manager

- Communicate findings and recommendations from Monitoring Contractor to the Weed Management Contractor.
- Document the work performed by the Weed Management Contractor and provide documentation to Monitoring Contractor. Documentation should include type and quantity

of herbicides applied, dates applied, and any associated EPA/U.S. Department of Environmental Quality licensing/documentation of chemicals used.

- Reviews annual reports to ensure all treatments performed by the Weed Management Contractor are documented.
- Maintain landowner communications, providing guidance to the Monitoring Contractor and Weed Management Contractor regarding landowner restrictions/requests for performing noxious weed monitoring/treatment on their properties.
- Attend quarterly calls with Monitoring Contractor and the Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Weed Management Contractor

- Review Monitoring Contractor memos describing noxious weed occurrences and recommendations and plan appropriate treatment to address those issues.
- Communicate treatment plan to the Certificate Holder.
- Maintain records of when, where, and what type of noxious weed treatments are being performed.
- Maintain all appropriate documentation of chemicals applied. Shares documentation during the quarterly calls with the Certificate Holder and Monitoring Contractor, and prior to Annual Report preparation.
- Attend quarterly calls with Monitoring Contractor and Certificate Holder.

Morrow County

- Review Monitoring Contractor memos describing weed occurrences and recommendations.
- Attend quarterly calls and provide recommendations.

6.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE. This Plan may also be amended periodically as the Certificate Holder continues to evaluate and modify, as needed, agricultural dual use activities at the Facility.

7.0 References

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Appendix A: Oregon State Noxious Weed List

OREGON
DEPARTMENT OF
AGRICULTURE

Noxious Weed Policy and Classification System 2024

Noxious Weed Control Program

Address: 635 Capitol Street NE, Salem, Oregon 97301
Phone: (503) 986-4625 **Fax:** (503) 986-4786
www.oregon.gov/ODA/programs/Weeds/Pages/AboutWeeds.aspx

Mission Statement

To protect Oregon's natural resources and agricultural economy from the invasion and proliferation of invasive noxious weeds.

Program Overview

The Oregon Department of Agriculture (ODA) Noxious Weed Control Program provides statewide leadership for coordination and management of state listed noxious weeds. The state program focuses on noxious weed control efforts by implementing early detection and rapid response projects for new invasive noxious weeds, implementing biological control, implementing statewide inventory and survey, assisting the public and cooperators through technology transfer and noxious weed education, maintaining noxious weed data and maps for priority listed noxious weeds, and assisting land managers and cooperators with integrated weed management projects. The Noxious Weed Control Program also supports the Oregon State Weed Board (OSWB) with administration of the OSWB Grant Program, developing statewide management objectives, developing weed risk assessments, and maintaining the state noxious weed list.

Troy Abercrombie
Program Manager
troy.abercrombie@oda.oregon.gov
(503) 986-4625

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Noxious Weed Control Policy and Classification System

Definition

“Noxious weed” means a terrestrial, aquatic or marine plant designated by the Oregon State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.

Noxious weeds have become so thoroughly established and are spreading so rapidly on private, state, county, and federally owned lands, that they have been declared by ORS 569.350 to be a menace to public welfare. Steps leading to eradication, where possible, and intensive control are necessary. It is further recognized that the responsibility for eradication and intensive control rests not only on the private landowner and operator, but also on the county, state, and federal governments.

Weed Control Policy

Therefore, it shall be the policy of ODA to:

1. Assess non-native plants through risk assessment processes and make recommendations to the Oregon State Weed Board for potential listing.
2. Rate and classify weeds at the state level.
3. Prevent the establishment and spread of listed noxious weeds.
4. Encourage and implement the control or containment of infestations of listed noxious weed species and, if possible, eradicate them.
5. Develop and manage a biological weed control program.
6. Increase awareness of potential economic losses and other undesirable effects of existing and newly invading noxious weeds, and to act as a resource center for the dissemination of information.
7. Encourage and assist in the organization and operation of noxious weed control programs with government agencies and other weed management entities.
8. Develop partnerships with county weed control districts, universities, and other cooperators in the development of control methods.
9. Conduct statewide noxious weed surveys and weed control efficacy studies.

Weed Classification System

The purpose of this Classification System is to:

1. Act as the ODA's official guideline for prioritizing and implementing noxious weed control projects.
2. Assist the ODA in the distribution of available funds through the Oregon State Weed Board to assist county weed programs, cooperative weed management groups, private landowners, and other weed management entities.
3. Serve as a model for private and public sectors in developing noxious weed classification systems that aid in setting effective noxious weed control strategies.

Criteria for Determining Economic and Environmental Significance

Detrimental Effects

1. A plant species that causes or has the potential to cause severe negative impacts to Oregon's agricultural economy and natural resources.
2. A plant species that has the potential to or does endanger native flora and fauna by its encroachment into forest, range, aquatic and conservation areas.
3. A plant species that has the potential or does hamper the full utilization and enjoyment of recreational areas.
4. A plant species that is poisonous, injurious, or otherwise harmful to humans and/or animals.

Plant Reproduction

1. A plant that reproduces by seed capable of being dispersed over wide areas or that is long-lived, or produced in large numbers.
2. A plant species that reproduces and spreads by tubers, creeping roots, stolons, rhizomes, or other natural vegetative means.

Distribution

1. A weed of known economic importance which occurs in Oregon in small enough infestations to make eradication/containment possible; or not known to occur, but its presence in neighboring states makes future occurrence seem imminent.
2. A weed of economic or ecological importance and of limited distribution in Oregon.
3. A weed that has not infested the full extent of its potential habitat in Oregon.

Difficulty of Control

A plant species that is not easily controlled with current management practices such as chemical, cultural, biological, and physical methods.

Noxious Weed Control Classification Definitions

Noxious weeds, for the purpose of this system, shall be listed as either A or B, and may also be designated as T, which are priority targets for control, as directed by the Oregon State Weed Board.

- **A Listed Weed**:
  A weed of known economic importance which occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent (Table I).
  Recommended action: Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed**:
  A weed of economic importance which is regionally abundant, but which may have limited distribution in some counties (Table II).
  Recommended action: Limited to intensive control at the state, county or regional level as determined on a site specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.
- **T-Designated Weed (T)**:
  A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

Weed Biological Control

Oregon implements biological control, or “biocontrol” as part of its integrated pest management approach to managing noxious weeds. This is the practice of using host-specific natural enemies such as insects or pathogens to control noxious weeds. The Oregon Department of Agriculture Noxious Weed Program has adopted the International Code of Best Practices for biological control of weeds. Only safe, effective, and federally-approved natural enemies will be used for biocontrol.

Table I: A Listed Weeds

Common Name	Scientific Name
African rue	*Peganum harmala*
Camelthorn	*Alhagi pseudalhagi*
Cape-ivy	*Delairea odorata*
Coltsfoot	*Tussilago farfara*
Common frogbit	*Hydrocharis morsus-ranae*
Cordgrass	
Common	*Spartina anglica*
Dense-flowered	*Spartina densiflora*
Saltmeadow	*Spartina patens*
Smooth	*Spartina alterniflora*
Delta arrowhead	*Sagittaria platyphyla*
European water chestnut	*Trapa natans*
Flowering rush	*Butomus umbellatus*
Garden yellow loosestrife	*Lysimachia vulgaris*
Giant hogweed	*Heracleum mantegazzianum*
Goatgrass	
Barbed	*Aegilops triuncialis*
Ovate	*Aegilops ovata*
Goatsrue	*Galega officinalis*
Hawkweed	
King-devil	*Hieracium piloselloides*
Mouse-ear	*Hieracium pilosella*
Orange	*Hieracium aurantiacum*
Yellow	*Hieracium floribundum*
Hoary alyssum	*Berteroa incana*
Hydrilla	*Hydrilla verticillata*
Japanese dodder	*Cuscuta japonica*
Kudzu	*Pueraria lobata*
Matgrass	*Nardus stricta*
Oblong spurge	*Euphorbia oblongata*
Palmer amaranth	*Amaranthus palmeri*
Paterson's curse	*Echium plantagineum*
Purple nutsedge	*Cyperus rotundus*
Ravennagrass	*Saccharum ravennae*
Squarrose knapweed	*Centaurea virgata*

(Continued) Table I: A Listed Weeds

Common Name	Scientific Name
Starthistle	
Iberian	*Centaurea iberica*
Purple	*Centaurea calcitrapa*
Thistle	
Plumeless	*Carduus acanthoides*
Smooth distaff	*Carthamus baeticus*
Taurian	*Onopordum tauricum*
Turkish	*Carduus cinereus*
Welted (curly plumeless)	*Carduus crispus*
Woolly distaff	*Carthamus lanatus*
Water soldiers	*Stratiotes aloides*
West Indian spongeplant	*Limnobium laevigatum*
White bryonia	*Bryonia alba*
Yellow floating heart	*Nymphoides peltata*
Yellowtuft	*Alyssum murale, A. corsicum*

Table II: B Listed Weeds

Common Name	Scientific Name
Armenian (Himalayan) blackberry	*Rubus armeniacus (R. procerus, R. discolor)*
Biddy-biddy	*Acaena novae-zelandiae*
Broom	
French*****	*Genista monspessulana*
Portuguese (T)	*Cytisus striatus*
Scotch*****	*Cytisus scoparius*
Spanish	*Spartium junceum*
Butterfly bush	*Buddleja davidii (B. variabilis)*
Common bugloss (T)	*Anchusa officinalis*
Common crupina **(T)**	*Crupina vulgaris*
Common reed	*Phragmities australis ssp. australis*
Common viper's bugloss (T)	*Echium vulgare*
Cutleaf teasel	*Dipsacus laciniatus*
Dyer's woad (T)	*Isatis tinctoria*
English hawthorn	*Crataegus monogyna*
Eurasian watermilfoil	*Myriophyllum spicatum*
False brome	*Brachypodium sylvaticum*
Field bindweed	*Convolvulus arvensis*
Garlic mustard (T)	*Alliaria petiolata*
Geranium	
Herb Robert	*Geranium robertianum*
Shiny leaf	*Geranium lucidum*
Giant reed (T)	*Arundo donax*
Gorse***** (T)	*Ulex europaeus*
Halogeton	*Halogeton glomeratus*
Houndstongue	*Cynoglossum officinale*

* Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Indigo bush	*Amorpha fruticosa*
Ivy	
Atlantic	*Hedera hibernica*
English	*Hedera helix*
Jointed goatgrass	*Aegilops cylindrica*
Jubata grass	*Cortaderia jubata*
Knapweed	
Diffuse*****	*Centaurea diffusa*
Meadow*****	*Centaurea pratensis*
Russian*****	*Acroptilon repens*
Spotted*****	*Centaurea stoebe (C. maculosa)*
Knotweed	
Bohemian*****	*Fallopia x bohemica*
Giant*****	*Fallopia sachalinensis (Polygonum)*
Himalayan	*Polygonum polystachyum*
Japanese*****	*Fallopia japonica (Polygonum)*
Kochia	*Kochia scoparia*
Lesser celandine	*Ranunculus ficaria*
Meadow hawkweed (T)	*Pilosella caespitosum (Hieracium)*
Mediterranean sage*	*Salvia aethiopis*
Medusahead rye	*Taeniatherum caput-medusae*
Old man’s beard	*Clematis vitalba*
Parrot feather	*Myriophyllum aquaticum*
Perennial peavine	*Lathyrus latifolius*
Perennial pepperweed (T)	*Lepidium latifolium*
Pheasant’s eye	*Adonis aestivalis*
Pine echium (T)	*Echium pininana*
Poison hemlock*****	*Conium maculatum*
Policeman’s helmet	*Impatiens glandulifera*
Primrose-willow	
Large-flower (T)	*Ludwigia grandiflora*
Water primrose (T)	*Ludwigia hexapetala*
Floating (T)	*Ludwigia peploides*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Puncturevine*****	*Tribulus terrestris*
Purple loosestrife*****	*Lythrum salicaria*
Ribbongrass (T)	*Phalaris arundinacea var. Picta*
Rose	
Dog	*Rosa canina*
Sweetbriar	*Rosa rubiginosa*
Rush skeletonweed***** (T)	*Chondrilla juncea*
Saltcedar***** (T)	*Tamarix ramosissima*
Small broomrape	*Orabanche minor*
South American waterweed	*Egeria densa (Elodea)*
Spanish heath	*Erica lusitanica*
Spurge laurel	*Daphne laureola*
Spurge	
Leafy***** (T)	*Euphorbia esula*
Myrtle	*Euphorbia myrsinites*
St. Johnswort	*Hypericum perforatum*
Sulfur cinquefoil	*Potentilla recta*
Swainsonpea	*Sphaerophysa salsula*
Tansy ragwort***** (T)	*Senecio jacobaea (Jacobaea vulgaris)*
Thistle	
Bull	*Cirsium vulgare*
Canada*****	*Cirsium arvense*
Italian	*Carduus pycnocephalus*
Milk	*Silybum marianum*
Musk	*Carduus nutans*
Scotch	*Onopordum acanthium*
Slender-flowered	*Carduus tenuiflorus*
Toadflax	
Dalmatian*****	*Linaria dalmatica*
Yellow*****	*Linaria vulgaris*
Tree of heaven	*Ailanthus altissima*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Ventenata grass	*Ventenata dubia*
Whitetop	
Hairy	*Lepidium pubescens*
Lens-podded	*Lepidium chalepensis*
Whitetop (hoary cress)*****	*Lepidium draba*
Yellow archangel	*Lamiastrum galeobdolon*
Yellow flag iris	*Iris pseudacorus*
Yellow nutsedge	*Cyperus esculentus*
Yellow starthistle*	*Centaurea solstitialis*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

Appendix B: Morrow County Noxious Weed List

Morrow County Weed List:

NOXIOUS WEEDS

Noxious Weeds – “A” List” – Any plant that is determined by the weed advisory board, and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land or property under provisions of Oregon State Statute and thus mandated for control.

Rush Skeletonweed

Yellow Starthistle

Tansy Ragwort

Yellow Toadflax

Dalmatian Toadflax

Mediterranean Sage

Leafy Spurge

Spikeweed

Musk Thistle

Scotch Thistle

Purple Loosestrife

Common Crupina

Whitetop (Hoary Cress)

Houndstongue

Flowering Rush

Yellow Flag Iris

Plumeless Thistle

WEEDS OF ECONOMIC IMPORTANCE

Weeds of Economic Importance – “B” List – Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

Poison Hemlock

Canada Thistle

Jointed Goatgrass

St. Johnswort

Perennial Sowthistle

Field Bindweed

Cereal Rye

Johnsongrass

Russian Knapweed

Diffuse Knapweed

Spotted Knapweed

Field Dodder

Water Hemlock

Medusahead Rye

Puncturevine

Kochia

Perennial Pepperweed

Myrtle Spurge

Ventenata

Morrow County Weed Advisory Board

The Morrow Soil and Water Conservation District Board also serves as the Weed Advisory Board

Sunstone Solar Project 4
Draft Revegetation and Reclamation Plan

Prepared for

PINEGATE
RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 4, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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1.0 Introduction

Sunstone Solar 4, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 4 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon (Figure 1). The proposed Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 200-hour MW distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Revegetation and Reclamation Plan (Plan) has been prepared to guide revegetation of areas temporarily disturbed during construction of the Facility, as well as revegetation within the solar array fence in compliance with Site Certificate Conditions PRE-FW-01 and PRE-SP-01. This Plan will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE), the Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Agriculture (ODA), and Morrow County Weed Department to reflect the final layout of the Facility.

Prior to construction, this Plan shall be finalized based on the following:

1. Certificate Holder shall finalize the Plan based on disturbance associated with the final design/layout by disturbance level and habitat type and category.
2. Certificate Holder shall develop and incorporate maps showing anticipated construction disturbance levels along with the total acreage and major activities associated with each level.
3. Certificate Holder shall update Table 1 prior to construction to reflect the disturbance acreage by habitat subtype for the final layout.
4. Certificate Holder shall develop and incorporate revegetation methods for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department.

Prior to construction, the following shall be completed:

1. Certificate Holder shall provide shapefiles showing anticipated construction disturbance levels at the site as a submittal to ODOE.
2. Certificate Holder shall provide the revegetation and seeding contractor’s qualifications and scope of work as a submittal to ODOE.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

3. Certificate Holder shall submit baseline soil compaction sample locations and baseline compaction results to ODOE.
4. Certificate Holder shall hold a kick-off meeting with their environmental contractor, construction contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
5. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the construction contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.

Prior to initiation of revegetation, the following shall be completed:

1. Certificate Holder shall hold a kick-off meeting with their environmental contractor, revegetation and seeding contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
2. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the revegetation and seeding contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.
3. Certificate Holder shall complete post-construction soil compaction testing and submit results for review and approval to ODOE.

Throughout construction, revegetation, and operation activities, the Certificate Holder will take appropriate actions to prevent the spread of state and county listed noxious weeds. A stand-alone Draft Noxious Weed Control Plan has also been prepared (see Exhibit P, Attachment P-3[2]; updated for RFA 1, see Attachment 6), which contains information on state and Morrow County listed noxious weeds, noxious weeds observed during surveys, and treatment and monitoring of noxious weeds.

2.0 Site Description

The Facility includes a 1,273-acre site boundary within which all Facility components will be located. The Facility lies within the Columbia Plateau Ecoregion at elevations from 1,020 to 1,120 feet. The Facility is sited entirely on private land, which primarily consists of agriculture land used for growing dryland wheat. Native vegetation within the site boundary has been modified primarily through agricultural conversion, but also through the introduction of exotic grasses and other non-native vegetation.

Habitat mapping and categorization of the site boundary were conducted for the Facility in 2022. Habitat types within the site boundary include Agriculture, Pasture, and Mixed Environs (habitat subtype: Orchards, Vineyards, Wheat Fields, Other Row Crops). Details on habitat types, subtypes, and categories can be found in Exhibit P of the Facility's ASC, especially Attachment P-1 which

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[2] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

contains the biological survey reports. Details on potential disturbance to habitat from construction and operation of the Facility, as well as avoidance and minimization measures, can be found in the ASC Exhibits P and Q[3].

3.0 Description of Disturbance

Construction of the Facility will result in temporary and permanent disturbance (see Exhibits C[4] and P). Section 3.1.1 (below) details the acres of each habitat subtype that will be temporarily and permanently disturbed during construction and operation of the Facility.

All areas within the solar array fence are considered a permanent disturbance and will be revegetated for the purposes of site stabilization to reduce erosion, dust pollution, and topsoil depletion, and to reduce potential for invasion by noxious and invasive plants. The entire solar array fence will occupy approximately 1,267 acres. As noted above, this area is considered permanently disturbed; however, vegetation within the solar array fence will be retained and/or revegetated and this area would be reclaimed upon retirement.

Temporary disturbance will occur in areas outside the solar array fence that will be disturbed during construction activities, but which will not be occupied by permanent facilities. Temporary disturbance will occur in association with the construction of aboveground and underground collector and transmission lines, new roads, and perimeter fence.

Prior to construction, a crosswalk of the final version of this Plan will be prepared for use by the construction contractor to facilitate Plan implementation and ensure ground disturbance is minimized to the extent practicable. A kick-off meeting with the Certificate Holder, their environmental contractor, construction contractor, and ODOE will be held at least 14 days prior to construction. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify that anticipated disturbance levels are followed to the extent possible and will document any variances and justifications for those variances for ODOE review.

3.1 Disturbance Levels

Revegetation needs will be determined by a combination of disturbance level and existing vegetative cover. Disturbance levels will primarily be determined by site conditions such as slope, gradient, and existing vegetation. Disturbance levels are defined as follows:

Level 1 - Mowing: Mowing is used to conserve vegetative resources within a facility while mitigating risk of fire and facilitating construction activities. Vegetation will be limited to a height of 12 inches and mowed to no less than 6 inches during construction. Mowing to no less than 6 inches protects perennial grass crowns and allows grasses to regenerate. Depending on facility objectives, vegetation

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[3] Complete Application for Site Certificate, Exhibit Q, May 16, 2024.
[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

can be allowed to reach a normal height or kept trimmed to a height between 6 inches and the plant's full height potential. Crushing of vegetation will be minimal and this disturbance level is designed to have a minimal impact on existing vegetation. This method is least likely to result in invasions of undesirable plant species.

Level 2 – Overland Drive and Crush: Disturbance caused by accessing a facility without significantly modifying the landscape. Vegetation is crushed to the ground, but no surface soil is removed so root structures are left intact. Even though vegetation may be damaged or destroyed, the surface soil and seed bank remain in place. Some crushed vegetation will likely sprout after disturbance ceases. These activities would result in minimal to moderate disturbance. This type of disturbance will result in a faster recovery time for vegetation compared to Levels 3 and 4. Soil seed banks remain largely in place, perennial vegetation can grow back, and minimal external efforts are necessary. This method is less likely to result in invasions of undesirable plant species compared to Levels 3 and 4.

Level 3 – Clear and Cut: Disturbance caused by accessing the facility including having to remove all vegetation in order to improve or provide suitable access for other equipment. All vegetation is removed, soils are compacted, and the root zone or soil A-horizon may be disturbed, but no sub-surface soil is removed. Clear and cut activities would result in moderate disturbance. This type of disturbance will result in moderate recovery times for vegetation. This method has a moderate risk for invasion of undesirable plant species. An example is imprinting to crush vegetation down into the soil or incidental grading and smoothing of surface soils.

Level 4 – Clear and Cut with Soil Removal: Disturbance is caused by removing all vegetation in the impact zone, soils are compacted, and surface soil and subsoil are displaced. These activities result in heavy disturbance. This type of disturbance results in an extensive recovery time for vegetation, and is most likely to lead to invasions of undesirable plant species, which can result in lengthy and expensive control efforts. Includes disc-and-roll construction, and other traditional construction methods where soils are disturbed and no vegetation is left intact. This category includes all work requiring the segregation and replacement of topsoils.

3.1.1 Facility Disturbance

To the maximum extent practicable, Level 1 and Level 2 disturbance will be used during Facility construction. Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable, although construction vehicles driving across the site may affect existing root systems by compacting soils. Grading within solar arrays will be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically, but not exclusively, 10 percent maximum on North slopes and 15 percent maximum in other directions). Areas where the slope and gradient are within panel and racking tolerances will only be graded in road, inverter, and energy storage footprints where possible. Preservation of existing root systems will minimize soil erosion, providing both improved compliance with stormwater and dust management requirements, facilitate revegetation success, and preserve soil productivity for future agricultural use. Construction will be coordinated and sequenced to the extent practicable with landowners to maintain land in current production and

weed control until just prior to construction. This will avoid land being left unmanaged and minimize weed issues that can complicate revegetation.

Prior to construction, the Certificate Holder will provide maps and shapefiles showing anticipated construction disturbance levels at the Facility, along with total acreage and major activities associated with each level. This will serve to demonstrate the Certificate Holder's avoidance and minimization of ground disturbing activities to the extent practicable.

Table 1 presents the estimated maximum acreage of temporary and permanent disturbance to habitat subtypes associated with Facility construction and operation based on the permitted layout. Table 1 will be updated prior to construction to reflect the final disturbance acreage by habitat subtype for the final layout. Figures depicting the location of Facility infrastructure are included in Exhibit C, and a figure depicting habitat subtypes within the site boundary is available in Exhibit P.

Table 1. Maximum Temporary and Permanent Disturbance by Habitat Subtype

ODFW Habitat Category	Habitat Subtype	Permanent Disturbance (Acres)[1, 2]	Temporary Disturbance (Acres) [1]
6	Orchards, Vineyards, Wheat Fields, Other Row Crops	1,267	1.4
	Grand Total[1]	**1,267**	**1.4**

1. Additional details associated with temporary and permanent disturbance are provided in Exhibit C of the ASC. Disturbances were calculated based on the layout permitted in the ASC and will be updated prior to construction based on an updated layout.
2. Acres of permanent disturbance includes the entire area within the solar array area fence including the footprints of all solar components and supporting facilities, as well as the areas outside of the footprint of permanent components and facilities (e.g., areas underneath and between rows of solar panels).

4.0 Reclamation and Revegetation Methods

This plan addresses revegetation methods for temporary disturbance to agricultural lands, as well as revegetation and vegetation management of lands within the solar array fence. Revegetation of temporarily disturbed developed habitat (i.e., Urban and Mixed Environs habitat subtype) will be determined on a case-by-case basis and is not covered further in this plan. Temporary disturbance to agricultural habitat (i.e., Orchards, Vineyards, Wheat Fields, Other Row Crops habitat subtype) will be restored as described in Section 4.5.1. The Certificate Holder will restore temporarily disturbed areas by re-establishing slope, surface stability, and drainage features, as needed, followed by soil preparation and seeding. Soil preparation and seeding techniques are described below.

Revegetation will begin as soon as feasible after completion of each construction phase. Seeding and planting will be done in a timely manner and in the appropriate season to facilitate germination and establishment of seeded species.

Prior to construction, final revegetation methods will be developed for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department and will be incorporated as an amendment to this Plan upon ODOE approval.

4.1 Roles and Responsibilities

A construction contractor qualified to perform revegetation and seeding will be responsible for implementing measures in the National Pollutant Discharge Elimination System (NPDES) 1200-C permit, as well as revegetation activities discussed herein during and immediately after construction. A qualified botanist or revegetation specialist will be responsible for monitoring and reporting on revegetation success. Remedial revegetation actions, if needed during the operation phase, will be performed by a qualified contractor. The Certificate Holder will be responsible for ensuring that all contractors perform work in accordance with permit requirements and all agreed upon methods for revegetation.

The goal of this Plan is to increase the probability of revegetation success, reduce early weed establishment, reduce erosion and dust pollution, protect topsoil for future agricultural use in permanent disturbance areas, and ensure no loss of habitat quality for temporary disturbance to wildlife habitat. To ensure this goal is met, the Certificate Holder will ensure that the contractor selected for revegetation will be a qualified revegetation and seeding contractor with demonstrated experience in the Columbia Plateau. Options for contracting and managing this work include:

- Having the construction contractor subcontract revegetation work out to a qualified revegetation and seeding contractor. The contract will stipulate the Certificate Holder’s right to dictate the timing, methods, and management of seeding.
- Contracting directly with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.
- Having the environmental contractor contract with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.

The revegetation and seeding contractor’s qualifications and scope of work will be provided as a submittal to ODOE prior to construction. Additionally, a crosswalk of the final version of this Plan will be prepared for use by the revegetation and seeding contractor prior to initiation of revegetation to facilitate Plan implementation. A kick-off meeting with the Certificate Holder, their environmental contractor, revegetation and seeding contractor, and ODOE will be held at least 14 days prior to initiation of revegetation activities. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify seeding methods and timing requirements are followed appropriately and will document any variances and the justifications for those variances. Monitoring and follow-up will be provided as described in Section 6.0 to ensure oversight and increase the probability of revegetation success.

4.2 Soil Reclamation

Soil scientists use a soil penetrometer to field measure subsurface compaction in soil. This tool measures resistance (pressure) to the advance of a cone-tipped rod with a T-handle, vertically through the soil column. The metric intends to measure soil compaction that can inhibit the ability of plants to penetrate the soil. An operator pushes the penetrometer rod with a cone base into the ground with consistent force. A pressure gauge records pressure in pounds per square inch (psi), equaling levels of resistance at differing soil layers. Resistance is measured at 3-inch intervals until the meter goes above 300 psi, which is a level of soil compaction most roots cannot penetrate. For this test compaction would be measured at 3, 6, 9, and 12 inches if the soils allow. Soil compaction testing must be completed in spring or late fall when soils are at field capacity (approximately 24 hours after a soaking rain). Baseline soil compaction measurements will be taken prior to construction. Baseline soil compaction sample locations and baseline compaction results will be submitted to ODOE prior to construction.

1. Baseline and post-construction soil compaction measurements and testing must be done in conditions favorable to soil testing (e.g. non-saturated or frozen soils).
2. Baseline soil compaction measurements will be documented and established by using the above protocol, or other protocol as approved by ODOE, to establish baseline soil conditions within temporary disturbance areas.
3. Recordation of the baseline soil plots must be represented on a map based on final Facility design.
4. Post-construction soil compaction testing following the above protocols must be completed in spring or late fall when soil conditions are favorable to soil testing (non-saturated or frozen soils). Compaction testing will occur after soil stockpiles are replaced and grading is complete but prior to initiation of revegetation activities.
5. If soil monitoring demonstrates that soils are compacted more than 300 psi, then remediation activities must be completed prior to initiation of revegetation activities. See Section 4.3 below, the Facility NPDES 1200-C permit, and applicable Site Certificate Conditions.

In addition, in areas where soil is removed during construction, the following measures will be taken where appropriate:

- During construction, excavated topsoil will be stockpiled separately from subsoil and replaced in proper order with topsoil on the surface to maintain soil productivity. Stockpiled soil will be put back in place prior to revegetation activities.
- Soils will be stabilized during construction using the appropriate best management practices as determined by the onsite stormwater pollution prevention plan implementor.
- Soil preparation will involve standard, commonly used methods (i.e. tracking, decompaction, and tilling), and will consider all relevant site-specific factors, including slope, size of area, and erosion potential. Soils will be de-compacted if necessary to create a

uniform seedbed using an agricultural disc, soil ripper, or similar equipment. Additional details regarding soil preparation are in Section 4.3.

- Topsoil and other soils from noxious weed infested areas will not be moved outside of the infested areas and will be returned to their previous location during reclamation activities to eliminate the transport of weed seeds, roots, or rhizomes.
- Soils from weed-infested areas will be treated with a non-persistent, pre-emergent herbicide prior to initiation of revegetation efforts, depending on site-specific conditions.
- Prior to final regrade and revegetation efforts, any weeds that have grown during periods of construction dormancy should be treated as described in the Noxious Weed Control Plan.
- The construction contractor will use appropriate erosion and sediment control practices (i.e., seeded or unseeded hydromulch, tackifier, weed-free erosion control blankets, weed-free or locally sourced straw mulch) to maintain topsoil during construction in both temporary and permanent disturbance areas.

4.3 Site Preparation

Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable. Areas where the slope and gradient are within the solar panel and racking tolerances will receive minimal grading, with grading in those areas limited to the roads, inverter, and energy storage footprints. In areas where soil is removed during construction, the Certificate Holder will demonstrate adequate soil stabilization to prevent erosion and dust pollution. The following measures will be taken where appropriate:

- Site preparation will take into account all relevant site-specific factors, including slope, size of area, and erosion potential.
- Areas of severe machine or vehicle tracking that would hinder seeding success and are unnecessary for soil stabilization will be regraded.
- In the spring, fall or winter of the year prior to when construction would occur, areas of high erosion risk (e.g., slopes, areas with low vegetative cover) should be seeded with a non-invasive, non-persistent cover crop such as triticale to stabilize soils.
- If soils are not suitable for revegetation, soil amendments may be required. Any imported topsoil, if required, will be demonstrated to be suitable for vegetative success.
- Where soil compaction testing demonstrates that soils are compacted greater than 300 psi, soils will be mechanically scarified (e.g., tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction, to maintain soil productivity, and reduce the potential for erosion on compacted soils. Dry soils should be de-compacted using an agricultural disc, soil ripper, or similar equipment.
- Prior to seeding and/or planting of revegetation areas, soils will be prepared into a firm, fine-textured seedbed that is relatively free of debris. Shallow tilling with a disc, followed by a harrow or drag if necessary, can typically achieve this. If replaced soil is too soft, then

seeds may be buried too deep to properly germinate; a roller or culti-packer should be used to pack down the soil.

- In non-cropland temporary disturbance areas, site complexity will be considered during soil preparation. For instance, it may be desirable to purposely create an uneven, patchy site that allows for depressions and other microsites that result in small variations in aspect and moisture holding to promote complexity.
- Seeded areas will be temporarily stabilized to facilitate establishment. This can be accomplished by application of seedless, certified weed-free hydromulch containing a tackifier or straw mulch crimping. Alternate methods may be proposed by the revegetation and seeding contractor but will require prior written approval by ODOE and must provide demonstrated success in sites with similar wind and soil conditions.
- The Certificate Holder or a designated construction contractor will use mulching and other appropriate practices, as required by the anticipated NPDES 1200-C permit, to control erosion and sediment during construction and revegetation work.

4.4 Revegetation of Permanent Disturbance Areas

During construction, the Certificate Holder will implement site stabilization measures, including seeding of all disturbed areas according to the Certificate Holder’s anticipated NPDES 1200-C permit. Approximately 6 months prior to commercial operation of each phase of construction, the Certificate Holder will meet with ODFW, ODOE, and Morrow County Weed Department personnel to review the actual extent and conditions of disturbed areas and confirm the revegetation methods to be implemented.

As portions of the Facility are prepared for installation of Facility components (i.e., grading is complete), but prior to installation, all areas with less than 70 percent vegetative cover should be seeded with a non-invasive, non-persistent cover crop. The cover crop will be selected based on the time of year and site conditions; for example, winter wheat or sterile triticale can be seeded from fall to early spring, while peas should be seeded in spring. Tillage radish and sunflowers can be seeded in spring to break up compaction but are not suitable options for soil stability. A cover crop will stabilize soils and suppress noxious weed infestations to reduce erosion and facilitate revegetation of desired plant species.

Following the completion of each construction phase, permanent disturbance areas will be reseeded with a mix of native or non-invasive, non-native grasses and forbs as appropriate based on disturbance level and actual site conditions (see Section 4.4). All seeds will be obtained from a reputable supplier in compliance with the Oregon Seed Law (OAR 603-056). The final seed mix for permanent disturbance areas will include low growing grasses and pollinator-friendly forbs compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Table 3 in Section 4.7 includes an example of low-growing seed mix for permanent disturbance areas.

4.5 Revegetation of Temporary Disturbance Areas

4.5.1 Agricultural Lands

Temporarily disturbed agricultural lands will be reseeded with the appropriate crop or maintained as fallow in consultation with the landowner or farm operator. The Certificate Holder will consult with the landowner or farm operator to determine the seed mix, application methods, and rates for seed and fertilizer. Success of cropland revegetation will have been achieved when production of the revegetated area is comparable to that of adjacent, non-disturbed croplands of the same type.

Agricultural lands will be reseeded to match the timing of the crop rotation on adjacent cropland to facilitate easy harvest and re-establish the appropriate crop rotation. Agricultural lands that will be seeded in the year that construction is complete can be temporarily hydromulched or otherwise stabilized until seeding can occur in the fall; agricultural lands that will be fallow for a year (i.e., fallow rather than reseeded the year construction is complete) will be planted with a cover crop (dependent on timing of construction closeout) or have continued stabilization with hydromulch, straw mulch crimping, or other best management practices through the fallow year.

Soil compaction as a result of construction activity is a concern for restoring agricultural soils to their pre-construction productivity. Within temporary disturbance areas, the Certificate Holder will excavate and store topsoil separately from subsoil, so that topsoil is replaced and restored appropriately. During post-construction revegetation of temporary disturbance to agricultural lands, the Certificate Holder will loosen agricultural soil by mechanical scarification (tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction. Soil amendment, by addition of organic matter (e.g., compost), may also be necessary to alleviate compaction.

Success determination will involve consultation with the landowner or farm operator, and the Certificate Holder will report to ODOE on the success of agricultural land revegetation efforts. Noxious weed control is necessary for successful revegetation of agricultural lands and will be implemented per the methods described in the Draft Noxious Weed Control Plan (Exhibit P, Attachment P-3; updated for RFA 1, see Attachment 6).

4.5.2 Wildlife Habitat

There is no temporary disturbance to wildlife habitat because no wildlife habitat will be disturbed by Facility construction. Revegetation of wildlife habitat is not discussed in this Plan.

4.6 Seeding Methods

The seeding method and timing of planting will be appropriate to the seed mixes (see Section 4.7), weather conditions (e.g., precipitation, wind speed, temperature, etc.), and site conditions (including area size, slope, and erosion potential) based upon consultation with ODOE, ODA, ODFW, the Morrow County Weed Department, and the seed supplier. Seeding from late September to March is typically recommended; however, the Certificate Holder will consult with ODOE, ODFW,

ODA, Morrow County Weed Department, and/or the seed supplier to determine the optimal timing for seed application based on climatic conditions of the particular year when construction and revegetation efforts are implemented.

Common seed application methods that may be used for revegetation are broadcast seeding, drill seeding, imprint seeding, and hydroseeding; each of these are discussed further below. Other seeding methods may be proposed for review and approval prior to revegetation efforts.

4.6.1 Broadcast Seeding

Broadcast seeding is the application of seed directly to the ground surface. This method may be chosen for areas with shallow and rocky soils, and the type of broadcast spreader would depend on the size of the area to be seeded and the terrain. Broadcast seeding may be completed before or after panel and fence installation.

In this method, the seed mix is typically broadcast at a rate of 20 to 24 pounds pure live seed per acre, or twice the recommended rate for drill seeding; this rate may be adjusted depending on the recommendation of the actual seed supplier and agencies. When feasible, due to the seasonality of when planting can occur, the entire area will be seeded after grading is complete but before placement of Facility components, providing more flexibility in seed application. In those instances where seeding occurs prior to installation of components, follow-up seeding will occur in areas temporarily disturbed by installation and any areas that are deficient in vegetation from the first round of seeding. Immediately following seed application, hydromulch or certified weed-free straw would be applied. Broadcast seeding will not be employed if winds exceed 5 miles per hour. If certified weed-free straw is unavailable, the Certificate Holder or a designated construction contractor will identify a local source of straw. The local source of the straw will be approved by the county weed master and ODFW prior to purchase. This straw will either be crimped into the ground or applied with a tackifier.

4.6.2 Drill Seeding

Drill seeding can be used for larger areas with deeper soils and moderate to gentle terrain to accommodate mechanical equipment. This method provides the advantage of planting the seed at a uniform depth and may provide better soil to seed contact. Drill seeding plants seeds using an agricultural or range seed drill at a rate of 12 to 14 pounds pure live seed per acre, per discussions with a seed supplier and ODFW. The rate may be adjusted depending on the recommendations of the actual seed supplier. Drill seeding will be difficult after Facility components have been installed so it will primarily be used if seeding occurs after grading is complete but before components are installed or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.3 *Imprint Seeding*

Imprint seeding is a no-till drill seeding method used to restore grasslands in areas with low annual precipitation. Seeds will be sown at 20 to 24 pounds pure live seed per acre or according to application rates recommended by the seed supplier. The seeder consists of a heavy metal drum roller with V-shaped, angled teeth and a seed agitator box. The teeth create V-shaped troughs with a depth of 4-7 inches to collect rainwater. The rolling drum presses the seed into the soil, insuring good seed-to-soil contact. The troughs collect rainwater for seed germination and seedling growth. Imprint seeders can be used on steep slopes and generally do not require seed bed preparation before seeding. Seeding can occur on soils with light to moderate vegetative cover, with vegetation acting as a mulch to prevent soil erosion until seedlings are established. Imprint seeders do not work well in areas with shrubs or heavy vegetation cover. Heavily compacted soils may need to be ripped or de-compacted before seeding. Imprint seeding will be difficult after solar components have been installed, so it will primarily be used if seeding occurs after grading is complete but before components are installed, or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.4 *Hydroseeding*

Hydroseeding is a method of hydraulically applying seeds, stabilizers, and soil amendments to the surface of the soil. Hydroseeding is most applicable for areas where drill or broadcast seeding machinery cannot access; this usually includes steeper sloped or narrow terrain but can be used in all terrains. Hydroseeding is feasible after panel installation but before the Facility is fenced. Soil bed preparation is also crucial for growth success and frequently includes tracking perpendicular to the slope to create micro conditions for seed. Flat grading and compaction are not recommended. Seeding rates increase by 30 to 50 percent of broadcast seeding rates (i.e., 30 pounds pure live seed per acre) per consultation with the seed supplier and ODFW. Prior to hydroseeding the tackifier and fertilizer, if included, will be reviewed and approved in consultation with ODOE. Fertilizer should not be used when hydroseeding wildlife habitat.

4.7 Seed Mixes

Two seed mixes are proposed for revegetation efforts: one for revegetation of temporary disturbance areas outside the solar array fence, and one for revegetation of permanent disturbance areas within the solar array fence. Tables 2 and 3 present example seed mixes that would be considered for revegetation. However, the number of seed mixes and composition of final seed mixes will be determined in consultation with ODOE and ODFW and will be based on pre-construction conditions and availability of seed at the time of procurement.

Grassland Seed Mix #1 would be appropriate for revegetation of temporarily disturbed areas outside the solar array fence, with the exception of areas that would be returned to agricultural production following construction (as noted in Section 4.5.1). The example seed mix is presented in Table 2 and contains a mixture of native grasses and native, pollinator-friendly forbs. This seed mix includes a mixture of deep-rooted grasses and flowering plants as these types of species can

capture and filter stormwater, build topsoil, and provide food sources and for native insects (Davis 2021). Forbs included in this seed mix were also chosen based on their bloom period. Including plants that flower throughout the growing season provides a continuous source of nectar and pollen and can attract a variety of pollinators (NRCS 2011).

Table 2. Example Grassland Seed Mix #1

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Bluebunch wheatgrass[1]	*Pseudoroegneria spicata*	35
	Sandberg's bluegrass[2]	*Poa secunda* ssp. *secunda*	15
	Bottlebrush squirreltail	*Elymus elymoides*	10
	Needle-and-thread grass[3]	*Hesperostipa comata*	10
Forbs	Low gumweed	*Grindelia nana*	5
	Hoary aster	*Dieteria* (*Machaeranthera*) *canescens*	5
	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Munro's globemallow[4]	*Sphaeralcea munroana*	5
	Western blue flax	*Linum lewisii*	5
	Yarrow	*Achillea millefolium*	5

1. An alternative to bluebunch wheatgrass is Snake River wheatgrass (*Elymus wawawaiensis*; also sold as "Secar" bluebunch wheatgrass).
2. An alternative to Sandberg's bluegrass is big bluegrass (*Poa secunda* subsp. *juncifolia*; also sold as *P. ampla*).
3. Alternatives to needle-and-thread grass include the non-native bunchgrasses crested wheatgrass (*Agropyron cristatum*) and sheep/hard fescue (*Festuca ovina/F. trachyphylla*).
4. An alternative to Munro's globemallow is blanketflower (*Gaillardia aristata*)

A second grassland seed mix, Grassland Seed Mix #2, is suggested for post-construction revegetation within the solar array fence, including areas that previously consisted of agricultural lands. The example seed mix presented in Table 3 contains a mixture of low-growing native and non-native grasses and native and non-native pollinator friendly forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Similar to Grassland Seed Mix #1, this seed mix includes a mixture of deep-rooted grasses and flowering plants that flower throughout the growing season.

Table 3. Example Grassland Seed Mix #2

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Sandberg's bluegrass	*Poa secunda* ssp. *secunda*	35
	Bottlebrush squirreltail, common squirreltail	*Elymus elymoides* ssp. *elymoides*	15
	Desert fescue[1]	*Vulpia microstachys*	10
	Thurber's needlegrass	*Eriocoma (Achnatherum) thurberianum*	10

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Forbs	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Bigseed bisuitroot[2]	*Lomatium macrocarpum*	5
	Erigeron/fleabane	*Erigeron filifolius, E. linearis,* or *E. pumilus*	5
	Oregon sunshine	*Eriophyllum lanatum*	5
	Snow buckwheat	*Eriogonum niveum*	5
	Wollypod milkvetch	*Astragalus purshii*	5

1. Alternatives to desert fescue are sixweeks fescue (*Vulpia octoflora*) or sheep/hard fescue (*Festuca ovina*/*F. trachyphylla*).

2. An alternative to bigseed biscuitroot is longleaf phlox (*Phlox longifolia*).

4.8 Revegetation Methods by Disturbance Level

Revegetation methods for each disturbance level were developed to tailor revegetation to specific conditions (Table 4). Revegetation should follow soil reclamation, site preparation, and seeding methods described in Sections 4.2 through 4.7.

Table 4. Revegetation Methods by Disturbance Level

Disturbance Level	Soil Reclamation	Site Preparation	Seeding
1 – Mowing	Ensure vegetation remains intact.	Retain existing vegetation root systems to prevent erosion. Control weeds.	Seed if necessary to achieve success criteria
2 – Overland Drive and Crush	Measure soil compaction in areas of high vehicle traffic.	Retain existing vegetation root systems and/or mulch to prevent erosion. Decompact soil in areas of high vehicle traffic if necessary. Control weeds.	Seed if necessary to achieve success criteria
3 – Clear and Cut	Measure soil compaction.	Mulch to prevent erosion. Decompact soil if necessary. Control weeds.	Required
4 – Clear and Cut with Soil Removal	Measure soil compaction. Stockpile topsoil separately from subsoil and stabilize during construction.	Mulch to prevent erosion. Decompact soil. Regrade and replace subsoil then topsoil prior to seeding. Control weeds.	Required

5.0 Revegetation Documentation

Records will be kept of revegetation efforts in all temporary and permanent disturbance areas. Records will include:

- Date construction phase was completed;
- Acreage of each disturbance level;
- Description and photos of the affected area;
- Date revegetation was initiated;
- Description of the revegetation effort, including methods and timing;
- Supporting figures representing the location, acres affected, and pre-disturbance condition of the revegetation area; and
- Confirmation from the landowner that temporary disturbance in cropland have been satisfactorily restored.

The Certificate Holder will meet with ODOE at least 14 days prior to initiation of revegetation efforts. The Certificate Holder will update ODOE with these records monthly as revegetation work occurs and will provide ODOE with copies of these records along with submission of the monitoring report that is required by the Site Certificate.

6.0 Monitoring

6.1 Monitoring of Permanent Disturbance Areas

In accordance with the Certificate Holder's anticipated NPDES 1200-C permit all areas within the solar array fence must be revegetated to stabilize soils for the purposes of erosion and dust pollution control. Pursuant to OAR 345-022-0022, construction and operation of the Facility must not result in significant adverse impacts to soils, including but not limited to, erosion. Pursuant to MCZO 3.010.K.3.f.(3), construction or maintenance activities shall not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. Therefore, monitoring is required to demonstrate compliance with the above site stabilization and weed control requirements. The Certificate Holder will monitor permanent disturbance areas to assess the following:

- Dominant species composition;
- Relative cover of desirable and undesirable forbs and grasses;
- Percent cover of bare soil;
- Degree of erosion;
- Presence noxious weeds; and

- Qualitative assessment of overall vigor of vegetation within revegetated areas.

Monitoring will be conducted by a qualified botanist or revegetation specialist and will begin within 60 days of the completion of initial site revegetation. Permanent disturbance areas will be monitored using a meander survey. During the meander survey, the surveyor will walk within the solar array fence and document the assessment items listed above using photos and spatial data collection. Areas of erosion and significant patches of bare soil will be mapped and photographed. The surveyor will record dominant species, overall percent cover of forbs and grasses, and general notes about plant vigor.

Monitoring will be conducted at least once per season during the first year following construction. After the first complete year of monitoring, the Certificate Holder will consult with ODOE to determine if the monitoring cycle can be reduced based on revegetation progress. After five years of monitoring, the Certificate Holder will design a long-term monitoring plan in consultation with ODOE.

6.1.1 Success Criteria

Success criteria outlined below will demonstrate compliance with the soil protection standard (OAR 345-022-0022); NPDES 1200-C permit requirements; and the requirements of MCZO 3.010.K.3.f.(4):

- Establish uniform (i.e., evenly distributed, without large bare areas) perennial, non-invasive vegetation that provides 70 percent or more cover on all exposed areas.

Requirements of the soil protection standard and MCZO 3.010.K.3.f.(4) apply to the construction and operation of the Facility. Therefore, the Certificate Holder shall maintain compliance with revegetation success criteria for all areas within the solar array fence for the life of the Facility. In each monitoring report, the Certificate Holder will include an assessment of whether the area within the solar array fence is meeting or trending toward meeting the revegetation success criteria. Final determination of whether the Certificate Holder is in compliance with the revegetation obligations will be made by ODOE. Remedial actions and/or additional monitoring for areas may be required in areas that have been determined by ODOE not to have met the success criteria.

6.1.2 Reporting

Monitoring reports will be prepared and submitted to ODOE once per season during the first year following construction. After the first year of monitoring is complete, the reporting cycle will be modified to align with the new monitoring cycle determined in consultation with ODOE. The first monitoring report will include a detailed description and timeline of revegetation methods that were implemented including species, amounts, and locations of seed applications and dates revegetation work was performed.

Each monitoring report will include:

- GIS maps of revegetation areas and disturbance levels;
- Monitoring methods;
- Local climatic data (i.e., precipitation, temperature) for the monitoring month and year and percent deviation from the historical average;
- Results of monitoring efforts;
- The investigator's assessment of whether the revegetated areas are trending toward meeting the success criteria;
- Assessments of factors impacting the ability of revegetated area to trend towards meeting the success criteria; and
- Recommendations for adaptive management, if any.

6.2 Monitoring of Temporary Disturbance Areas

Per ODFW recommendations on other projects, temporary disturbance monitoring is not required for temporary disturbance areas less than 0.5 acres or when the area is not sufficiently large to accommodate a monitoring site. Because there are no non-agricultural habitat types with temporary disturbance areas greater than 0.5 acres, no monitoring or reference sites will be established for this Facility.

6.3 Adaptive Management

After each revegetation monitoring visit in either temporary or permanent disturbance areas, the Certificate Holder's qualified investigator will report to the Certificate Holder regarding the revegetation progress of each revegetation area. If applicable, the investigator will make recommendations to the Certificate Holder for reseeding, weed control, or other remedial measures for areas that are not showing progress toward achieving revegetation success. The investigator will provide a description of factors that may be contributing to the lack of revegetation success. The Certificate Holder will include the investigator's recommendations for adaptive management and the measures taken in the next monitoring report. ODOE may require reseeding or other remedial measures in cases where success criteria have not been met.

If a revegetation area is damaged by wildfire during the first 5 years following initial seeding, the Certificate Holder will amend this Plan, subject to ODOE approval, to restore the damaged area. The Certificate Holder will continue to monitor and report on revegetation progress during the remainder of the 5-year period. The Certificate Holder will report to ODOE and ODFW the area impacted by the fire (with a map or figure) within 72 hours of discovery.

6.4 Soil Reclamation Monitoring

Soil measurements conducted per Section 4.2 shall be evaluated to determine whether soils within disturbance areas have compaction readings of greater than 300 psi. If results show soils have compaction readings of greater than 300 psi, then remediation activities must be completed before revegetation can begin. Prior to initiation of revegetation, the Certificate Holder will provide the results of soil compaction testing to ODOE.

7.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

8.0 References

Davis, R. 2021. Global buzz for solar with pollinators and beekeeping. Fresh Energy, Center for Pollinators in Energy. Available at: https://fresh-energy.org/solar-beekeeping-goes-global

Mosley, J. 2018. Targeted Livestock Grazing to Suppress Cheatgrass. Department of Animal and Range Sciences, Montana State University. November. Available at: https://www.montana.edu/extension/sanders/Prescription%20for%20Cheatgrass%20November%2025%202018.pdf

NRCS (Natural Resources Conservation Service). 2011. Plants for Pollinators in the Inland Northwest. U.S.D.A Natural Resources Conservation Service, Spokane, Washington – Boise, Idaho.

Figure

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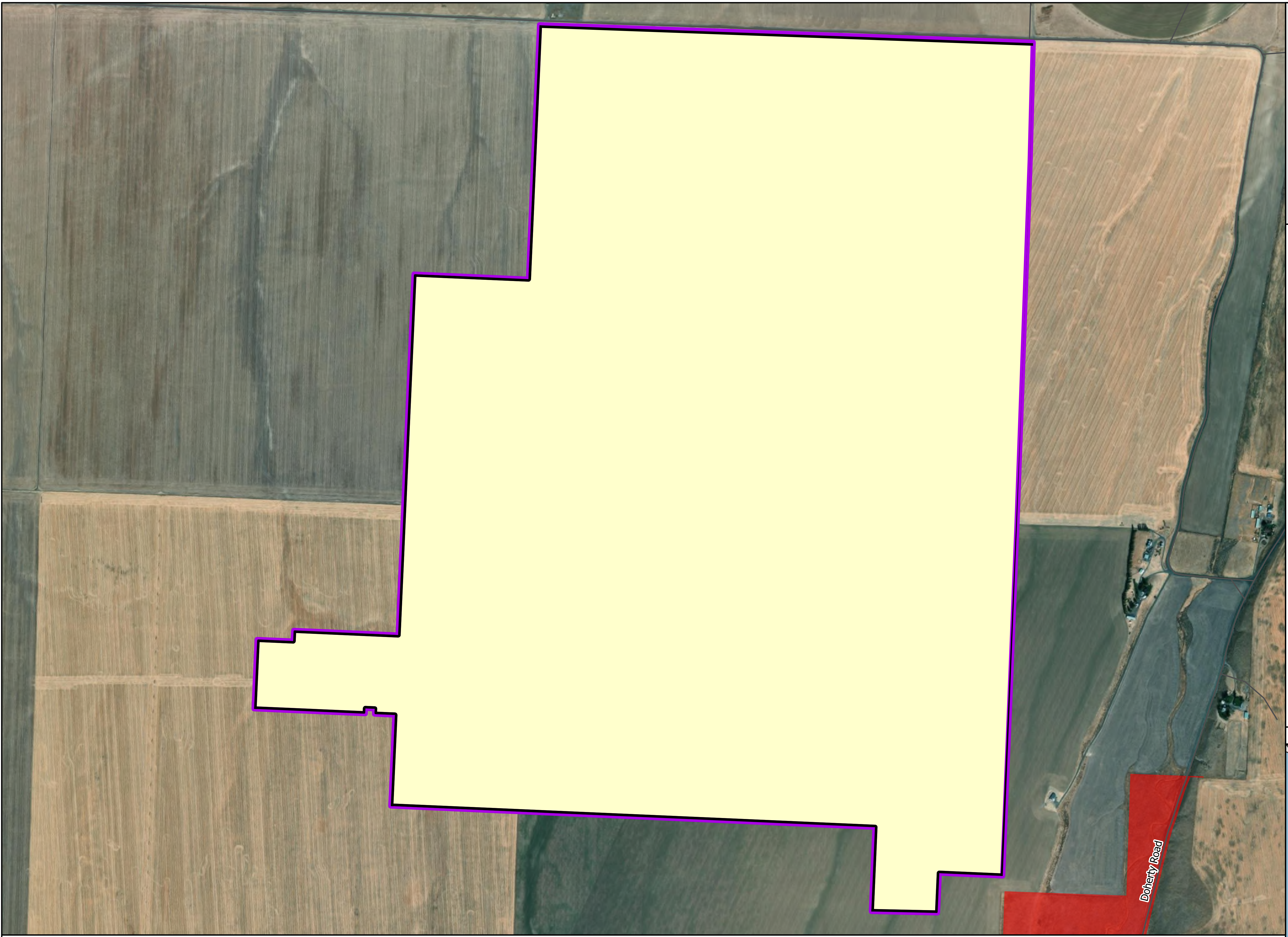
Sunstone Solar Project

Figure 1
Sunstone Solar Project 4

MORROW COUNTY, OR



- 🟪 SS 4 Site Boundary
- ☐ Permitted Fenceline
- 🟥 Excluded from Development
- — Local Roads

Habitat Subtypes by Category

Category 4
- 🟪 Intermittent or Ephemeral Stream

Category 6
- 🟨 Orchards, Vineyards, Wheat Fields, Other Row Crop

TETRA TECH

PINEGATE RENEWABLES

Reference Map

N

1:12,000

WGS 1984 UTM Zone 11N

NOT FOR CONSTRUCTION

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Sunstone Solar Project 4
Draft Wildlife Monitoring Plan

Prepared for

PINEGATE RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 4, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

Table of Contents

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1.0 Introduction

Sunstone Solar 4, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 4 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities and the anticipated phasing of construction are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Wildlife Monitoring Plan (WMP) describes wildlife monitoring the Certificate Holder will conduct during operation of the Facility. This WMP has the following components:

1. Raptor nest surveys
2. Washington ground squirrel (WAGS; *Urocitellus washingtoni)* monitoring
3. Wildlife Reporting and Handling System (WRHS)
4. Data reporting

This WMP will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE) and the Oregon Department of Fish and Wildlife (ODFW) and will be updated as needed to reflect the final layout of the Facility.

2.0 Raptor Nest Surveys

The objectives of raptor nest surveys are: (1) to count raptor nests on the ground or above ground at the Facility; and (2) to determine whether there are noticeable changes in nesting activity in the local populations of raptor species, with particular focus on Swainson's hawks (*Buteo swainsoni*), the only state sensitive raptor species documented nesting during baseline surveys.

The Certificate Holder will conduct long-term ground-based monitoring of nests identified during the baseline raptor nest surveys, as well as any other nests identified subsequently. The ground-based surveys will be used to evaluate nest success by gathering data on nest occupancy. The Certificate Holder will employ qualified personnel to perform raptor nest surveys.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

2.1 Initial Monitoring

The first monitoring season will be in the first full raptor nesting season after the commercial operating date. During the first monitoring season, the surveyor will conduct one ground survey for raptor nests in late May or early June and additional surveys as described in this section. The ground surveys will be conducted within the site boundary to determine nest occupancy.

All nests discovered during the anticipated pre-construction surveys and any nests discovered during post-construction surveys, whether active or inactive, will be given identification numbers. Global Positioning System (GPS) coordinates will be recorded for each nest. Locations of inactive nests will be recorded because they could become occupied during future years.

After the first monitoring season, the surveyor will analyze this one year of data compared to the baseline data. The Certificate Holder will provide a summary of the first-year results in the monitoring report described in Section 5.0.

2.2 Long-Term Monitoring

The surveyor will conduct raptor nest surveys at 5-year intervals for the life of the Facility.[2] The surveyor will conduct long-term raptor nest surveys following the methods described in Section 2.3 every 5 years after the first monitoring season in years divisible by 5. This may result in a greater than 5-year period between the initial monitoring season and the first long-term monitoring season (e.g., if the initial monitoring season is 2028, the first long-term monitoring season would be 2035 rather than 2033). During each long-term monitoring event biologists will visit all previously identified nest locations in addition to searching the survey area for new nest sites.

In conducting long-term surveys, the surveyor will follow the same survey protocols as the initial survey (Section 2.3), unless the Certificate Holder proposes alternative protocols that are approved by ODOE. In developing an alternative protocol, the Certificate Holder will consult with ODFW and ODOE and will take into consideration other raptor nest monitoring conducted in adjacent or overlapping areas.

The Certificate Holder will analyze the data to identify any trends in the number of raptor breeding attempts the Facility supports and the success of those attempts. The Certificate Holder will submit a report after each year of long-term raptor nest surveys.

2.3 Monitoring Protocol

Qualifications of surveyors: Surveys and nest monitoring will be conducted by professional, qualified biologists with a relevant academic background and sufficient field experience pertaining to avian biology and species identification.

Survey period: Occupancy surveys will be conducted between March 1 and May 31. The survey period may be extended in consultation with ODFW and ODOE.

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[2] As used in this plan, "life of the Facility" means continuously until the Facility is restored and the site certificate is terminated in accordance with OAR 345-027-0110.

Survey area: The survey area will be limited to leased parcels within the Site Boundary, where surveyor access is granted. Surveys will be performed from public roads and project roads, or from participating landowner parcels only, as site conditions safely permit (e.g. snow, mud).

Survey protocol: Biologists will conduct a ground-based search for raptor nest activity using binoculars and/or spotting scopes to search potential nest sites. Previously identified nests will be surveyed to determine the occupancy status of nests. New nests that are discovered will also be surveyed and visited in future monitoring years. A log will be kept to track nest occupancy status on all nests. ArcGIS Online or similar GIS program will be used to locate and track the nests.

Data collection: Data collected during the survey will include, at a minimum, the location, occupancy status, occupying species, activity observed, and condition of each nest.

Nest Location: Nest/Burrow Identification Number: Existing IDs will be used where possible in addition to corresponding GPS waypoint numbers.

Occupying Species: Using four-letter American Ornithologists' Union codes (e.g., SWHA = Swainson's hawk).

Raptor Activity:

- Adult Present: Proximity of the adult to the nest (e.g., on nest, nearby, or unknown).
- Eggs or Young: Number of eggs or young observed.
- Nest Substrate: Structure in which nest was located (e.g., broadleaf tree, cut bank, transmission pole, etc.).
- Nest Height: Height relative to the structure it is on (e.g., on top of transmission pole, 3/4 of height of tree).

Nest Condition: To assess nest condition the following criteria will be used:

- No Longer Present: For nests that are no longer present.
- Unknown: The nest cannot be found, was not surveyed, or the nest is present, but because of its location a determination cannot be made.
- Excellent: Defined cup or nest bowl with a well-maintained rim; adult or young present.
- Good: Nest bowl intact and rim defined; minor repair needed for nest to be used; margins of nest in loose configuration, minor slumping occurring.
- Fair: Nest bowl intact and nest not dilapidated; but needs significant repair in order to be used; material is slumping or sliding.
- Poor: Loose structure of nest bowl still present; nest walls and side falling out; nest is in need of major repair to be used.
- Remnant: Nest bowl not defined; scant material remaining and not usable unless fully rebuilt.

Determination of active nests: Nest occupancy status will be determined using the definitions below.

Active: Defined by the presence of one or more eggs, dependent young, or adults on the nest in the past 10 days during the breeding season, including the period when adults are displaying courtship behaviors and are building or adding to the nest in preparation for egg-laying.

Potentially Active: There is not observable activity during the visit, but active status cannot be confirmed.

Inactive: The inactive status will only be determined if the nest is observed for at least one hour each time over the course of two consecutive visits separated by at least one day.

3.0 Washington Ground Squirrel Monitoring

No WAGS were detected during baseline surveys, but any new colonies that are detected incidentally during other surveys, such as raptor nest monitoring, will be documented and the extent of those colonies delineated and included in future WAGS monitoring and reporting activities.

If any incidental WAGS are detected, the Certificate Holder will employ qualified personnel to monitor these locations every 5 years thereafter in years divisible by five for the life of the Facility (i.e., on the same monitoring schedule as the raptor nest surveys). The survey area will include the colonies (i.e., groups of active burrows) and a buffer of 785 feet in suitable habitat, if accessible. The surveyors will walk linear transects spaced 165 to 230 feet (50 to 70 meters) apart two times between February 15 and May 31. Surveys of each location will be spaced at least 2 weeks apart. Surveyors will record locations of activity centers and colony boundaries using a sub-meter accuracy GPS unit; approximate number of burrows; and representative photographs of burrows and scat. Surveyors will describe habitat characteristics at each location and note any noticeable land use or habitat changes that may have occurred since detection.

After each survey, the Certificate Holder will report the results to ODFW and ODOE and will include maps of the areas surveyed and detection locations. WAGS surveys will not be conducted if there are barriers to WAGS dispersal (i.e., active agriculture fields, highways, perennial waterbodies) or no suitable habitat.

4.0 Wildlife Reporting and Handling System

The Certificate Holder will document fatalities found during routine maintenance activities and any other incidentally detected fatalities. However, systematic post-construction fatality monitoring studies are not likely to produce significant findings or provide meaningful data on impacts based on the attributes of this Facility (especially relative to the costs that they incur to implement) as described below, and therefore no systematic post-construction fatality monitoring study is proposed for the Facility nor is one needed to meet the standards under Oregon Administrative Rule (OAR) 345-022-0060. In a December 2023 meeting with the Certificate Holder and ODOE, ODFW stated they are not requesting a post-construction fatality monitoring study for the Facility. If evidence of significant fatality events is detected by operations and maintenance (O&M) staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring and adaptive management.

Although mortality at the Facility due to collision with infrastructure is possible, as it is with most human development (e.g., buildings), the available literature on avian mortality at utility-scale photovoltaic solar energy sites suggests that mortality at these facilities is comparatively low (Walston et al. 2016, Loss et al. 2014, Kosciuch et al. 2020, Smith et al. 2021). In Oregon, results of a fatality study at a 56-MW photovoltaic facility near Prineville detected only three bird fatalities, only two of which were native birds (i.e., a horned lark [*Eremophila alpestris*] and a dark-eyed junco [*Junco hyemalis*]), during 1 year of standardized searches (ODOE 2020). These results suggest that large fatality events are unlikely at photovoltaic solar facilities in the region but that low numbers of fatalities of common ground-dwelling bird species could be detected at the Facility (ODOE 2020), and may be similar to background mortality levels. Post-construction fatality monitoring studies conducted at utility-scale photovoltaic solar facilities to date have reported lower fatality rates compared to other human development types, with fatalities in general primarily composed of resident ground-nesting birds.

In contrast to wind energy development, impacts to wildlife from photovoltaic solar development are primarily associated with habitat loss rather than direct mortality from collisions. The Facility is located almost entirely on wheat fields, and impacts to wildlife habitat will be minimal, restricted primarily to small tracts of disturbed grasslands. This habitat will be mitigated in accordance with ODFW's Habitat Mitigation Policy (OAR 635-415-0025), as described in the Facility's Exhibit P and Habitat Mitigation Plan (Attachment P-2 to Exhibit P; updated for RFA 1, see Attachment 6). The Certificate Holder will adhere to standard best management practices including following Avian Powerline Interaction Committee guidelines for minimizing avian collisions and electrocutions (APLIC 2006, 2012), primarily burying the medium voltage collector line system, and implementing down-shield lighting for permanent lighting at the substations and O&M buildings, and identifying a licensed local wildlife rehabilitator capable of responding to the Facility in the event of injured wildlife. Based on coordination with ODFW, the Certificate Holder will additionally install flight diverters on the overhead collector line that crosses Sand Hollow. The Certificate Holder will use wildlife-friendly fencing that does not include a top strand. Thus, the Facility has already minimized the risk of avian collision fatalities, based on known risk factors such as lighting (Gehring et al. 2009; Kerlinger et al. 2010; USFWS 2012, 2013).

Additionally, post-construction fatality monitoring is not necessary for the Certificate Holder to meet the standards under OAR 345-022-0060 (i.e., that the design, construction and operation of the facility, taking into account mitigation, are consistent with the general fish and wildlife habitat mitigation goals and standards of OAR 635-415-0025, ODFW's Fish and Wildlife Habitat Mitigation Policy) because the mitigation goals and standards relate to fish and wildlife habitat quality and quantity rather than fatalities of fish and wildlife individuals. OAR 635-415-0025 goals and standards for impacts to Category 2, 3, 4, and 5 habitat (i.e., the habitat categories addressed in the Facility's Habitat Mitigation Plan) include avoidance and, where impacts are unavoidable, mitigation to achieve the goal of no net loss of either habitat quantity or quality (Category 2, 3 and 4 habitat) and/or a net benefit in habitat quantity or quality (Category 2 and 5 habitat). Fatality monitoring, in itself, does not improve or maintain habitat quantity or quality, nor would the results of monitoring affect the habitat mitigation ratios or the size of the mitigation need described in the

Facility's Habitat Mitigation Plan attached to Exhibit P and Attachment 6 for RFA 1. Therefore, a systematic post-construction fatality monitoring study is not necessary for the Energy Facility Siting Council (EFSC) to determine that the Facility is consistent with OAR 635-415-0025

Although standardized fatality searches will not be implemented, all incidentally detected fatalities will be reported in the WRHS. The WRHS is a program for O&M staff to report wildlife (including bird and bat) casualties found during operation of the Facility. O&M staff will be trained in the methods needed to carry out this program. This monitoring program includes the initial response, handling, and reporting of bird and bat carcasses discovered incidental to maintenance operations ("incidental finds"). Approximately 10 permanent O&M staff are anticipated to be on-site for Facility operations and be responsible for WRHS program implementation. If a battery energy storage system is installed, additional workers will be on-site, but they will likely be contract employees and will not be included in WRHS program implementation. As part of routine O&M activities, O&M staff will visit each inverter pad approximately every 6 months to visually inspect equipment. If evidence of significant fatality events is detected by O&M staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring.

All carcasses discovered by O&M staff will be photographed and recorded. If O&M staff find a carcass at the Facility, they will notify qualified personnel who will identify the carcass. If the qualified personnel determines that a carcass is a state or federally threatened or endangered or otherwise protected species, agency reporting procedures and timelines specified in Section 5.0 shall be followed. Information recorded for each carcass and reported to ODFW and ODOE will include the location, date of discovery, species if known, as well as any evidence that might assist in determination of cause of death, such as evidence of electrocution, vehicular strike, wire strike, predation, or disease. Based on coordination with ODFW, feather spots[3] will be documented if found as well, consistent with industry standards; however, feather spots will not necessarily be attributed to a Facility-caused fatality (personal communication with J. Thompson, ODFW, December 13, 2023). Fatalities documented by O&M staff will be reported to ODOE and ODFW annually, as described in Section 5.0.

Prior to construction, the Certificate Holder will develop and implement a protocol for handling injured birds. Any injured native birds found at the Facility may be carefully captured by trained qualified personnel and transported to a qualified rehabilitation specialist approved by ODOE. Alternatively, the Certificate Holder may contact a qualified rehabilitation specialist approved by ODOE to respond to injured wildlife. Blue Mountain Wildlife (https://bluemountainwildlife.org/, 541.278.0215), located in Pendleton, Oregon, has confirmed the ability to respond to injured native wildlife, especially migratory birds, at the Facility (Lynn Tompkins, personal communication, April 11, 2023). The Certificate Holder will pay costs, if any, charged for time and expenses related to care and rehabilitation of injured native birds found on the site, unless the cause of injury is clearly demonstrated to be unrelated to Facility operations.

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[3] Feather spots are defined as at least 5 tail feathers, or 2 primary feathers, or a total of at least 10 feathers with no attached bone or tissue, within 5 meters of each other (CEC and CDFG 2007).

5.0 Data Reporting

The Certificate Holder will report wildlife monitoring methods, data, and data analysis to ODOE for each calendar year in which wildlife monitoring occurs. Monitoring data include raptor nest survey data, WAGS monitoring data (if applicable), and WRHS data. The Certificate Holder may include the reporting of wildlife monitoring data and analysis in the annual report required under OAR 345-026-0080 or submit this information as a separate document at the same time the annual report is submitted. In addition, the Certificate Holder will provide to ODOE data or records generated in carrying out this WMP upon request by ODOE.

The Certificate Holder will notify the U.S. Fish and Wildlife Service and ODFW if any federal or state endangered or threatened species are killed or injured at the Facility within 24 hours of species identification.

6.0 Plan Amendment

This WMP may be amended from time to time by agreement of the Certificate Holder and EFSC. Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this WMP. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

7.0 References

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Inadvertent Discovery Plan

Sunstone Solar Project 4
Morrow County, Oregon

October 2025

Author:
Lara Rooke, MA, RPA

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

130 Roberts Street
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TETRA TECH

1.0 INTRODUCTION

Pine Gate Renewables (PGR) proposes to construct and operate the approved Sunstone Solar Project 4 (Facility), a solar energy generation facility with related or supporting facilities including an energy storage system on private lands in Morrow County, Oregon. PGR seeks a Site Certificate through the Oregon Department of Energy (ODOE), Oregon Energy Facility Siting Council (EFSC or Council) for the Facility. The Facility will include an up to 200-megawatt (MW) solar project, battery energy storage system, and related or supporting facilities in Morrow County, Oregon. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1). The approved solar facility siting area (Facility site boundary) is located on privately owned agricultural land with areas of sage brush near the drainages and along Sand Hollow Canyon.

To meet the requirements for site certification, PGR must develop an Inadvertent Discovery Plan (IDP) for monitoring construction activities and responding to the discovery of archaeological resources or buried human remains.

2.0 CULTURAL RESOURCES IN THE PROJECT AREA

The entirety of the Facility site boundary and a 2-mile viewshed was surveyed for cultural resources, including pedestrian surveys along with subsurface shovel probing within the Facility site boundary. One Historic Property of Religious or Cultural Significance to Indian Tribes (HPRCSIT), Sand Hollow Battleground, is identified in the Oregon State Historic Preservation Office’s (SHPO) archaeological database as overlapping a portion of the Facility site boundary. The HPRCSITs are eligible for listing on the NRHP.

Due to the presence of two culturally important resource areas to the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) within the Facility site boundary and its viewshed, the CTUIR has recommended monitoring to protect potential HPRCSIT-associated subsurface resources. The CTUIR has recommended that monitoring occur in the following areas:

- Within the HPRCSIT boundaries and a 100-foot surrounding buffer area, monitoring should occur for all ground disturbing activities, except driving posts for the solar modules; and
- Monitoring should occur within the Facility site boundary for all excavation work related to the proposed 3-foot-deep collector cable system.

Prior to construction, PGR will develop a Monitoring Plan that incorporates this IDP and includes necessary staff, agency, and tribal contact information once determined. This plan should include monitoring protocols and staffing roles and incorporate input from the CTUIR.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

3.0 PROCEDURES FOR THE DISCOVERY OF ARCHAEOLOGICAL RESOURCES

If any staff, contractors, or subcontractors, including archaeological and/or tribal monitors, believe that they have encountered cultural or archaeological remains of any kind, all work at and adjacent to the discovery shall immediately cease. The area of work stoppage will be adequate to provide for the security, protection, and integrity of the archaeological discovery. A cultural resource discovery may be pre-contact period or historic period in age and consist of (but not limited to):

- Areas of charcoal or charcoal-stained soil and stones;
- Stone tools or waste flakes (i.e., an arrowhead or stone chips);
- Bone, burned rock, or shell, whether or not seen in association with stone tools or chips;
- Clusters of tin cans, ceramics, flat glass, or bottles; and
- Concentrations of brick, railway tracks, or logging or agricultural equipment.

In the event unrecorded archaeological resources are identified during the construction or operation of the Sunstone Solar Project 4, work within 100 feet of the find shall be halted and directed away from the discovery until a Qualified Archaeologist[2] assesses the resource and its significance for inclusion on the NRHP. This assessment will include coordination with the CTUIR. (A wider avoidance area will be required for human remains; see below.) The archaeologist, in coordination with ODOE, the SHPO, Facility personnel, CTUIR, and the landowner, shall make the necessary plans for treatment of the finds and for the evaluation and mitigation of impacts if the finds are found to be eligible for listing on the NRHP.

A Qualified Archaeologist will determine if the resources are archaeological and greater than 50 years old. If the archaeologist believes that the discovery is a cultural resource, he or she in coordination with the PGR Construction Manager will establish a 100-foot avoidance buffer to protect the discovery site where construction activities will be suspended until treatment of the discovery can be determined. Vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery site or avoidance area. Any newly discovered archaeological resource will be considered eligible to the NRHP until determined otherwise. Work in the immediate area will not resume until treatment of the discovery has been completed.

If archaeological artifacts are observed during construction, the Qualified Archaeologist will ensure proper documentation and assessment of any discovered cultural resources. All precontact and historic cultural material discovered during project construction will be recorded by the archaeologist in SHPO's online archaeological site form database. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/sediment descriptions will be prepared for subsurface exposure. Discovery locations will be documented on scaled site plans and site location maps.

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[2] *Qualified Archaeologist* - means a person with qualifications meeting the federal secretary of the interior's standards for a Professional Archaeologist . An individual who has: (A) A post-graduate degree in archaeology, anthropology, history, classics or other germane discipline with a specialization in archaeology, or a documented equivalency of such a degree; (B) Twelve weeks of supervised experience in basic archaeological field research, including both survey and excavation and four weeks of laboratory analysis or curating; and (C) Has designed and executed an archaeological study, as evidenced by a Master of Arts or Master of Science thesis, or report equivalent in scope and quality, dealing with archaeological field research.

If the Qualified Archaeologist in consultation with the SHPO and CTUIR determines that the discovery is an NRHP-eligible cultural resource, they will consult to determine appropriate treatment to be presented and agreed upon in a Memorandum of Agreement (MOA) or other appropriate documentation. Mitigation measures will be developed in consultation with PGR, ODOE, SHPO, CTUIR, and the landowner, and could include avoidance through redesign, conducting data recovery, and/or relocating materials. Treatment measures performed may include protecting in place or data recovery such as mapping, photography, limited probing, and sample collection, or other activity deemed appropriate through an MOA or other appropriate documentation.

If human remains are inadvertently discovered, ODOE, SHPO, the Legislative Commission on Indian Services (LCIS), and CTUIR will decide when construction may continue at the discovery location. Where cultural resources are encountered during construction, but additional project effects to the resources are not anticipated, Facility construction may continue while documentation and assessment of the cultural resources proceed. If continued construction is likely to cause additional impacts to such resources, Facility activities within a radius of 100 feet of the discovery will cease until the Qualified Archaeologist has documented the site, evaluated its significance in consultation with CTUIR, and assessed potential effects to the site.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the discovery of the cultural resource, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 100 foot buffer—work may continue outside of this buffer.
3) Notify PGR Project Manager and ODOE (see Attachment A).
4) Construction Manager will need to contact a Qualified Archaeologist to assess the find.
5) If archaeologist determines the find is an archaeological site or object, contact SHPO. If it is determined to *not* be archaeological, you may continue work.

4.0 PROCEDURES FOR THE DISCOVERY OF HUMAN REMAINS

If human remains and/or associated grave goods are inadvertently encountered during Project activities, the Oregon State legislature protocol[3] for inadvertent discovery of human remains will be followed (Oregon State Legislature 2025). All activity that may cause further disturbance to the remains shall cease and the area secured and protected from further disturbance. A 200-foot avoidance buffer will be utilized for human remains and associated grave goods until appropriate

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[3] https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

treatment is completed. The presence of skeletal remains will be immediately reported to the County Medical Examiner, Oregon State Police, SHPO, and LCIS. The remains will not be touched, moved, or further disturbed. The County Medical Examiner or LCIS State Physical Anthropologist will assume jurisdiction over the human skeletal remains and determine whether those remains are forensic or non-forensic. If the remains are non-forensic, then they will report that finding to SHPO and the State Physical Anthropologist with the LCIS, who will then take jurisdiction over the remains and will notify CTUIR.

Although excavation work in the immediate area of a human remains find will not resume until assessment has been completed, excavation work may continue in other parts of the Facility that have been surveyed for cultural resources. Due to the sensitive nature of such a find, human remains should never be left unattended. No work will resume in the area of a human remains discovery until written authorization has been received from the LCIS and SHPO.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.

2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the inadvertent discovery, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 60-meter/200-foot buffer, then work may continue outside of this buffer with caution.

3) Cover remains from view and protect them from damage or exposure, restrict access, and leave in place until directed otherwise. Do not take photographs. Do not speak to the media.

4) Notify (refer to Attachment A for contact information):
    - PGR Project Manager
    - ODOE
    - Oregon State Police **DO NOT CALL 911**
    - SHPO
    - LCIS State Physical Anthropologist
    - CTUIR and other appropriate Native American Tribes determined by LCIS

5) If the site is determined not to be a crime scene by the Oregon State Police, do not move anything! The remains will continue to be secured in place along with any associated funerary objects, and protected from weather, water runoff, and shielded from view.

6) Do not resume any work in the buffered area until a plan is developed and carried out between ODOE, SHPO, LCIS, and appropriate Native American Tribes and you are directed that work may proceed.

5.0 CONFIDENTIALITY

The Facility and employees shall make their best efforts, in accordance with federal and state law, to ensure that its personnel and contractors keep the discovery confidential. The media, or any third-party member or members of the public are not to be contacted or have information regarding the discovery, and any public or media inquiry is to be reported to ODOE. Prior to any release, the responsible agencies and Tribes shall concur on the amount of information, if any, to be released to the public.

To protect fragile, vulnerable, or threatened sites, the National Historic Preservation Act, as amended (Section 304 [16 U.S.C. 470s-3]), and Oregon State law (Oregon Revised Statute 192.501(11)) establishes that the location of archaeological sites, both on land and underwater, shall be confidential.

6.0 REFERENCES

Oregon State Legislature

2025 Electronic document accessed July 2025, https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

ATTACHMENT A: CONTACTS

1. Pine Gate Renewables

Project Manager	To be determined prior to construction

2. Cultural Resource Contacts

Qualified Archaeologist	Lara Rooke, Tetra Tech (425) 217 7625 (Cell)
Oregon SHPO State Archaeologist	John Pouley (503) 480-9164
State Physical Anthropologist, LCIS	Dr. Elissa Bullion (971) 707-1372 or (503) 986-1067

3. Agency Contacts

ODOE	Christopher Clark (503) 871-7254
Oregon State Police	Craig Heuberger (503) 731-0079 or (503) 731-3030 (dispatch)
Morrow County Medical Examiner	(541) 676-5421

4. Tribal Contacts

CTUIR	Teara Farrow Ferman (Human Remains) (541) 429-7230 or (541) 377-2959 (cell) Ashley Morton (Archaeological Resources) (541) 429-7214

Sunstone Solar Project 4

Draft Construction Wildfire Mitigation Plan

Sunstone Solar Project 4
October 2025

Prepared for

Sunstone Solar 4, LLC

Prepared by

Tetra Tech, Inc.

Table of Contents

List of Tables

Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 4, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
EMP	Emergency Management Plan
Facility	Sunstone Solar Project 4
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 4, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 4 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) is attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described in this plan, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final Construction WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.
[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During construction, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to construction of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115, if significantly different from Final Order on ASC and the Request for Amendment 1.

4.0 Inspection and Management

OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;

4.1 Vegetation Management

The Certificate Holder and contractor(s) will maintain vegetation within the Site Boundary and will also maintain a defensible space clearance along Facility features. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

The following best management practices to minimize fire risk from vehicle travel and fueling activities would be implemented at the site during construction:

- The movement of vehicles will be planned and managed to minimize fire risk.
- The contractor(s) will be responsible for identifying and marking paths for all off-road vehicle travel. All off-road vehicle travel will be required to stay on the identified paths. No off-road vehicle travel will be permitted while working alone. Travel off road or parking in vegetated areas will be restricted during fire season.
- Areas with grass that are as tall or taller than the exhaust system of a vehicle must be wetted before vehicles travel through it.
- Workers will be instructed to shut off the engine of any vehicle that gets stuck, and periodically inspect the area adjacent to the exhaust system for evidence of ignition of vegetation. Stuck vehicles will be pulled out rather than "rocked" free and the area will be inspected again after the vehicle has been moved.
- All combustion engines (including but not limited to off road vehicles, chainsaws, and generators) will be equipped with a spark arrester that meets U.S. Forest Service Standard 5100-1.
- The contractor(s) will designate a location for field fueling operations at the temporary construction yards. Any fueling of generators, pumps, etc. shall take place at this location only.
- Fuel containers, if used, shall remain in a vehicle or equipment trailer, parked at a designated location alongside a county right-of-way. No fuel containers shall be in the vehicles that exit the right-of-way except the five-gallon container that is required for the water truck pump.
- Smoking shall only be allowed in designated smoking areas at the Facility.

5.0 Preventative and Minimization Actions for Wildfire Risk

> *OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;*

5.1 Preventative Actions

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads[3]. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. The areas immediately around the substations and battery energy storage system will be graveled, with no vegetation present. See Exhibit U[4] for additional discussion of Project fire prevention measures and coordination with local emergency responders.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during construction of the Facility, as applicable.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

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[3] Complete Application for Site Certificate, Exhibit D, May 16, 2024.

[4] Complete Application for Site Certificate, Exhibit U, May 16, 2024.

5.2.2 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fore spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high risk locations, designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.3 Emergency Management Plan

The EMP will be prepared prior to construction by the Certificate Holder and construction contractor and will contain policies and procedures for preparing for and responding to a range of potential emergencies, including fires. Implementation of the EMP will ensure risks to public health and safety and risks to emergency responders are minimized. Any potential fires inside the solar array will be controlled by trained staff who will be able to access the Facility around the clock. These measures will help keep external fires out or internal fires in. The EMP will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The plan will also specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, a construction kickoff meeting to discuss emergency planning, and invitations to observe any emergency drill conducted at the Facility.

In addition to the emergency responses to be stipulated in the EMP, personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

Another safety mitigation measure is to have available on site during construction is a water truck, water buffalo, or tank with minimum 500 gallon capacity.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

The Certificate Holder will track the industry groups and applicable design standards outlined in Table 2 to identify future technologies or best practices that could be implemented at the Facility.

Table 2: Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the substation enclosure.	Remodeling to the enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

Reference	Description	Method
1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/. 2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf. 3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.		

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Sunstone Solar Project 4
Draft Operational Wildfire Mitigation Plan

Sunstone Solar Project 4
October 2025

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 4, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

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List of Tables

Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 4, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
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EMP	Emergency Management Plan
Facility	Sunstone Solar Project 4
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 4, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 4 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) was attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described above, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers, (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire, (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs, battery components, and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During operation, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires and how to safely respond to fires involving BESS components. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment Update

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to operation of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115.

4.0 Inspection and Management

> *OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;*

4.1 Facility Inspections

Facility components will be inspected quarterly. The supervisory, control, and data acquisition (SCADA) system collects operating and performance data from the Facility as a whole and allows remote operation. The Certificate Holder will monitor the Facility components, such as the substation and solar arrays, 24 hours a day, 7 days a week including shutdown capabilities. These operational monitoring and maintenance measures are also discussed in Section 4.0.

The battery energy storage system may consist of either zinc-based batteries or lithium-ion (Li-ion) batteries and will be stored in completely contained, leak-proof modules. The modules will be stored on a concrete pad to capture any leaks that may occur. Operations and maintenance (O&M) employees will conduct inspections of the battery energy storage systems according to the manufacturer's recommendations, which are assumed to be monthly inspections.

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Section 2.7.1 of Exhibit B summarizes the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected.

Table 2 below provides draft operational inspections for electrical facility components from similar types of facilities. As part of finalizing the final operational WMP, the Certificate Holder may update this table as applicable to facility equipment, standards, and inspections.

Table 2: Draft Operational Inspections for Electrical Components

Inspection	Procedure	Standard	Time frame
Solar Inverter	Visual inspection of inverter and surrounding area.	SPCC Plan[1] Manufacturer's maintenance recommendations	Monthly SPCC Bi-annual Preventative Maintenance
Substation	Visual inspection of MPT, Avian Power Line Interaction Committee (APLIC) measures, and surrounding area.	Manufacturer's maintenance recommendations APLIC[2]	Monthly Yearly (APLIC)
BESS	Visual inspection of BESS, PCS, and surrounding areas	SPCC Plan Manufacturer's maintenance recommendations	Monthly
Overhead electrical lines	Visual inspection of components, grounding, APLIC measures, vertical clearance distance between conductor and vegetation.	National Energy reliability Corporation (NERC)[3] APLIC	Bi-annual

Inspection	Procedure	Standard	Time frame
1. The Operational Spill Prevention, Control, and Countermeasure Plan for the facility will require these components to be inspected monthly for spills. During these inspections, Operational Staff will also visually inspect the component and surrounding area. 2. The Certificate Holder will develop an inspection checklist and program of electrical equipment based on manufacturer's recommendations for individual components. 3. Vegetation maintenance standard FAC-003-0 .			

4.2 Vegetation Management

Vegetation within areas temporarily disturbed during construction of the Facility, as well as revegetation of areas within the solar array fence line area, will be revegetated as outlined in the Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4[3]; updated for RFA 1, see Attachment 6). As noted in the Revegetation and Reclamation Plan, areas within the solar array fence line area will be revegetated with a mixture of low-growing grasses and forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). In addition, vegetation within the solar array fence line area will be managed as needed to reduce fuels for fire. This would include mowing vegetation under solar panels periodically, if required. The Certificate Holder will also maintain a 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

A physical vegetation survey assessment of the fenced area will be completed at least twice a year to monitor for vegetation clearances, maintain fire breaks, as applicable, and monitor for wildfire hazards. One of the vegetation survey assessments will occur in May or June, prior to the start of the dry season, a time when wildfire risk begins to become heightened. The survey will be conducted by the Site Operations Manager and will be used to assess the frequency of any upcoming vegetation maintenance required and identify areas that may need additional attention. The Site Operations Manager will visually assess and document vegetation height, abundance, and areas where vegetation should not be present such as crushed rock bed around collector substations. The vegetation survey assessment will determine that clearances and fire breaks (vegetative clearance areas and areas determined to remain clear to act as permanent fire breaks or areas where temporary fire breaks may be deployed in the event of a fire) are satisfactory, and if not, the mitigation procedures will be implemented (e.g., vegetation management) to ensure clearances and fire breaks are satisfactory The vegetation survey will document::

- Location of observations
- Species
- Estimated growth rate
- Abundance

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[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

- Clearance / Setbacks
- Risk of fire hazard

Additional vegetation surveys may be required throughout the season based on seasonally heightened fire risk. Vegetation Maintenance procedures and BMPs will be followed during operation of the Facility to ensure that vegetation does not grow in a manner that blocks or reduces solar radiation reaching the solar panels and reduce the risk of starting a fire. Vegetation control will employ best management practices (BMPs) and techniques that are most appropriate for the local environment. BMPs may include physical vegetation control such as mowing. Noxious weeds within the site boundary will be controlled in accordance with the Noxious Weed Control Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). Efforts will be made to minimize the use of herbicides and only herbicides approved for use by the U.S. Environmental Protection Agency and Oregon Department of Agriculture will be used. Herbicides used for vegetation management of the site will be selected and used in a manner that fully complies with all applicable laws and regulations.

Vegetation within the fence line and below the solar arrays will be maintained to a height of 18 inches and provide a minimum of 24-inch clear distance to any exposed electrical cables. Exposed electrical wires should be running under the solar panels at the midpoint or higher than the center of the panel. The areas immediately around the substations and battery energy storage system will be graveled, with no vegetation present.

Ongoing vegetation management to ensure that vegetation does not grow in these graveled areas is outlined in Table 3.

Table 3. Vegetation Management Procedures by Facility Component

Vegetation Management	Procedure	Standard	Time Frame
Solar Inverter	Herbicide application on gravel pad around inverter to prevent vegetation growth.	Institute of Electrical and Electronics Engineers (IEEE) 80[1] National Electrical Code (NEC) 70[2]	Yearly, depending on vegetation condition.
Substation	Herbicide application on substation gravel pad. Highly compacted gravel foundations of substation are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.
Battery energy storage system	Herbicide application on gravel pad surrounding the battery energy storage system. Highly compacted gravel foundations of the battery energy storage system are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.
Overhead electrical lines	Mow vegetation to achieve clearance requirements between conductor and ground.	North American Electric Reliability Corporation (NERC)[3]	Yearly, depending on vegetation condition.

Vegetation Management	Procedure	Standard	Time Frame
1. IEEE (2015) 2. NFPA (2023) 3. NERC (2009)			

5.0 Preventative and Minimization Actions for Wildfire Risk

> *OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;*

5.1 Preventative Actions and Design Features

The Certificate Holder will minimize risk of operation of the facility causing wildfire by implementing a number of systems and procedures. During O&M activities, these will include requirements to conduct welding or metal cutting only in areas cleared of vegetation, and maintaining emergency firefighting equipment on-site. Employees will keep vehicles on roads and off dry grassland when feasible during the dry months of the year, unless such activities are required for emergency purposes, in which case fire precautions will be observed. Fire extinguishers and shovels will be kept in all vehicles. On-site employees will also receive training on fire prevention and response and have on-site fire extinguishers to respond to small fires. In the event of a large fire, emergency responders will be dispatched.

The Certificate Holder will minimize risk of Facility components causing wildfire through preventative actions. In the design of the Facility, the Certificate Holder will implement the design considerations and best practices outlined in Table 4 to minimize electrical fire risk from facility components.

Table 4. Design Considerations for Fire Safety by Facility Component

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Electrical connections by qualified electricians	X	X	X	X
Inspections for mechanical integrity prior to energizations	X	X	X	X
Lighting protection	X	X	X	X
Corrosion protection	X	X	X	X
Strain relief of connecting cabling	X	X	X	X
Protection against moisture	X	X	X	X
Grounding systems	X	X	X	X
Safety setback from structures	X[1]	X[1]	X[1]	X[2]

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Technology specific design standards	X[3]	X[4]	X[5]	X[3]
1. Graveled inside structure's perimeter fence with additional 3-foot gravel setback outside of structure's perimeter fence 2. Vertical and horizontal clearances from structures depends on voltage of conductor. 3. NFPA 70 (.NFPA 2023). 4. IEEE 979 (IEEE 2012). 5. NFPA 1, Chapter 52 (NFPA 2021).				

During Facility operations, the areas within the site boundary that are subject to a heightened risk of wildfire include the solar array areas. The solar array areas will have low-growing vegetation maintained below the solar arrays during the operational period of the Facility. Measures for reducing the risk of fire ignition and reducing the risk of equipment damage were a wildfire to occur are discussed further in Section 3.0, including the Facility's vegetation management program (see Section 3.2), and through the emergency response procedures that will be described in the Emergency Management Plan (EMP). The EMP will be developed for the Facility and is outlined below in Section 4.2.5. The collector substation area, transformer pads, and the permanent, fenced parking and storage area will have reduced risk for fire due to the fact that these areas will have a gravel base with no vegetation within a 10-foot perimeter to reduce fire risk.

The Facility components will meet National Electrical Code and Institute of Electrical and Electronics Engineers standards and will not pose a significant fire risk. The solar array will have shielded electrical cabling, as required by applicable code, to prevent electrical fires. In addition, the collector system and substation will have redundant surge arrestors to deactivate the Facility during unusual operational events that could start fires. The collector substation will have also sufficient spacing between equipment to prevent the spread of fire.

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. A 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary will be maintained. The areas immediately around the substations and battery energy storage system will be graveled, with no vegetation present. See Exhibit U for additional discussion of Project fire prevention measures and coordination with local emergency responders. Vegetation free areas such as gravel pads or base and facility perimeter and interior roads act as a permanent fire break which could minimize the spread of fires on site or impacts from an external wildfire.

Smoke/fire detectors will be placed around the site that will be tied to the SCADA system and will contact local firefighting services. This communication system allows each solar string, battery energy storage system, and substation to be monitored by a SCADA system, accessed through both the SCADA control room in the substations or remotely. This system monitors these components for variables such as meteorological conditions, critical operating parameters, and power output. The solar array is controlled and monitored via the SCADA system and can be controlled remotely. SCADA software is tuned specifically to the needs of each project by the solar module manufacturer or a third-party SCADA vendor. This system will be monitored 24/7 by a remote operations center.

The Certificate Holder proposes to construct either a direct current–coupled distributed battery energy storage system (located throughout the solar array fence line area at the inverter and transformer sites) or alternating current–coupled battery energy storage system (concentrated in a single location within the solar array fence). The system as a whole will use a series of self-contained containers located within the solar array fence line area. The containers may have their own additional fencing, to be determined prior to construction. Each container will be placed on a concrete foundation. Regardless of the battery technology selected, the containers are estimated to require up to 0.2 to 0.4 acre each with a total of 2,491 containers. Each container is rated for outdoor environments and holds the batteries and a battery management system.

The Facility will use either Li-ion batteries or zinc batteries to store up to 200 MW alternating current of power over a 6-hour discharge duration (1,200 megawatt-hours alternating current) (ASC Exhibit C, Figure C-2[4]).

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Additionally, zinc batteries will have fans and a heating unit for climate control.

The following paragraphs summarize the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected. The chemicals used in Li-ion batteries are generally nontoxic but do present a flammability hazard. Li-ion systems would also include a fire prevention system and cooling units placed either on top of the containers or along the side. Li-ion batteries are susceptible to overheating and typically require cooling systems dedicated to each battery energy storage system enclosure, especially at the utility scale (Jeevarajan et al. 2022). The gas released by an overheating Li-ion cell is mainly carbon dioxide but may also include carbon monoxide, methane, ethylene, and propylene (Jeevarajan et al. 2022).

The Certificate Holder will implement the following fire prevention and control methods to minimize fire and safety risks for the Li-ion batteries proposed for the battery energy storage system:

- The batteries will be stored in completely contained, leak-proof modules.
- Ample working space will be provided around the battery energy storage system for maintenance and safety purposes.

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[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

- Off-site, 24-hour monitoring of the battery energy storage system will be implemented and will include shutdown capabilities.
- Transportation of Li-ion batteries is subject to 49 Code of Federal Regulations (CFR) 173.185 – Department of Transportation Pipeline and Hazardous Material Administration. This regulation contains requirements for prevention of a dangerous evolution of heat; prevention of short circuits; prevention of damage to the terminals; and prevention of batteries coming into contact with other batteries or conductive materials. Adherence to the requirements and regulations, personnel training, safe interim storage, and segregation from other potential waste streams will minimize any public hazard related to transport, use, or disposal of batteries.
- Design of the battery energy storage system will be in accordance with applicable Underwriters Laboratories (UL; specifically, 1642, 1741, 1973, 9540A), National Electric Code, and National Fire Protection Association (specifically 855) standards, which require rigorous industry testing and certification related to fire safety and/or other regulatory requirements applicable to battery storage at the time of construction.
- Additionally, the Certificate Holder will employ the following design practices, as applicable to the available technology and design at time of construction:
  - Use of Li-ion phosphate battery chemistry that does not release oxygen when it decomposes due to temperature;
  - Employment of an advanced and proven battery management system;
  - Qualification testing of battery systems in accordance with UL 9540A (UL Solutions 2025);
  - Employment of Fike fire control panels with 24-hour battery backup at every battery container;
  - Installation of fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems in every battery container;
  - Installation of doors that are equipped with a contact that will shut down the battery container if opened;
  - Installation of fire extinguishing and thermal insulation sheets between each individual battery cell;
  - Implementation of locks and fencing to prevent entry of unauthorized personnel;
  - Installation of remote power disconnect switches; and
  - Clear and visible signs to identify remote power disconnect switches.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during operations of the Facility.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

5.2.2 Electrical Safety Program

All operational workers will be trained in electrical safety and the specific hazards of the Facility. This training will address:

- Minimum experience requirements to work on different types of electrical components;
- Electrical equipment testing and troubleshooting;
- Switching system;
- Provisions for entering high voltage areas (e.g., substation);
- Minimum approach distances; and
- Required personal protective equipment.

5.2.3 Lock Out/Tag Out Program

During maintenance activities, electrical equipment will be de-energized and physically locked or tagged in the de-energized positions to inadvertent events that could result in arc flash.

5.2.4 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fire spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high-risk locations, as designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.5 Emergency Management Plan

Emergency Management will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The final WMP will specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, annual meetings to discuss emergency planning, protocols for how to respond to electrical fires and safely respond to a fire involving BESS components, and invitations to observe any emergency drill conducted at the Facility.

At the beginning of Facility operations, a copy of the site plan indicating the arrangement of the Facility structures, access points, and fire breaks will be provided to the local fire district.

Personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and

- Drip Can.

During times of heightened wildfire risk, a water truck, water buffalo, or tank with minimum 500 gallon capacity will be stationed at the site during operations and maintenance activities.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the amended site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

This Plan will be updated by the Certificate Holder every 5 years. Updates to this Plan will account for changes in local fire protection agency personnel and changes in best practices for minimizing and mitigating fire risk. It is recommended to consult with Morrow County, the local fire department, and the Morrow County Emergency Manager.

After each 5-year review, a copy of the updated plans will be provided to the Oregon Department of Energy with the annual compliance report required under OAR 345-026-008(2).

Every 5 years, the Certificate Holder will review wildfire risk and update this Plan for the site boundary. Evaluation of wildfire risk will be consistent with the requirements of OAR 345-022-0115(1) using current data from reputable sources.

The Certificate Holder may consider revisions to this Plan at its sole discretion to incorporate future best practices or emerging technology depending on whether the new technology is cost effective and suitable for the site conditions. The Certificate Holder will track the industry groups and applicable design standards outlined in Table 5 to identify future technologies or best practices that could be implemented at the Facility.

Table 5. Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.

Reference	Description	Method
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the substation enclosure.	Remodeling to the enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).
1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/. 2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf. 3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.		

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Sunstone Solar Project 5

Sunstone Solar Project 5
Draft Fugitive Dust Control Plan

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 5, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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Table of Contents

List of Attachments

1.0 Introduction

This Fugitive Dust Control Plan (Plan) has been developed by Sunstone Solar 5, LLC (Certificate Holder), a subsidiary of Pine Gate Renewables, LLC, for the approved Sunstone Solar Project 5 (Facility) in Morrow County, Oregon. The purpose of this Plan is to reduce fugitive dust emissions associated with construction-related activities of a photovoltaic energy generation facility with up to 200 megawatts (MW) alternating current and related or supporting facilities, as well as a 1,200 MW-hour distributed battery energy storage system. The majority of the site consists of a mix of fallow fields and fields in small grain production, primarily dryland wheat; no farmlands within the site boundary receive irrigation (the application of water to land for purposes of growing agricultural products; Sunstone Solar 2024). This Plan summarizes the sources of and regulatory issues that relate to fugitive dust emissions; identifies responsibilities, monitoring, and training; and provides reasonable available control methods for fugitive dust in a table for easy reference in the field (Attachment 1).

This is an owner-imposed Plan that is expected to be implemented, maintained, and adaptively managed by the selected contractor throughout all phases of construction. The performance criteria and suggested measures identified in this Plan are minimums, and the contractor is expected to identify and implement additional measures as needed to fully meet all regulatory and public safety performance criteria. As identified in this Plan, the contractor may propose alternative approaches for consideration by the owner.

1.1 Fugitive Dust Sources

The Natural Resources Conservation Service (NRCS) Web Soil Survey identified 11 major soil types within the project area (NRCS 2025). Approximately 33 percent of the site is composed of Warden silt loam, which is moderately or severely susceptible to erosion from ground disturbance, wind, and vehicle traffic on unpaved roads due to its composition of hemic organic soil materials and very fine sand (NRCS 2025, NRCS 2011). Additionally, 40 percent of the site is composed of Ritzville silt loam, which is also moderately or severely susceptible to erosion from ground disturbance, wind, and vehicle traffic due to its composition of silt and fibric organic material (NRCS 2025, NRCS 2011). Due to their composition, the retention of moisture in these sediments is thus restricted. Furthermore, these sediment particles have a low resistance to dust propagation and would be transported or drift to adjacent lands due to the lack of water through irrigation; thus, these soils are considered at high risk for fugitive dust.

Fugitive dust can arise from a variety of construction and operational activities associated with solar development. The sources can be grouped into three general categories: dust created from ground-disturbing activities such as clearing and grading, dust created from wind action on bare soils and stockpiles such as those not fully stabilized post-construction with either vegetation or a tackifier, and dust created from traffic on unpaved roads. Sediment is the basis for fugitive dust, meaning that sediment particles can become fugitive dust if they are windborne. Therefore, the thresholds for treating sediment and erosion on the site will be similar if not the same as the thresholds for treating fugitive dust. Maintaining existing vegetation and root systems is the single most effective method for avoiding fugitive dust and sediment. Where existing vegetation and root systems are disturbed, quickly reestablishing vegetation is critical.

1.2 Regulatory Compliance

Fugitive dust is a source of particulate matter with a mean diameter less than 10 microns (PM_{10}) which is one of the seven air pollutants the U.S. Environmental Protection Agency (EPA) regulates under the National Ambient Air Quality Standards (NAAQS). To a lesser extent, fugitive dust is a source of particulate matter with a mean diameter less than 2.5 microns ($PM_{2.5}$), which has proposed regulations pending under NAAQS. These soil particles are very small, can remain suspended in the air for long periods of time, and are easily inhaled into the lungs. Increased risks of death and disease have been linked to periods of high outdoor PM_{10} and $PM_{2.5}$ concentrations. These fine particles can potentially be lifted thousands of feet into the atmosphere and transported across continents and oceans creating global health, ecological, and climate change impacts.

The EPA shares responsibility with the Oregon Department of Environmental Quality (ODEQ) for the implementation of Clean Air Act (CAA) criteria in Oregon. ODEQ implements the CAA rules under the EPA-approved Oregon Administrative Rules (Chapter 340, Division 21 General Emission Standards for Particulate Matter). Fugitive dust is the primary concern related to the CAA at the Project. Fugitive dust is defined by ODEQ as dust that visibly leaves the project site for a period of more than **18 seconds in a 6-minute period,** determined by the attached EPA Method 22 (ODEQ 2019) at the downwind property boundary (Oregon Administrative Rules [OAR] 340-208-0210 (2)-a and -b).

The ODEQ Rule 340-208-0210 contains the following requirements for fugitive dust:

- Reasonable precautions must be taken to prevent particulate matter from becoming airborne. This includes, but is not limited to, the use of water or other chemicals to control dust during construction, on unpaved roads, and during the transport of materials; enclosure of materials stockpiles and covering of open-body trucks; and prompt removal from paved streets of earth or other material.
- If fugitive dust is discovered, ODEQ may require the Facility to cease work until the fugitive dust emissions are controlled. Emissions are considered controlled when fugitive dust is no longer leaving the Facility site for more than 18 seconds in a 6-minute period.

Further, ODEQ Rule 340-208-0300 specifies that it is prohibited to cause or allow any air contaminants (e.g., fugitive dust) to create a nuisance. If ODEQ determines that a nuisance has been created, the agency may pursue informal or formal enforcement actions to abate the nuisance.

A National Pollutant Discharge Elimination System Construction Stormwater Discharge Permit (Oregon 1200-C Construction Stormwater Permit), pursuant to Oregon Revised Statutes 468.050 and Section 402 of the federal Clean Water Act, will be obtained from ODEQ. This permit requires the permit holder to "Prevent wind-blown soil and dust from areas with exposed soil through the appropriate application of water or other dust suppression techniques to control the generation of pollutants that could be discharged in stormwater from the site" (Section 2.2.9) and requires permit holders to implement measures including monitoring, record keeping, reporting of exceedances, and installation, maintenance, and adaptive management of best management practices (BMPs) to control both stormwater and fugitive dust discharges. Implementation of these measures is intended to reduce fugitive dust to a negligible impact and ensure compliance with applicable air quality regulations.

The Morrow County Code regulates nuisances through the Oregon State Statute Chapter 203. Controlling fugitive dust emissions is required to avoid creating a public nuisance, which is defined as "any thing, substance, or act that is a threat to the public health, safety or welfare" (Morrow County Code Enforcement Ordinance ORD-2021-4).

2.0 Fugitive Dust Control Plan

2.1 Responsibility

The expectation is that the Contractor will implement and adaptively manage this Plan, controlling fugitive dust emissions and meeting all regulatory and public safety performance criteria throughout construction. As described in Section 1.2 above, the holder of the Oregon 1200-C permit is required to control fugitive dust emissions, including ensuring compliance by all subcontractors and outside service providers.

If the Certificate Holder identifies that the regulatory and public safety performance criteria are not being met, the Certificate Holder will implement enforcement measures, including but not limited to:

- Issuance of a Non-Conformance and/or Non-Compliance Report.
- Contractor to prepare and submit a corrective action plan.
- Contractor to document corrective actions taken and performance criteria met.
- Partial or full stoppage of work on site through activation of shut-down clause in contract.
- At the Certificate Holder's sole discretion, an outside contractor may be contracted to implement corrective actions, to be reimbursed by the Contractor.

Additionally, the Certificate Holder may establish a Community Action Council to create an open and ongoing pathway for communication with stakeholders for the Project, including controlling fugitive dust emissions and avoiding the creation of nuisances. The Community Action Council could include representatives from the Morrow County Commissioners' Office, Morrow County Planning Department, Oregon Department of Transportation, and neighboring landowners. The Contractor will work with the Certificate Holder to determine whether this Community Action Council will be established, and if so, the details of its establishment.

2.2 Monitoring

As required by the 1200-C permit, the permit holder will perform visual monitoring and recordkeeping by a Certified Erosion and Sediment Control or Storm Water Quality Inspector (inspector). The Contractor's construction site manager and inspector will be responsible for ensuring that the measures in this Plan are implemented, monitored, and adaptively managed, and that any exceedances are immediately reported to the Certificate Holder.

The visual monitoring required by the 1200-C permit must occur at least once every 14 calendar days. However, because OAR 340-208-0210 restricts visible fugitive emissions on a continuous standard to a maximum of 18 seconds in a given 6-minute period, and because fugitive dust emissions may provide an immediate public safety concern in this location, this Plan requires that fugitive dust be monitored and controlled on an ongoing basis.

Monitoring for fugitive dust emissions shall include:

- Use of EPA Method 22 (ODEQ 2019; see Attachment 2) as specified in OAR 340-208-0210, at least once a day.
- The observation shall be performed during times of peak construction activity at the downwind property boundary.
- Recording of observations in a fugitive dust inspection log that is kept on site and shall be available digitally to the Certificate Holder. This log shall include all information required in EPA Method 22 and shall also include photos and/or video taken during the observation period to document conditions.
- Installation and operation of a weather station, recording (at a minimum) wind speed and direction.

Triggers for additional, more frequent monitoring will include:

- Observation of visible fugitive dust emissions by Contractor, agency, or the Certificate Holder staff.
- Request by a member of the Community Action Council established by the Certificate Holder.
- Wind speeds greater than 15 miles per hour.
- Receipt of complaints or concerns through the Project Dust Control Hotline.

2.3 Training

EPA Method 22 (ODEQ 2019) does not require a specific certification, but it is necessary that the person responsible for observations completed for this method be knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in the references cited in Method 22 (EPA 2019) or from the lecture portion of the EPA Method 9 certification course. The Contractor shall document in the inspection log how the person responsible for observations meets this requirement.

Construction workers will attend a Worker Environmental Awareness Program training prior to conducting construction activities. This training will include a summary of fugitive dust control measures included in this Plan and the responsibilities of personnel working on the Facility related to fugitive dust control.

2.4 Fugitive Dust Prevention and Management

This document and the attached table are intended to provide guidance to construction personnel on measures intended to minimize impacts and control fugitive dust emissions during construction. It is the responsibility of the Contractor to monitor and adaptively manage the site to maintain compliance with all local, state, and federal requirements. Additionally, this Plan is supplemental to the Contractor's Erosion and Sediment Control Plan and does not substitute for any requirements of ODEQ or other agencies.

This Plan is performance-based. As shown in the flow chart in Figure 1, if fugitive dust emissions in excess of the ODEQ criteria of **18 seconds in a 6-minute period** occur, the Contractor shall:

- Implement adaptive management actions, including altering work operations and/or pause work until the fugitive dust emissions are controlled.
- Document that fugitive dust emissions have been controlled, including monitoring with EPA Method 22.
- In addition to any reporting requirements required in the 1200-C permit, report noncompliance incidents and adaptive management actions taken by the Certificate Holder within 24 hours of occurrence.

The Contractor shall maintain and implement this Plan during all phases of construction. The table in Attachment 1 provides suggested Reasonable Available Control Measures (RACMs) for anticipated fugitive dust sources based on industry-standard BMPs and reasonable precautions specified in the Oregon 1200-C permit, ODEQ's Construction Stormwater Best Management Practices Manual (Manual) (ODEQ 2021), and OAR 340-208-0210. Supplemental RACMs are identified in the table in case initial RACMs are not effective in controlling fugitive dust or are not feasible to implement (Attachment 1).

The Contractor shall identify and implement additional RACMs as needed to control fugitive dust emissions. Additionally, the Contractor may propose alternative approaches and RACMs for controlling fugitive dust. This proposal shall be made in writing and is subject to the approval of the Certificate Holder.

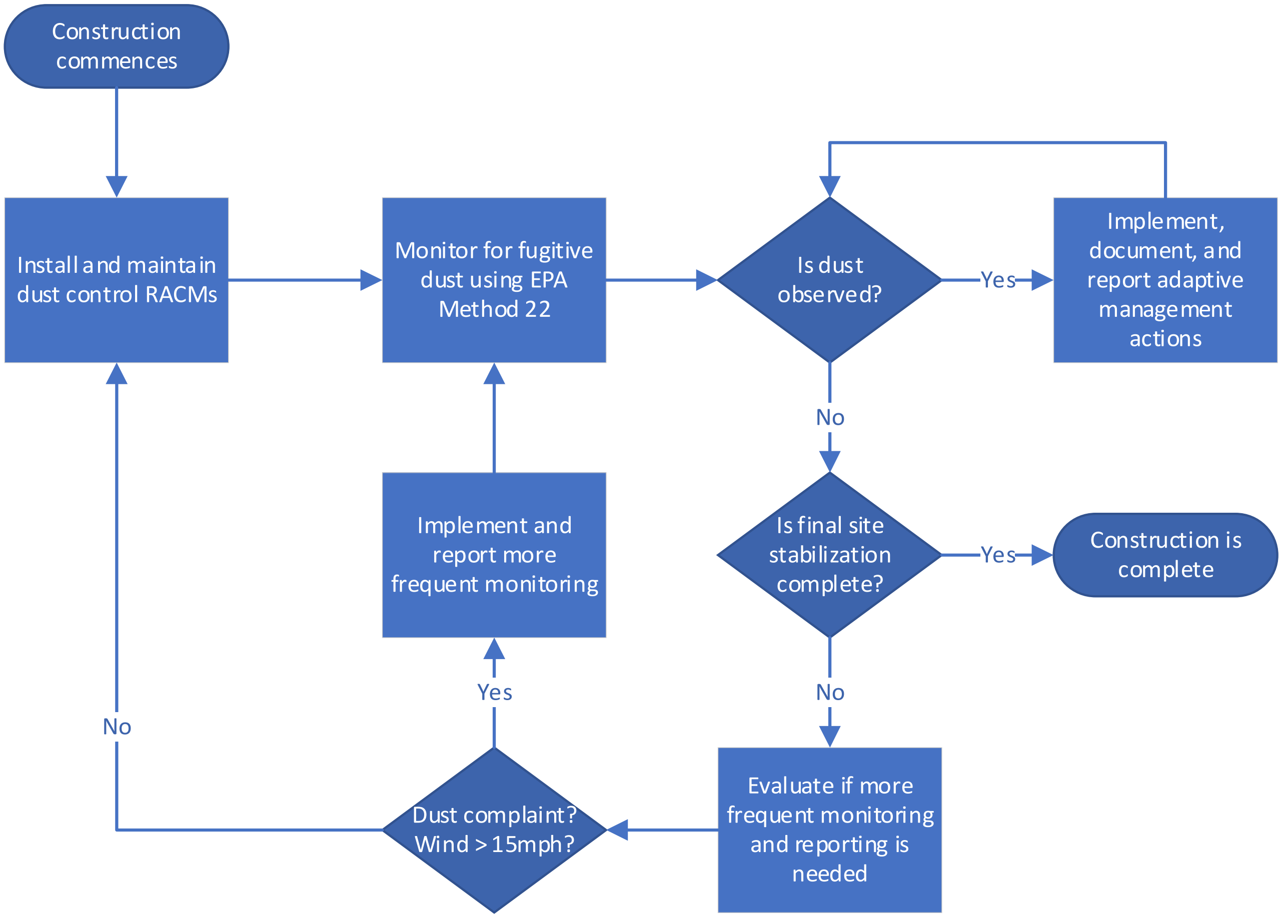

Figure 1. Dust Control Plan Flow Chart

3.0 References

NRSC (Natural Resources Conservation Service). 2011. United States Department of Agriculture, Natural Resources Conservation Service, National Agronomy Manual 190-V-NAM, 4th Edition.

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Attachment 1: Fugitive Dust Sources and Reasonable Available Control Measures

Fugitive Dust Sources and Reasonable Available Control Measures

Construction Phase	RACM(s)	Supplemental RACM(s)
All Phases of Construction	Daily fugitive dust monitoring and record keeping.	Increase frequency of monitoring.
	Prominent display of Dust Control Hotline signs, providing direct access to the Contractor's site manager or inspector.	If established, proactive engagement with Community Action Council.
	If established, Worker Environmental Awareness Program training for all construction employees.	Additional trainings and refreshers for employees.
	Maintain stockpile of BMPs on site, including sufficient palliatives for a single treatment of all site access roads and sufficient palliatives, mulch, and/or hydromulch for a minimum of 25 percent of the total disturbed area, and machinery for application.	Increase stockpile of palliatives, mulch, and/or hydromulch and add additional BMPs.
	Documentation and reporting of adaptive management actions.	Development and submittal of revised Fugitive Dust Control Plan.
Site Access	Install and maintain stabilized construction entrances at ingress/egress locations and restrict traffic to these locations.	Add additional construction entrance BMPs (e.g., wheel wash).
	Daily sweeping up of sediment from paved surfaces utilizing vacuum sweeper with HEPA filtration.	Increase sweeper frequency.
	Access roads shall be graveled.	Road maintenance and reapplication of gravel.
	Access roads will be stabilized with water or palliative sufficient to eliminate visible and sustained dust from vehicular travel and wind erosion. Reapply stabilization as necessary to maintain dust-free condition.	If water is unavailable or ineffective, or if water use is limited by any agency or regulation, access roads will be stabilized with longer-lasting palliatives.
	Restrict construction traffic to established and stabilized access routes.	Install fencing or barricades to prevent traffic outside of established routes.
	Limit traffic speeds to 15 miles per hour on stabilized unpaved roads within the site as long as such speeds do not create significant visible dust emissions. Traffic speed signs shall be displayed prominently at all site entrances and exits.	Limit traffic speeds within the site to 5 or 10 miles per hour.

Construction Phase	RACM(s)	Supplemental RACM(s)
Clearing, Grading, and Unstable Surfaces	Maintain the natural topography and vegetation of the site to the extent possible, including by limited grading and limited establishment of temporary access roads.	Reduce area being actively worked and stabilize unworked areas.
	Phase construction to expose the minimum amount of soil necessary.	Increase construction phasing to further minimize exposed soil.
	Leave existing vegetation intact to the extent possible.	Utilize mowing and rolling techniques to maintain plant root systems for soil stabilization.
	Minimize disturbance areas and soil exposure to the maximum extent feasible.	Limit work to a portion of the disturbed area until all disturbed areas receive temporary or final stabilization.
	When wind speeds exceed 15 miles per hour, minimize new disturbances to the extent possible and/or mobilize additional water trucks or palliatives to minimize fugitive dust from exposed surfaces.	Stop all ground disturbing activities and apply additional dust control measures until measures are effective or wind speeds slow and fugitive emissions stop.
	Separate and cover topsoil.	Increase maintenance frequency for topsoil cover. Combine methods, such as mulch plus tackifier.
	Stabilize exposed soils within the timeframes established in the 1200-C permit. Stabilize exposed soils in stages based on site conditions and weather.	Stabilize exposed soils more frequently, even if additional work is anticipated within the timeframe established in the 1200-C permit. Reapply stabilization measures following any additional disturbances.
	Temporarily stabilize exposed surfaces to prohibit significant and sustained visible fugitive dust from wind erosion. Utilize BMPs such as mulch, hydromulch with or without seeds, tackifier, spreading stone or gravel, and trackwalking.	Combine stabilization methods, such as mulch plus tackifier, or trackwalking plus hydromulch. Increase frequency of maintenance of stabilization.
	Seed exposed surfaces during the appropriate season with approved temporary or permanent seed mixes.	Reapply seed to newly disturbed areas or areas with poor germination. Use temporary seeding even if additional work is anticipated before final stabilization. Use irrigation to enhance seeding success.
	Gate seals should be tight on dump trucks. Soil load shall be kept below 6 inches of the freeboard of the truck. Drop heights shall be minimized when loaders dump soil into trucks.	Cover haul trucks with a tarp or other suitable cover.

Attachment 2: EPA Method 22

State of Oregon Department of Environmental Quality

OAR 340-208-0210

EPA Method 22

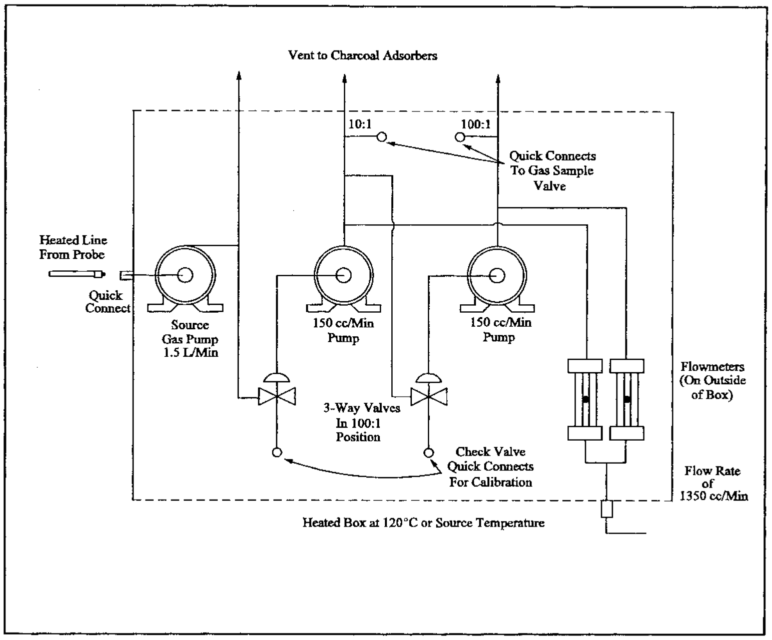


Figure 18-13. Schematic Diagram of the Heated Box Required for Dilution of Sample Gas.

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST

[Respond with initials or number as appropriate]

1. Presurvey data:
    - A. Grab sample collected .... ☐ ______
        - B. Grab sample analyzed for composition .... ☐ ______
        - Method GC .... ☐ ______
            - GC/MS .... ☐ ______
            - Other .... ☐ ______
    - C. GC-FID analysis performed .... ☐ ______
2. Laboratory calibration data:
    - A. Calibration curves prepared .... ☐ ______
        - Number of components .... ☐ ______
        - Number of concentrations/component (3 required). ☐ ______
    - B. Audit samples (optional):
    - Analysis completed .... ☐ ______
    - Verified for concentration .... ☐ ______
    - OK obtained for field work .... ☐ ______
3. Sampling procedures:
    - A. Method:
        - Bag sample .... ☐ ______
        - Direct interface .... ☐ ______
        - Dilution interface .... ☐ ______
    - B. Number of samples collected .... ☐ ______
4. Field Analysis:
    - A. Total hydrocarbon analysis performed .... ☐ ______
    - B. Calibration curve prepared .... ☐ ______
        - Number of components .... ☐ ______
        - Number of concentrations per component (3 required). ☐ ______

Gaseous Organic Sampling and Analysis Data

Plant ____________________

Date ____________________

Location ____________________

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST (RESPOND WITH INITIALS OR NUMBER AS APPROPRIATE)

1. Pre-survey data	Date
A. Grab sample collected	________
B. Grab sample analyzed for composition	________
Method GC	________
GC/MS	________
Other____________________	________
C. GC–FID analysis performed	________
2. Laboratory calibration curves prepared	________
A. Number of components	________
B. Number of concentrations per component (3 required)	________
C. OK obtained for field work	________
3. Sampling procedures.	
A. Method.	
Bag sample	________
Direct interface	________
Dilution interface	________
B. Number of samples collected	________
4. Field Analysis.	
A. Total hydrocarbon analysis performed	________
B. Calibration curve prepared	________
Number of components	________
Number of concentrations per component (3 required)	________

Figure 18–14. Sampling and Analysis Sheet

[36 FR 24877, Dec. 23, 1971]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting appendix A–6 to part 60, see the List of CFR sections Affected, which appears in the Finding Aids section of the printed volume and at *www.fdsys.gov*.

APPENDIX A–7 TO PART 60—TEST METHODS 19 THROUGH 25E

Method 19—Determination of sulfur dioxide removal efficiency and particulate, sulfur dioxide and nitrogen oxides emission rates

Method 20—Determination of nitrogen oxides, sulfur dioxide, and diluent emissions from stationary gas turbines

Method 21—Determination of volatile organic compound leaks

Method 22—Visual determination of fugitive emissions from material sources and smoke emissions from flares

Method 23—Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans From Stationary Sources

Method 24—Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

Method 24A—Determination of volatile matter content and density of printing inks and related coatings

Method 25—Determination of total gaseous nonmethane organic emissions as carbon

Method 25A—Determination of total gaseous organic concentration using a flame ionization analyzer

Method 25B—Determination of total gaseous organic concentration using a nondispersive infrared analyzer

Method 25C—Determination of nonmethane organic compounds (NMOC) in MSW landfill gases

Method 25D—Determination of the Volatile Organic Concentration of Waste Samples

Method 25E—Determination of Vapor Phase Organic Concentration in Waste Samples

The test methods in this appendix are referred to in §60.8 (Performance Tests) and §60.11 (Compliance With Standards and Maintenance Requirements) of 40 CFR part 60, subpart A (General Provisions). Specific uses of these test methods are described in the standards of performance contained in the subparts, beginning with Subpart D.

Within each standard of performance, a section title ‘‘Test Methods and Procedures’’ is provided to: (1) Identify the test methods to be used as reference methods to the facility subject to the respective standard and (2) identify any special instructions or conditions to be followed when applying a method to the respective facility. Such instructions (for example, establish sampling rates, volumes, or temperatures) are to be used either in addition to, or as a substitute for procedures in a test method. Similarly, for sources subject to emission monitoring requirements, specific instructions pertaining to any use of a test method as a reference method are provided in the subpart or in Appendix B.

Inclusion of methods in this appendix is not intended as an endorsement or denial of their applicability to sources that are not subject to standards of performance. The methods are potentially applicable to other sources; however, applicability should be confirmed by careful and appropriate evaluation of the conditions prevalent at such sources.

The approach followed in the formulation of the test methods involves specifications for equipment, procedures, and performance. In concept, a performance specification approach would be preferable in all methods because this allows the greatest flexibility to the user. In practice, however, this approach is impractical in most cases because performance specifications cannot be established. Most of the methods described herein, therefore, involve specific equipment specifications and procedures, and only a few methods in this appendix rely on performance criteria.

Minor changes in the test methods should not necessarily affect the validity of the results and it is recognized that alternative and equivalent methods exist. section 60.8 provides authority for the Administrator to specify or approve (1) equivalent methods, (2) alternative methods, and (3) minor changes in the methodology of the test methods. It should be clearly understood that unless otherwise identified all such methods and changes must have prior approval of the Administrator. An owner employing such methods or deviations from the test methods without obtaining prior approval does so at the risk of subsequent disapproval and retesting with approved methods.

Within the test methods, certain specific equipment or procedures are recognized as being acceptable or potentially acceptable and are specifically identified in the methods. The items identified as acceptable options may be used without approval but must be identified in the test report. The potentially approvable options are cited as ‘‘subject to the approval of the Administrator’’ or as ‘‘or equivalent.’’ Such potentially approvable techniques or alternatives may be used at the discretion of the owner without prior approval. However, detailed descriptions for applying these potentially approvable techniques or alternatives are not provided in the test methods. Also, the potentially approvable options are not necessarily acceptable in all applications. Therefore, an owner electing to use such potentially approvable techniques or alternatives is responsible for: (1) assuring that the techniques or alternatives are in fact applicable and are properly executed; (2) including a written description of the alternative method in the test report (the written method must be clear and must be capable of being performed without additional instruction, and the degree of detail should be similar to the detail contained in the test methods); and (3) providing any rationale or supporting data necessary to show the validity of the alternative in the particular application. Failure to meet these requirements can result in the Administrator's disapproval of the alternative.

METHOD 19—DETERMINATION OF SULFUR DIOXIDE REMOVAL EFFICIENCY AND PARTICULATE MATTER, SULFUR DIOXIDE, AND NITROGEN OXIDE EMISSION RATES

1.0 Scope and Application

1.1 Analytes. This method provides data reduction procedures relating to the following pollutants, but does not include any sample collection or analysis procedures.

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X), including:		
Nitric oxide (NO)	10102–43–9	N/A
Nitrogen dioxide (NO_2)	10102–44–0.	
Particulate matter (PM)	None assigned	N/A
Sulfur dioxide (SO_2)	7499–09–05	N/A

1.2 Applicability. Where specified by an applicable subpart of the regulations, this method is applicable for the determination of (a) PM, SO_2, and NO_X emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions.

2.0 Summary of Method

2.1 Emission Rates. Oxygen (O_2) or carbon dioxide (CO_2) concentrations and appropriate F factors (ratios of combustion gas volumes to heat inputs) are used to calculate pollutant emission rates from pollutant concentrations.

2.2 Sulfur Reduction Efficiency and SO_2 Removal Efficiency. An overall SO_2 emission reduction efficiency is computed from the efficiency of fuel pretreatment systems, where applicable, and the efficiency of SO_2 control devices.

2.2.1 The sulfur removal efficiency of a fuel pretreatment system is determined by fuel sampling and analysis of the sulfur and heat contents of the fuel before and after the pretreatment system.

2.2.2 The SO_2 removal efficiency of a control device is determined by measuring the SO_2 rates before and after the control device.

2.2.2.1 The inlet rates to SO_2 control systems (or, when SO_2 control systems are not used, SO_2 emission rates to the atmosphere) are determined by fuel sampling and analysis.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety [Reserved]

6.0 Equipment and Supplies [Reserved]

7.0 Reagents and Standards [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transport [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedures [Reserved]

12.0 Data Analysis and Calculations

12.1 Nomenclature

B_{wa} = Moisture fraction of ambient air, percent.

B_{ws} = Moisture fraction of effluent gas, percent.

%C = Concentration of carbon from an ultimate analysis of fuel, weight percent.

C_d = Pollutant concentration, dry basis, ng/scm (lb/scf)

$\%CO_{2d}$,$\%CO_{2w}$ = Concentration of carbon dioxide on a dry and wet basis, respectively, percent.

C_w = Pollutant concentration, wet basis, ng/scm (lb/scf).

D = Number of sampling periods during the performance test period.

E = Pollutant emission rate, ng/J (lb/million Btu).

E_a = Average pollutant rate for the specified performance test period, ng/J (lb/million Btu).

E_{ao}, E_{ai} = Average pollutant rate of the control device, outlet and inlet, respectively, for the performance test period, ng/J (lb/million Btu).

E_{bi} = Pollutant rate from the steam generating unit, ng/J (lb/million Btu)

E_{bo} = Pollutant emission rate from the steam generating unit, ng/J (lb/million Btu).

E_{ci} = Pollutant rate in combined effluent, ng/J (lb/million Btu).

E_{co} = Pollutant emission rate in combined effluent, ng/J (lb/million Btu).

E_d = Average pollutant rate for each sampling period (*e.g.*, 24-hr Method 6B sample or 24-hr fuel sample) or for each fuel lot (*e.g.*, amount of fuel bunkered), ng/J (lb/million Btu).

E_{di} = Average inlet SO_2 rate for each sampling period d, ng/J (lb/million Btu)

E_g = Pollutant rate from gas turbine, ng/J (lb/million Btu).

E_{ga} = Daily geometric average pollutant rate, ng/J (lbs/million Btu) or ppm corrected to 7 percent O_2.

E_{jo},E_{ji} = Matched pair hourly arithmetic average pollutant rate, outlet and inlet, respectively, ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

E_h = Hourly average pollutant, ng/J (lb/million Btu).

E_{hj} = Hourly arithmetic average pollutant rate for hour ''j,'' ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

EXP = Natural logarithmic base (2.718) raised to the value enclosed by brackets.

F_d, F_w, F_c = Volumes of combustion components per unit of heat content, scm/J (scf/million Btu).

GCV = Gross calorific value of the fuel consistent with the ultimate analysis, kJ/kg (Btu/lb).

GCV_p, GCV_r = Gross calorific value for the product and raw fuel lots, respectively, dry basis, kJ/kg (Btu/lb).

%H = Concentration of hydrogen from an ultimate analysis of fuel, weight percent.

H = Total number of operating hours for which pollutant rates are determined in the performance test period.

H_b = Heat input rate to the steam generating unit from fuels fired in the steam generating unit, J/hr (million Btu/hr).

H_g = Heat input rate to gas turbine from all fuels fired in the gas turbine, J/hr (million Btu/hr).

$\%H_2O$ = Concentration of water from an ultimate analysis of fuel, weight percent.
H_r = Total numbers of hours in the performance test period (*e.g.*, 720 hours for 30-day performance test period).
K = Conversion factor, 10^{-5} (kJ/J)/(%) [10^6 Btu/million Btu].
K_c = (9.57 scm/kg)/% [(1.53 scf/lb)/%].
K_{cc} = (2.0 scm/kg)/% [(0.321 scf/lb)/%].
K_{hd} = (22.7 scm/kg)/% [(3.64 scf/lb)/%].
K_{hw} = (34.74 scm/kg)/% [(5.57 scf/lb)/%].
K_n = (0.86 scm/kg)/% [(0.14 scf/lb)/%].
K_o = (2.85 scm/kg)/% [(0.46 scf/lb)/%].
K_s = (3.54 scm/kg)/% [(0.57 scf/lb)/%].
K_w = (1.30 scm/kg)/% [(0.21 scf/lb)/%].
ln = Natural log of indicated value.
L_p,L_r = Weight of the product and raw fuel lots, respectively, metric ton (ton).
%N = Concentration of nitrogen from an ultimate analysis of fuel, weight percent.
N = Number of fuel lots during the averaging period.
n = Number of fuels being burned in combination.
n_d = Number of operating hours of the affected facility within the performance test period for each E_d determined.
n_t = Total number of hourly averages for which paired inlet and outlet pollutant rates are available within the 24-hr midnight to midnight daily period.
%O = Concentration of oxygen from an ultimate analysis of fuel, weight percent.
$\%O_{2d}$, $\%O_{2w}$ = Concentration of oxygen on a dry and wet basis, respectively, percent.
P_s = Potential SO_2 emissions, percent.
$\%R_f$ = SO_2 removal efficiency from fuel pretreatment, percent.
$\%R_g$ = SO_2 removal efficiency of the control device, percent.
$\%R_{ga}$ = Daily geometric average percent reduction.
$\%R_o$ = Overall SO_2 reduction, percent.
%S = Sulfur content of as-fired fuel lot, dry basis, weight percent.
S_e = Standard deviation of the hourly average pollutant rates for each performance test period, ng/J (lb/million Btu).
$\%S_f$ = Concentration of sulfur from an ultimate analysis of fuel, weight percent.
S_i = Standard deviation of the hourly average inlet pollutant rates for each performance test period, ng/J (lb/million Btu).
S_o = Standard deviation of the hourly average emission rates for each performance test period, ng/J (lb/million Btu).
$\%S_p$, $\%S_r$ = Sulfur content of the product and raw fuel lots respectively, dry basis, weight percent.
$t_{0.95}$ = Values shown in Table 19–3 for the indicated number of data points n.
X_k = Fraction of total heat input from each type of fuel k.

12.2 Emission Rates of PM, SO_2, and NO_X. Select from the following sections the applicable procedure to compute the PM, S_{O2}, or NO_X emission rate (E) in ng/J (lb/million Btu). The pollutant concentration must be in ng/scm (lb/scf) and the F factor must be in scm/J (scf/million Btu). If the pollutant concentration (C) is not in the appropriate units, use Table 19–1 in section 17.0 to make the proper conversion. An F factor is the ratio of the gas volume of the products of combustion to the heat content of the fuel. The dry F factor (F_d) includes all components of combustion less water, the wet F factor (F_w) includes all components of combustion, and the carbon F factor (F_c) includes only carbon dioxide.

NOTE: Since F_w factors include water resulting only from the combustion of hydrogen in the fuel, the procedures using F_w factors are not applicable for computing E from steam generating units with wet scrubbers or with other processes that add water (*e.g.*, steam injection).

12.2.1 Oxygen-Based F Factor, Dry Basis. When measurements are on a dry basis for both O ($\%O_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_d \frac{20.9}{\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-1}$$

12.2.2 Oxygen-Based F Factor, Wet Basis. When measurements are on a wet basis for both O_2 ($\%O_{2w}$) and pollutant (C_w) concentrations, use either of the following:

12.2.2.1 If the moisture fraction of ambient air (B_{wa}) is measured:

$$E = C_w F_w \frac{20.9}{\left[20.9\left(1 - B_{wa}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-2}$$

Instead of actual measurement, B_{wa} may be estimated according to the procedure below.

NOTE: The estimates are selected to ensure that negative errors will not be larger than −1.5 percent. However, positive errors, or over-estimation of emissions by as much as 5 percent may be introduced depending upon the geographic location of the facility and the associated range of ambient moisture.

12.2.2.1.1 B_{wa} = 0.027. This value may be used at any location at all times.

12.2.2.1.2 B_{wa} = Highest monthly average of B_{wa} that occurred within the previous calendar year at the nearest Weather Service Station. This value shall be determined annually and may be used as an estimate for the entire current calendar year.

12.2.2.1.3 B_{wa} = Highest daily average of Bwa that occurred within a calendar month at the nearest Weather Service Station, calculated from the data from the past 3 years. This value shall be computed for each month and may be used as an estimate for the current respective calendar month.

12.2.2.2 If the moisture fraction (B_{ws}) of the effluent gas is measured:

$$E = C_w F_d \frac{20.9}{\left[20.9\left(1 - B_{ws}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-3}$$

12.2.3 Oxygen-Based F Factor, Dry/Wet Basis.

12.2.3.1 When the pollutant concentration is measured on a wet basis (C_w) and O_2 concentration is measured on a dry basis ($\%O_{2d}$), use the following equation:

$$E = \frac{\left(C_w F_d\right)(20.9)}{\left(1 - B_{ws}\right)\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-4}$$

12.2.3.2 When the pollutant concentration is measured on a dry basis (C_d) and the O_2 concentration is measured on a wet basis ($\%O_{2w}$), use the following equation:

$$E = \frac{C_d F_d 20.9}{\dfrac{\left(20.9 - \%O_{2w}\right)}{\left(1 - B_{ws}\right)}} \qquad \text{Eq. 19-5}$$

12.2.4 Carbon Dioxide-Based F Factor, Dry Basis. When measurements are on a dry basis for both CO_2 ($\%CO_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_c \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-6}$$

12.2.5 Carbon Dioxide-Based F Factor, Wet Basis. When measurements are on a wet basis for both CO_2 ($\%CO_{2w}$) and pollutant (C_w) concentrations, use the following equation:

$$E = C_w F_c \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-7}$$

12.2.6 Carbon Dioxide-Based F Factor, Dry/Wet Basis.

12.2.6.1 When the pollutant concentration is measured on a wet basis (C_w) and CO_2 concentration is measured on a dry basis ($\%CO_{2d}$), use the following equation:

$$E = \frac{C_w F_c}{\left(1 - B_{ws}\right)} \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-8}$$

12.2.6.2 When the pollutant concentration is measured on a dry basis (C_d) and CO_2 concentration is measured on a wet basis ($\%CO_{2w}$), use the following equation:

$$E = C_d F_c \left(1 - B_{ws}\right) \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-9}$$

12.2.7 Direct-Fired Reheat Fuel Burning. The effect of direct-fired reheat fuel burning (for the purpose of raising the temperature of the exhaust effluent from wet scrubbers to above the moisture dew-point) on emission rates will be less than 1.0 percent and, therefore, may be ignored.

12.2.8 Combined Cycle-Gas Turbine Systems. For gas turbine-steam generator combined cycle systems, determine the emissions from the steam generating unit or the percent reduction in potential SO_2 emissions as follows:

12.2.8.1 Compute the emission rate from the steam generating unit using the following equation:

$$E_{bo} = E_{co} + \frac{H_g}{H_b}\left(E_{co} - E_g\right) \qquad \text{Eq. 19-10}$$

12.2.8.1.1 Use the test methods and procedures section of 40 CFR Part 60, Subpart GG to obtain E_{co} and E_g. Do not use F_w factors for determining E_g or E_{co}. If an SO_2 control device is used, measure E_{co} after the control device.

12.2.8.1.2 Suitable methods shall be used to determine the heat input rates to the steam generating units (H_b) and the gas turbine (H_g).

12.2.8.2 If a control device is used, compute the percent of potential SO_2 emissions (P_s) using the following equations:

$$E_{bi} = E_{ci} - \frac{H_g}{H_b}\left(E_{ci} - E_g\right) \qquad \text{Eq. 19-11}$$

$$P_s = 100\left(1 - \frac{E_{bo}}{E_{bi}}\right) \qquad \text{Eq. 19-12}$$

NOTE: Use the test methods and procedures section of Subpart GG to obtain E_{ci} and E_g. Do not use F_w factors for determining E_g or E_{ci}.

12.3 F Factors. Use an average F factor according to section 12.3.1 or determine an applicable F factor according to section 12.3.2. If combined fuels are fired, prorate the applicable F factors using the procedure in section 12.3.3.

12.3.1 Average F Factors. Average F factors (F_d, F_w, or F_c) from Table 19–2 in section 17.0 may be used.

12.3.2 Determined F Factors. If the fuel burned is not listed in Table 19–2 or if the owner or operator chooses to determine an F factor rather than use the values in Table 19–2, use the procedure below:

12.3.2.1 Equations. Use the equations below, as appropriate, to compute the F factors:

$$F_d = \frac{K\left(K_{hd}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O\right)}{GCV} \qquad \text{Eq. 19-13}$$

$$F_w = \frac{K\left[K_{hw}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O + K_w\%H_2O\right]}{GCV_w} \qquad \text{Eq. 19-14}$$

$$F_c = \frac{K\left(K_{cc}\%C\right)}{GCV} \qquad \text{Eq. 19-15}$$

NOTE: Omit the $\%H_2O$ term in the equations for F_w if %H and %O include the unavailable hydrogen and oxygen in the form of H_2O.)

12.3.2.2 Use applicable sampling procedures in section 12.5.2.1 or 12.5.2.2 to obtain samples for analyses.

12.3.2.3 Use ASTM D 3176–74 or 89 (all cited ASTM standards are incorporated by reference—see §60.17) for ultimate analysis of the fuel.

12.3.2.4 Use applicable methods in section 12.5.2.1 or 12.5.2.2 to determine the heat content of solid or liquid fuels. For gaseous fuels, use ASTM D 1826–77 or 94 (incorporated by reference—see §60.17) to determine the heat content.

12.3.3 F Factors for Combination of Fuels. If combinations of fuels are burned, use the following equations, as applicable unless otherwise specified in an applicable subpart:

$$F_d = \sum_{k=1}^{n}\left(X_k F_{dk}\right) \qquad \text{Eq. 19-16}$$

$$F_w = \sum_{k=1}^{n}\left(X_k F_{wk}\right) \qquad \text{Eq. 19-17}$$

$$F_c = \sum_{k=1}^{n}\left(X_k F_{ck}\right) \qquad \text{Eq. 19-18}$$

12.4 Determination of Average Pollutant Rates.

12.4.1 Average Pollutant Rates from Hourly Values. When hourly average pollutant rates (E_h), inlet or outlet, are obtained (*e.g.*, CEMS values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{1}{H}\sum_{j=1}^{n} E_{hj} \qquad \text{Eq. 19-19}$$

12.4.2 Average Pollutant Rates from Other than Hourly Averages. When pollutant rates are determined from measured values representing longer than 1-hour periods (*e.g.*, daily fuel sampling and analyses or Method 6B values), or when pollutant rates are determined from combinations of 1-hour and longer than 1-hour periods (*e.g.*, CEMS and Method 6B values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{\sum_{j=1}^{D}\left(n_d E_d\right)_j}{\sum_{j=1}^{D} n_{dj}} \qquad \text{Eq. 19-20}$$

12.4.3 Daily Geometric Average Pollutant Rates from Hourly Values. The geometric average pollutant rate (E_{ga}) is computed using the following equation:

$$E_{ga} = \exp\left[\frac{1}{n_t}\sum_{j=1}^{n_t}\left[\ln\left(E_{hj}\right)\right]\right] \qquad \text{Eq. 19-21}$$

12.5 Determination of Overall Reduction in Potential Sulfur Dioxide Emission.

12.5.1 Overall Percent Reduction. Compute the overall percent SO_2 reduction ($\%R_o$) using the following equation:

$$\%R_o = 100\left[1.0 - \left(1.0 - \frac{\%R_f}{100}\right)\left(1.0 - \frac{\%R_g}{100}\right)\right] \qquad \text{Eq. 19-22}$$

12.5.2 Pretreatment Removal Efficiency (Optional). Compute the SO_2 removal efficiency from fuel pretreatment ($\%R_f$) for the averaging period (*e.g.*, 90 days) as specified in the applicable regulation using the following equation:

$$\%R_f = 100\left[1.0 - \frac{\displaystyle\sum_{j=1}^{N}\left(\frac{\%S_{pj}}{GCV_{pj}}\right)L_{pj}}{\displaystyle\sum_{j=1}^{N}\left(\frac{\%S_{rj}}{GCV_{rj}}\right)L_{rj}}\right] \qquad \text{Eq. 19-23}$$

NOTE: In calculating $\%R_f$, include %S and GCV values for all fuel lots that are not pretreated and are used during the averaging period.

12.5.2.1 Solid Fossil (Including Waste) Fuel/Sampling and Analysis.

NOTE: For the purposes of this method, raw fuel (coal or oil) is the fuel delivered to the desulfurization (pretreatment) facility. For oil, the input oil to the oil desulfurization process (*e.g.*, hydrotreatment) is considered to be the raw fuel.

12.5.2.1.1 Sample Increment Collection. Use ASTM D 2234–76, 96, 97a, or 98 (incorporated by reference—see §60.17), Type I, Conditions A, B, or C, and systematic spacing. As used in this method, systematic spacing is intended to include evenly spaced increments in time or increments based on equal weights of coal passing the collection area. As a minimum, determine the number and weight of increments required per gross sample representing each coal lot according to Table 2 or Paragraph 7.1.5.2 of ASTM D 2234. Collect one gross sample for each lot of raw coal and one gross sample for each lot of product coal.

12.5.2.1.2 ASTM Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of product coal is the weight of product coal from one type of raw coal. The lot size of raw coal is the weight of raw coal used to produce one lot of product coal. Typically, the lot size is the weight of coal processed in a 1-day (24-hour) period. If more than one type of coal is treated and produced in 1 day, then gross samples must be collected and analyzed for each type of coal. A coal lot size equaling the 90-day quarterly fuel quantity for a steam generating unit may be used if representative sampling can be conducted for each raw coal and product coal.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.1.3 Gross Sample Analysis. Use ASTM D 2013–72 or 86 to prepare the sample, ASTM D 3177–75 or 89 or ASTM D 4239–85, 94, or 97 to determine sulfur content (%S), ASTM D 3173–73 or 87 to determine moisture content, and ASTM D 2015–77 (Reapproved 1978) or 96, D 3286–85 or 96, or D 5865–98 or 10 to determine gross calorific value (GCV) (all standards cited are incorporated by reference—see §60.17 for acceptable versions of the standards) on a dry basis for each gross sample.

12.5.2.2 Liquid Fossil Fuel-Sampling and Analysis. See Note under section 12.5.2.1.

12.5.2.2.1 Sample Collection. Follow the procedures for continuous sampling in ASTM D 270 or D 4177–95 (incorporated by reference—see §60.17) for each gross sample from each fuel lot.

12.5.2.2.2 Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of a product oil is the weight of product oil from one pretreatment facility and intended as one shipment (ship load, barge load, etc.). The lot size of raw oil is the weight of each crude liquid fuel type used to produce a lot of product oil.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.2.3 Sample Analysis. Use ASTM D 129–64, 78, or 95, ASTM D 1552–83 or 95, or ASTM D 4057–81 or 95 to determine the sulfur content (%S) and ASTM D 240–76 or 92 (all standards cited are incorporated by reference—see § 60.17) to determine the GCV of each gross sample. These values may be assumed to be on a dry basis. The owner or operator of an affected facility may elect to determine the GCV by sampling the oil combusted on the first steam generating unit operating day of each calendar month and then using the lowest GCV value of the three GCV values per quarter for the GCV of all oil combusted in that calendar quarter.

12.5.2.3 Use appropriate procedures, subject to the approval of the Administrator, to determine the fraction of total mass input derived from each type of fuel.

12.5.3 Control Device Removal Efficiency. Compute the percent removal efficiency ($\%R_g$) of the control device using the following equation:

$$\%R_g = 100\left(1.0 - \frac{E_{ao}}{E_{ai}}\right) \qquad \text{Eq. 19-24}$$

12.5.3.1 Use continuous emission monitoring systems or test methods, as appropriate, to determine the outlet SO_2 rates and, if appropriate, the inlet SO_2 rates. The rates may be determined as hourly (E_h) or other sampling period averages (E_d). Then, compute the average pollutant rates for the performance test period (E_{ao} and E_{ai}) using the procedures in section 12.4.

12.5.3.2 As an alternative, as-fired fuel sampling and analysis may be used to determine inlet SO_2 rates as follows:

12.5.3.2.1 Compute the average inlet SO_2 rate (E_{di}) for each sampling period using the following equation:

$$E_{di} = K\frac{\%S}{GCV} \qquad \text{Eq. 19-25}$$

Where:

$$K = 2\times10^7\left(\frac{\text{ng } SO_2}{\%S}\right)\left(\frac{(\text{kJ})}{\text{J}}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^4\left(\frac{\text{lb } SO_2}{\%S}\right)\left(\frac{\text{Btu}}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4 to determine the average inlet SO_2 rate for the performance test period (E_{ai}).

12.5.3.2.2 Collect the fuel samples from a location in the fuel handling system that provides a sample representative of the fuel bunkered or consumed during a steam generating unit operating day. For the purpose of as-fired fuel sampling under section 12.5.3.2 or section 12.6, the lot size for coal is the weight of coal bunkered or consumed during each steam generating unit operating day. The lot size for oil is the weight of oil supplied to the ‘‘day’’ tank or consumed during each steam generating unit operating day. For reporting and calculation purposes, the gross sample shall be identified with the calendar day on which sampling began. For steam generating unit operating days when a coal-fired steam generating unit is operated without coal being added to the bunkers, the coal analysis from the previous ‘‘as bunkered’’ coal sample shall be used until coal is bunkered again. For steam generating unit operating days when an oil-fired steam generating unit is operated without oil being added to the oil ‘‘day’’ tank, the oil analysis from the previous day shall be used until the ‘‘day’’ tank is filled again. Alternative definitions of fuel lot size may be used, subject to prior approval of the Administrator.

12.5.3.2.3 Use ASTM procedures specified in section 12.5.2.1 or 12.5.2.2 to determine %S and GCV.

12.5.4 Daily Geometric Average Percent Reduction from Hourly Values. The geometric average percent reduction ($\%R_{ga}$) is computed using the following equation:

$$\%R_{ga} = 100\left[1 - \text{EXP}\left(\frac{1}{n_t}\sum_{j=1}^{n_t} 1n\frac{E_{jo}}{E_{ji}}\right)\right] \qquad \text{Eq. 19-26}$$

NOTE: The calculation includes only paired data sets (hourly average) for the inlet and outlet pollutant measurements.

12.6 Sulfur Retention Credit for Compliance Fuel. If fuel sampling and analysis procedures in section 12.5.2.1 are being used to determine average SO_2 emission rates (E_{as}) to the atmosphere from a coal-fired steam generating unit when there is no SO_2 control device, the following equation may be used to adjust the emission rate for sulfur retention credits (no credits are allowed for oil-fired systems) (E_{di}) for each sampling period using the following equation:

$$E_{di} = 0.97K \frac{\%S}{GDV} \qquad \text{Eq. 19-27}$$

Where:

$$K = 2\times10^{7}\left(\frac{\text{ng } SO_2}{\%S}\right)\left(\frac{kJ}{J}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^{4}\left(\frac{\text{lb } SO_2}{\%S}\right)\left(\frac{Btu}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4.2 to determine the average SO_2 emission rate to the atmosphere for the performance test period (E_{ao}).

12.7 Determination of Compliance When Minimum Data Requirement Is Not Met.

12.7.1 Adjusted Emission Rates and Control Device Removal Efficiency. When the minimum data requirement is not met, the Administrator may use the following adjusted emission rates or control device removal efficiencies to determine compliance with the applicable standards.

12.7.1.1 Emission Rate. Compliance with the emission rate standard may be determined by using the lower confidence limit of the emission rate (E_{ao}*) as follows:

$$E_{ao}^{*} = E_{ao} - t_{0.95} S_o \qquad \text{Eq. 19-28}$$

12.7.1.2 Control Device Removal Efficiency. Compliance with the overall emission reduction ($\%R_o$) may be determined by using the lower confidence limit of the emission rate (E_{ao}*) and the upper confidence limit of the inlet pollutant rate (E_{ai}*) in calculating the control device removal efficiency ($\%R_g$) as follows:

$$\%R_g = 100\left(1.0 - \frac{E_{ao}^{*}}{E_{ai}^{*}}\right) \qquad \text{Eq. 19-29}$$

$$E_{ai}^{*} = E_{ai} + t_{0.95} S_i \qquad \text{Eq. 19-30}$$

12.7.2 Standard Deviation of Hourly Average Pollutant Rates. Compute the standard deviation (S_e) of the hourly average pollutant rates using the following equation:

$$S_e = \sqrt{\frac{1}{H} - \frac{1}{H_r}}\sqrt{\frac{\sum_{j=1}^{H}\left(E_{hj} - E_a\right)^2}{H-1}} \qquad \text{Eq. 19-31}$$

Equation 19–19 through 19–31 may be used to compute the standard deviation for both the outlet (S_o) and, if applicable, inlet (S_i) pollutant rates.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References [Reserved]

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION

From	To	Multiply by
g/scm	ng/scm	10^9
mg/scm	ng/scm	10^6
lb/scf	ng/scm	1.602×10^{13}

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION—Continued

From	To	Multiply by
ppm SO_2	ng/scm	2.66×10^6
ppm NO_X	ng/scm	1.912×10^6
ppm SO_2	lb/scf	1.660×10^{-7}
ppm NO_X	lb/scf	1.194×10^{-7}

TABLE 19–2—F FACTORS FOR VARIOUS FUELS[1]

Fuel Type	F_d		F_w		F_c	
	dscm/J	dscf/10^6 Btu	wscm/J	wscf/10^6 Btu	scm/J	scf/10^6 Btu
Coal:						
Anthracite[2]	2.71×10^{-7}	10,100	2.83×10^{-7}	10,540	0.530×10^{-7}	1,970
Bituminus[2]	2.63×10^{-7}	9,780	2.86×10^{-7}	10,640	0.484×10^{-7}	1,800
Lignite	2.65×10^{-7}	9,860	3.21×10^{-7}	11,950	0.513×10^{-7}	1,910
Oil[3]	2.47×10^{-7}	9,190	2.77×10^{-7}	10,320	0.383×10^{-7}	1,420
Gas:.						
Natural	2.34×10^{-7}	8,710	2.85×10^{-7}	10,610	0.287×10^{-7}	1,040
Propane	2.34×10^{-7}	8,710	2.74×10^{-7}	10,200	0.321×10^{-7}	1,190
Butane	2.34×10^{-7}	8,710	2.79×10^{-7}	10,390	0.337×10^{-7}	1,250
Wood	2.48×10^{-7}	9,240			0.492×10^{-7}	1,830
Wood Bark	2.58×10^{-7}	9,600			0.516×10^{-7}	1,920
Municipal	2.57×10^{-7}	9,570			0.488×10^{-7}	1,820
Solid Waste						

[1] Determined at standard conditions: 20 °C (68 °F) and 760 mm Hg (29.92 in Hg)
[2] As classified according to ASTM D 388.
[3] Crude, residual, or distillate.

TABLE 19–3—VALUES FOR $T_{0.95}$*

n[1]	$t_{0.95}$	n[1]	$t_{0.95}$	n[1]	$t_{0.95}$
2	6.31	8	1.89	22–26	1.71
3	2.42	9	1.86	27–31	1.70
4	2.35	10	1.83	32–51	1.68
5	2.13	11	1.81	52–91	1.67
6	2.02	12–16	1.77	92–151	1.66
7	1.94	17–21	1.73	152 or more	1.65

[1] The values of this table are corrected for n-1 degrees of freedom. Use n equal to the number (H) of hourly average data points.

METHOD 20—DETERMINATION OF NITROGEN OXIDES, SULFUR DIOXIDE, AND DILUENT EMISSIONS FROM STATIONARY GAS TURBINES

1.0 Scope and Application

What is Method 20?

Method 20 contains the details you must follow when using an instrumental analyzer to determine concentrations of nitrogen oxides, oxygen, carbon dioxide, and sulfur dioxide in the emissions from stationary gas turbines. This method follows the specific instructions for equipment and performance requirements, supplies, sample collection and analysis, calculations, and data analysis in the methods listed in section 2.0.

1.1 Analytes. What does this method determine?

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X) as nitrogen dioxide:	10102–43–9	Typically <2% of Calibration Span.
Nitric oxide (NO)	10102–44–0	
Nitrogen dioxide NO_2.		
Diluent oxygen (O_2) or carbon dioxide (CO_2)		Typically <2% of Calibration Span.
Sulfur dioxide (SO_X)	7446–09–5	Typically <2% of Calibration Span.

1.2 Applicability. When is this method required? The use of Method 20 may be required by specific New Source Performance Standards, Clean Air Marketing rules, and State Implementation Plans and permits where

measuring SO_2, NO_X, CO_2, and/or O_2 concentrations in stationary gas turbines emissions are required. Other regulations may also require its use.

1.3 Data Quality Objectives. How good must my collected data be? Refer to section 1.3 of Method 7E.

2.0 Summary of Method

In this method, NO_X, O_2 (or CO_2), and SO_X are measured using the following methods found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 3A—Determination of Oxygen and Carbon Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(c) Method 6C—Determination of Sulfur Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(d) Method 7E—Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(e) Method 19—Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates.

3.0 Definitions

Refer to section 3.0 of Method 7E for the applicable definitions.

4.0 Interferences

Refer to section 4.0 of Methods 3A, 6C, and 7E as applicable.

5.0 Safety

Refer to section 5.0 of Method 7E.

6.0 Equipment and Supplies

The measurement system design is shown in Figure 7E–1 of Method 7E. Refer to the appropriate methods listed in section 2.0 for equipment and supplies.

7.0 Reagents and Standards

Refer to the appropriate methods listed in section 2.0 for reagents and standards.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling Site and Sampling Points. Follow the procedures of section 8.1 of Method 7E. For the stratification test in section 8.1.2, determine the diluent-corrected pollutant concentration at each traverse point.

8.2 Initial Measurement System Performance Tests. You must refer to the appropriate methods listed in section 2.0 for the measurement system performance tests as applicable.

8.3 Interference Check. You must follow the procedures in section 8.3 of Method 3A or 6C, or section 8.2.7 of Method 7E (as appropriate).

8.4 Sample Collection. You must follow the procedures of section 8.4 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

8.5 Post-Run System Bias Check, Drift Assessment, and Alternative Dynamic Spike Procedure. You must follow the procedures of sections 8.5 and 8.6 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

9.0 Quality Control

Follow quality control procedures in section 9.0 of Method 7E.

10.0 Calibration and Standardization

Follow the procedures for calibration and standardization in section 10.0 of Method 7E.

11.0 Analytical Procedures

Because sample collection and analysis are performed together (see section 8), additional discussion of the analytical procedure is not necessary.

12.0 Calculations and Data Analysis

You must follow the procedures for calculations and data analysis in section 12.0 of the appropriate method listed in section 2.0. Follow the procedures in section 12.0 of Method 19 for calculating fuel-specific F factors, diluent-corrected pollutant concentrations, and emission rates.

13.0 Method Performance

The specifications for the applicable performance checks are the same as in section 13.0 of Method 7E.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures

Refer to section 16.0 of the appropriate method listed in section 2.0 for alternative procedures.

17.0 References

Refer to section 17.0 of the appropriate method listed in section 2.0 for references.

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Refer to section 18.0 of the appropriate method listed in section 2.0 for tables, diagrams, flowcharts, and validation data.

METHOD 21—DETERMINATION OF VOLATILE ORGANIC COMPOUND LEAKS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile Organic Compounds (VOC).	No CAS number assigned.

1.2 Scope. This method is applicable for the determination of VOC leaks from process equipment. These sources include, but are not limited to, valves, flanges and other connections, pumps and compressors, pressure relief devices, process drains, open-ended valves, pump and compressor seal system degassing vents, accumulator vessel vents, agitator seals, and access door seals.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A portable instrument is used to detect VOC leaks from individual sources. The instrument detector type is not specified, but it must meet the specifications and performance criteria contained in section 6.0. A leak definition concentration based on a reference compound is specified in each applicable regulation. This method is intended to locate and classify leaks only, and is not to be used as a direct measure of mass emission rate from individual sources.

3.0 Definitions

3.1 *Calibration gas* means the VOC compound used to adjust the instrument meter reading to a known value. The calibration gas is usually the reference compound at a known concentration approximately equal to the leak definition concentration.

3.2 *Calibration precision* means the degree of agreement between measurements of the same known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration.

3.3 *Leak definition concentration* means the local VOC concentration at the surface of a leak source that indicates that a VOC emission (leak) is present. The leak definition is an instrument meter reading based on a reference compound.

3.4 *No detectable emission* means a local VOC concentration at the surface of a leak source, adjusted for local VOC ambient concentration, that is less than 2.5 percent of the specified leak definition concentration. that indicates that a VOC emission (leak) is not present.

3.5 *Reference compound* means the VOC species selected as the instrument calibration basis for specification of the leak definition concentration. (For example, if a leak definition concentration is 10,000 ppm as methane, then any source emission that results in a local concentration that yields a meter reading of 10,000 on an instrument meter calibrated with methane would be classified as a leak. In this example, the leak definition concentration is 10,000 ppm and the reference compound is methane.)

3.6 *Response factor* means the ratio of the known concentration of a VOC compound to the observed meter reading when measured using an instrument calibrated with the reference compound specified in the applicable regulation.

3.7 *Response time* means the time interval from a step change in VOC concentration at the input of the sampling system to the time at which 90 percent of the corresponding final value is reached as displayed on the instrument readout meter.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Pollutants. Several of the compounds, leaks of which may be determined by this method, may be irritating or corrosive to tissues (*e.g.*, heptane) or may be toxic (*e.g.*, benzene, methyl alcohol). Nearly all are fire hazards. Compounds in emissions should be determined through familiarity with the source. Appropriate precautions can be found in reference documents, such as reference No. 4 in section 16.0.

6.0 Equipment and Supplies

A VOC monitoring instrument meeting the following specifications is required:

6.1 The VOC instrument detector shall respond to the compounds being processed. Detector types that may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption, and photoionization.

6.2 The instrument shall be capable of measuring the leak definition concentration specified in the regulation.

6.3 The scale of the instrument meter shall be readable to ±2.5 percent of the specified leak definition concentration.

6.4 The instrument shall be equipped with an electrically driven pump to ensure that a sample is provided to the detector at a constant flow rate. The nominal sample flow rate, as measured at the sample probe tip, shall be 0.10 to 3.0 l/min (0.004 to 0.1 ft^3/min) when the probe is fitted with a glass wool plug or filter that may be used to prevent plugging of the instrument.

6.5 The instrument shall be equipped with a probe or probe extension or sampling not to exceed 6.4 mm (¼ in) in outside diameter,

with a single end opening for admission of sample.

6.6 The instrument shall be intrinsically safe for operation in explosive atmospheres as defined by the National Electrical Code by the National Fire Prevention Association or other applicable regulatory code for operation in any explosive atmospheres that may be encountered in its use. The instrument shall, at a minimum, be intrinsically safe for Class 1, Division 1 conditions, and/or Class 2, Division 1 conditions, as appropriate, as defined by the example code. The instrument shall not be operated with any safety device, such as an exhaust flame arrestor, removed.

7.0 Reagents and Standards

7.1 Two gas mixtures are required for instrument calibration and performance evaluation:

7.1.1 Zero Gas. Air, less than 10 parts per million by volume (ppmv) VOC.

7.1.2 Calibration Gas. For each organic species that is to be measured during individual source surveys, obtain or prepare a known standard in air at a concentration approximately equal to the applicable leak definition specified in the regulation.

7.2 Cylinder Gases. If cylinder calibration gas mixtures are used, they must be analyzed and certified by the manufacturer to be within 2 percent accuracy, and a shelf life must be specified. Cylinder standards must be either reanalyzed or replaced at the end of the specified shelf life.

7.3 Prepared Gases. Calibration gases may be prepared by the user according to any accepted gaseous preparation procedure that will yield a mixture accurate to within 2 percent. Prepared standards must be replaced each day of use unless it is demonstrated that degradation does not occur during storage.

7.4 Mixtures with non-Reference Compound Gases. Calibrations may be performed using a compound other than the reference compound. In this case, a conversion factor must be determined for the alternative compound such that the resulting meter readings during source surveys can be converted to reference compound results.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Instrument Performance Evaluation. Assemble and start up the instrument according to the manufacturer's instructions for recommended warmup period and preliminary adjustments.

8.1.1 Response Factor. A response factor must be determined for each compound that is to be measured, either by testing or from reference sources. The response factor tests are required before placing the analyzer into service, but do not have to be repeated at subsequent intervals.

8.1.1.1 Calibrate the instrument with the reference compound as specified in the applicable regulation. Introduce the calibration gas mixture to the analyzer and record the observed meter reading. Introduce zero gas until a stable reading is obtained. Make a total of three measurements by alternating between the calibration gas and zero gas. Calculate the response factor for each repetition and the average response factor.

8.1.1.2 The instrument response factors for each of the individual VOC to be measured shall be less than 10 unless otherwise specified in the applicable regulation. When no instrument is available that meets this specification when calibrated with the reference VOC specified in the applicable regulation, the available instrument may be calibrated with one of the VOC to be measured, or any other VOC, so long as the instrument then has a response factor of less than 10 for each of the individual VOC to be measured.

8.1.1.3 Alternatively, if response factors have been published for the compounds of interest for the instrument or detector type, the response factor determination is not required, and existing results may be referenced. Examples of published response factors for flame ionization and catalytic oxidation detectors are included in References 1–3 of section 17.0.

8.1.2 Calibration Precision. The calibration precision test must be completed prior to placing the analyzer into service and at subsequent 3-month intervals or at the next use, whichever is later.

8.1.2.1 Make a total of three measurements by alternately using zero gas and the specified calibration gas. Record the meter readings. Calculate the average algebraic difference between the meter readings and the known value. Divide this average difference by the known calibration value and multiply by 100 to express the resulting calibration precision as a percentage.

8.1.2.2 The calibration precision shall be equal to or less than 10 percent of the calibration gas value.

8.1.3 Response Time. The response time test is required before placing the instrument into service. If a modification to the sample pumping system or flow configuration is made that would change the response time, a new test is required before further use.

8.1.3.1 Introduce zero gas into the instrument sample probe. When the meter reading has stabilized, switch quickly to the specified calibration gas. After switching, measure the time required to attain 90 percent of the final stable reading. Perform this test sequence three times and record the results. Calculate the average response time.

8.1.3.2 The instrument response time shall be equal to or less than 30 seconds. The instrument pump, dilution probe (if any), sample probe, and probe filter that will be used

during testing shall all be in place during the response time determination.

8.2 Instrument Calibration. Calibrate the VOC monitoring instrument according to section 10.0.

8.3 Individual Source Surveys.

8.3.1 Type I—Leak Definition Based on Concentration. Place the probe inlet at the surface of the component interface where leakage could occur. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained. Leave the probe inlet at this maximum reading location for approximately two times the instrument response time. If the maximum observed meter reading is greater than the leak definition in the applicable regulation, record and report the results as specified in the regulation reporting requirements. Examples of the application of this general technique to specific equipment types are:

8.3.1.1 Valves. The most common source of leaks from valves is the seal between the stem and housing. Place the probe at the interface where the stem exits the packing gland and sample the stem circumference. Also, place the probe at the interface of the packing gland take-up flange seat and sample the periphery. In addition, survey valve housings of multipart assembly at the surface of all interfaces where a leak could occur.

8.3.1.2 Flanges and Other Connections. For welded flanges, place the probe at the outer edge of the flange-gasket interface and sample the circumference of the flange. Sample other types of nonpermanent joints (such as threaded connections) with a similar traverse.

8.3.1.3 Pumps and Compressors. Conduct a circumferential traverse at the outer surface of the pump or compressor shaft and seal interface. If the source is a rotating shaft, position the probe inlet within 1 cm of the shaft-seal interface for the survey. If the housing configuration prevents a complete traverse of the shaft periphery, sample all accessible portions. Sample all other joints on the pump or compressor housing where leakage could occur.

8.3.1.4 Pressure Relief Devices. The configuration of most pressure relief devices prevents sampling at the sealing seat interface. For those devices equipped with an enclosed extension, or horn, place the probe inlet at approximately the center of the exhaust area to the atmosphere.

8.3.1.5 Process Drains. For open drains, place the probe inlet at approximately the center of the area open to the atmosphere. For covered drains, place the probe at the surface of the cover interface and conduct a peripheral traverse.

8.3.1.6 Open-ended Lines or Valves. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.7 Seal System Degassing Vents and Accumulator Vents. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.8 Access door seals. Place the probe inlet at the surface of the door seal interface and conduct a peripheral traverse.

8.3.2 Type II—''No Detectable Emission''. Determine the local ambient VOC concentration around the source by moving the probe randomly upwind and downwind at a distance of one to two meters from the source. If an interference exists with this determination due to a nearby emission or leak, the local ambient concentration may be determined at distances closer to the source, but in no case shall the distance be less than 25 centimeters. Then move the probe inlet to the surface of the source and determine the concentration as outlined in section 8.3.1. The difference between these concentrations determines whether there are no detectable emissions. Record and report the results as specified by the regulation. For those cases where the regulation requires a specific device installation, or that specified vents be ducted or piped to a control device, the existence of these conditions shall be visually confirmed. When the regulation also requires that no detectable emissions exist, visual observations and sampling surveys are required. Examples of this technique are:

8.3.2.1 Pump or Compressor Seals. If applicable, determine the type of shaft seal. Perform a survey of the local area ambient VOC concentration and determine if detectable emissions exist as described in section 8.3.2.

8.3.2.2 Seal System Degassing Vents, Accumulator Vessel Vents, Pressure Relief Devices. If applicable, observe whether or not the applicable ducting or piping exists. Also, determine if any sources exist in the ducting or piping where emissions could occur upstream of the control device. If the required ducting or piping exists and there are no sources where the emissions could be vented to the atmosphere upstream of the control device, then it is presumed that no detectable emissions are present. If there are sources in the ducting or piping where emissions could be vented or sources where leaks could occur, the sampling surveys described in section 8.3.2 shall be used to determine if detectable emissions exist.

8.3.3 Alternative Screening Procedure.

8.3.3.1 A screening procedure based on the formation of bubbles in a soap solution that is sprayed on a potential leak source may be used for those sources that do not have continuously moving parts, that do not have surface temperatures greater than the boiling point or less than the freezing point of the soap solution, that do not have open

areas to the atmosphere that the soap solution cannot bridge, or that do not exhibit evidence of liquid leakage. Sources that have these conditions present must be surveyed using the instrument technique of section 8.3.1 or 8.3.2.

8.3.3.2 Spray a soap solution over all potential leak sources. The soap solution may be a commercially available leak detection solution or may be prepared using concentrated detergent and water. A pressure sprayer or squeeze bottle may be used to dispense the solution. Observe the potential leak sites to determine if any bubbles are formed. If no bubbles are observed, the source is presumed to have no detectable emissions or leaks as applicable. If any bubbles are observed, the instrument techniques of section 8.3.1 or 8.3.2 shall be used to determine if a leak exists, or if the source has detectable emissions, as applicable.

9.0 Quality Control

Section	Quality control measure	Effect
8.1.2	Instrument calibration precision check	Ensure precision and accuracy, respectively, of instrument response to standard.
10.0	Instrument calibration.	

10.0 Calibration and Standardization

10.1 Calibrate the VOC monitoring instrument as follows. After the appropriate warmup period and zero internal calibration procedure, introduce the calibration gas into the instrument sample probe. Adjust the instrument meter readout to correspond to the calibration gas value.

NOTE: If the meter readout cannot be adjusted to the proper value, a malfunction of the analyzer is indicated and corrective actions are necessary before use.

11.0 Analytical Procedures [Reserved]

12.0 Data Analyses and Calculations [Reserved]

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Dubose, D.A., and G.E. Harris. Response Factors of VOC Analyzers at a Meter Reading of 10,000 ppmv for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81051. September 1981.

2. Brown, G.E., *et al.* Response Factors of VOC Analyzers Calibrated with Methane for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–022. May 1981.

3. DuBose, D.A. *et al.* Response of Portable VOC Analyzers to Chemical Mixtures. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–110. September 1981.

4. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 22—VISUAL DETERMINATION OF FUGITIVE EMISSIONS FROM MATERIAL SOURCES AND SMOKE EMISSIONS FROM FLARES

NOTE: This method is not inclusive with respect to observer certification. Some material is incorporated by reference from Method 9.

1.0 Scope and Application

This method is applicable for the determination of the frequency of fugitive emissions from stationary sources, only as specified in an applicable subpart of the regulations. This method also is applicable for the determination of the frequency of visible smoke emissions from flares.

2.0 Summary of Method

2.1 Fugitive emissions produced during material processing, handling, and transfer operations or smoke emissions from flares are visually determined by an observer without the aid of instruments.

2.2 This method is used also to determine visible smoke emissions from flares used for combustion of waste process materials.

2.3 This method determines the amount of time that visible emissions occur during the observation period (*i.e.*, the accumulated emission time). This method does not require that the opacity of emissions be determined. Since this procedure requires only the determination of whether visible emissions occur and does not require the determination of opacity levels, observer certification according to the procedures of Method 9 is not required. However, it is necessary that the observer is knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative

to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in References 1 and 2 or from the lecture portion of the Method 9 certification course.

3.0 Definitions

3.1 *Emission frequency* means the percentage of time that emissions are visible during the observation period.

3.2 *Emission time* means the accumulated amount of time that emissions are visible during the observation period.

3.3 *Fugitive emissions* means emissions generated by an affected facility which is not collected by a capture system and is released to the atmosphere. This includes emissions that (1) escape capture by process equipment exhaust hoods; (2) are emitted during material transfer; (3) are emitted from buildings housing material processing or handling equipment; or (4) are emitted directly from process equipment.

3.4 *Observation period* means the accumulated time period during which observations are conducted, not to be less than the period specified in the applicable regulation.

3.5 *Smoke emissions* means a pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission.

4.0 Interferences

4.1 Occasionally, fugitive emissions from sources other than the affected facility (*e.g.*, road dust) may prevent a clear view of the affected facility. This may particularly be a problem during periods of high wind. If the view of the potential emission points is obscured to such a degree that the observer questions the validity of continuing observations, then the observations shall be terminated, and the observer shall clearly note this fact on the data form.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment

6.1 Stopwatches (two). Accumulative type with unit divisions of at least 0.5 seconds.

6.2 Light Meter. Light meter capable of measuring illuminance in the 50 to 200 lux range, required for indoor observations only.

7.0 Reagents and Supplies [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transfer [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

11.1 Selection of Observation Location. Survey the affected facility, or the building or structure housing the process to be observed, and determine the locations of potential emissions. If the affected facility is located inside a building, determine an observation location that is consistent with the requirements of the applicable regulation (*i.e.*, outside observation of emissions escaping the building/structure or inside observation of emissions directly emitted from the affected facility process unit). Then select a position that enables a clear view of the potential emission point(s) of the affected facility or of the building or structure housing the affected facility, as appropriate for the applicable subpart. A position at least 4.6 m (15 feet), but not more than 400 m (0.25 miles), from the emission source is recommended. For outdoor locations, select a position where the sunlight is not shining directly in the observer's eyes.

11.2 Field Records.

11.2.1 Outdoor Location. Record the following information on the field data sheet (Figure 22–1): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record also the estimated wind speed, wind direction, and sky condition. Sketch the process unit being observed, and note the observer location relative to the source and the sun. Indicate the potential and actual emission points on the sketch.

11.2.2 Indoor Location. Record the following information on the field data sheet (Figure 22–2): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record as appropriate the type, location, and intensity of lighting on the data sheet. Sketch the process unit being observed, and note the observer location relative to the source. Indicate the potential and actual fugitive emission points on the sketch.

11.3 Indoor Lighting Requirements. For indoor locations, use a light meter to measure the level of illumination at a location as close to the emission source(s) as is feasible. An illumination of greater than 100 lux (10 foot candles) is considered necessary for proper application of this method.

11.4 Observations.

11.4.1 Procedure. Record the clock time when observations begin. Use one stopwatch to monitor the duration of the observation

period. Start this stopwatch when the observation period begins. If the observation period is divided into two or more segments by process shutdowns or observer rest breaks (see section 11.4.3), stop the stopwatch when a break begins and restart the stopwatch without resetting it when the break ends. Stop the stopwatch at the end of the observation period. The accumulated time indicated by this stopwatch is the duration of observation period. When the observation period is completed, record the clock time. During the observation period, continuously watch the emission source. Upon observing an emission (condensed water vapor is not considered an emission), start the second accumulative stopwatch; stop the watch when the emission stops. Continue this procedure for the entire observation period. The accumulated elapsed time on this stopwatch is the total time emissions were visible during the observation period (*i.e.,* the emission time.)

11.4.2 Observation Period. Choose an observation period of sufficient length to meet the requirements for determining compliance with the emission standard in the applicable subpart of the regulations. When the length of the observation period is specifically stated in the applicable subpart, it may not be necessary to observe the source for this entire period if the emission time required to indicate noncompliance (based on the specified observation period) is observed in a shorter time period. In other words, if the regulation prohibits emissions for more than 6 minutes in any hour, then observations may (optional) be stopped after an emission time of 6 minutes is exceeded. Similarly, when the regulation is expressed as an emission frequency and the regulation prohibits emissions for greater than 10 percent of the time in any hour, then observations may (optional) be terminated after 6 minutes of emission are observed since 6 minutes is 10 percent of an hour. In any case, the observation period shall not be less than 6 minutes in duration. In some cases, the process operation may be intermittent or cyclic. In such cases, it may be convenient for the observation period to coincide with the length of the process cycle.

11.4.3 Observer Rest Breaks. Do not observe emissions continuously for a period of more than 15 to 20 minutes without taking a rest break. For sources requiring observation periods of greater than 20 minutes, the observer shall take a break of not less than 5 minutes and not more than 10 minutes after every 15 to 20 minutes of observation. If continuous observations are desired for extended time periods, two observers can alternate between making observations and taking breaks.

11.5 Recording Observations. Record the accumulated time of the observation period on the data sheet as the observation period duration. Record the accumulated time emissions were observed on the data sheet as the emission time. Record the clock time the observation period began and ended, as well as the clock time any observer breaks began and ended.

12.0 Data Analysis and Calculations

If the applicable subpart requires that the emission rate be expressed as an emission frequency (in percent), determine this value as follows: Divide the accumulated emission time (in seconds) by the duration of the observation period (in seconds) or by any minimum observation period required in the applicable subpart, if the actual observation period is less than the required period, and multiply this quotient by 100.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

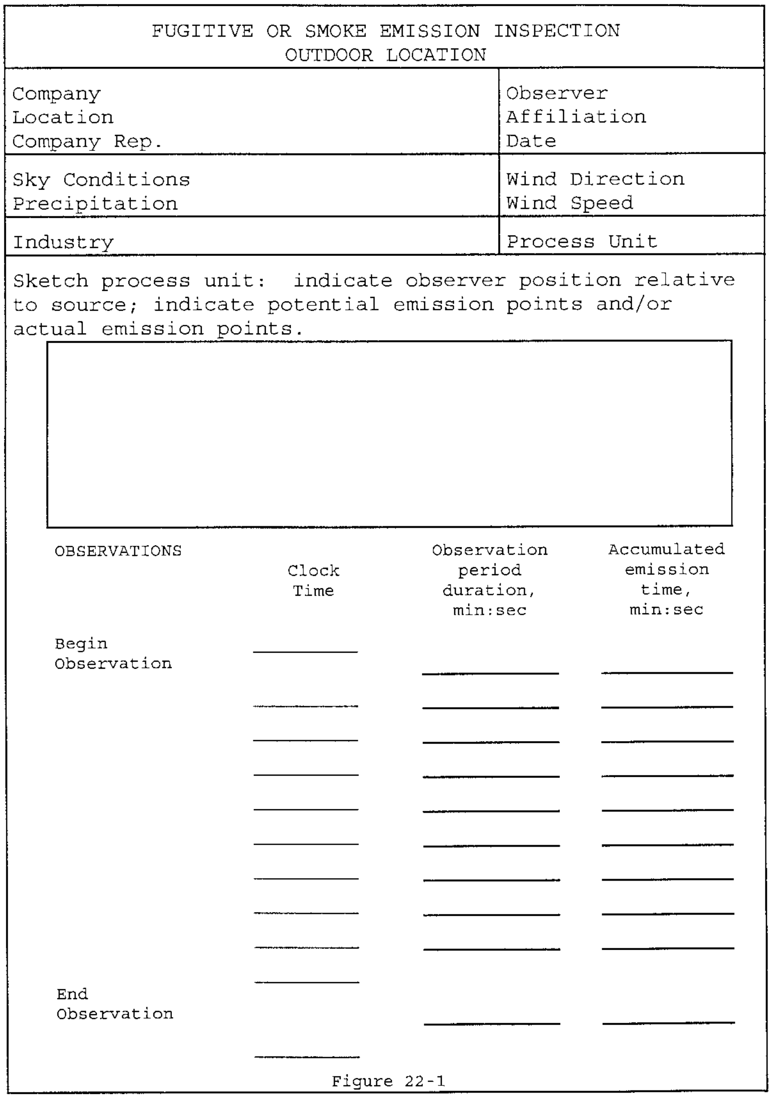
15.0 Waste Management [Reserved]

16.0 References

1. Missan, R., and A. Stein. Guidelines for Evaluation of Visible Emissions Certification, Field Procedures, Legal Aspects, and Background Material. EPA Publication No. EPA–340/1–75–007. April 1975.

2. Wohlschlegel, P., and D.E. Wagoner. Guideline for Development of a Quality Assurance Program: Volume IX—Visual Determination of Opacity Emissions from Stationary Sources. EPA Publication No. EPA–650/4–74–005i. November 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data



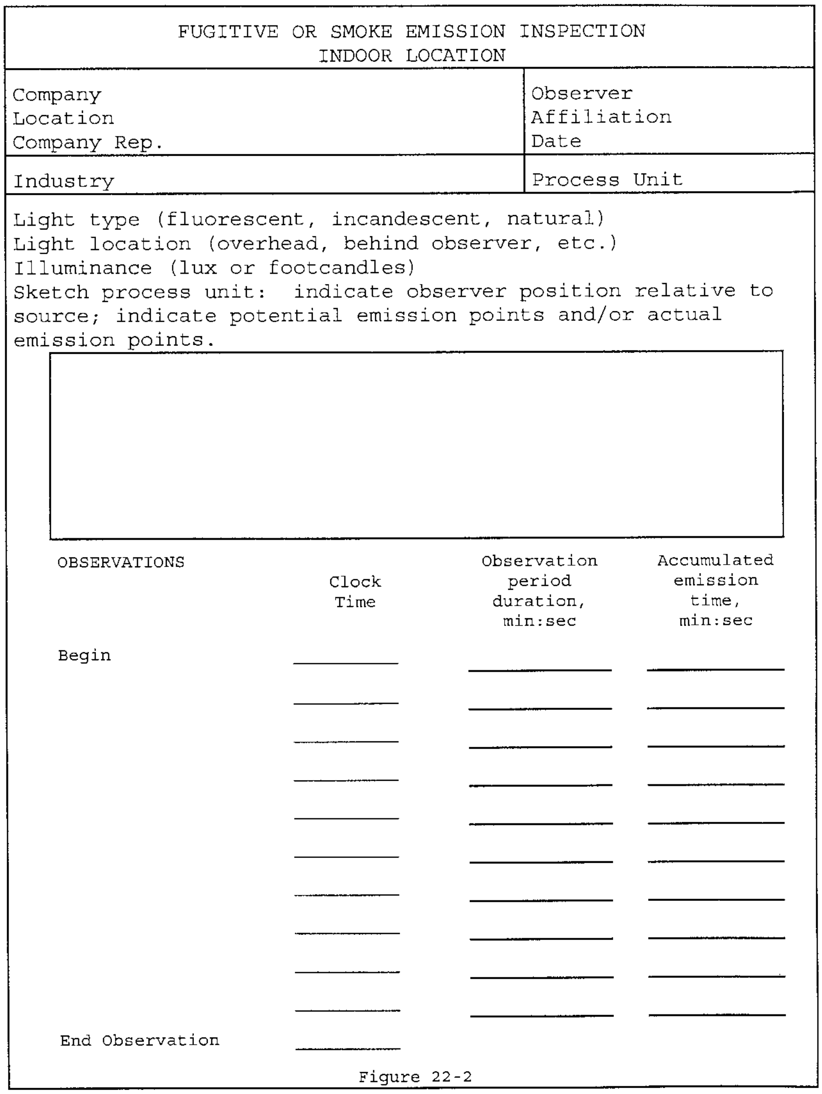
FUGITIVE OR SMOKE EMISSION INSPECTION
OUTDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Sky Conditions Precipitation	Wind Direction Wind Speed
Industry	Process Unit

Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin Observation			
End Observation			

Figure 22-1



FUGITIVE OR SMOKE EMISSION INSPECTION
INDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Industry	Process Unit

Light type (fluorescent, incandescent, natural)
Light location (overhead, behind observer, etc.)
Illuminance (lux or footcandles)
Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin			
End Observation			

Figure 22-2

METHOD 23—DETERMINATION OF POLYCHLORINATED DIBENZO-P-DIOXINS AND POLYCHLORINATED DIBENZOFURANS FROM STATIONARY SOURCES

1. Applicability and Principle

1.1 Applicability. This method is applicable to the determination of polychlorinated dibenzo-p-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) from stationary sources.

1.2 Principle. A sample is withdrawn from the gas stream isokinetically and collected in the sample probe, on a glass fiber filter, and on a packed column of adsorbent material. The sample cannot be separated into a particle vapor fraction. The PCDD's and

PCDF's are extracted from the sample, separated by high resolution gas chromatography, and measured by high resolution mass spectrometry.

2. Apparatus

2.1 Sampling. A schematic of the sampling train used in this method is shown in Figure 23–1. Sealing greases may not be used in assembling the train. The train is identical to that described in section 2.1 of Method 5 of this appendix with the following additions:

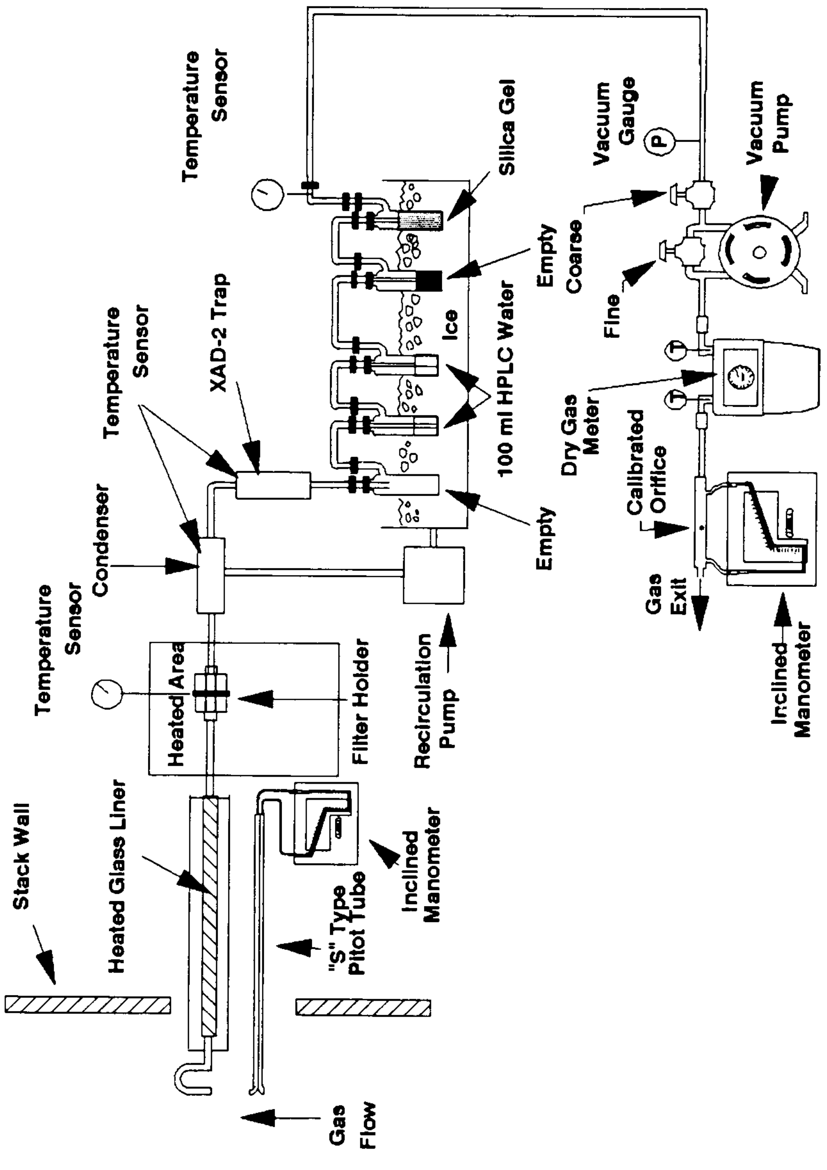


Figure 23.1 Sampling train

2.1.1 Nozzle. The nozzle shall be made of nickel, nickel-plated stainless steel, quartz, or borosilicate glass.

2.1.2 Sample Transfer Lines. The sample transfer lines, if needed, shall be heat traced, heavy walled TFE (½ in. OD with ⅛ in. wall) with connecting fittings that are capable of forming leak-free, vacuum-tight connections without using sealing greases. The line shall be as short as possible and must be maintained at 120 °C.

2.1.1 Filter Support. Teflon or Teflon-coated wire.

2.1.2 Condenser. Glass, coil type with compatible fittings. A schematic diagram is shown in Figure 23–2.

2.1.3 Water Bath. Thermostatically controlled to maintain the gas temperature exiting the condenser at <20 °C (68 °F).

2.1.4 Adsorbent Module. Glass container to hold the solid adsorbent. A shematic diagram is shown in Figure 23–2. Other physical configurations of the resin trap/condenser assembly are acceptable. The connecting fittings shall form leak-free, vacuum tight seals. No sealant greases shall be used in the sampling train. A coarse glass frit is included to retain the adsorbent.

2.2 Sample Recovery.

2.2.1 Fitting Caps. Ground glass, Teflon tape, or aluminum foil (Section 2.2.6) to cap off the sample exposed sections of the train.

2.2.2 Wash Bottles. Teflon, 500-ml.

2.2.3 Probe-Liner Probe-Nozzle, and Filter-Holder Brushes. Inert bristle brushes with precleaned stainless steel or Teflon handles. The probe brush shall have extensions of stainless steel or Teflon, at least as long as the probe. The brushes shall be properly sized and shaped to brush out the nozzle, probe liner, and transfer line, if used.

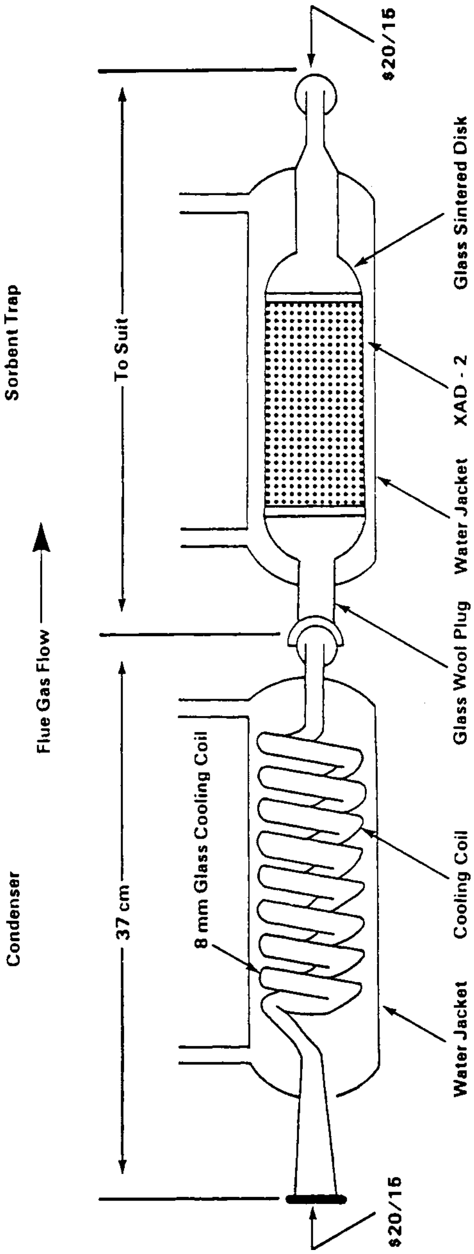


Figure 23.2. Condenser and adsorbent trap

2.2.4 Filter Storage Container. Sealed filter holder, wide-mouth amber glass jar with Teflon-lined cap, or glass petri dish.

2.2.5 Balance. Triple beam.

2.2.6 Aluminum Foil. Heavy duty, hexane-rinsed.

2.2.7 Storage Container. Air-tight container to store silica gel.

2.2.8 Graduated Cylinder. Glass, 250-ml with 2-ml graduation.

2.2.9 Glass Sample Storage Container. Amber glass bottle for sample glassware washes, 500- or 1000-ml, with leak free Teflon-lined caps.

2.3 Analysis.

2.3.1 Sample Container. 125- and 250-ml flint glass bottles with Teflon-lined caps.

2.3.2 Test Tube. Glass.

2.3.3 Soxhlet Extraction Apparatus. Capable of holding 43 × 123 mm extraction thimbles.

2.3.4 Extraction Thimble. Glass, precleaned cellulosic, or glass fiber.

2.3.5 Pasteur Pipettes. For preparing liquid chromatographic columns.

2.3.6 Reacti-vials. Amber glass, 2-ml, silanized prior to use.

2.3.7 Rotary Evaporator. Buchi/Brinkman RF–121 or equivalent.

2.3.8 Nitrogen Evaporative Concentrator. N-Evap Analytical Evaporator Model III or equivalent.

2.3.9 Separatory Funnels. Glass, 2-liter.

2.3.10 Gas Chromatograph. Consisting of the following components:

2.3.10.1 Oven. Capable of maintaining the separation column at the proper operating temperature ±°C and performing programmed increases in temperature at rates of at least 40 °C/min.

2.3.10.2 Temperature Gauge. To monitor column oven, detector, and exhaust temperatures ±1 °C.

2.3.10.3 Flow System. Gas metering system to measure sample, fuel, combustion gas, and carrier gas flows.

2.3.10.4 Capillary Columns. A fused silica column, 60 × 0.25 mm inside diameter (ID), coated with DB–5 and a fused silica column, 30 m × 0.25 mm ID coated with DB–225. Other column systems may be used provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

2.3.11 Mass Spectrometer. Capable of routine operation at a resolution of 1:10000 with a stability of ±5 ppm.

2.3.12 Data System. Compatible with the mass spectrometer and capable of monitoring at least five groups of 25 ions.

2.3.13 Analytical Balance. To measure within 0.1 mg.

3. Reagents

3.1 Sampling.

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Standard Method D 2986–71 (Reapproved 1978) (incorporated by reference—see §60.17).

3.1.1.1 Precleaning. All filters shall be cleaned before their initial use. Place a glass extraction thimble and 1 g of silica gel and a plug of glass wool into a Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Place no more than 50 filters in the thimble onto the silica gel bed and top with the cleaned glass wool. Charge the Soxhlet with toluene and reflux for 16 hours. After extraction, allow the Soxhlet to cool, remove the filters, and dry them under a clean N_2 stream. Store the filters in a glass petri dish sealed with Teflon tape.

3.1.2 Adsorbent Resin. Amberlite XAD–2 resin. Thoroughly cleaned before initial use.

3.1.2.1 Cleaning Procedure. This procedure may be carried out in a giant Soxhlet extractor. An all-glass filter thimble containing an extra-course frit is used for extraction of XAD–2. The frit is recessed 10–15 mm above a crenelated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass wool plug and a stainless steel ring because it floats on methylene chloride. This process involves sequential extraction in the following order.

Solvent	Procedure
Water	Initial rinse: Place resin in a beaker, rinse once with water, and discard. Fill with water a second time, let stand overnight, and discard.
Water	Extract with water for 8 hours.
Methanol	Extract for 22 hours.
Methylene Chloride	Extract for 22 hours.
Toluene	Extract for 22 hours.

3.1.2.2 Drying.

3.1.2.2.1 Drying Column. Pyrex pipe, 10.2 cm ID by 0.6 m long, with suitable retainers.

3.1.2.2.2 Procedure. The adsorbent must be dried with clean inert gas. Liquid nitrogen from a standard commercial liquid nitrogen cylinder has proven to be a reliable source of large volumes of gas free from organic contaminants. Connect the liquid nitrogen cylinder to the column by a length of cleaned copper tubing, 0.95 cm ID, coiled to pass through a heat source. A convenient heat source is a water-bath heated from a steam line. The final nitrogen temperature should only be warm to the touch and not over 40 °C. Continue flowing nitrogen through the adsorbent until all the residual solvent is removed. The flow rate should be sufficient to gently agitate the particles but not so excessive as the cause the particles to fracture.

3.1.2.3 Quality Control Check. The adsorbent must be checked for residual toluene.

3.1.2.3.1 Extraction. Weigh 1.0 g sample of dried resin into a small vial, add 3 ml of toluene, cap the vial, and shake it well.

3.1.2.3.2 Analysis. Inject a 2 µl sample of the extract into a gas chromatograph operated under the following conditions:

Column: 6 ft × ⅛ in stainless steel containing 10 percent OV–101 on 100/120 Supelcoport.
Carrier Gas: Helium at a rate of 30 ml/min.
Detector: Flame ionization detector operated at a sensitivity of 4×10^{-11} A/mV.
Injection Port Temperature: 250 °C.
Detector Temperature: 305 °C.
Oven Temperature: 30 °C for 4 min; programmed to rise at 40 °C/min until it reaches 250 °C; return to 30 °C after 17 minutes.

Compare the results of the analysis to the results from the reference solution. Prepare the reference solution by injection 2.5 µl of methylene chloride into 100 ml of toluene. This corresponds to 100 µg of methylene chloride per g of adsorbent. The maximum acceptable concentration is 1000 µg/g of adsorbent. If the adsorbent exceeds this level, drying must be continued until the excess methylene chloride is removed.

3.1.2.4 Storage. The adsorbent must be used within 4 weeks of cleaning. After cleaning, it may be stored in a wide mouth amber glass container with a Teflon-lined cap or placed in one of the glass adsorbent modules tightly sealed with glass stoppers. If precleaned adsorbent is purchased in sealed containers, it must be used within 4 weeks after the seal is broken.

3.1.3 Glass Wool. Cleaned by sequential immersion in three aliquots of methylene chloride, dried in a 110 °C oven, and stored in a methylene chloride-washed glass jar with a Teflon-lined screw cap.

3.1.4 Water. Deionized distilled and stored in a methylene chloride-rinsed glass container with a Teflon-lined screw cap.

3.1.5 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175 °C (350 °F) for two hours. New silica gel may be used as received. Alternately other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.6 Chromic Acid Cleaning Solution. Dissolve 20 g of sodium dichromate in 15 ml of water, and then carefully add 400 ml of concentrated sulfuric acid.

3.2 Sample Recovery.

3.2.2 Acetone. Pesticide quality.

3.2.2 Methylene Chloride. Pesticide qualtity.

3.2.3 Toluene. Pesticide quality.

3.3 Analysis.

3.3.1 Potassium Hydroxide. ACS grade, 2-percent (weight/volume) in water.

3.3.2 Sodium Sulfate. Granulated, reagent grade. Purify prior to use by rinsing with methylene chloride and oven drying. Store the cleaned material in a glass container with a Teflon-lined screw cap.

3.3.3 Sulfuric Acid. Reagent grade.

3.3.4 Sodium Hydroxide. 1.0 N. Weigh 40 g of sodium hydroxide into a 1-liter volumetric flask. Dilute to 1 liter with water.

3.3.5 Hexane. Pesticide grade.

3.3.6 Methylene Chloride. Pesticide grade.

3.3.7 Benzene. Pesticide Grade.

3.3.8 Ethyl Acetate.

3.3.9 Methanol. Pesticide Grade.

3.3.10 Toluene. Pesticide Grade.

3.3.11 Nonane. Pesticide Grade.

3.3.12 Cyclohexane. Pesticide Grade.

3.3.13 Basic Alumina. Activity grade 1, 100–200 mesh. Prior to use, activate the alumina by heating for 16 hours at 130 °C before use. Store in a desiccator. Pre-activated alumina may be purchased from a supplier and may be used as received.

3.3.14 Silica Gel. Bio-Sil A, 100–200 mesh. Prior to use, activate the silica gel by heating for at least 30 minutes at 180 °C. After cooling, rinse the silica gel sequentially with methanol and methylene chloride. Heat the rinsed silica gel at 50 °C for 10 minutes, then increase the temperature gradually to 180 °C over 25 minutes and maintain it at this temperature for 90 minutes. Cool at room temperature and store in a glass container with a Teflon-lined screw cap.

3.3.15 Silica Gel Impregnated with Sulfuric Acid. Combine 100 g of silica gel with 44 g of concentrated sulfuric acid in a screw capped glass bottle and agitate thoroughly. Disperse the solids with a stirring rod until a uniform mixture is obtained. Store the mixture in a glass container with a Teflon-lined screw cap.

3.3.16 Silica Gel Impregnated with Sodium Hydroxide. Combine 39 g of 1 N sodium hydroxide with 100 g of silica gel in a screw capped glass bottle and agitate thoroughly. Disperse solids with a stirring rod until a uniform mixture is obtained. Store the mixture in glass container with a Teflon-lined screw cap.

3.3.17 Carbon/Celite. Combine 10.7 g of AX–21 carbon with 124 g of Celite 545 in a 250-ml glass bottle with a Teflon-lined screw cap. Agitate the mixture thoroughly until a uniform mixture is obtained. Store in the glass container.

3.3.18 Nitrogen. Ultra high purity.

3.3.19 Hydrogen. Ultra high purity.

3.3.20 Internal Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Internal Standards'' in 10 ml of nonane.

3.3.21 Surrogate Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Surrogate Standards'' in 10 ml of nonane.

3.3.22 Recovery Standard Solution. Prepare a stock standard solution containing the

isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Recovery Standards'' in 10 ml of nonane.

4. Procedure

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation.

4.1.1.1 Cleaning Glassware. All glass components of the train upstream of and including the adsorbent module, shall be cleaned as described in section 3A of the ''Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.'' Special care shall be devoted to the removal of residual silicone grease sealants on ground glass connections of used glassware. Any residue shall be removed by soaking the glassware for several hours in a chromic acid cleaning solution prior to cleaning as described above.

4.1.1.2 Adsorbent Trap. The traps must be loaded in a clean area to avoid contamination. They may not be loaded in the field. Fill a trap with 20 to 40 g of XAD–2. Follow the XAD–2 with glass wool and tightly cap both ends of the trap. Add 100 µl of the surrogate standard solution (section 3.3.21) to each trap.

4.1.1.3 Sample Train. It is suggested that all components be maintained according to the procedure described in APTD–0576. Alternative mercury-free thermometers may be used if the thermometers are, at a minimum, equivalent in terms of performance or suitably effective for the specific temperature measurement application.

4.1.1.4 Silica Gel. Weigh several 200 to 300 g portions of silica gel in an air tight container to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel may be weighed directly in its impinger or sampling holder just prior to sampling.

4.1.1.5 Filter. Check each filter against light for irregularities and flaws or pinhole leaks. Pack the filters flat in a clean glass container.

4.1.2 Preliminary Determinations. Same as section 4.1.2 of Method 5.

4.1.3 Preparation of Collection Train.

4.1.3.1 During preparation and assembly of the sampling train, keep all train openings where contamination can enter, sealed until just prior to assembly or until sampling is about to begin.

NOTE: Do not use sealant grease in assembling the train.

4.1.3.2 Place approximately 100 ml of water in the second and third impingers, leave the first and fourth impingers empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fifth impinger.

4.1.3.3 Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

4.1.3.4 Assemble the train as shown in Figure 23–1.

4.1.3.5 Turn on the adsorbent module and condenser coil recirculating pump and begin monitoring the adsorbent module gas entry temperature. Ensure proper sorbent temperature gas entry temperature before proceeding and before sampling is initiated. It is extremely important that the XAD–2 adsorbent resin temperature never exceed 50 °C because thermal decomposition will occur. During testing, the XAD–2 temperature must not exceed 20 °C for efficient capture of the PCDD's and PCDF's.

4.1.4 Leak-Check Procedure. Same as Method 5, section 4.1.4.

4.1.5 Sample Train Operation. Same as Method 5, section 4.1.5.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Seal the nozzle end of the sampling probe with Teflon tape or aluminum foil.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe. Remove the probe from the train and close off both ends with aluminum foil. Seal off the inlet to the train with Teflon tape, a ground glass cap, or aluminum foil.

Transfer the probe and impinger assembly to the cleanup area. This area shall be clean and enclosed so that the chances of losing or contaminating the sample are minimized. Smoking, which could contaminate the sample, shall not be allowed in the cleanup area.

Inspect the train prior to and during disassembly and note any abnormal conditions, e.g., broken filters, colored impinger liquid, etc. Treat the samples as follows:

4.2.1 Container No. 1. Either seal the filter holder or carefully remove the filter from the filter holder and place it in its identified container. Use a pair of cleaned tweezers to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the container any particulate matter and filter fibers which adhere to the filter holder gasket, by using a dry inert bristle brush and a sharp-edged blade. Seal the container.

4.2.2 Adsorbent Module. Remove the module from the train, tightly cap both ends, label it, cover with aluminum foil, and store it on ice for transport to the laboratory.

4.2.3 Container No. 2. Quantitatively recover material deposited in the nozzle, probe transfer lines, the front half of the filter holder, and the cyclone, if used, first, by

brushing while rinsing three times each with acetone and then, by rinsing the probe three times with methylene chloride. Collect all the rinses in Container No. 2.

Rinse the back half of the filter holder three times with acetone. Rinse the connecting line between the filter and the condenser three times with acetone. Soak the connecting line with three separate portions of methylene chloride for 5 minutes each. If using a separate condenser and adsorbent trap, rinse the condenser in the same manner as the connecting line. Collect all the rinses in Container No. 2 and mark the level of the liquid on the container.

4.2.4 Container No. 3. Repeat the methylene chloride-rinsing described in section 4.2.3 using toluene as the rinse solvent. Collect the rinses in Container No. 3 and mark the level of the liquid on the container.

4.2.5 Impinger Water. Measure the liquid in the first three impingers to within ±1 ml by using a graduated cylinder or by weighing it to within ±0.5 g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

Discard the liquid after measuring and recording the volume or weight.

4.2.7 Silica Gel. Note the color of the indicating silica gel to determine if it has been completely spent and make a mention of its condition. Transfer the silica gel from the fifth impinger to its original container and seal. If a moisture determination is made, follow the applicable procedures in sections 8.7.6.3 and 11.2.3 of Method 5 to handle and weigh the silica gel. If moisture is not measured, the silica gel may be disposed.

5. Analysis

All glassware shall be cleaned as described in section 3A of the ‘‘Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.’’ All samples must be extracted within 30 days of collection and analyzed within 45 days of extraction.

5.1 Sample Extraction.

5.1.1 Extraction System. Place an extraction thimble (section 2.3.4), 1 g of silica gel, and a plug of glass wool into the Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Remove the extraction thimble from the extraction system and place it in a glass beaker to catch the solvent rinses.

5.1.2 Container No. 1 (Filter). Transfer the contents directly to the glass thimble of the extraction system and extract them simultaneously with the XAD–2 resin.

5.1.3 Adsorbent Cartridge. Suspend the adsorbent module directly over the extraction thimble in the beaker (See section 5.1.1). The glass frit of the module should be in the up position. Using a Teflon squeeze bottle containing toluene, flush the XAD–2 into the thimble onto the bed of cleaned silica gel. Thoroughly rinse the glass module catching the rinsings in the beaker containing the thimble. If the resin is wet, effective extraction can be accomplished by loosely packing the resin in the thimble. Add the XAD–2 glass wool plug into the thimble.

5.1.4 Container No. 2 (Acetone and Methylene Chloride). Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus, at a temperature of less than 37 °C. Rinse the sample container three times with small portions of methylene chloride and add these to the concentrated solution and concentrate further to near dryness. This residue contains particulate matter removed in the rinse of the train probe and nozzle. Add the concentrate to the filter and the XAD–2 resin in the Soxhlet apparatus described in section 5.1.1.

5.1.5 Extraction. Add 100 µl of the internal standard solution (Section 3.3.20) to the extraction thimble containing the contents of the adsorbent cartridge, the contents of Container No. 1, and the concentrate from section 5.1.4. Cover the contents of the extraction thimble with the cleaned glass wool plug to prevent the XAD–2 resin from floating into the solvent reservoir of the extractor. Place the thimble in the extractor, and add the toluene contained in the beaker to the solvent reservoir. Pour additional toluene to fill the reservoir approximately ⅔ full. Add Teflon boiling chips and assemble the apparatus. Adjust the heat source to cause the extractor to cycle three times per hour. Extract the sample for 16 hours. After extraction, allow the Soxhlet to cool. Transfer the toluene extract and three 10-ml rinses to the rotary evaporator. Concentrate the extract to approximately 10 ml. At this point the analyst may choose to split the sample in half. If so, split the sample, store one half for future use, and analyze the other according to the procedures in sections 5.2 and 5.3. In either case, use a nitrogen evaporative concentrator to reduce the volume of the sample being analyzed to near dryness. Dissolve the residue in 5 ml of hexane.

5.1.6 Container No. 3 (Toluene Rinse). Add 100 µl of the Internal Standard solution (section 3.3.2) to the contents of the container. Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus at a temperature of less than 37 °C. Rinse the sample container apparatus at a temperature of less than 37 °C. Rinse the sample container three times with small portions of toluene and add these to the concentrated solution and concentrate further to near dryness. Analyze the extract separately according to the procedures in sections 5.2 and 5.3, but concentrate the solution in a rotary evaporator apparatus rather than a nitrogen evaporative concentrator.

5.2 Sample Cleanup and Fractionation.

5.2.1 Silica Gel Column. Pack one end of a glass column, 20 mm × 230 mm, with glass wool. Add in sequence, 1 g silica gel, 2 g of sodium hydroxide impregnated silica gel, 1 g silica gel, 4 g of acid-modified silica gel, and 1 g of silica gel. Wash the column with 30 ml of hexane and discard it. Add the sample extract, dissolved in 5 ml of hexane to the column with two additional 5-ml rinses. Elute the column with an additional 90 ml of hexane and retain the entire eluate. Concentrate this solution to a volume of about 1 ml using the nitrogen evaporative concentrator (section 2.3.7).

5.2.2 Basic Alumina Column. Shorten a 25-ml disposable Pasteur pipette to about 16 ml. Pack the lower section with glass wool and 12 g of basic alumina. Transfer the concentrated extract from the silica gel column to the top of the basic alumina column and elute the column sequentially with 120 ml of 0.5 percent methylene chloride in hexane followed by 120 ml of 35 percent methylene chloride in hexane. Discard the first 120 ml of eluate. Collect the second 120 ml of eluate and concentrate it to about 0.5 ml using the nitrogen evaporative concentrator.

5.2.3 AX–21 Carbon/Celite 545 Column. Remove the botton 0.5 in. from the tip of a 9-ml disposable Pasteur pipette. Insert a glass fiber filter disk in the top of the pipette 2.5 cm from the constriction. Add sufficient carbon/celite mixture to form a 2 cm column. Top with a glass wool plug. In some cases AX–21 carbon fines may wash through the glass wool plug and enter the sample. This may be prevented by adding a celite plug to the exit end of the column. Rinse the column in sequence with 2 ml of 50 percent benzene in ethyl acetate, 1 ml of 50 percent methylene chloride in cyclohexane, and 2 ml of hexane. Discard these rinses. Transfer the concentrate in 1 ml of hexane from the basic alumina column to the carbon/celite column along with 1 ml of hexane rinse. Elute the column sequentially with 2 ml of 50 percent methylene chloride in hexane and 2 ml of 50 percent benzene in ethyl acetate and discard these eluates. Invert the column and elute in the reverse direction with 13 ml of toluene. Collect this eluate. Concentrate the eluate in a rotary evaporator at 50 °C to about 1 ml. Transfer the concentrate to a Reacti-vial using a toluene rinse and concentrate to a volume of 200 µl using a stream of N_2. Store extracts at room temperature, shielded from light, until the analysis is performed.

5.3 Analysis. Analyze the sample with a gas chromatograph coupled to a mass spectrometer (GC/MS) using the instrumental parameters in sections 5.3.1 and 5.3.2. Immediately prior to analysis, add a 20 µl aliquot of the Recovery Standard solution from Table 1 to each sample. A 2 µl aliquot of the extract is injected into the GC. Sample extracts are first analyzed using the DB–5 capillary column to determine the concentration of each isomer of PCDD's and PCDF's (tetra-through octa-). If tetra-chlorinated dibenzofurans are detected in this analysis, then analyze another aliquot of the sample in a separate run, using the DB–225 column to measure the 2,3,7,8 tetra-chloro dibenzofuran isomer. Other column systems may be used, provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

5.3.1 Gas Chromatograph Operating Conditions.

5.3.1.1 Injector. Configured for capillary column, splitless, 250 °C.

5.3.1.2 Carrier Gas. Helium, 1–2 ml/min.

5.3.1.3 Oven. Initially at 150 °C. Raise by at least 40 °C/min to 190 °C and then at 3 °C/min up to 300 °C.

5.3.2 High Resolution Mass Spectrometer.

5.3.2.1 Resolution. 10000 m/e.

5.3.2.2 Ionization Mode. Electron impact.

5.3.2.3 Source Temperature 250 °C.

5.3.2.4 Monitoring Mode. Selected ion monitoring. A list of the various ions to be monitored is summarized in Table 3.

5.3.2.5 Identification Criteria. The following identification criteria shall be used for the characterization of polychlorinated dibenzodioxins and dibenzofurans.

1. The integrated ion-abundance ratio (M/M + 2 or M + 2/M + 4) shall be within 15 percent of the theoretical value. The acceptable ion-abundance ratio ranges for the identification of chlorine-containing compounds are given in Table 4.
2. The retention time for the analytes must be within 3 seconds of the corresponding ^{13}C-labeled internal standard, surrogate or alternate standard.
3. The monitored ions, shown in Table 3 for a given analyte, shall reach their maximum within 2 seconds of each other.
4. The identification of specific isomers that do not have corresponding ^{13}C-labeled standards is done by comparison of the relative retention time (RRT) of the analyte to the nearest internal standard retention time with reference (i.e., within 0.005 RRT units) to the comparable RRT's found in the continuing calibration.
5. The signal to noise ratio for all monitored ions must be greater than 2.5.
6. The confirmation of 2, 3, 7, 8–TCDD and 2, 3, 7, 8–TCDF shall satisfy all of the above identification criteria.
7. For the identification of PCDF's, no signal may be found in the corresponding PCDPE channels.

5.3.2.6 Quantification. The peak areas for the two ions monitored for each analyte are summed to yield the total response for each analyte. Each internal standard is used to quantify the indigenous PCDD's or PCDF's in its homologous series. For example, the $^{13}C_{12}$–2,3,7,8-tetra chlorinated dibenzodioxin is used to calculate the concentrations of all

other tetra chlorinated isomers. Recoveries of the tetra- and penta- internal standards are calculated using the $^{13}C_{12}$–1,2,3,4–TCDD. Recoveries of the hexa- through octa- internal standards are calculated using $^{13}C_{12}$–1,2,3,7,8,9–HxCDD. Recoveries of the surrogate standards are calculated using the corresponding homolog from the internal standard.

6. Calibration

Same as Method 5 with the following additions.

6.1 GC/MS System.

6.1.1 Initial Calibration. Calibrate the GC/MS system using the set of five standards shown in Table 2. The relative standard deviation for the mean response factor from each of the unlabeled analytes (Table 2) and of the internal, surrogate, and alternate standards shall be less than or equal to the values in Table 5. The signal to noise ratio for the GC signal present in every selected ion current profile shall be greater than or equal to 2.5. The ion abundance ratios shall be within the control limits in Table 4.

6.1.2 Daily Performance Check.

6.1.2.1 Calibration Check. Inject on µl of solution Number 3 from Table 2. Calculate the relative response factor (RRF) for each compound and compare each RRF to the corresponding mean RRF obtained during the initial calibration. The analyzer performance is acceptable if the measured RRF's for the labeled and unlabeled compounds for the daily run are within the limits of the mean values shown in Table 5. In addition, the ion-abundance ratios shall be within the allowable control limits shown in Table 4.

6.1.2.2 Column Separation Check. Inject a solution of a mixture of PCDD's and PCDF's that documents resolution between 2,3,7,8–TCDD and other TCDD isomers. Resolution is defined as a valley between peaks that is less than 25 percent of the lower of the two peaks. Identify and record the retention time windows for each homologous series.

Perform a similar resolution check on the confirmation column to document the resolution between 2,3,7,8 TCDF and other TCDF isomers.

6.2 Lock Channels. Set mass spectrometer lock channels as specified in Table 3. Monitor the quality control check channels specified in Table 3 to verify instrument stability during the analysis.

7. Quality Control

7.1 Sampling Train Collection Efficiency Check. Add 100 µl of the surrogate standards in Table 1 to the absorbent cartridge of each train before collecting the field samples.

7.2 Internal Standard Percent Recoveries. A group of nine carbon labeled PCDD's and PCDF's representing, the tetra-through octachlorinated homologues, is added to every sample prior to extraction. The role of the internal standards is to quantify the native PCDD's and PCDF's present in the sample as well as to determine the overall method efficiency. Recoveries of the internal standards must be between 40 to 130 percent for the tetra-through hexachlorinated compounds while the range is 25 to 130 percent for the higher hepta- and octachlorinated homologues.

7.3 Surrogate Recoveries. The five surrogate compounds in Table 2 are added to the resin in the adsorbent sampling cartridge before the sample is collected. The surrogate recoveries are measured relative to the internal standards and are a measure of collection efficiency. They are not used to measure native PCDD's and PCDF's. All recoveries shall be between 70 and 130 percent. Poor recoveries for all the surrogates may be an indication of breakthrough in the sampling train. If the recovery of all standards is below 70 percent, the sampling runs must be repeated. As an alternative, the sampling runs do not have to be repeated if the final results are divided by the fraction of surrogate recovery. Poor recoveries of isolated surrogate compounds should not be grounds for rejecting an entire set of the samples.

7.4 Toluene QA Rinse. Report the results of the toluene QA rinse separately from the total sample catch. Do not add it to the total sample.

8.0 [Reserved]

9. Calculations

Same as Method 5, section 6 with the following additions.

9.1 Nomenclature.

A_{ai} = Integrated ion current of the noise at the retention time of the analyte.

A^*_{ci} = Integrated ion current of the two ions characteristic of the internal standard i in the calibration standard.

A_{cij} = Integrated ion current of the two ions characteristic of compound i in the jth calibration standard.

A^*_{cij} = Integrated ion current of the two ions characteristic of the internal standard i in the jth calibration standard.

A_{csi} = Integrated ion current of the two ions characteristic of surrogate compound i in the calibration standard.

A_i = Integrated ion current of the two ions characteristic of compound i in the sample.

A^*_i = Integrated ion current of the two ions characteristic of internal standard i in the sample.

A_{rs} = Integrated ion current of the two ions characteristic of the recovery standard.

A_{si} = Integrated ion current of the two ions characteristic of surrogate compound i in the sample.

C_i = Concentration of PCDD or PCDF i in the sample, pg/M^3.

C_T = Total concentration of PCDD's or PCDF's in the sample, pg/M^3.

m_{ci} = Mass of compound i in the calibration standard injected into the analyzer, pg.

m_{rs} = Mass of recovery standard in the calibration standard injected into the analyzer, pg.

m_{si} = Mass of surrogate compound in the calibration standard, pg.

RRF_i = Relative response factor.

RRF_{rs} = Recovery standard response factor.

RRF_s = Surrogate compound response factor.

9.2 Average Relative Response Factor.

$$RRF_i = \frac{1}{n}\sum_{j=1}^{n}\frac{A_{cij}\, m{*}_{ci}}{A{*}_{cij}\, m_{ci}} \qquad \text{Eq. 23-1}$$

9.3 Concentration of the PCDD's and PCDF's.

$$C_i = \frac{m_i{*}A_i}{A_i{*}RRF_i V_{mstd}} \qquad \text{Eq. 23-2}$$

9.4 Recovery Standard Response Factor.

$$RRF_{rs} = \frac{A_{ci}{*}m_{rs}}{A_{rs}m_{ci}{*}} \qquad \text{Eq. 23-3}$$

9.5 Recovery of Internal Standards (R*).

$$R{*} = \frac{A_i{*}m_{rs}}{A_{rs}RF_{rs}m_i{*}} \times 100\% \qquad \text{Eq. 23-4}$$

9.6 Surrogate Compound Response Factor.

$$RRF_s = \frac{A_{ci}{*}m_s}{A_{cis}m_{ci}{*}} \qquad \text{Eq. 23-5}$$

9.7 Recovery of Surrogate Compounds (R_s).

$$R_s = \frac{A_s m_i{*}}{A_i{*}RRF_s m_s} \times 100\% \qquad \text{Eq. 23-6}$$

9.8 Minimum Detectable Limit (MDL).

$$MDL = \frac{2.5\ A_{ai}m_i{*}}{A_{ci}{*}RRF_i} \qquad \text{Eq. 23-7}$$

9.9 Total Concentration of PCDD's and PCDF's in the Sample.

$$C_{Tr} = \sum_{i=1}^{n} C_i \qquad \text{Eq. 23-8}$$

Any PCDD's or PCDF's that are reported as nondetected (below the MDL) shall be counted as zero for the purpose of calculating the total concentration of PCDD's and PCDF's in the sample.

10. Bibliography

1. American Society of Mechanical Engineers. Sampling for the Determination of Chlorinated Organic Compounds in Stack Emissions. Prepared for U.S. Department of Energy and U.S. Environmental Protection Agency. Washington DC. December 1984. 25 p.

2. American Society of Mechanical Engineers. Analytical Procedures to Assay Stack Effluent Samples and Residual Combustion Products for Polychlorinated Dibenzo-p-Dioxins (PCDD) and Polychlorinated Dibenzofurans (PCDF). Prepared for the U.S. Department of Energy and U.S. Environmental Protection Agency. Washington, DC. December 1984. 23 p.

3. Thompson, J. R. (ed.). Analysis of Pesticide Residues in Human and Environmental Samples. U.S. Environmental Protection Agency. Research Triangle Park, NC. 1974.

4. Triangle Laboratories. Case Study: Analysis of Samples for the Presence of Tetra Through Octachloro-p-Dibenzodioxins and Dibenzofurans. Research Triangle Park, NC. 1988. 26 p.

5. U.S. Environmental Protection Agency. Method 8290—The Analysis of Polychlorinated Dibenzo-p-dioxin and Polychlorinated Dibenzofurans by High-Resolution Gas Chromotography/High-Resolution Mass Spectrometry. In: Test Methods for Evaluating Solid Waste. Washington, DC. SW–846.

TABLE 1—COMPOSITION OF THE SAMPLE FORTIFICATION AND RECOVERY STANDARDS SOLUTIONS

Analyte	Concentration (pg/µl)
Internal Standards:	
^{13} C_{12}-2,3,7,8-TCDD	100
^{13} C_{12}-1,2,3,7,8-PeCDD	100
^{13} C_{12}-1,2,3,6,7,8-HxCDD	100
^{13} C_{12}-1,2,3,4,6,7,8-HpCDD	100
^{13} C_{12}-OCDD	100
^{13} C_{12}-2,3,7,8-TCDF	100
^{13} C_{12}-1,2,3,7,8-PeCDF	100
^{13} C_{12}-1,2,3,6,7,8-HxCDF	100
^{13} C_{12}-1,2,3,4,6,7,8-HpCDF	100
Surrogate Standards:	
^{37} Cl_4-2,3,7,8-TCDD	100
^{13} C_{12}-1,2,3,4,7,8-HxCDD	100
^{13} C_{12}-2,3,4,7,8-PeCDF	100
^{13} C_{12}-1,2,3,4,7,8-HxCDF	100
^{13} C_{12}-1,2,3,4,7,8,9-HpCDF	100
Recovery Standards:	
^{13} C_{12}-1,2,3,4-TCDD	500
^{13} C_{12}-1,2,3,7,8,9-HxCDD	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS

Compound	Concentrations (pg/µL)				
	Solution No.				
	1	2	3	4	5
Alternate Standard:					
^{13} C_{12}-1,2,3,7,8,9-HxCDF	2.5	5	25	250	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS—Continued

Compound	Concentrations (pg/μL)				
	Solution No.				
	1	2	3	4	5
Recovery Standards:					
^{13} C_{12}-1,2,3,4-TCDD ..	100	100	100	100	100
^{13} C_{12}-1,2,3,7,8,9-HxCDD	100	100	100	100	100

TABLE 3—ELEMENTAL COMPOSITIONS AND EXACT MASSES OF THE IONS MONITORED BY HIGH RESOLUTION MASS SPECTROMETRY FOR PCDD'S AND PCDF'S

Descriptor No.	Accurate mass	Ion type	Elemental composition	Analyte
2	292.9825	LOCK	C_7F_{11}	PFK
	303.9016	M	$C_{12}H_4{}^{35}Cl_4O$	TCDF
	305.8987	M + 2	$C_{12}H_4{}^{35}Cl^{37}O$	TCDF
	315.9419	M	$^{13}C_{12}H_4{}^{35}Cl_4O$	TCDF (S)
	317.9389	M + 2	$^{13}C_{12}H_4{}^{35}Cl_3{}^{37}ClO$	TCDF (S)
	319.8965	M	$C_{12}H_4{}^{35}ClO_2$	TCDD
	321.8936	M + 2	$C_{12}H_4{}^{35}Cl_3{}^{37}ClO_2$	TCDD
	327.8847	M	$C_{12}H_4{}^{37}Cl_4O_2$	TCDD (S)
	330.9792	QC	C_7F_{13}	PFK
	331.9368	M	$^{13}C_{12}H_4{}^{35}Cl_4O_2$	TCDD (S)
	333.9339	M + 2	$^{13}C_{12}H_4{}^{35}Cl^{37}ClO_2$	TCDD (S)
	339.8597	M + 2	$C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PECDF
	341.8567	M + 4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O$	PeCDF
	351.9000	M + 2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF (S)
	353.8970	M + 4	$^{13}C_{12}H_3{}^{35}Cl^{3537}Cl_2O$	PeCDF (S)
	355.8546	M + 2	$C_{12}H_3{}^{35}Cl_337ClO_2$	PeCDD
	357.8516	M + 4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O_2$	PeCDD
	367.8949	M + 2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO_2$	PeCDD (S)
	369.8919	M + 4	$^{13}C_{12}H_3{}^{35}Cl_3{}^{37}\ Cl_2O_2$	PeCDD (S)
	375.8364	M + 2	$C_{12}H_4{}^{35}Cl_5{}^{37}ClO$	HxCDPE
	409.7974	M + 2	$C_{12}H_3{}^{35}Cl_6{}^{37}ClO$	HpCPDE
3	373.8208	M + 2	$C_{12}H_235Cl_5{}^{37}ClO$	HxCDF
	375.8178	M + 4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDF
	383.8639	M	$^{13}C_{12}H_2{}^{35}Cl_6O$	HxCDF (S)
	385.8610	M + 2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO$	HxCDF (S)
	389.8157	M + 2	$C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD
	391.8127	M + 4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O_2$	HxCDD
	392.9760	LOCK	C_9F_{15}	PFK
	401.8559	M + 2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD (S)
	403.8529	M + 4	$^{13}C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDD (S)
	445.7555	M + 4	$C_{12}H_2{}^{35}Cl_6{}^{37}Cl_2O$	OCDPE
	430.9729	QC	C_9F_{17}	PFK
4	407.7818	M + 2	$C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF
	409.7789	M + 4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O$	HpCDF
	417.8253	M	$^{13}C_{12}H^{35}Cl_7O$	HpCDF (S)
	419.8220	M + 2	$^{13}C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF (S)
	423.7766	M + 2	$C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD
	425.7737	M + 4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD
	435.8169	M + 2	$^{13}C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD (S)
	437.8140	M + 4	$^{13}C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD (S)
	479.7165	M + 4	$C_{12}H^{35}Cl_7{}^{37}Cl_2O$	NCPDE
	430.9729	LOCK	C_9F_{17}	PFK
	441.7428	M + 2	$C_{12}{}^{35}Cl_7{}^{37}ClO$	OCDF
	443.7399	M + 4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O$	OCDF
	457.7377	M + 2	$C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD
	459.7348	M + 4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD
	469.7779	M + 2	$^{13}C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD (S)
	471.7750	M + 4	$^{13}C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD (S)
	513.6775	M + 4	$C_{12}{}^{35}Cl_8{}^{37}Cl_2O_2$	DCDPE
	442.9728	QC	$C_{10}F_{17}$	PFK

(a) The following nuclidic masses were used:
H = 1.007825
C = 12.000000
^{13}C = 13.003355
F = 18.9984
O = 15.994915
^{35}Cl = 34.968853
^{37}Cl = 36.965903

S = Labeled Standard
QC = Ion selected for monitoring instrument stability during the GC/MS analysis.

TABLE 4—ACCEPTABLE RANGES FOR ION-ABUNDANCE RATIOS OF PCDD'S AND PCDF'S

No. of chlorine atoms	Ion type	Theoretical ratio	Control limits	
			Lower	Upper
4	M/M + 2	0.77	0.65	0.89
5	M + 2/M + 4	1.55	1.32	1.78
6	M + 2/M + 4	1.24	1.05	1.43
6[a]	M/M + 2	0.51	0.43	0.59
7[b]	M/M + 2	0.44	0.37	0.51
7	M + 2/M + 4	1.04	0.88	1.20
8	M + 2/M + 4	0.89	0.76	1.02

[a] Used only for ^{13}C-HxCDF.
[b] Used only for ^{13}C-HpCDF.

TABLE 5—MINIMUM REQUIREMENTS FOR INITIAL AND DAILY CALIBRATION RESPONSE FACTORS

Compound	Relative response factors	
	Initial calibration RSD	Daily calibration % difference
Unlabeled Analytes:		
2,3,7,8-TCDD	25	25
2,3,7,8-TCDF	25	25
1,2,3,7,8-PeCDD	25	25
1,2,3,7,8-PeCDF	25	25
2,3,4,7,8-PeCDF	25	25
1,2,4,5,7,8-HxCDD	25	25
1,2,3,6,7,8-HxCDD	25	25
1,2,3,7,8,9-HxCDD	25	25
1,2,3,4,7,8-HxCDF	25	25
1,2,3,6,7,8-HxCDF	25	25
1,2,3,7,8,9-HxCDF	25	25
2,3,4,6,7,8-HxCDF	25	25
1,2,3,4,6,7,8-HpCDD	25	25
1,2,3,4,6,7,8-HpCDF	25	25
OCDD	25	25
OCDF	30	30
Internal Standards:		
$^{13}C_{12}$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-1,2,3,7,8-PeCDD	30	30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	25	25
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	30	30
$^{13}C_{12}$-OCDD	30	30
$^{13}C_{12}$-2,3,7,8-TCDF	30	30
$^{13}C_{12}$-1,2,3,7,8-PeCDF	30	30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	30	30
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	30	30
Surrogate Standards:		
$^{37}Cl_4$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-2,3,4,7,8-PeCDF	25	25
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	25	25
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	25	25
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	25	25
Alternate Standard:		
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	25	25

METHOD 24—DETERMINATION OF VOLATILE MATTER CONTENT, WATER CONTENT, DENSITY, VOLUME SOLIDS, AND WEIGHT SOLIDS OF SURFACE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds	No CAS Number assigned
Water.	7732–18–5

1.2 Applicability. This method is applicable for the determination of volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

1.3 Precision and Bias. Intra-and inter-laboratory analytical precision statements are presented in section 13.1. No bias has been identified.

2.0 Summary of Method

2.1 Standard methods are used to determine the volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

3.0 Definitions

3.1 *Waterborne coating* means any coating which contains more than 5 percent water by weight in its volatile fraction.

3.2 *Multicomponent coatings* are coatings that are packaged in two or more parts, which are combined before application. Upon combination a coreactant from one part of the coating chemically reacts, at ambient conditions, with a coreactant from another part of the coating.

3.3 *Ultraviolet (UV) radiation-cured coatings* are coatings which contain unreacted monomers that are polymerized by exposure to ultraviolet light.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Several of the compounds that may be contained in the coatings analyzed by this method may be irritating or corrosive to tissues (e.g., heptane) or may be toxic (e.g., benzene, methyl alcohol). Nearly all are fire hazards.

Appropriate precautions can be found in reference documents, such as Reference 3 of section 16.0.

6.0 Equipment and Supplies

The equipment and supplies specified in the ASTM methods listed in sections 6.1 through 6.6 (incorporated by reference—see § 60.17 for acceptable versions of the methods) are required:

6.1 ASTM D 1475–60, 80, or 90, Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products.

6.2 ASTM D 2369–81, 87, 90, 92, 93, or 95, Standard Test Method for Volatile Content of Coatings.

6.3 ASTM D 3792–79 or 91, Standard Test Method for Water Content of Water Reducible Paints by Direct Injection into a Gas Chromatograph.

6.4 ASTM D 4017–81, 90, or 96a, Standard Test Method for Water in Paints and Paint Materials by the Karl Fischer Titration Method.

6.5 ASTM 4457–85 91, Standard Test Method for Determination of Dichloromethane and 1,1,1-Trichloroethane in Paints and Coatings by Direct Injection into a Gas Chromatograph.

6.6 ASTM D 5403–93, Standard Test Methods for Volatile Content of Radiation Curable Materials.

6.7 ASTM D 6419–00, Test Method for Volatile Content of Sheet-Fed and Coldset Web Offset Printing Inks.

7.0 Reagents and Standards

7.1 The reagents and standards specified in the ASTM methods listed in sections 6.1 through 6.6 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 1 of section 16.0.

9.0 Quality Control

9.1 Reproducibility

NOTE: Not applicable to UV radiation-cured coatings). The variety of coatings that may be subject to analysis makes it necessary to verify the ability of the analyst and the analytical procedures to obtain reproducible results for the coatings tested. Verification is accomplished by running duplicate analyses on each sample tested (Sections 11.2 through 11.4) and comparing the results with the intra-laboratory precision statements (Section 13.1) for each parameter.

9.2 Confidence Limits for Waterborne Coatings. Because of the inherent increased imprecision in the determination of the VOC content of waterborne coatings as the weight percent of water increases, measured parameters for waterborne coatings are replaced with appropriate confidence limits (Section 12.6). These confidence limits are based on measured parameters and inter-laboratory precision statements.

10.0 Calibration and Standardization

10.1 Perform the calibration and standardization procedures specified in the ASTM methods listed in sections 6.1 through 6.6.

11.0 Analytical Procedure

Additional guidance can be found in Reference 2 of section 16.0.

11.1 Non Thin-film Ultraviolet Radiation-cured (UV radiation-cured) Coatings.

11.1.1 Volatile Content. Use the procedure in ASTM D 5403 to determine the volatile matter content of the coating except the curing test described in NOTE 2 of ASTM D 5403 is required.

11.1.2 Water Content. To determine water content, follow section 11.3.2.

11.1.3 Coating Density. To determine coating density, follow section 11.3.3.

11.1.4 Solids Content. To determine solids content, follow section 11.3.4.

11.1.5 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the equation in section 12.2. If C is less than 0.2 g and A is greater than or equal to 225 cm^2 (35 in^2) then the coating or ink is considered a thin-film UV radiation-cured coating and ASTM D 5403 is not applicable.

NOTE: As noted in section 1.4 of ASTM D 5403, this method may not be applicable to radiation curable materials wherein the volatile material is water.

11.2 Multi-component Coatings.

11.2.1 Sample Preparation.

11.2.1.1 Prepare about 100 ml of sample by mixing the components in a storage container, such as a glass jar with a screw top or a metal can with a cap. The storage container should be just large enough to hold the mixture. Combine the components (by weight or volume) in the ratio recommended by the manufacturer. Tightly close the container between additions and during mixing to prevent loss of volatile materials. However, most manufacturers mixing instructions are by volume. Because of possible error caused by expansion of the liquid when measuring the volume, it is recommended that the components be combined by weight. When weight is used to combine the components and the manufacturer's recommended ratio is by volume, the density must be determined by section 11.3.3.

11.2.1.2 Immediately after mixing, take aliquots from this 100 ml sample for determination of the total volatile content, water content, and density.

11.2.2 Volatile Content. To determine total volatile content, use the apparatus and

reagents described in ASTM D2369 (incorporated by reference; see §60.17 for the approved versions of the standard), respectively, and use the following procedures:

11.2.2.1 Weigh and record the weight of an aluminum foil weighing dish. Add 3 ±1 ml of suitable solvent as specified in ASTM D2369 to the weighing dish. Using a syringe as specified in ASTM D2369, weigh to 1 mg, by difference, a sample of coating into the weighing dish. For coatings believed to have a volatile content less than 40 weight percent, a suitable size is 0.3 + 0.10 g, but for coatings believed to have a volatile content greater than 40 weight percent, a suitable size is 0.5 ±0.1 g.

NOTE: If the volatile content determined pursuant to section 12.4 is not in the range corresponding to the sample size chosen repeat the test with the appropriate sample size. Add the specimen dropwise, shaking (swirling) the dish to disperse the specimen completely in the solvent. If the material forms a lump that cannot be dispersed, discard the specimen and prepare a new one. Similarly, prepare a duplicate. The sample shall stand for a minimum of 1 hour, but no more than 24 hours prior to being oven cured at 110 ±5 °C (230 ±9 °F) for 1 hour.

11.2.2.2 Heat the aluminum foil dishes containing the dispersed specimens in the forced draft oven for 60 min at 110 ±5 °C (230 ±9 °F). Caution—provide adequate ventilation, consistent with accepted laboratory practice, to prevent solvent vapors from accumulating to a dangerous level.

11.2.2.3 Remove the dishes from the oven, place immediately in a desiccator, cool to ambient temperature, and weigh to within 1 mg.

11.2.2.4 Run analyses in pairs (duplicate sets) for each coating mixture until the criterion in section 11.4 is met. Calculate W_V following Equation 24–2 and record the arithmetic average.

11.2.3 Water Content. To determine water content, follow section 11.3.2.

11.2.4 Coating Density. To determine coating density, follow section 11.3.3.

11.2.5 Solids Content. To determine solids content, follow section 11.3.4.

11.2.6 Exempt Solvent Content. To determine the exempt solvent content, follow section 11.3.5.

NOTE: For all other coatings (*i.e.,* water-or solvent-borne coatings) not covered by multicomponent or UV radiation-cured coatings, analyze as shown below:

11.3 Water-or Solvent-borne coatings.

11.3.1 Volatile Content. Use the procedure in ASTM D 2369 to determine the volatile matter content (may include water) of the coating.

11.3.1.1 Record the following information:

W_1 = weight of dish and sample before heating, g

W_2 = weight of dish and sample after heating, g

W_3 = sample weight, g.

11.3.1.2 Calculate the weight fraction of the volatile matter (W_v) for each analysis as shown in section 12.3.

11.3.1.3 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.1.4 Record the arithmetic average (W_v).

11.3.2 Water Content. For waterborne coatings only, determine the weight fraction of water (W_w) using either ASTM D 3792 or ASTM D 4017.

11.3.2.1 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.2.2 Record the arithmetic average (w_w).

11.3.3 Coating Density. Determine the density (Dc, kg/l) of the surface coating using the procedure in ASTM D 1475.

11.3.3.1 Run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement in section 13.1.

11.3.3.2 Record the arithmetic average (D_c).

11.3.4 Solids Content. Determine the volume fraction (V_s) solids of the coating by calculation using the manufacturer's formulation.

11.3.5 Exempt Solvent Content. Determine the weight fraction of exempt solvents (W_E) by using ASTM Method D4457. Run a duplicate set of determinations and record the arithmetic average (W_E).

11.4 Sample Analysis Criteria. For W_v and W_w, run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement for that parameter. For D_c, run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement. If, after several attempts, it is concluded that the ASTM procedures cannot be used for the specific coating with the established intra-laboratory precision (excluding UV radiation-cured coatings), the U.S. Environmental Protection Agency (EPA) will assume responsibility for providing the necessary procedures for revising the method or precision statements upon written request to: Director, Emissions, Monitoring, and Analysis Division, MD–14, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

12.0 Calculations and Data Analysis

12.1 Nomenclature.

A = Area of substrate, cm^2, (in^2).

C = Amount of coating or ink added to the substrate, g.

D_c = Density of coating or ink, g/cm^3 (g/in^3).

F = Manufacturer's recommended film thickness, cm (in).
W_o = Weight fraction of nonaqueous volatile matter, g/g.
W_s = Weight fraction of solids, g/g.
W_v = Weight fraction of the volatile matter, g/g.
W_w = Weight fraction of the water, g/g.

12.2 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the following equation:

$$C = F\,A\,D_c \qquad \text{Eq. 24-1}$$

12.3 Calculate W_v for each analysis as shown below:

$$W_v = \frac{W_1 - W_2}{W_3} \qquad \text{Eq. 24-2}$$

12.4 Nonaqueous Volatile Matter.

12.4.1 Solvent-borne Coatings.

$$W_o = W_v \qquad \text{Eq. 24-3}$$

12.4.2 Waterborne Coatings.

$$W_o = W_v - W_w \qquad \text{Eq. 24-4}$$

12.4.3 Coatings Containing Exempt Solvents.

$$W_o = W_v - W_E - W_w \qquad \text{Eq. 24-5}$$

12.5 Weight Fraction Solids.

$$W_s = 1 - W_v \qquad \text{Eq. 24-6}$$

12.6 Confidence Limit Calculations for Waterborne Coatings. To calculate the lower confidence limit, subtract the appropriate inter-laboratory precision value from the measured mean value for that parameter. To calculate the upper confidence limit, add the appropriate inter-laboratory precision value to the measured mean value for that parameter. For W_v and D_c, use the lower confidence limits; for W_w, use the upper confidence limit. Because W_s is calculated, there is no adjustment for this parameter.

13.0 Method Performance

13.1 Analytical Precision Statements. The intra-and inter-laboratory precision statements are given in Table 24–1 in section 17.0.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as specified in section 6.0, with the addition of the following:

1. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.
2. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A.
EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.
3. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 24–1—ANALYTICAL PRECISION STATEMENTS

	Intra-laboratory	Inter-laboratory
Volatile matter content, W_v	±0.015 $\overline{W}_v$	±0.047 $\overline{W}_v$
Water content, W_w	±0.029 $\overline{W}_w$	±0.075 $\overline{W}_w$
Density, D_c	±0.001 kg/l	±0.002 kg/l

METHOD 24A—DETERMINATION OF VOLATILE MATTER CONTENT AND DENSITY OF PUBLICATION ROTOGRAVURE INKS AND RELATED PUBLICATION ROTOGRAVURE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds (VOC).	No CAS number assigned.

1.2 Applicability. This method is applicable for the determination of the VOC content and density of solvent-borne (solvent-reducible) publication rotogravure inks and related publication rotogravure coatings.

2.0 Summary of Method

2.1 Separate procedures are used to determine the VOC weight fraction and density of the ink or related coating and the density of the solvent in the ink or related coating. The VOC weight fraction is determined by measuring the weight loss of a known sample quantity which has been heated for a specified length of time at a specified temperature. The density of both the ink or related coating and solvent are measured by a standard procedure. From this information, the VOC volume fraction is calculated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Some of the compounds that may be contained in the inks or related coatings analyzed by this method may be irritating or corrosive to tissues or may be toxic. Nearly all are fire hazards. Appropriate precautions can be found in reference documents, such as Reference 6 of section 16.0.

6.0 Equipment and Supplies

The following equipment and supplies are required for sample analysis:

6.1 Weighing Dishes. Aluminum foil, 58 mm (2.3 in.) in diameter by 18 mm (0.7 in.) high, with a flat bottom. There must be at least three weighing dishes per sample.

6.2 Disposable Syringe. 5 ml.

6.3 Analytical Balance. To measure to within 0.1 mg.

6.4 Oven. Vacuum oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) and an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) for 4 hours. Alternatively, a forced draft oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) for 24 hours.

6.5 The equipment and supplies specified in ASTM D 1475–60, 80, or 90 (incorporated by reference—see § 60.17).

7.0 Reagents and Standards

7.1 The reagents and standards specified in ASTM D 1475–60, 80, or 90 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 4 of section 16.0.

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

Additional guidance can be found in Reference 5 of section 16.0.

11.1 VOC Weight Fraction. Shake or mix the ink or related coating sample thoroughly to assure that all the solids are completely suspended. Label and weigh to the nearest 0.1 mg a weighing dish and record this weight (M_{x1}). Using a 5 ml syringe, without a needle, extract an aliquot from the ink or related coating sample. Weigh the syringe and aliquot to the nearest 0.1 mg and record this weight (M_{cy1}). Transfer 1 to 3 g of the aliquot to the tared weighing dish. Reweigh the syringe and remaining aliquot to the nearest 0.1 mg and record this weight (M_{cy2}). Heat the weighing dish with the transferred aliquot in a vacuum oven at an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) and a temperature of 120 ±2 °C (248 ±4 °F) for 4 hours. Alternatively, heat the weighing dish with the transferred aliquot in a forced draft oven at a temperature of 120 ±2 °C for 24 hours. After the weighing dish has cooled, reweigh it to the nearest 0.1 mg and record the weight (M_{x2}). Repeat this procedure two times for each ink or related coating sample, for a total of three samples.

11.2 Ink or Related Coating Density. Determine the density of the ink or related coating (D_c) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the ink or related coating density as the arithmetic average (D_c) of the three determinations.

11.3 Solvent Density. Determine the density of the solvent (D_o) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the solvent density as the arithmetic average (D_o) of the three determinations.

12.0 Calculations and Data Analysis

12.1 VOC Weight Fraction. For each determination, calculate the volatile organic content weight fraction (W_o) using the following equation:

$$W_o = \frac{M_{x1} + M_{cy1} - M_{cy2} - M_{x2}}{M_{cy1} - M_{cy2}} \qquad \text{Eq. 24A-1}$$

Make a total of three determinations. Report the VOC weight fraction as the arithmetic average ($\bar{W}_o$) of the three determinations.

12.2 VOC Volume Fraction. Calculate the volume fraction volatile organic content (V_o) using the following equation:

$$V_o = \frac{\overline{W}_o \overline{D}_c}{\overline{D}_o} \qquad \text{Eq. 24A-2}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. ASTM Designation D 1475.

2. Teleconversation. Wright, Chuck, Inmont Corporation with Reich, R., A., Radian Corporation. September 25, 1979, Gravure Ink Analysis.

3. Teleconversation. Oppenheimer, Robert, Gravure Research Institute with Burt, Rick, Radian Corporation, November 5, 1979, Gravure Ink Analysis.

4. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

5. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A. EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

6. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25—DETERMINATION OF TOTAL GASEOUS NONMETHANE ORGANIC EMISSIONS AS CARBON

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total gaseous nonmethane organic compounds (TGNMO)	N/A	Dependent upon analytical equipment.

1.2 Applicability.

1.2.1 This method is applicable for the determination of volatile organic compounds (VOC) (measured as total gaseous nonmethane organics (TGNMO) and reported as carbon) in stationary source emissions. This method is not applicable for the determination of organic particulate matter.

1.2.2 This method is not the only method that applies to the measurement of VOC. Costs, logistics, and other practicalities of source testing may make other test methods more desirable for measuring VOC contents of certain effluent streams. Proper judgment is required in determining the most applicable VOC test method. For example, depending upon the molecular composition of the organics in the effluent stream, a totally automated semicontinuous nonmethane organics (NMO) analyzer interfaced directly to the source may yield accurate results. This approach has the advantage of providing emission data semicontinuously over an extended time period.

1.2.3 Direct measurement of an effluent with a flame ionization detector (FID) analyzer may be appropriate with prior characterization of the gas stream and knowledge that the detector responds predictably to the organic compounds in the stream. If present, methane (CH_4) will, of course, also be measured. The FID can be used under any of the following limited conditions: (1) Where only one compound is known to exist; (2) when the organic compounds consist of only hydrogen and carbon; (3) where the relative percentages of the compounds are known or can be determined, and the FID responses to the compounds are known; (4) where a consistent mixture of the compounds exists before and after emission control and only the relative concentrations are to be assessed; or (5) where the FID can be calibrated against mass standards of the compounds emitted (solvent emissions, for example).

1.2.4 Another example of the use of a direct FID is as a screening method. If there is enough information available to provide a rough estimate of the analyzer accuracy, the FID analyzer can be used to determine the VOC content of an uncharacterized gas stream. With a sufficient buffer to account for possible inaccuracies, the direct FID can be a useful tool to obtain the desired results without costly exact determination.

1.2.5 In situations where a qualitative/quantitative analysis of an effluent stream is desired or required, a gas chromatographic FID system may apply. However, for sources emitting numerous organics, the time and expense of this approach will be formidable.

2.0 Summary of Method

2.1 An emission sample is withdrawn from the stack at a constant rate through a heated filter and a chilled condensate trap by means of an evacuated sample tank. After sampling is completed, the TGNMO are determined by independently analyzing the condensate trap and sample tank fractions and combining the analytical results. The organic content of the condensate trap fraction is determined by oxidizing the NMO to carbon dioxide (CO_2) and quantitatively collecting in the effluent in an evacuated vessel; then a portion of the CO_2 is reduced to CH_4 and measured by an FID. The organic content of the sample tank fraction is measured by injecting a portion of the sample into a gas chromatographic column to separate the NMO from carbon monoxide (CO), CO_2, and CH_4; the NMO are oxidized to CO_2, reduced to CH_4, and measured by an FID. In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 Carbon Dioxide and Water Vapor. When carbon dioxide (CO_2) and water vapor are present together in the stack, they can produce a positive bias in the sample. The magnitude of the bias depends on the concentrations of CO_2 and water vapor. As a guideline, multiply the CO_2 concentration, expressed as volume percent, times the water vapor concentration. If this product does not exceed 100, the bias can be considered insignificant. For example, the bias is not significant for a source having 10 percent CO_2 and 10 percent water vapor, but it might be significant for a source having 10 percent CO_2 and 20 percent water vapor.

4.2. Particulate Matter. Collection of organic particulate matter in the condensate trap would produce a positive bias. A filter is included in the sampling equipment to minimize this bias.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

6.1 Sample Collection. The sampling system consists of a heated probe, heated filter, condensate trap, flow control system, and sample tank (see Figure 25–1). The TGNMO sampling equipment can be constructed from commercially available components and components fabricated in a machine shop. The following equipment is required:

6.1.1 Heated Probe. 6.4-mm (¼-in.) OD stainless steel tubing with a heating system capable of maintaining a gas temperature at the exit end of at least 129 °C (265 °F). The probe shall be equipped with a temperature sensor at the exit end to monitor the gas temperature. A suitable probe is shown in Figure 25–1. The nozzle is an elbow fitting attached to the front end of the probe while the temperature sensor is inserted in the side arm of a tee fitting attached to the rear of the probe. The probe is wrapped with a suitable length of high temperature heating tape, and then covered with two layers of glass cloth insulation and one layer of aluminum foil or an equivalent wrapping.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.2 Filter Holder. 25-mm (15⁄16-in.) ID Gelman filter holder with 303 stainless steel body and 316 stainless steel support screen with the Viton O-ring replaced by a Teflon O-ring.

6.1.3 Filter Heating System.

6.1.3.1 A metal box consisting of an inner and an outer shell separated by insulating material with a heating element in the inner shell capable of maintaining a gas temperature at the filter of 121 ±3 °C (250 ±5 °F). The heating box shall include temperature sensors to monitor the gas temperature immediately upstream and immediately downstream of the filter.

6.1.3.2 A suitable heating box is shown in Figure 25–2. The outer shell is a metal box that measures 102 mm × 280 mm × 292 mm (4 in. × 11 in. × 11½ in.), while the inner shell is a metal box measuring 76 mm × 229 mm × 241 mm (3 in. × 9 in. × 9½ in.). The inner box is supported by 13-mm (½-in.) phenolic rods. The void space between the boxes is filled with ceramic fiber insulation which is sealed in place by means of a silicon rubber bead around the upper sides of the box. A removable lid made in a similar manner, with a 25-mm (1-in.) gap between the parts is used to cover the heating chamber. The inner box is heated with a 250-watt cartridge heater, shielded by a stainless steel shroud. The heater is regulated by a thermostatic temperature controller which is set to maintain a gas temperature of 121 °C (250 °F) as measured by the temperature sensor upstream of the filter.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.4 Condensate Trap. 9.5-mm (⅜-in.) OD 316 stainless steel tubing bent into a U-shape. Exact dimensions are shown in Figure

25–3. The tubing shall be packed with coarse quartz wool, to a density of approximately 0.11 g/cm^3 before bending. While the condensate trap is packed with dry ice in the Dewar, an ice bridge may form between the arms of the condensate trap making it difficult to remove the condensate trap. This problem can be prevented by attaching a steel plate between the arms of the condensate trap in the same plane as the arms to completely fill the intervening space.

6.1.5 Valve. Stainless steel control valve for starting and stopping sample flow.

6.1.6 Metering Valve. Stainless steel valve for regulating the sample flow rate through the sample train.

6.1.7 Rate Meter. Rotameter, or equivalent, capable of measuring sample flow in the range of 60 to 100 cm^3/min (0.13 to 0.21 ft^3/hr).

6.1.8 Sample Tank. Stainless steel or aluminum tank with a minimum volume of 4 liters (0.14 ft^3).

NOTE: Sample volumes greater than 4 liters may be required for sources with low organic concentrations.

6.1.9 Mercury Manometer. U-tube manometer or absolute pressure gauge capable of measuring pressure to within 1 mm Hg in the range of 0 to 900 mm.

6.1.10 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

6.2 Condensate Recovery. The system for the recovery of the organics captured in the condensate trap consists of a heat source, an oxidation catalyst, a nondispersive infrared (NDIR) analyzer, and an intermediate collection vessel (ICV). Figure 25–4 is a schematic of a typical system. The system shall be capable of proper oxidation and recovery, as specified in section 10.1.1. The following major components are required:

6.2.1 Heat Source. Sufficient to heat the condensate trap (including probe) to a temperature of 200 °C (390 °F). A system using both a heat gun and an electric tube furnace is recommended.

6.2.2 Heat Tape. Sufficient to heat the connecting tubing between the water trap and the oxidation catalyst to 100 °C (212 °F).

6.2.3 Oxidation Catalyst. A suitable length of 9.5 mm (3⁄8-in.) OD Inconel 600 tubing packed with 15 cm (6 in.) of 3.2 mm (3⁄8-in.) diameter 19 percent chromia on alumina pellets. The catalyst material is packed in the center of the catalyst tube with quartz wool packed on either end to hold it in place.

6.2.4 Water Trap. Leak-proof, capable of removing moisture from the gas stream.

6.2.5 Syringe Port. A 6.4-mm (1⁄4-in.) OD stainless steel tee fitting with a rubber septum placed in the side arm.

6.2.6 NDIR Detector. Capable of indicating CO_2 concentration in the range of zero to 5 percent, to monitor the progress of combustion of the organic compounds from the condensate trap.

6.2.7 Flow-Control Valve. Stainless steel, to maintain the trap conditioning system near atmospheric pressure.

6.2.8 Intermediate Collection Vessel. Stainless steel or aluminum, equipped with a female quick connect. Tanks with nominal volumes of at least 6 liters (0.2 ft^3) are recommended.

6.2.9 Mercury Manometer. Same as described in section 6.1.9.

6.2.10 Syringe. 10-ml gas-tight glass syringe equipped with an appropriate needle.

6.2.11 Syringes. 10-μl and 50-μl liquid injection syringes.

6.2.12 Liquid Sample Injection Unit. 316 Stainless steel U-tube fitted with an injection septum (see Figure 25–7).

6.3 Analysis.

6.3.1 NMO Analyzer. The NMO analyzer is a gas chromatograph (GC) with backflush capability for NMO analysis and is equipped with an oxidation catalyst, reduction catalyst, and FID. Figures 25–5 and 25–6 are schematics of a typical NMO analyzer. This semicontinuous GC/FID analyzer shall be capable of: (1) Separating CO, CO_2, and CH_4 from NMO, (2) reducing the CO_2 to CH_4 and quantifying as CH_4, and (3) oxidizing the NMO to CO_2, reducing the CO_2 to CH_4 and quantifying as CH_4, according to section 10.1.2. The analyzer consists of the following major components:

6.3.1.1 Oxidation Catalyst. A suitable length of 9.5-mm (3⁄8-in.) OD Inconel 600 tubing packed with 5.1 cm (2 in.) of 19 percent chromia on 3.2-mm (1⁄8-in.) alumina pellets. The catalyst material is packed in the center of the tube supported on either side by quartz wool. The catalyst tube must be mounted vertically in a 650 °C (1200 °F) furnace. Longer catalysts mounted horizontally may be used, provided they can meet the specifications of section 10.1.2.1.

6.3.1.2 Reduction Catalyst. A 7.6-cm (3-in.) length of 6.4-mm (1⁄4-in.) OD Inconel tubing fully packed with 100-mesh pure nickel powder. The catalyst tube must be mounted vertically in a 400 °C (750 °F) furnace.

6.3.1.3 Separation Column(s). A 30-cm (1-ft) length of 3.2-mm (1⁄8-in.) OD stainless steel tubing packed with 60/80 mesh Unibeads 1S followed by a 61-cm (2-ft) length of 3.2-mm (1⁄8-in.) OD stainless steel tubing packed with 60/80 mesh Carbosieve G. The Carbosieve and Unibeads columns must be baked separately at 200 °C (390 °F) with carrier gas flowing through them for 24 hours before initial use.

6.3.1.4 Sample Injection System. A single 10-port GC sample injection valve or a group of valves with sufficient ports fitted with a sample loop properly sized to interface with the NMO analyzer (1-cc loop recommended).

6.3.1.5 FID. An FID meeting the following specifications is required:

6.3.1.5.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.2.3.

6.3.1.5.2 Range. A full scale range of 10 to 50,000 ppm CH_4. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.3.1.6 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the analytical results.

6.3.2 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 1 mm Hg.

6.3.3 Temperature Sensor. Capable of measuring the laboratory temperature within 1 °C (2 °F).

6.3.4 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

7.0 Reagents and Standards

7.1 Sample Collection. The following reagents are required for sample collection:

7.1.1 Dry Ice. Solid CO2, crushed.

7.1.2 Coarse Quartz Wool. 8 to 15 um.

7.1.3 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Method D2986–71, 78, or 95a (incorporated by reference—see § 60.17). Test data from the supplier's quality control program are sufficient for this purpose.

7.2 NMO Analysis. The following gases are required for NMO analysis:

7.2.1 Carrier Gases. Helium (He) and oxygen (O_2) containing less than 1 ppm CO_2 and less than 0.1 ppm hydrocarbon.

7.2.2 Fuel Gas. Hydrogen (H_2), at least 99.999 percent pure.

7.2.3 Combustion Gas. Either air (less than 0.1 ppm total hydrocarbon content) or O_2 (purity 99.99 percent or greater), as required by the detector.

7.3 Condensate Analysis. The following are required for condensate analysis:

7.3.1 Gases. Containing less than 1 ppm carbon.

7.3.1.1 Air.

7.3.1.2 Oxygen.

7.3.2 Liquids. To conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society.

7.3.2.1 Hexane.

7.3.2.2 Decane.

7.4 Calibration. For all calibration gases, the manufacturer must recommend a maximum shelf life for each cylinder (i.e., the length of time the gas concentration is not expected to change more than ±5 percent from its certified value). The date of gas cylinder preparation, certified organic concentration, and recommended maximum shelf life must be affixed to each cylinder before shipment from the gas manufacturer to the buyer. The following calibration gases are required:

7.4.1 Oxidation Catalyst Efficiency Check Calibration Gas. Gas mixture standard with nominal concentration of 1 percent methane in air.

7.4.2 FID Linearity and NMO Calibration Gases. Three gas mixture standards with nominal propane concentrations of 20 ppm, 200 ppm, and 3000 ppm, in air.

7.4.3 CO_2 Calibration Gases. Three gas mixture standards with nominal CO_2 concentrations of 50 ppm, 500 ppm, and 1 percent, in air.

NOTE: Total NMO less than 1 ppm required for 1 percent mixture.

7.4.4 NMO Analyzer System Check Calibration Gases. Four calibration gases are needed as follows:

7.4.4.1 Propane Mixture. Gas mixture standard containing (nominal) 50 ppm CO, 50 ppm CH_4, 1 percent CO_2, and 20 ppm C_3H_8, prepared in air.

7.4.4.2 Hexane. Gas mixture standard containing (nominal) 50 ppm hexane in air.

7.4.4.3 Toluene. Gas mixture standard containing (nominal) 20 ppm toluene in air.

7.4.4.4 Methanol. Gas mixture standard containing (nominal) 100 ppm methanol in air.

8.0 Sample Collection, Preservation, Transport, and Storage

8.1 Sampling Equipment Preparation.

8.1.1 Condensate Trap Cleaning. Before its initial use and after each use, a condensate trap should be thoroughly cleaned and checked to ensure that it is not contaminated. Both cleaning and checking can be accomplished by installing the trap in the condensate recovery system and treating it as if it were a sample. The trap should be heated as described in section 11.1.3. A trap may be considered clean when the CO_2 concentration in its effluent gas drops below 10 ppm. This check is optional for traps that most recently have been used to collect samples which were then recovered according to the procedure in section 11.1.3.

8.1.2 Sample Tank Evacuation and Leak-Check. Evacuate the sample tank to 10 mm Hg absolute pressure or less. Then close the sample tank valve, and allow the tank to sit for 60 minutes. The tank is acceptable if a change in tank vacuum of less than 1 mm Hg is noted. The evacuation and leak-check may be conducted either in the laboratory or the field.

8.1.3 Sampling Train Assembly. Just before assembly, measure the tank vacuum using a mercury manometer. Record this vacuum, the ambient temperature, and the barometric pressure at this time. Close the sample tank valve and assemble the sampling

system as shown in Figure 25–1. Immerse the condensate trap body in dry ice at least 30 minutes before commencing sampling to improve collection efficiency. The point where the inlet tube joins the trap body should be 2.5 to 5 cm (1 to 2 in.) above the top of the dry ice.

8.1.4 Pretest Leak-Check. A pretest leak-check is required. Calculate or measure the approximate volume of the sampling train from the probe tip to the sample tank valve. After assembling the sampling train, plug the probe tip, and make certain that the sample tank valve is closed. Turn on the vacuum pump, and evacuate the sampling system from the probe tip to the sample tank valve to an absolute pressure of 10 mm Hg or less. Close the purge valve, turn off the pump, wait a minimum period of 10 minutes, and recheck the indicated vacuum. Calculate the maximum allowable pressure change based on a leak rate of 1 percent of the sampling rate using Equation 25–1, section 12.2. If the measured pressure change exceeds the allowable, correct the problem and repeat the leak-check before beginning sampling.

8.2 Sample Collection.

8.2.1 Unplug the probe tip, and place the probe into the stack such that the probe is perpendicular to the duct or stack axis; locate the probe tip at a single preselected point of average velocity facing away from the direction of gas flow. For stacks having a negative static pressure, seal the sample port sufficiently to prevent air in-leakage around the probe. Set the probe temperature controller to 129 °C (265 °F) and the filter temperature controller to 121 °C (250 °F). Allow the probe and filter to heat for about 30 minutes before purging the sample train.

8.2.2 Close the sample valve, open the purge valve, and start the vacuum pump. Set the flow rate between 60 and 100 cm^3/min (0.13 and 0.21 ft^3/hr), and purge the train with stack gas for at least 10 minutes.

8.2.3 When the temperatures at the exit ends of the probe and filter are within the corresponding specified ranges, check the dry ice level around the condensate trap, and add dry ice if necessary. Record the clock time. To begin sampling, close the purge valve and stop the pump. Open the sample valve and the sample tank valve. Using the flow control valve, set the flow through the sample train to the proper rate. Adjust the flow rate as necessary to maintain a constant rate (±10 percent) throughout the duration of the sampling period. Record the sample tank vacuum and flowmeter setting at 5-minute intervals. (See Figure 25–8.) Select a total sample time greater than or equal to the minimum sampling time specified in the applicable subpart of the regulations; end the sampling when this time period is reached or when a constant flow rate can no longer be maintained because of reduced sample tank vacuum.

NOTE: If sampling had to be stopped before obtaining the minimum sampling time (specified in the applicable subpart) because a constant flow rate could not be maintained, proceed as follows: After closing the sample tank valve, remove the used sample tank from the sampling train (without disconnecting other portions of the sampling train). Take another evacuated and leak-checked sample tank, measure and record the tank vacuum, and attach the new tank to the sampling train. After the new tank is attached to the sample train, proceed with the sampling until the required minimum sampling time has been exceeded.

8.3 Sample Recovery. After sampling is completed, close the flow control valve, and record the final tank vacuum; then record the tank temperature and barometric pressure. Close the sample tank valve, and disconnect the sample tank from the sample system. Disconnect the condensate trap at the inlet to the rate meter, and tightly seal both ends of the condensate trap. Do not include the probe from the stack to the filter as part of the condensate sample.

8.4 Sample Storage and Transport. Keep the trap packed in dry ice until the samples are returned to the laboratory for analysis. Ensure that run numbers are identified on the condensate trap and the sample tank(s).

9.0 Quality Control

Section	Quality control measure	Effect
10.1.1	Initial performance check of condensate recovery apparatus.	Ensure acceptable condensate recovery efficiency.
10.1.2, 10.2	NMO analyzer initial and daily performance checks.	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial Performance Checks.

10.1.1 Condensate Recovery Apparatus. Perform these tests before the system is first placed in operation, after any shutdown of 6 months or more, and after any major modification of the system, or at the frequency recommended by the manufacturer.

10.1.1.1 Carrier Gas and Auxiliary O_2 Blank Check. Analyze each new tank of carrier gas or auxiliary O_2 with the NMO analyzer to

check for contamination. Treat the gas cylinders as noncondensible gas samples, and analyze according to the procedure in section 11.2.3. Add together any measured CH_4, CO, CO_2, or NMO. The total concentration must be less than 5 ppm.

10.1.1.2 Oxidation Catalyst Efficiency Check.

10.1.1.2.1 With a clean condensate trap installed in the recovery system or a ⅛″ stainless steel connector tube, replace the carrier gas cylinder with the high level methane standard gas cylinder (Section 7.4.1). Set the four-port valve to the recovery position, and attach an ICV to the recovery system. With the sample recovery valve in vent position and the flow-control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

10.1.1.2.2 After the NDIR response has stabilized, switch the sample recovery valve from vent to collect. When the manometer or pressure gauge begins to register a slight positive pressure, open the flow-control valve. Keep the flow adjusted such that the pressure in the system is maintained within 10 percent of atmospheric pressure. Continue collecting the sample in a normal manner until the ICV is filled to a nominal gauge pressure of 300 mm Hg. Close the ICV valve, and remove the ICV from the system. Place the sample recovery valve in the vent position, and return the recovery system to its normal carrier gas and normal operating conditions. Analyze the ICV for CO_2 using the NMO analyzer; the catalyst efficiency is acceptable if the CO_2 concentration is within 2 percent of the methane standard concentration.

10.1.1.3 System Performance Check. Construct a liquid sample injection unit similar in design to the unit shown in Figure 25–7. Insert this unit into the condensate recovery and conditioning system in place of a condensate trap, and set the carrier gas and auxiliary O_2 flow rates to normal operating levels. Attach an evacuated ICV to the system, and switch from system vent to collect. With the carrier gas routed through the injection unit and the oxidation catalyst, inject a liquid sample (see sections 10.1.1.3.1 to 10.1.1.3.4) into the injection port. Operate the trap recovery system as described in section 11.1.3. Measure the final ICV pressure, and then analyze the vessel to determine the CO_2 concentration. For each injection, calculate the percent recovery according to section 12.7. Calculate the relative standard deviation for each set of triplicate injections according to section 12.8. The performance test is acceptable if the average percent recovery is 100 ±5 percent and the relative standard deviation is less than 2 percent for each set of triplicate injections.

10.1.1.3.1 50 μl hexane.

10.1.1.3.2 10 μl hexane.

10.1.1.3.3 50 μl decane.

10.1.1.3.4 10 μl decane.

10.1.2 NMO Analyzer. Perform these tests before the system is first placed in operation, after any shutdown longer than 6 months, and after any major modification of the system.

10.1.2.1 Oxidation Catalyst Efficiency Check. Turn off or bypass the NMO analyzer reduction catalyst. Make triplicate injections of the high level methane standard (Section 7.4.1). The oxidation catalyst operation is acceptable if the FID response is less than 1 percent of the injected methane concentration.

10.1.2.2 Reduction Catalyst Efficiency Check. With the oxidation catalyst unheated or bypassed and the heated reduction catalyst bypassed, make triplicate injections of the high level methane standard (Section 7.4.1). Repeat this procedure with both catalysts operative. The reduction catalyst operation is acceptable if the responses under both conditions agree within 5 percent of their average.

10.1.2.3 NMO Analyzer Linearity Check Calibration. While operating both the oxidation and reduction catalysts, conduct a linearity check of the analyzer using the propane standards specified in section 7.4.2. Make triplicate injections of each calibration gas. For each gas (*i.e.*, each set of triplicate injections), calculate the average response factor (area/ppm C) for each gas, as well as and the relative standard deviation (according to section 12.8). Then calculate the overall mean of the response factor values. The instrument linearity is acceptable if the average response factor of each calibration gas is within 2.5 percent of the overall mean value and if the relative standard deviation gas is less than 2 percent of the overall mean value. Record the overall mean of the propane response factor values as the NMO calibration response factor (RF_{NMO}). Repeat the linearity check using the CO_2 standards specified in section 7.4.3. Make triplicate injections of each gas, and then calculate the average response factor (area/ppm C) for each gas, as well as the overall mean of the response factor values. Record the overall mean of the response factor values as the CO_2 calibration response factor (RF_{CO2}). The RF_{CO2} must be within 10 percent of the RF_{NMO}.

10.1.2.4 System Performance Check. Check the column separation and overall performance of the analyzer by making triplicate injections of the calibration gases listed in section 7.4.4. The analyzer performance is acceptable if the measured NMO value for each gas (average of triplicate injections) is within 5 percent of the expected value.

10.2 NMO Analyzer Daily Calibration. The following calibration procedures shall be performed before and immediately after the

analysis of each set of samples, or on a daily basis, whichever is more stringent:

10.2.1 CO_2 Response Factor. Inject triplicate samples of the high level CO_2 calibration gas (Section 7.4.3), and calculate the average response factor. The system operation is adequate if the calculated response factor is within 5 percent of the RF_{CO2} calculated during the initial performance test (Section 10.1.2.3). Use the daily response factor (DRF_{CO2}) for analyzer calibration and the calculation of measured CO_2 concentrations in the ICV samples.

10.2.2 NMO Response Factors. Inject triplicate samples of the mixed propane calibration cylinder gas (Section 7.4.4.1), and calculate the average NMO response factor. The system operation is adequate if the calculated response factor is within 10 percent of the RF_{NMO} calculated during the initial performance test (Section 10.1.2.4). Use the daily response factor (DRF_{NMO}) for analyzer calibration and calculation of NMO concentrations in the sample tanks.

10.3 Sample Tank and ICV Volume. The volume of the gas sampling tanks used must be determined. Determine the tank and ICV volumes by weighing them empty and then filled with deionized distilled water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedure

11.1 Condensate Recovery. See Figure 25–9. Set the carrier gas flow rate, and heat the catalyst to its operating temperature to condition the apparatus.

11.1.1 Daily Performance Checks. Each day before analyzing any samples, perform the following tests:

11.1.1.1 Leak-Check. With the carrier gas inlets and the sample recovery valve closed, install a clean condensate trap in the system, and evacuate the system to 10 mm Hg absolute pressure or less. Monitor the system pressure for 10 minutes. The system is acceptable if the pressure change is less than 2 mm Hg.

11.1.1.2 System Background Test. Adjust the carrier gas and auxiliary oxygen flow rate to their normal values of 100 cc/min and 150 cc/min, respectively, with the sample recovery valve in vent position. Using a 10-ml syringe, withdraw a sample from the system effluent through the syringe port. Inject this sample into the NMO analyzer, and measure the CO_2 content. The system background is acceptable if the CO_2 concentration is less than 10 ppm.

11.1.1.3 Oxidation Catalyst Efficiency Check. Conduct a catalyst efficiency test as specified in section 10.1.1.2. If the criterion of this test cannot be met, make the necessary repairs to the system before proceeding.

11.1.2 Condensate Trap CO_2 Purge and Sample Tank Pressurization.

11.1.2.1 After sampling is completed, the condensate trap will contain condensed water and organics and a small volume of sampled gas. This gas from the stack may contain a significant amount of CO_2 which must be removed from the condensate trap before the sample is recovered. This is accomplished by purging the condensate trap with zero air and collecting the purged gas in the original sample tank.

11.1.2.2 Begin with the sample tank and condensate trap from the test run to be analyzed. Set the four-port valve of the condensate recovery system in the CO_2 purge position as shown in Figure 25–9. With the sample tank valve closed, attach the sample tank to the sample recovery system. With the sample recovery valve in the vent position and the flow control valve fully open, evacuate the manometer or pressure gauge to the vacuum of the sample tank. Next, close the vacuum pump valve, open the sample tank valve, and record the tank pressure.

11.1.2.3 Attach the dry ice-cooled condensate trap to the recovery system, and initiate the purge by switching the sample recovery valve from vent to collect position. Adjust the flow control valve to maintain atmospheric pressure in the recovery system. Continue the purge until the CO_2 concentration of the trap effluent is less than 5 ppm. CO_2 concentration in the trap effluent should be measured by extracting syringe samples from the recovery system and analyzing the samples with the NMO analyzer. This procedure should be used only after the NDIR response has reached a minimum level. Using a 10-ml syringe, extract a sample from the syringe port prior to the NDIR, and inject this sample into the NMO analyzer.

11.1.2.4 After the completion of the CO_2 purge, use the carrier gas bypass valve to pressurize the sample tank to approximately 1,060 mm Hg absolute pressure with zero air.

11.1.3 Recovery of the Condensate Trap Sample (See Figure 25–10).

11.1.3.1 Attach the ICV to the sample recovery system. With the sample recovery valve in a closed position, between vent and collect, and the flow control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

11.1.3.2 Begin auxiliary oxygen flow to the oxidation catalyst at a rate of 150 cc/min, then switch the four-way valve to the trap recovery position and the sample recovery valve to collect position. The system should now be set up to operate as indicated in Figure 25–10. After the manometer or pressure gauge begins to register a slight positive pressure, open the flow control valve. Adjust the flow-control valve to maintain atmospheric pressure in the system within 10 percent.

11.1.3.3 Remove the condensate trap from the dry ice, and allow it to warm to ambient temperature while monitoring the NDIR response. If, after 5 minutes, the CO_2 concentration of the catalyst effluent is below 10,000 ppm, discontinue the auxiliary oxygen flow to the oxidation catalyst. Begin heating the trap by placing it in a furnace preheated to 200 °C (390 °F). Once heating has begun, carefully monitor the NDIR response to ensure that the catalyst effluent concentration does not exceed 50,000 ppm. Whenever the CO_2 concentration exceeds 50,000 ppm, supply auxiliary oxygen to the catalyst at the rate of 150 cc/min. Begin heating the tubing that connected the heated sample box to the condensate trap only after the CO_2 concentration falls below 10,000 ppm. This tubing may be heated in the same oven as the condensate trap or with an auxiliary heat source such as a heat gun. Heating temperature must not exceed 200 °C (390 °F). If a heat gun is used, heat the tubing slowly along its entire length from the upstream end to the downstream end, and repeat the pattern for a total of three times. Continue the recovery until the CO_2 concentration drops to less than 10 ppm as determined by syringe injection as described under the condensate trap CO_2 purge procedure (Section 11.1.2).

11.1.3.4 After the sample recovery is completed, use the carrier gas bypass valve to pressurize the ICV to approximately 1060 mm Hg absolute pressure with zero air.

11.2 Analysis. Once the initial performance test of the NMO analyzer has been successfully completed (see section 10.1.2) and the daily CO_2 and NMO response factors have been determined (see section 10.2), proceed with sample analysis as follows:

11.2.1 Operating Conditions. The carrier gas flow rate is 29.5 cc/min He and 2.2 cc/min O_2. The column oven is heated to 85 °C (185 °F). The order of elution for the sample from the column is CO, CH_4, CO_2, and NMO.

11.2.2 Analysis of Recovered Condensate Sample. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (380 °F) as rapidly as possible. A rate of 30 °C/min (90 °F) has been shown to be adequate. Record the value obtained for the condensible organic material (C_{cm}) measured as CO_2 and any measured NMO. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average C_{cm}.

11.2.3 Analysis of Sample Tank. Perform the analysis as described in section 11.2.2, but record only the value measured for NMO (C_{tm}).

12.0 Data Analysis and Calculations

Carry out the calculations, retaining at least one extra significant figure beyond that of the acquired data. Round off figures after final calculations. All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature.

C = TGNMO concentration of the effluent, ppm C equivalent.

C_c = Calculated condensible organic (condensate trap) concentration of the effluent, ppm C equivalent.

C_{cm} = Measured concentration (NMO analyzer) for the condensate trap ICV, ppm CO_2.

C_t = Calculated noncondensible organic concentration (sample tank) of the effluent, ppm C equivalent.

C_{tm} = Measured concentration (NMO analyzer) for the sample tank, ppm NMO.

F = Sampling flow rate, cc/min.

L = Volume of liquid injected, μl.

M = Molecular weight of the liquid injected, g/g-mole.

M_c = TGNMO mass concentration of the effluent, mg C/dsm^3.

N = Carbon number of the liquid compound injected (N = 12 for decane, N = 6 for hexane).

n = Number of data points.

P_f = Final pressure of the intermediate collection vessel, mm Hg absolute.

P_b = Barometric pressure, cm Hg.

P_{ti} = Gas sample tank pressure before sampling, mm Hg absolute.

P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.

q = Total number of analyzer injections of intermediate collection vessel during analysis (where k = injection number, 1 * * * q).

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 * * * r).

r = Density of liquid injected, g/cc.

T_f = Final temperature of intermediate collection vessel, °K.

T_{ti} = Sample tank temperature before sampling, °K.

T_t = Sample tank temperature at completion of sampling, °K.

T_{tf} = Sample tank temperature after pressurizing, °K.

V = Sample tank volume, m^3.

V_t = Sample train volume, cc.

V_v = Intermediate collection vessel volume, m^3.

V_s = Gas volume sampled, dsm^3.

x_i = Individual measurements.

$\bar{x}$ = Mean value.

ΔP = Allowable pressure change, cm Hg.
Θ = Leak-check period, min.

12.2 Allowable Pressure Change. For the pretest leak-check, calculate the allowable pressure change using Equation 25–1:

$$\Delta P = 0.01\ \frac{FP_b\Theta}{V_t} \qquad \text{Eq. 25-1}$$

12.3 Sample Volume. For each test run, calculate the gas volume sampled using Equation 25–2:

$$V_s = 0.3857\ V\left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}\right) \qquad \text{Eq. 25-2}$$

12.4 Noncondensible Organics. For each sample tank, determine the concentration of nonmethane organics (ppm C) using Equation 25–3:

$$C_t = \left(\frac{\frac{P_{tf}}{T_{tf}}}{\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}}\right)\left(\frac{1}{r}\sum_{j=1}^{r} C_{tm_j}\right) \qquad \text{Eq. 25-3}$$

12.5 Condensible Organics. For each condensate trap determine the concentration of organics (ppm C) using Equation 25–4:

$$C_c = 0.3857\frac{V_v P_f}{V_s T_f}\left(\frac{1}{q}\sum_{k=1}^{q} C_{cm_k}\right) \qquad \text{Eq. 25-4}$$

12.6 TGNMO Mass Concentration. Determine the TGNMO mass concentration as carbon for each test run, using Equation 25–5:

$$M_c = 0.4993\ (C_t + C_c) \qquad \text{Eq. 25-5}$$

12.7 Percent Recovery. Calculate the percent recovery for the liquid injections to the condensate recovery and conditioning system using Equation 25–6:

$$\text{Percent Recovery} = K\ \frac{M\,V_v P_t C_{cm}}{L\,P\,T_f N} \qquad \text{Eq. 25-6}$$

where K = 1.604 (°K)(g-mole)(%)/(mm Hg)(ml)(m^3)(ppm).

12.8 Relative Standard Deviation. Use Equation 25–7 to calculate the relative standard deviation (RSD) of percent recovery and analyzer linearity.

$$RSD = \frac{100}{\bar{x}}\left[\frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}{n-1}\right]^{\frac{1}{2}} \qquad \text{Eq. 25-7}$$

13.0 Method Performance

13.1 Range. The minimum detectable limit of the method has been determined to be 50 parts per million by volume (ppm). No upper limit has been established.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, A.E., S. Witz, and R.D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, MA. June 15–20, 1975.) 14 p.

2. Salo, A.E., W.L. Oaks, and R.D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, CO. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

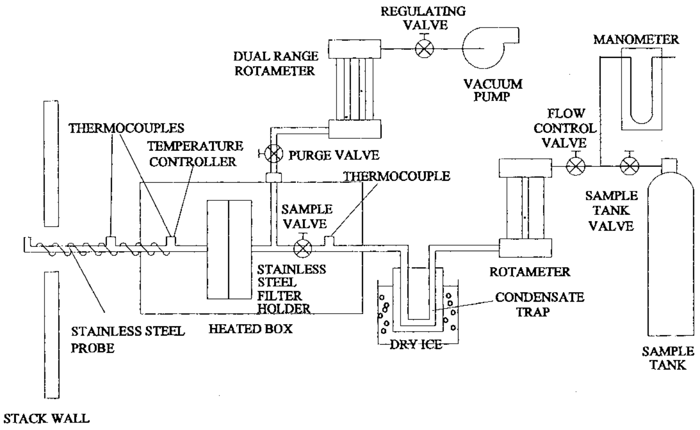


Figure 25-1. Sampling Train

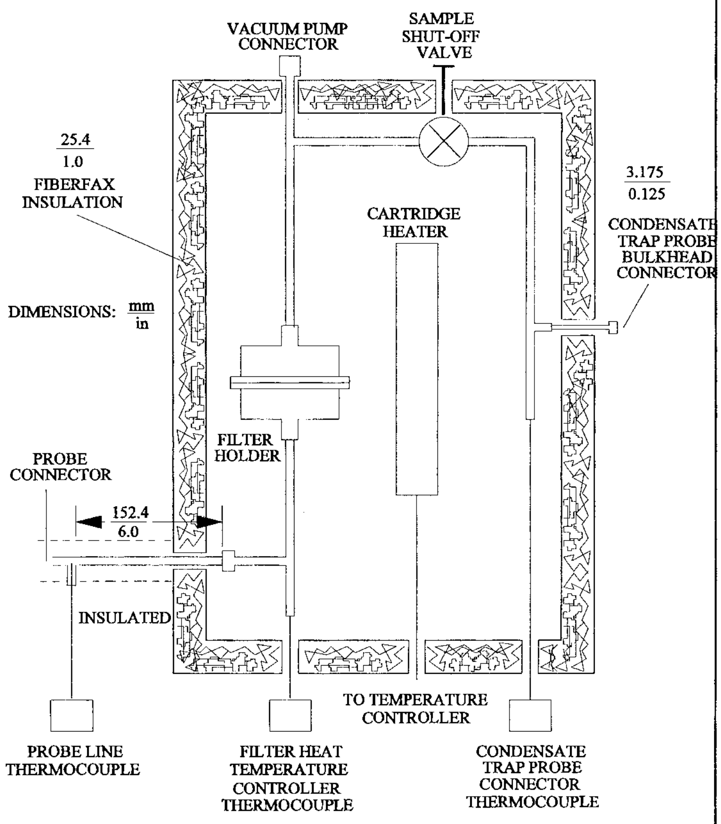


Figure 25-2. Out-of-stack Filter Box

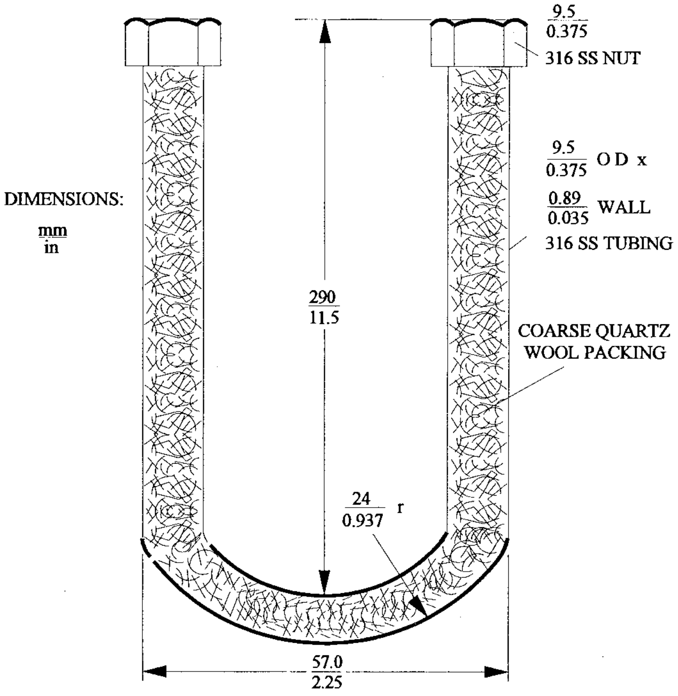


Figure 25-3. Condensate Trap

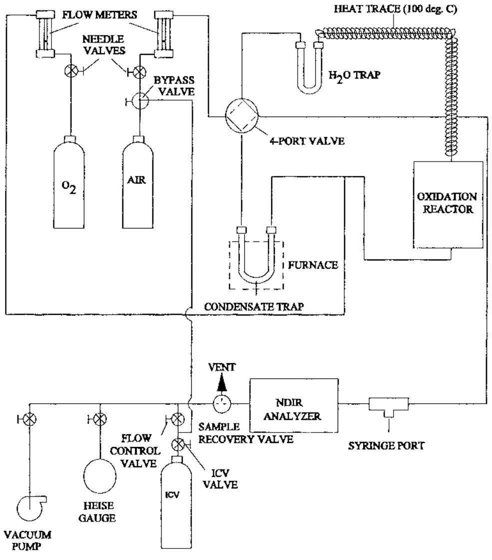


Figure 25-4. Condensate Recovery System

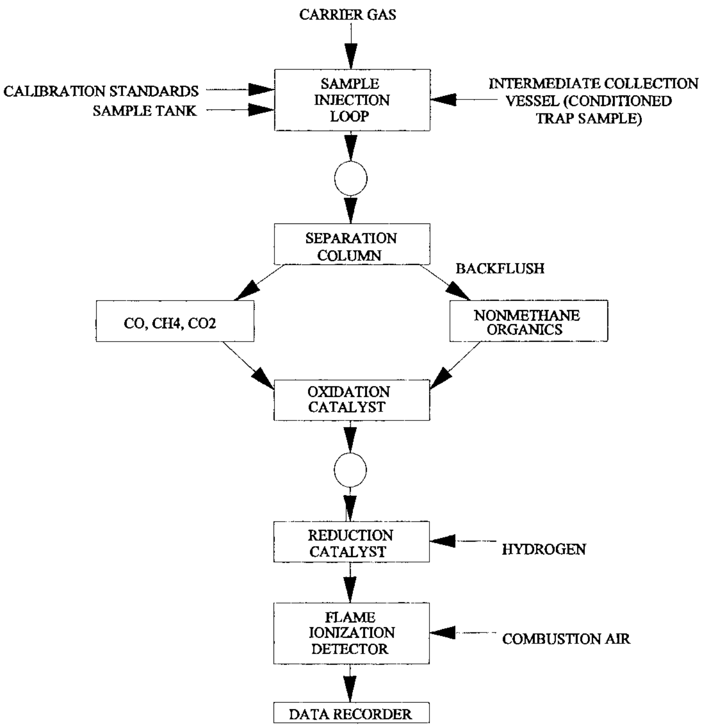


Figure 25-5. Simplified Schematic of Nonmethane Organic (NMO) Analyzer

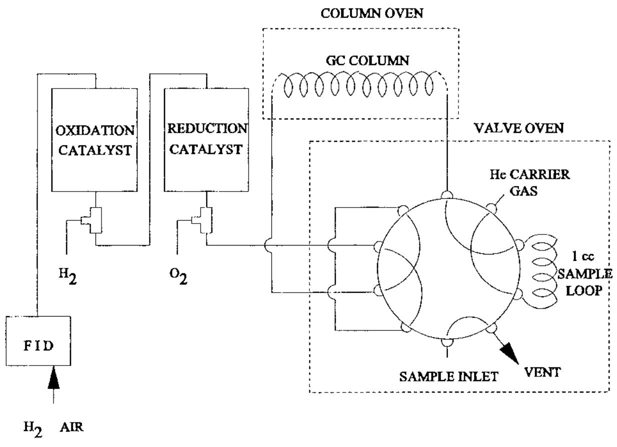


Figure 25-6. Nonmethane Organic Analyzer (NMO)

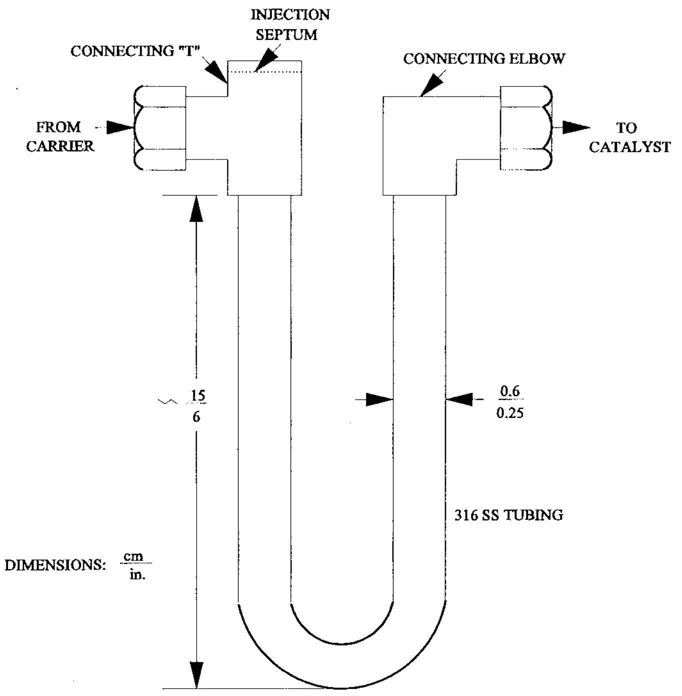
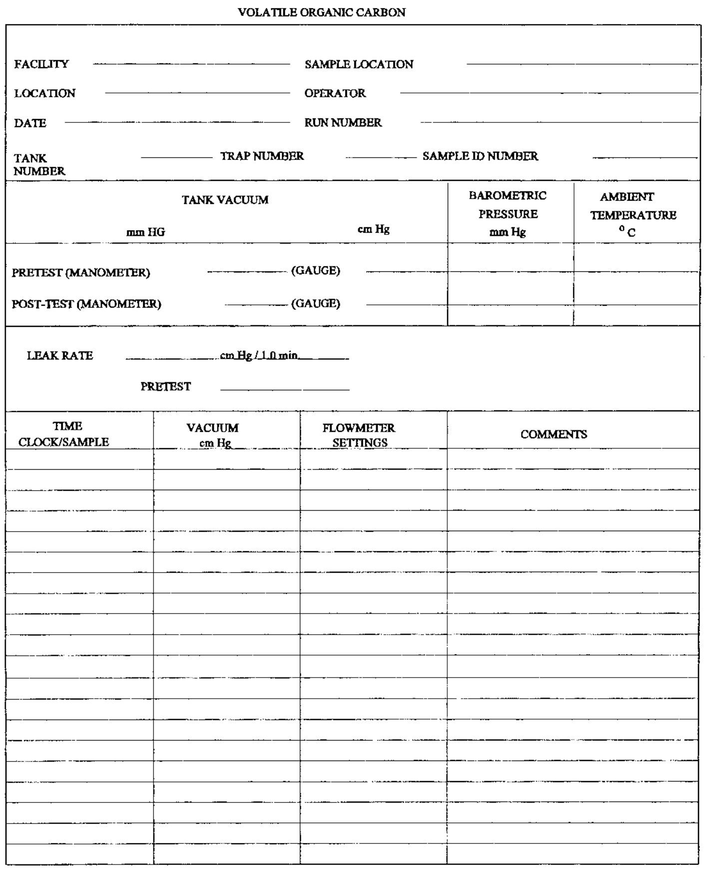


Figure 25-7. Liquid Sample Injection Unit



VOLATILE ORGANIC CARBON

FACILITY ____________ SAMPLE LOCATION ____________

LOCATION ____________ OPERATOR ____________

DATE ____________ RUN NUMBER ____________

TANK NUMBER ________ TRAP NUMBER ________ SAMPLE ID NUMBER ________

TANK VACUUM mm HG	TANK VACUUM cm Hg	BAROMETRIC PRESSURE mm Hg	AMBIENT TEMPERATURE °C
PRETEST (MANOMETER) ________	(GAUGE) ________		
POST-TEST (MANOMETER) ________	(GAUGE) ________		

LEAK RATE ________ cm Hg / 1.0 min ________

PRETEST ________

TIME CLOCK/SAMPLE	VACUUM cm Hg	FLOWMETER SETTINGS	COMMENTS

Figure 25-8. Example Field Data Form

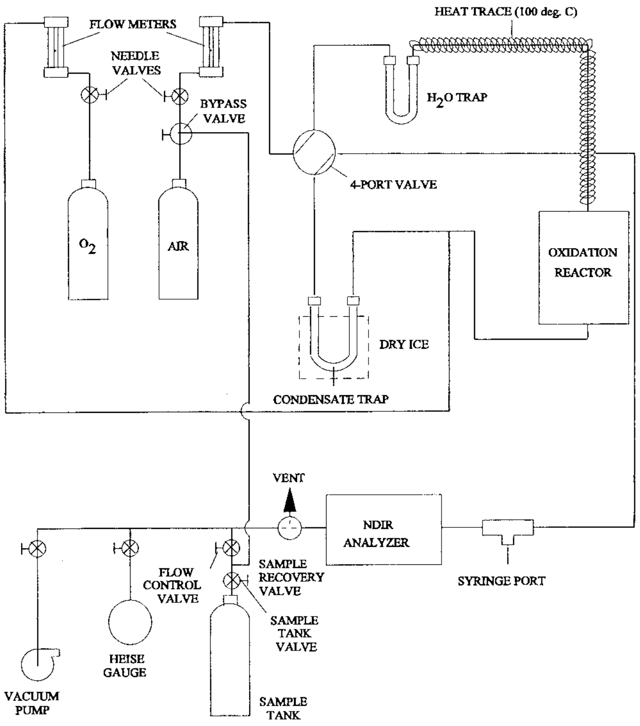


Figure 25-9. Condensate Recovery System, CO2 Purge

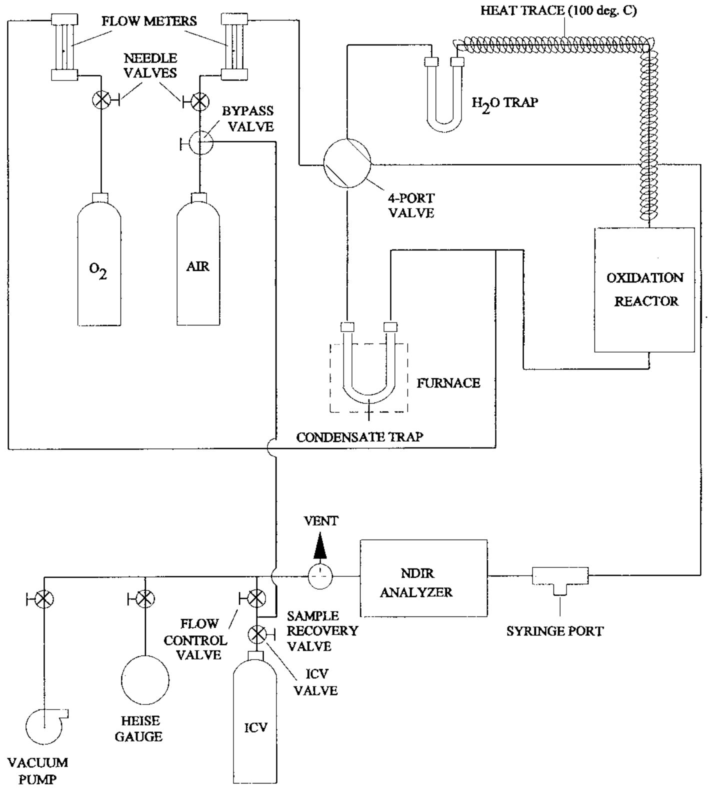


Figure 25-10. Condensate Recovery System, Collection of Trap Organics

METHOD 25A—DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A FLAME IONIZATION ANALYZER

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A gas sample is extracted from the source through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

3.1 *Calibration drift* means the difference in the measurement system response to a midlevel calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

3.2 *Calibration error* means the difference between the gas concentration indicated by the measurement system and the know concentration of the calibration gas.

3.3 *Calibration gas* means a known concentration of a gas in an appropriate diluent gas.

3.4 *Measurement system* means the total equipment required for the determination of the gas concentration. The system consists of the following major subsystems:

3.4.1 *Sample interface* means that portion of a system used for one or more of the following: sample acquisition, sample transportation, sample conditioning, or protection of the analyzer(s) from the effects of the stack effluent.

3.4.2 *Organic analyzer* means that portion of the measurement system that senses the gas to be measured and generates an output proportional to its concentration.

3.5 *Response time* means the time interval from a step change in pollutant concentration at the inlet to the emission measurement system to the time at which 95 percent of the corresponding final value is reached as displayed on the recorder.

3.6 *Span Value* means the upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the applicable emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected concentration. For convenience, the span value should correspond to 100 percent of the recorder scale.

3.7 *Zero drift* means the difference in the measurement system response to a zero level calibration gas before or after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

6.1 Measurement System. Any measurement system for total organic concentration that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 25A–1. All sampling components leading to the analyzer shall be heated ≥110 °C (220 °F) throughout the sampling period, unless safety reasons are cited (Section 5.2) The essential components of the measurement system are described below:

6.1.1 Organic Concentration Analyzer. A flame ionization analyzer (FIA) capable of meeting or exceeding the specifications of this method. The flame ionization detector block shall be heated >120 °C (250 °F).

6.1.2 Sample Probe. Stainless steel, or equivalent, three-hole rake type. Sample holes shall be 4 mm (0.16-in.) in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

6.1.3 Heated Sample Line. Stainless steel or Teflon'' tubing to transport the sample gas

to the analyzer. The sample line should be heated (≥110 °C) to prevent any condensation.

6.1.4 Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are applicable.

6.1.5 Particulate Filter. An in-stack or an out-of-stack glass fiber filter is recommended if exhaust gas particulate loading is significant. An out-of-stack filter should be heated to prevent any condensation.

6.1.6 Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

7.0 Reagents and Standards

7.1 Calibration Gases. The calibration gases for the gas analyzer shall be propane in air or propane in nitrogen. Alternatively, organic compounds other than propane can be used; the appropriate corrections for response factor must be made. Calibration gases shall be prepared in accordance with the procedure listed in Citation 2 of section 16. Additionally, the manufacturer of the cylinder should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change more than ±2 percent from the certified value. For calibration gas values not generally available (*i.e.*, organics between 1 and 10 percent by volume), alternative methods for preparing calibration gas mixtures, such as dilution systems (Test Method 205, 40 CFR Part 51, Appendix M), may be used with prior approval of the Administrator.

7.1.1 Fuel. A 40 percent H_2/60 percent N_2 gas mixture is recommended to avoid an oxygen synergism effect that reportedly occurs when oxygen concentration varies significantly from a mean value.

7.1.2 Zero Gas. High purity air with less than 0.1 part per million by volume (ppmv) of organic material (propane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

7.1.3 Low-level Calibration Gas. An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value.

7.1.4 Mid-level Calibration Gas. An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value.

7.1.5 High-level Calibration Gas. An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Selection of Sampling Site. The location of the sampling site is generally specified by the applicable regulation or purpose of the test (*i.e.*, exhaust stack, inlet line, etc.). The sample port shall be located to meet the testing requirements of Method 1.

8.2 Location of Sample Probe. Install the sample probe so that the probe is centrally located in the stack, pipe, or duct and is sealed tightly at the stack port connection.

8.3 Measurement System Preparation. Prior to the emission test, assemble the measurement system by following the manufacturer's written instructions for preparing sample interface and the organic analyzer. Make the system operable (Section 10.1).

8.4 Calibration Error Test. Immediately prior to the test series (within 2 hours of the start of the test), introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then introduce low-level and mid-level calibration gases successively to the measurement system. Record the analyzer responses for low-level and mid-level calibration gases and determine the differences between the measurement system responses and the predicted responses. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and must be replaced or repaired prior to testing. No adjustments to the measurement system shall be conducted after the calibration and before the drift check (Section 8.6.2). If adjustments are necessary before the completion of the test series, perform the drift checks prior to the required adjustments and repeat the calibration following the adjustments. If multiple electronic ranges are to be used, each additional range must be checked with a mid-level calibration gas to verify the multiplication factor.

8.5 Response Time Test. Introduce zero gas into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. Record the time from the concentration change to the measurement system response equivalent to 95 percent of the step change. Repeat the test three times and average the results.

8.6 Emission Measurement Test Procedure.

8.6.1 Organic Measurement. Begin sampling at the start of the test period, recording time and any required process information as appropriate. In particulate, note on the recording chart, periods of process interruption or cyclic operation.

8.6.2 Drift Determination. Immediately following the completion of the test period and hourly during the test period, reintroduce the zero and mid-level calibration gases, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until both the zero and calibration drift checks are made.) Record the analyzer response. If the drift values exceed the specified limits, invalidate the test results preceding the check and repeat the test following corrections to the measurement system. Alternatively, recalibrate the test measurement system as in section 8.4 and report the results using both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

NOTE: Note on the recording chart periods of process interruption or cyclic operation.

9.0 Quality Control

Method section	Quality control measure	Effect
8.4	Zero and calibration drift tests	Ensures that bias introduced by drift in the measurement system output during the run is no greater than 3 percent of span.

10.0 Calibration and Standardization

10.1 FIA equipment can be calibrated for almost any range of total organic concentrations. For high concentrations of organics (>1.0 percent by volume as propane), modifications to most commonly available analyzers are necessary. One accepted method of equipment modification is to decrease the size of the sample to the analyzer through the use of a smaller diameter sample capillary. Direct and continuous measurement of organic concentration is a necessary consideration when determining any modification design.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

12.1 Determine the average organic concentration in terms of ppmv as propane or other calibration gas. The average shall be determined by integration of the output recording over the period specified in the applicable regulation. If results are required in terms of ppmv as carbon, adjust measured concentrations using Equation 25A–1.

$$C_c = K C_{meas} \qquad \text{Eq. 25A-1}$$

Where:

C_c = Organic concentration as carbon, ppmv.

C_{meas} = Organic concentration as measured, ppmv.

K = Carbon equivalent correction factor.
= 2 for ethane.
= 3 for propane.
= 4 for butane.
= Appropriate response factor for other organic calibration gases.

13.0 Method Performance

13.1 Measurement System Performance Specifications.

13.1.1 Zero Drift. Less than ±3 percent of the span value.

13.1.2 Calibration Drift. Less than ±3 percent of span value.

13.1.3 Calibration Error. Less than ±5 percent of the calibration gas value.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Measurement of Volatile Organic Compounds—Guideline Series. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA–450/2–78–041. June 1978. p. 46–54.

2. EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards. U.S. Environmental Protection Agency, Quality Assurance and Technical Support Division. Research Triangle Park, N.C. September 1993.

3. Gasoline Vapor Emission Laboratory Evaluation—Part 2. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. EMB Report No. 75–GAS–6. August 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

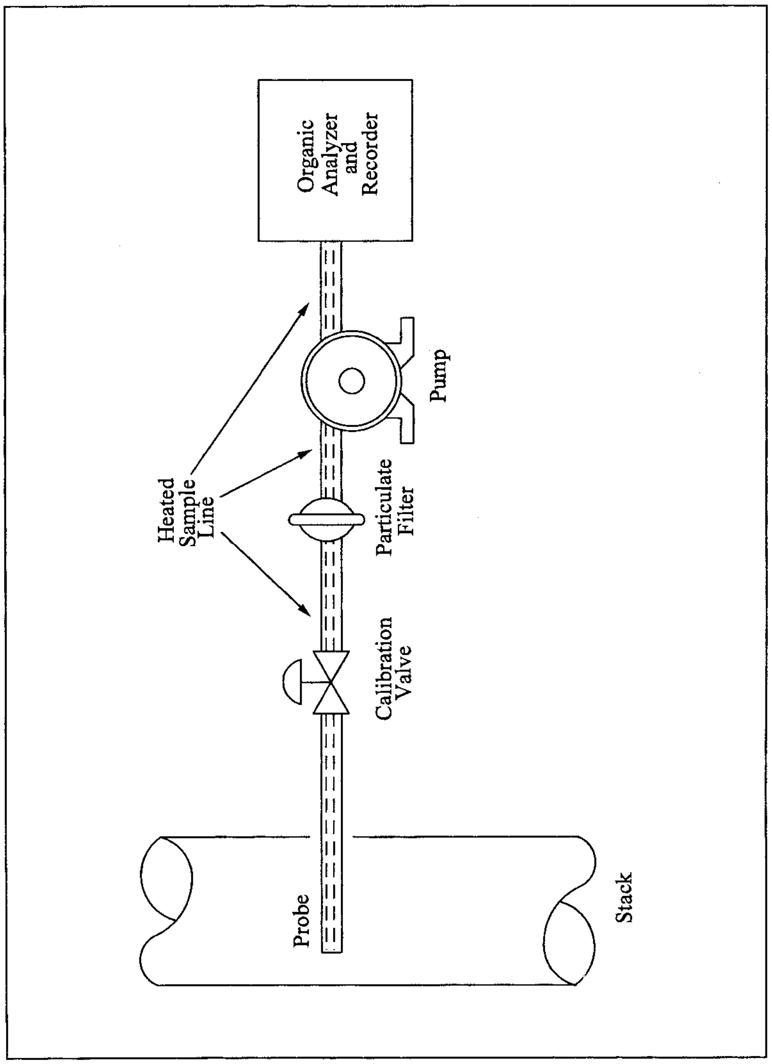


Figure 25A-1. Organic Concentration Measurement System.

METHOD 25B—DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A NONDISPERSIVE INFRARED ANALYZER

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 1, Method 6C, and Method 25A.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes. Other organic materials may be measured using the general procedure in this method, the appropriate calibration gas, and an analyzer set to the appropriate absorption band.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a nondispersive infrared analyzer (NDIR). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

Same as Method 25A, section 3.0.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

Same as Method 25A, section 6.0, with the exception of the following:

6.1 Organic Concentration Analyzer. A nondispersive infrared analyzer designed to measure alkane organics and capable of meeting or exceeding the specifications in this method.

7.0 Reagents and Standards

Same as Method 25A, section 7.1. No fuel gas is required for an NDIR.

8.0 Sample Collection, Preservation, Storage, and Transport

Same as Method 25A, section 8.0.

9.0 Quality Control

Same as Method 25A, section 9.0.

10.0 Calibration and Standardization

Same as Method 25A, section 10.0.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

Same as Method 25A, section 12.0.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as Method 25A, section 16.0.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25C—DETERMINATION OF NONMETHANE ORGANIC COMPOUNDS (NMOC) IN LANDFILL GASES

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling and analytical) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should also have a thorough knowledge of EPA Method 25.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Nonmethane organic compounds (NMOC).	No CAS number assigned.

1.2 Applicability. This method is applicable to the sampling and measurement of NMOC as carbon in landfill gases (LFG).

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A sample probe that has been perforated at one end is driven or augured to a depth of 0.9 m (3 ft) below the bottom of the landfill cover. A sample of the landfill gas is extracted with an evacuated cylinder. The NMOC content of the gas is determined by

injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4); the NMOC are oxidized to CO_2, reduced to CH_4, and measured by a flame ionization detector (FID). In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Since this method is complex, only experienced personnel should perform this test. LFG contains methane, therefore explosive mixtures may exist on or near the landfill. It is advisable to take appropriate safety precautions when testing landfills, such as refraining from smoking and installing explosion-proof equipment.

6.0 Equipment and Supplies

6.1 Sample Probe. Stainless steel, with the bottom third perforated. Teflon probe liners and sampling lines are also allowed. Non-perforated probes are allowed as long as they are withdrawn to create a gap equivalent to having the bottom third perforated. The sample probe must be capped at the bottom and must have a threaded cap with a sampling attachment at the top. The sample probe must be long enough to go through and extend no less than 0.9 m (3 ft) below the landfill cover. If the sample probe is to be driven into the landfill, the bottom cap should be designed to facilitate driving the probe into the landfill.

6.2 Sampling Train.

6.2.1 Rotameter with Flow Control Valve. Capable of measuring a sample flow rate of 100 ±10 ml/min. The control valve must be made of stainless steel.

6.2.2 Sampling Valve. Stainless steel.

6.2.3 Pressure Gauge. U-tube mercury manometer, or equivalent, capable of measuring pressure to within 1 mm Hg (0.5 in H_2O) in the range of 0 to 1,100 mm Hg (0 to 590 in H_2O).

6.2.4 Sample Tank. Stainless steel or aluminum cylinder, equipped with a stainless steel sample tank valve.

6.3 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg (5.4 in H_2O).

6.4 Purging Pump. Portable, explosion proof, and suitable for sampling NMOC.

6.5 Pilot Probe Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.1.

6.5.1 Pilot Probe. Tubing of sufficient strength to withstand being driven into the landfill by a post driver and an outside diameter of at least 6 mm (0.25 in.) smaller than the sample probe. The pilot probe shall be capped on both ends and long enough to go through the landfill cover and extend no less than 0.9 m (3 ft) into the landfill.

6.5.2 Post Driver and Compressor. Capable of driving the pilot probe and the sampling probe into the landfill. The Kitty Hawk portable post driver has been found to be acceptable.

6.6 Auger Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.2.

6.6.1 Auger. Capable of drilling through the landfill cover and to a depth of no less than 0.9 m (3 ft) into the landfill.

6.6.2 Pea Gravel.

6.6.3 Bentonite.

6.7 NMOC Analyzer, Barometer, Thermometer, and Syringes. Same as in sections 6.3.1, 6.3.2, 6.33, and 6.2.10, respectively, of Method 25.

7.0 Reagents and Standards

7.1 NMOC Analysis. Same as in Method 25, section 7.2.

7.2 Calibration. Same as in Method 25, section 7.4, except omit section 7.4.3.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sample Tank Evacuation and Leak-Check. Conduct the sample tank evacuation and leak-check either in the laboratory or the field. Connect the pressure gauge and sampling valve to the sample tank. Evacuate the sample tank to 10 mm Hg (5.4 in H_2O) absolute pressure or less. Close the sampling valve, and allow the tank to sit for 30 minutes. The tank is acceptable if no change more than ±2 mm is noted. Include the results of the leak-check in the test report.

8.2 Sample Probe Installation. The tester may use the procedure in section 8.2.1 or 8.2.2.

8.2.1 Pilot Probe Procedure. Use the post driver to drive the pilot probe at least 0.9 m (3 ft) below the landfill cover. Alternative procedures to drive the probe into the landfill may be used subject to the approval of the Administrator's designated representative.

8.2.1.1 Remove the pilot probe and drive the sample probe into the hole left by the pilot probe. The sample probe shall extend at least 0.9 m (3 ft) below the landfill cover and shall protrude about 0.3 m (1 ft) above the landfill cover. Seal around the sampling probe with bentonite and cap the sampling probe with the sampling probe cap.

8.2.2 Auger Procedure. Use an auger to drill a hole to at least 0.9 m (3 ft) below the landfill cover. Place the sample probe in the hole and backfill with pea gravel to a level 0.6 m (2 ft) from the surface. The sample probe shall protrude at least 0.3 m (1 ft) above the landfill cover. Seal the remaining area around the probe with bentonite. Allow 24

hours for the landfill gases to equilibrate inside the augured probe before sampling.

8.2.3 Driven Probes. Closed-point probes may be driven directly into the landfill in a single step. This method may not require backfilling if the probe is adequately sealed by its insertion. Unperforated probes that are inserted in this manner and withdrawn at a distance from a detachable tip to create an open space are also acceptable.

8.3 Sample Train Assembly. Just before assembling the sample train, measure the sample tank vacuum using the pressure gauge. Record the vacuum, the ambient temperature, and the barometric pressure at this time. Assemble the sampling probe purging system as shown in Figure 25C–1.

8.4 Sampling Procedure. Open the sampling valve and use the purge pump and the flow control valve to evacuate at least two sample probe volumes from the system at a flow rate of 500 ml/min or less. Close the sampling valve and replace the purge pump with the sample tank apparatus as shown in Figure 25C–2. Open the sampling valve and the sample tank valve and, using the flow control valve, sample at a flow rate of 500 ml/min or less until either a constant flow rate can no longer be maintained because of reduced sample tank vacuum or the appropriate composite volume is attained. Disconnect the sampling tank apparatus and pressurize the sample cylinder to approximately 1,060 mm Hg (567 in. H_2O) absolute pressure with helium, and record the final pressure. Alternatively, the sample tank may be pressurized in the lab.

8.4.1 The following restrictions apply to compositing samples from different probe sites into a single cylinder: (1) Individual composite samples per cylinder must be of equal volume; this must be verified by recording the flow rate, sampling time, vacuum readings, or other appropriate volume measuring data, (2) individual composite samples must have a minimum volume of 1 liter unless data is provided showing smaller volumes can be accurately measured, and (3) composite samples must not be collected using the final cylinder vacuum as it diminishes to ambient pressure.

8.4.2 Use Method 3C to determine the percent N_2 in each cylinder. The presence of N_2 indicates either infiltration of ambient air into the landfill gas sample or an inappropriate testing site has been chosen where anaerobic decomposition has not begun. The landfill gas sample is acceptable if the concentration of N_2 is less than 20 percent. Alternatively, Method 3C may be used to determine the oxygen content of each cylinder as an air infiltration test. With this option, the oxygen content of each cylinder must be less than 5 percent.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
8.4.2	Verify that landfill gas sample contains less than 20 percent N_2 or 5 percent O_2.	Ensures that ambient air was not drawn into the landfill gas sample and gas was sampled from an appropriate location.
10.1, 10.2	NMOC analyzer initial and daily performance checks.	Ensures precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial NMOC Analyzer Performance Test. Same as in Method 25, section 10.1, except omit the linearity checks for CO_2 standards.

10.2 NMOC Analyzer Daily Calibration.

10.2.1 NMOC Response Factors. Same as in Method 25, section 10.2.2.

10.3 Sample Tank Volume. The volume of the gas sampling tanks must be determined. Determine the tank volumes by weighing them empty and then filled with deionized water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedures

11.1 The oxidation, reduction, and measurement of NMOC's is similar to Method 25. Before putting the NMOC analyzer into routine operation, conduct an initial performance test. Start the analyzer, and perform all the necessary functions in order to put the analyzer into proper working order. Conduct the performance test according to the procedures established in section 10.1. Once the performance test has been successfully completed and the NMOC calibration response factor has been determined, proceed with sample analysis as follows:

11.1.1 Daily Operations and Calibration Checks. Before and immediately after the analysis of each set of samples or on a daily basis (whichever occurs first), conduct a calibration test according to the procedures established in section 10.2. If the criteria of the daily calibration test cannot be met, repeat

the NMOC analyzer performance test (Section 10.1) before proceeding.

11.1.2 Operating Conditions. Same as in Method 25, section 11.2.1.

11.1.3 Analysis of Sample Tank. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (383 °F) as rapidly as possible. A rate of 30 °C/min (54 °F/min) has been shown to be adequate. Record the value obtained for any measured NMOC. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average as C_{tm}.

12.0 Data Analysis and Calculations

NOTE: All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature

B_w = Moisture content in the sample, fraction.

C_{N2} = N_2 concentration in the diluted sample gas.

C_{mN2} = Measured N_2 concentration, fraction in landfill gas.

C_{mOx} = Measured Oxygen concentration, fraction in landfill gas.

C_{Ox} = Oxygen concentration in the diluted sample gas.

C_t = Calculated NMOC concentration, ppmv C equivalent.

C_{tm} = Measured NMOC concentration, ppmv C equivalent.

P_b = Barometric pressure, mm Hg.

P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.

P_{ti} = Gas sample tank pressure after evacuation, mm Hg absolute.

P_w = Vapor pressure of H_2O (from Table 25C–1), mm Hg.

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 . . . r).

T_t = Sample tank temperature at completion of sampling, °K.

T_{ti} = Sample tank temperature before sampling, °K.

T_{tf} = Sample tank temperature after pressuring, °K.

12.2 Water Correction. Use Table 25C–1 (Section 17.0), the LFG temperature, and barometric pressure at the sampling site to calculate B_w.

$$B_w = \frac{P_w}{P_b} \qquad \text{Eq. 25C-1}$$

12.3 Nitrogen Concentration in the landfill gas. Use equation 25C–2 to calculate the measured concentration of nitrogen in the original landfill gas.

$$C_{N2} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right] C_{mN2} \qquad \text{Eq.25C-2}$$

12.4 Oxygen Concentration in the landfill gas. Use equation 25C–3 to calculate the measured concentration of oxygen in the original landfill gas.

$$C_{Ox} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right] C_{mOx} \qquad \text{Eq.25C-3}$$

12.5 You must correct the NMOC Concentration for the concentration of nitrogen or oxygen based on which gas or gases passes the requirements in section 9.1.

12.5.1 NMOC Concentration with nitrogen correction. Use Equation 25C–4 to calculate the concentration of NMOC for each sample tank when the nitrogen concentration is less than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t}-\frac{P_{ti}}{T_{ti}}\right)\left(1-\frac{99}{78}C_{N2}\right)-B_w}\frac{1}{r}\sum_{j=1}^{r} C_{tm(j)} \qquad \text{Eq.25C-4}$$

12.5.2 NMOC Concentration with oxygen correction. Use Equation 25C–5 to calculate the concentration of NMOC for each sample tank if the landfill gas oxygen is less than 5 percent and the landfill gas nitrogen concentration is greater than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t}-\frac{P_{ti}}{T_{ti}}\right)\left(1-\frac{99}{21}C_{Ox}\right)-B_w}\frac{1}{r}\sum_{j=1}^{r} C_{tm(j)} \qquad \text{Eq.25C-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts. June 15–20, 1975.) 14 p.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

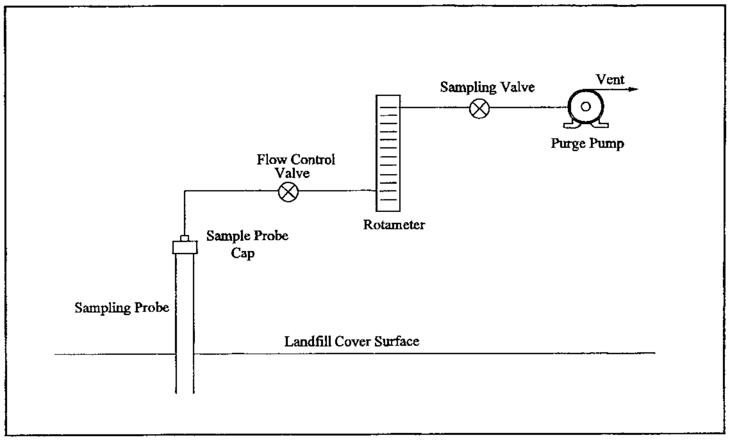


Figure 25C-1. Schematic of Sampling Probe Purging System

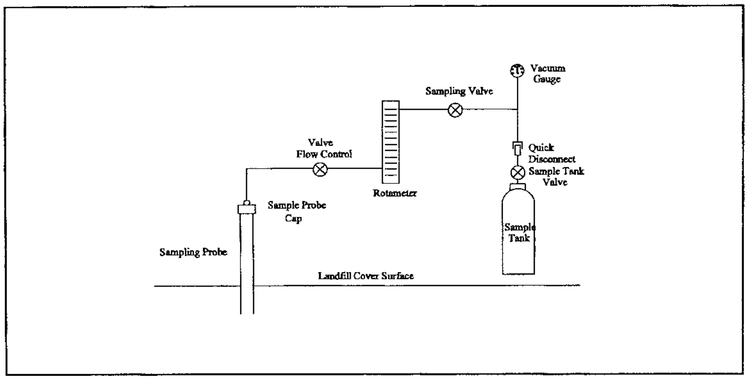


Figure 25C-2. Schematic of Sampling Train.

TABLE 25C–1—MOISTURE CORRECTION

Temperature, °C	Vapor Pressure of H_2O, mm Hg	Tempera-ture, °C	Vapor Pressure of H_2O, mm Hg
4	6.1	18	15.5
6	7.0	20	17.5
8	8.0	22	19.8
10	9.2	24	22.4
12	10.5	26	25.2
14	12.0	28	28.3
16	13.6	30	31.8

METHOD 25D—DETERMINATION OF THE VOLATILE ORGANIC CONCENTRATION OF WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) or an electrolytic conductivity detector (ELCD) because knowledge beyond the scope of this presentation is required.

1.0 Scope and Application

1.1 Analyte. Volatile Organic Compounds. No CAS No. assigned.

1.2 Applicability. This method is applicable for determining the volatile organic (VO) concentration of a waste sample.

2.0 Summary of Method

2.1 Principle. A sample of waste is obtained at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). The sample is suspended in an organic/aqueous matrix, then heated and purged with nitrogen for 30 min. in order to separate certain organic compounds. Part of the sample is analyzed for carbon concentration, as methane, with an FID, and part of the sample is analyzed for chlorine concentration, as chloride, with an ELCD. The VO concentration is the sum of the carbon and chlorine content of the sample.

3.0 Definitions

3.1 *Well-mixed* in the context of this method refers to turbulent flow which results in multiple-phase waste in effect behaving as single-phase waste due to good mixing.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1 Sampling. The following equipment is required:

6.1.1 Sampling Tube. Flexible Teflon, 0.25 in. ID (6.35 mm).

6.1.2 Sample Container. Borosilicate glass, 40-mL, and a Teflon-lined screw cap capable of forming an air tight seal.

6.1.3 Cooling Coil. Fabricated from 0.25 in (6.35 mm). ID 304 stainless steel tubing with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Purging Apparatus. For separating the VO from the waste sample. A schematic of the system is shown in Figure 25D–1. The purging apparatus consists of the following major components.

6.2.1.1 Purging Flask. A glass container to hold the sample while it is heated and purged with dry nitrogen. The cap of the purging flask is equipped with three fittings: one for a purging lance (fitting with the #7 Ace-thread), one for the Teflon exit tubing (side fitting, also a #7 Ace-thread), and a third (a 50-mm Ace-thread) to attach the base of the purging flask as shown in Figure 25D–2. The base of the purging flask is a 50-mm ID (2 in) cylindrical glass tube. One end of the tube is open while the other end is sealed. Exact dimensions are shown in Figure 25D–2.

6.2.1.2 Purging Lance. Glass tube, 6-mm OD (0.2 in) by 30 cm (12 in) long. The purging end of the tube is fitted with a four-arm bubbler with each tip drawn to an opening 1 mm (0.04 in) in diameter. Details and exact dimensions are shown in Figure 25D–2.

6.2.1.3 Coalescing Filter. Porous fritted disc incorporated into a container with the same dimensions as the purging flask. The details of the design are shown in Figure 25D–3.

6.2.1.4 Constant Temperature Chamber. A forced draft oven capable of maintaining a uniform temperature around the purging flask and coalescing filter of 75 ±2 °C (167 ±3.6 °F).

6.2.1.5 Three-way Valve. Manually operated, stainless steel. To introduce calibration gas into system.

6.2.1.6 Flow Controllers. Two, adjustable. One capable of maintaining a purge gas flow rate of 6 ±0.06 L/min (0.2 ±0.002 ft^3/min) The other capable of maintaining a calibration gas flow rate of 1–100 mL/min (0.00004–0.004 ft^3/min).

6.2.1.7 Rotameter. For monitoring the air flow through the purging system (0–10 L/min)(0–0.4 ft^3/min).

6.2.1.8 Sample Splitters. Two heated flow restrictors (placed inside oven or heated to 120 ±10 °C (248 ±18 °F)). At a purge rate of 6 L/min (0.2 ft^3/min), one will supply a constant flow to the first detector (the rest of the flow will be directed to the second sample splitter). The second splitter will split the analytical flow between the second detector and the flow restrictor. The approximate flow to the FID will be 40 mL/min (0.0014 ft^3/min) and to the ELCD will be 15 mL/min (0.0005 ft^3/min), but the exact flow must be adjusted to be compatible with the individual detector and to meet its linearity requirement. The two sample splitters will be connected to each other by 1/8′ OD (3.175 mm) stainless steel tubing.

6.2.1.9 Flow Restrictor. Stainless steel tubing, 1/8′ OD (3.175 mm), connecting the second sample splitter to the ice bath. Length is determined by the resulting pressure in the purging flask (as measured by the pressure gauge). The resulting pressure from the use of the flow restrictor shall be 6–7 psig.

6.2.1.10 Filter Flask. With one-hole stopper. Used to hold ice bath. Excess purge gas is vented through the flask to prevent condensation in the flowmeter and to trap volatile organic compounds.

6.2.1.11 Four-way Valve. Manually operated, stainless steel. Placed inside oven, used to bypass purging flask.

6.2.1.12 On/Off Valves. Two, stainless steel. One heat resistant up to 130 °C (266 °F) and placed between oven and ELCD. The other a toggle valve used to control purge gas flow.

6.2.1.13 Pressure Gauge. Range 0–40 psi. To monitor pressure in purging flask and coalescing filter.

6.2.1.14 Sample Lines. Teflon, 1/4′ OD (6.35 mm), used inside the oven to carry purge gas to and from purging chamber and to and from coalescing filter to four-way valve. Also used to carry sample from four-way valve to first sample splitter.

6.2.1.15 Detector Tubing. Stainless steel, 1/8′ OD (3.175 mm), heated to 120 ±10 °C (248 ±18 °F) . Used to carry sample gas from each sample splitter to a detector. Each piece of tubing must be wrapped with heat tape and insulating tape in order to insure that no cold spots exist. The tubing leading to the ELCD will also contain a heat-resistant on-off valve (Section 6.2.1.12) which shall also be wrapped with heat-tape and insulation.

6.2.2 Volatile Organic Measurement System. Consisting of an FID to measure the carbon concentration of the sample and an ELCD to measure the chlorine concentration.

6.2.2.1 FID. A heated FID meeting the following specifications is required.

6.2.2.1.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.1.

6.2.2.1.2 Range. A full scale range of 50 pg carbon/sec to 50 μg carbon/sec. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.1.3 Data Recording System. A digital integration system compatible with the FID for permanently recording the output of the detector. The recorder shall have the capability to start and stop integration at points selected by the operator or it shall be capable of the ‘‘integration by slices’’ technique (this technique involves breaking down the chromatogram into smaller increments, integrating the area under the curve for each portion, subtracting the background for each portion, and then adding all of the areas together for the final area count).

6.2.2.2 ELCD. An ELCD meeting the following specifications is required. 1-propanol must be used as the electrolyte. The electrolyte flow through the conductivity cell shall be 1 to 2 mL/min (0.00004 to 0.00007 ft^3/min).

NOTE: A ¼-in. ID (6.35 mm) quartz reactor tube is strongly recommended to reduce carbon buildup and the resulting detector maintenance.

6.2.2.2.1 Linearity. A linear response (±10 percent) over the response range as demonstrated by the procedures in section 10.1.2.

6.2.2.2.2 Range. A full scale range of 5.0 pg/sec to 500 ng/sec chloride. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.2.3 Data Recording System. A digital integration system compatible with the output voltage range of the ELCD. The recorder must have the capability to start and stop integration at points selected by the operator or it shall be capable of performing the ‘‘integration by slices’’ technique.

7.0 Reagents and Standards

7.1 Sampling.

7.1.1 Polyethylene Glycol (PEG). Ninety-eight percent pure with an average molecular weight of 400. Before using the PEG, remove any organic compounds that might be detected as volatile organics by heating it to 120 °C (248 °F) and purging it with nitrogen at a flow rate of 1 to 2 L/min (0.04 to 0.07 ft^3/min) for 2 hours. The cleaned PEG must be stored under a 1 to 2 L/min (0.04 to 0.07 ft^3/min) nitrogen purge until use. The purge apparatus is shown in Figure 25D–4.

7.2 Analysis.

7.2.1 Sample Separation. The following are required for the sample purging step.

7.2.1.1 PEG. Same as section 7.1.1.

7.2.1.2 Purge Gas. Zero grade nitrogen (N_2), containing less than 1 ppm carbon.

7.2.2 Volatile Organics Measurement. The following are required for measuring the VO concentration.

7.2.2.1 Hydrogen (H_2). Zero grade H_2, 99.999 percent pure.

7.2.2.2 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2.2.3 Calibration Gas. Pressurized gas cylinder containing 10 percent propane and 1 percent 1,1-dichloroethylene by volume in nitrogen.

7.2.2.4 Water. Deionized distilled water that conforms to American Society for Testing and Materials Specification D 1193–74, Type 3, is required for analysis. At the option of the analyst, the $KMnO_4$ test for oxidizable organic matter may be omitted when high concentrations are not expected to be present.

7.2.2.5 1-Propanol. ACS grade or better. Electrolyte Solution. For use in the ELCD.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling.

8.1.1 Sampling Plan Design and Development. Use the procedures in chapter nine of Reference 1 in section 16 as guidance in developing a sampling plan.

8.1.2 Single Phase or Well-mixed Waste.

8.1.2.1 Install a sampling tap to obtain the sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). Assemble the sampling apparatus as shown in Figure 25D–5.

8.1.2.2 Prepare the sampling containers as follows: Pour 30 mL of clean PEG into the container. PEG will reduce but not eliminate the loss of organics during sample collection. Weigh the sample container with the screw cap, the PEG, and any labels to the nearest 0.01 g and record the weight (m_{st}). Store the containers in an ice bath until 1 hour before sampling (PEG will solidify at ice bath temperatures; allow the containers to reach room temperature before sampling).

8.1.2.3 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.1.2.4 After purging, stop the sample flow and direct the sampling tube to a preweighed sample container, prepared as described in section 8.1.2.2. Keep the tip of the tube below the surface of the PEG during sampling to minimize contact with the atmosphere. Sample at a flow rate such that the temperature of the waste is less than 10 °C (50 °F). Fill the sample container and immediately cap it (within 5 seconds) so that a minimum headspace exists in the container. Store immediately in a cooler and cover with ice.

8.1.3 Multiple-phase Waste. Collect a 10 g sample of each phase of waste generated using the procedures described in section 8.1.2 or 8.1.5. Each phase of the waste shall be analyzed as a separate sample. Calculate the weighted average VO concentration of the waste using Equation 25D–13 (Section 12.14).

8.1.4 Solid waste. Add approximately 10 g of the solid waste to a container prepared in the manner described in section 8.1.2.2, minimizing headspace. Cap and chill immediately.

8.1.5 Alternative to Tap Installation. If tap installation is impractical or impossible, fill a large, clean, empty container by submerging the container into the waste below the surface of the waste. Immediately fill a container prepared in the manner described in section 8.1.2.2 with approximately 10 g of the waste collected in the large container. Minimize headspace, cap and chill immediately.

8.1.6 Alternative sampling techniques may be used upon the approval of the Administrator.

8.2 Sample Recovery.

8.2.1 Assemble the purging apparatus as shown in Figures 25D–1 and 25D–2. The oven shall be heated to 75 ±2 °C (167 ±3.6 °F). The sampling lines leading from the oven to the detectors shall be heated to 120 ±10 °C (248 ±18 °F) with no cold spots. The flame ionization detector shall be operated with a heated block. Adjust the purging lance so that it reaches the bottom of the chamber.

8.2.2 Remove the sample container from the cooler, and wipe the exterior of the container to remove any extraneous ice, water, or other debris. Reweigh the sample container to the nearest 0.01 g, and record the weight (m_{sf}). Pour the contents of the sample container into the purging flask, rinse the sample container three times with a total of 20 mL of PEG (since the sample container originally held 30 mL of PEG, the total volume of PEG added to the purging flask will be 50 mL), transferring the rinsings to the purging flask after each rinse. Cap purging flask between rinses. The total volume of PEG in the purging flask shall be 50 mL. Add 50 mL of water to the purging flask.

9.0 Quality Control

9.1 Quality Control Samples. If audit samples are not available, prepare and analyze the two types of quality control samples (QCS) listed in Sections 9.1.1 and 9.1.2. Before placing the system in operation, after a shutdown of greater than six months, and after any major modifications, analyze each QCS in triplicate. For each detector, calculate the percent recovery by dividing measured concentration by theoretical concentration and multiplying by 100. Determine the mean percent recovery for each detector for each QCS triplicate analysis. The RSD for any triplicate analysis shall be $\leq$10 percent. For QCS 1 (methylene chloride), the percent recovery shall be $\geq$90 percent for carbon as methane, and $\geq$55 percent for chlorine as chloride. For QCS 2 (1,3-dichloro-2-propanol), the percent recovery shall be $\leq$15 percent for carbon as methane, and $\leq$6 percent for chlorine as chloride. If the analytical system does not meet the above-mentioned criteria for both detectors, check the system parameters (temperature, system pressure, purge rate, etc.), correct the problem, and repeat the triplicate analysis of each QCS.

9.1.1 QCS 1, Methylene Chloride. Prepare a stock solution by weighing, to the nearest 0.1 mg, 55 µL of HPLC grade methylene chloride in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 µL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze

the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 3.777×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 1.670×10^{-2}.

9.1.2 QCS 2, 1,3-dichloro-2-propanol. Prepare a stock solution by weighing, to the nearest 0.1 mg, 60 µL of high purity grade 1,3-dichloro-2-propanol in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 µL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 7.461×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 1.099×10^{-2}.

9.1.3 Routine QCS Analysis. For each set of compliance samples (in this context, set is per facility, per compliance test), analyze one QCS 1 and one QCS 2 sample. The percent recovery for each sample for each detector shall be ±13 percent of the mean recovery established for the most recent set of QCS triplicate analysis (Section 9.4). If the sample does not meet this criteria, check the system components and analyze another QCS 1 and 2 until a single set of QCS meet the ±13 percent criteria.

10.0 Calibration and Standardization

10.1 Initial Performance Check of Purging System. Before placing the system in operation, after a shutdown of greater than six months, after any major modifications, and at least once per month during continuous operation, conduct the linearity checks described in sections 10.1.1 and 10.1.2. Install calibration gas at the three-way calibration gas valve. See Figure 25D–1.

10.1.1 Linearity Check Procedure. Using the calibration standard described in section 7.2.2.3 and by varying the injection time, it is possible to calibrate at multiple concentration levels. Use Equation 25D–3 to calculate three sets of calibration gas flow rates and run times needed to introduce a total mass of carbon, as methane, (m_c) of 1, 5, and 10 mg into the system (low, medium and high FID calibration, respectively). Use Equation 25D–4 to calculate three sets of calibration gas flow rates and run times needed to introduce a total chloride mass (m_{ch}) of 1, 5, and 10 mg into the system (low, medium and high ELCD calibration, respectively). With the system operating in standby mode, allow the FID and the ELCD to establish a stable baseline. Set the secondary pressure regulator of the calibration gas cylinder to the same pressure as the purge gas cylinder and set the proper flow rate with the calibration flow controller (see Figure 25D–1). The calibration gas flow rate can be measured with a flowmeter attached to the vent position of the calibration gas valve. Set the four-way bypass valve to standby position so that the calibration gas flows through the coalescing filter only. Inject the calibration gas by turning the calibration gas valve from vent position to inject position. Continue the calibration gas flow for the appropriate period of time before switching the calibration valve to vent position. Continue recording the response of the FID and the ELCD for 5 min after switching off calibration gas flow. Make triplicate injections of all six levels of calibration.

10.1.2 Linearity Criteria. Calculate the average response factor (Equations 25D–5 and 25D–6) and the relative standard deviation (RSD) (Equation 25D–10) at each level of the calibration curve for both detectors. Calculate the overall mean of the three response factor averages for each detector. The FID linearity is acceptable if each response factor is within 5 percent of the overall mean and if the RSD for each set of triplicate injections is less than 5 percent. The ELCD linearity is acceptable if each response factor is within 10 percent of the overall mean and if the RSD for each set of triplicate injections is less than 10 percent. Record the overall mean value of the response factors for the FID and the ELCD. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2 Daily Calibrations.

10.2.1 Daily Linearity Check. Follow the procedures outlined in section 10.1.1 to analyze the medium level calibration for both the FID and the ELCD in duplicate at the start of the day. Calculate the response factors and the RSDs for each detector. For the FID, the calibration is acceptable if the average response factor is within 5 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 5 percent. For the ELCD, the calibration is acceptable if the average response factor is within 10 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 10 percent. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2.2 Calibration Range Check.

10.2.2.1 If the waste concentration for either detector falls below the range of calibration for that detector, use the procedure outlined in section 10.1.1 to choose two calibration points that bracket the new target

concentration. Analyze each of these points in triplicate (as outlined in section 10.1.1) and use the criteria in section 10.1.2 to determine the linearity of the detector in this ''mini-calibration'' range.

10.2.2.2 After the initial linearity check of the mini-calibration curve, it is only necessary to test one of the points in duplicate for the daily calibration check (in addition to the points specified in section 10.2.1). The average daily mini-calibration point should fit the linearity criteria specified in section 10.2.1. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat the calibration procedure mentioned in the first paragraph of section 10.2.2. A mini-calibration curve for waste concentrations above the calibration curve for either detector is optional.

10.3 Analytical Balance. Calibrate against standard weights.

11.0 Analysis

11.1 Sample Analysis.

11.1.1 Turn on the constant temperature chamber and allow the temperature to equilibrate at 75 ±2 °C (167 ±3.6 °F). Turn the four-way valve so that the purge gas bypasses the purging flask, the purge gas flowing through the coalescing filter and to the detectors (standby mode). Turn on the purge gas. Allow both the FID and the ELCD to warm up until a stable baseline is achieved on each detector. Pack the filter flask with ice. Replace ice after each run and dispose of the waste water properly. When the temperature of the oven reaches 75 ±2 °C (167 ±3.6 °F), start both integrators and record baseline. After 1 min, turn the four-way valve so that the purge gas flows through the purging flask, to the coalescing filter and to the sample splitters (purge mode). Continue recording the response of the FID and the ELCD. Monitor the readings of the pressure gauge and the rotameter. If the readings fall below established setpoints, stop the purging, determine the source of the leak, and resolve the problem before resuming. Leaks detected during a sampling period invalidate that sample.

11.1.2 As the purging continues, monitor the output of the detectors to make certain that the analysis is proceeding correctly and that the results are being properly recorded. Every 10 minutes read and record the purge flow rate, the pressure and the chamber temperature. Continue the purging for 30 minutes.

11.1.3 For each detector output, integrate over the entire area of the peak starting at 1 minute and continuing until the end of the run. Subtract the established baseline area from the peak area. Record the corrected area of the peak. See Figure 25D–6 for an example integration.

11.2 Water Blank. A water blank shall be analyzed for each batch of cleaned PEG prepared. Transfer about 60 mL of water into the purging flask. Add 50 mL of the cleaned PEG to the purging flask. Treat the blank as described in sections 8.2 and 8.3, excluding section 8.2.2. Calculate the concentration of carbon and chlorine in the blank sample (assume 10 g of waste as the mass). A VO concentration equivalent to ≤10 percent of the applicable standard may be subtracted from the measured VO concentration of the waste samples. Include all blank results and documentation in the test report.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A_b = Area under the water blank response curve, counts.

A_c = Area under the calibration response curve, counts.

A_s = Area under the sample response curve, counts.

C = Concentration of volatile organics in the sample, ppmw.

C_c = Concentration of carbon, as methane, in the calibration gas, mg/L.

C_{ch} = Concentration of chloride in the calibration gas, mg/L.

C_j = VO concentration of phase j, ppmw.

DR_t = Average daily response factor of the FID, mg CH_4/counts.

Dr_{th} = Average daily response factor of the ELCD, mg Cl^-/counts.

F_j = Weight fraction of phase j present in the waste.

m_c = Mass of carbon, as methane, in a calibration run, mg.

m_{ch} = Mass of chloride in a calibration run, mg.

m_s = Mass of the waste sample, g.

m_{sc} = Mass of carbon, as methane, in the sample, mg.

m_{sf} = Mass of sample container and waste sample, g.

m_{sh} = Mass of chloride in the sample, mg.

m_{st} = Mass of sample container prior to sampling, g.

m_{VO} = Mass of volatile organics in the sample, mg.

n = Total number of phases present in the waste.

P_p = Percent propane in calibration gas (L/L).

P_{vc} = Percent 1,1-dichloroethylene in calibration gas (L/L).

Q_c = Flow rate of calibration gas, L/min.

t_c = Length of time standard gas is delivered to the analyzer, min.

W = Weighted average VO concentration, ppmw.

12.2 Concentration of Carbon, as Methane, in the Calibration Gas.

$$C_c = \left(19.681 \times P_p\right) + \left(13.121 \times P_{vc}\right) \qquad \text{Eq. 25D-1}$$

12.3 Concentration of Chloride in the Calibration Gas.

$$C_{ch} = 28.998 \times P_{vc} \qquad \text{Eq. 25D-2}$$

12.4 Mass of Carbon, as Methane, in a Calibration Run.

$$M_c = C_c \times Q_c \times t_c \qquad \text{Eq. 25D-3}$$

12.5 Mass of Chloride in a Calibration Run.

$$m_{ch} = C_{ch} \times Q_c \times t_c \qquad \text{Eq. 25D-4}$$

12.6 FID Response Factor, mg/counts.

$$DR_t = \frac{m_c}{A_c} \qquad \text{Eq. 25D-5}$$

12.7 ELCD Response Factor, mg/counts.

$$DR_{th} = \frac{m_{ch}}{A_c} \qquad \text{Eq. 25D-6}$$

12.8 Mass of Carbon in the Sample.

$$m_{sc} = DR_t\left(A_s - A_b\right) \qquad \text{Eq. 25D-7}$$

12.9 Mass of Chloride in the Sample.

$$m_{sh} = DR_{th}\left(A_s - A_b\right) \qquad \text{Eq. 25D-8}$$

12.10 Mass of Volatile Organics in the Sample.

$$m_{vo} = m_{sc} + m_{sh} \qquad \text{Eq. 25D-9}$$

12.11 Relative Standard Deviation.

$$RSD = \frac{100}{\overline{x}}\sqrt{\frac{\sum_{i=1}^{n}\left(x_i - \overline{x}\right)^2}{n-1}} \qquad \text{Eq. 25D-10}$$

12.12 Mass of Sample.

$$m_s = m_{sf} - m_{st} \qquad \text{Eq. 25D-11}$$

12.13 Concentration of Volatile Organics in Waste.

$$C = \frac{\left(m_{vo} \times 1000\right)}{m_s} \qquad \text{Eq. 25D-12}$$

12.14 Weighted Average VO Concentration of Multi-phase Waste.

$$W = \sum_{j=1}^{n} F_j \, x \, \overline{C}_j \qquad \text{Eq. 25D-13}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. “Test Methods for Evaluating Solid Waste, Physical/Chemistry Methods”, U.S. Environmental Protection Agency. Publication SW–846, 3rd Edition, November 1986 as amended by Update I, November 1990.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

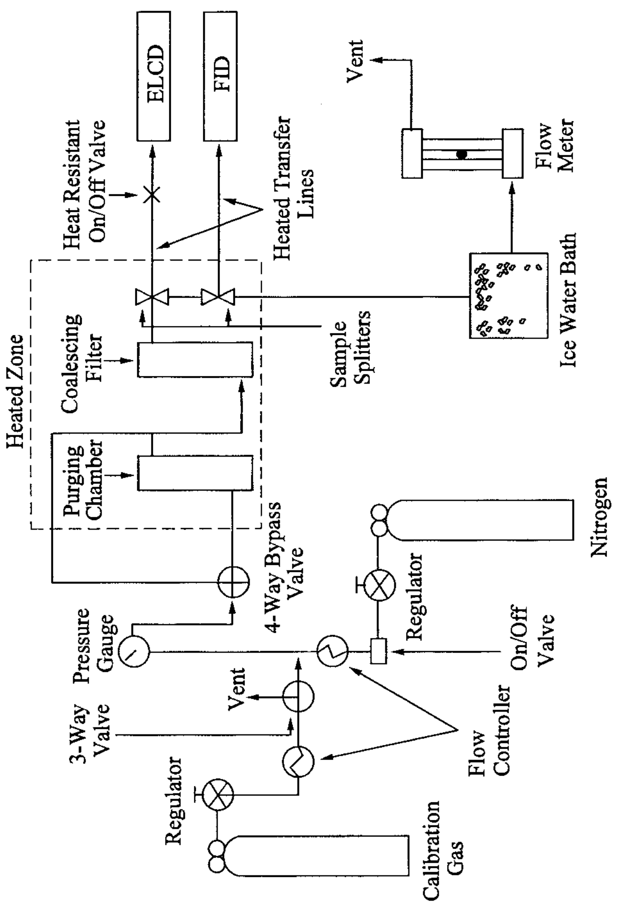


Figure 25D-1. Schematic of Purging Apparatus.

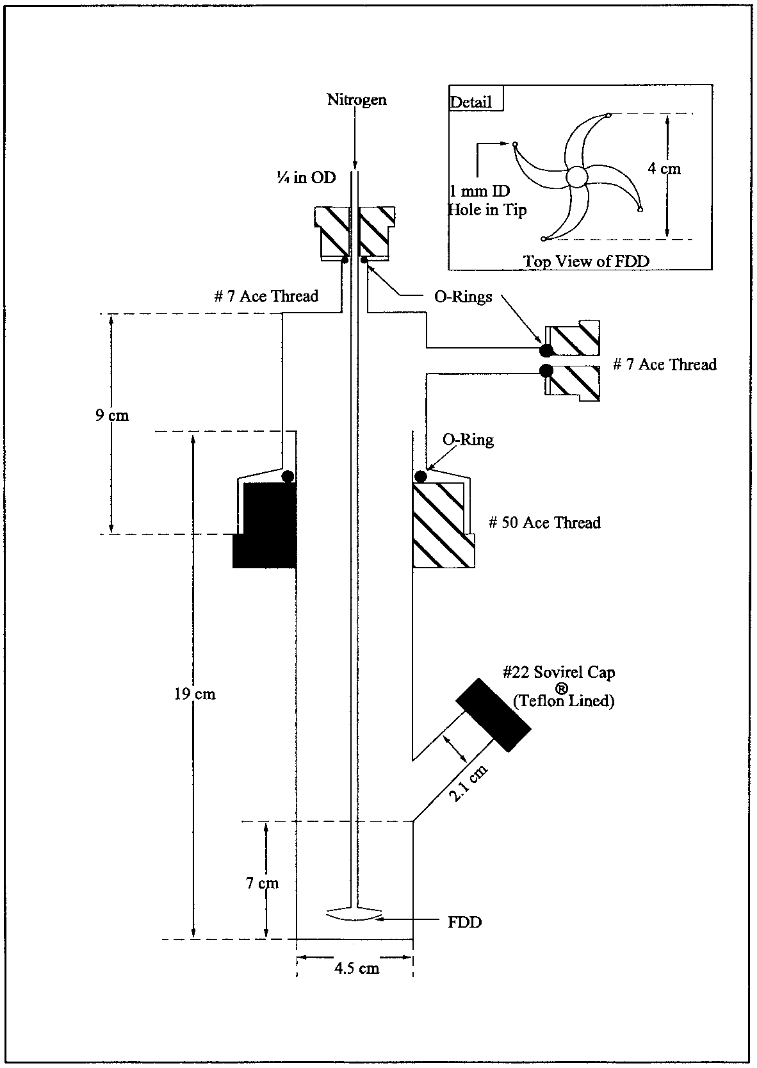
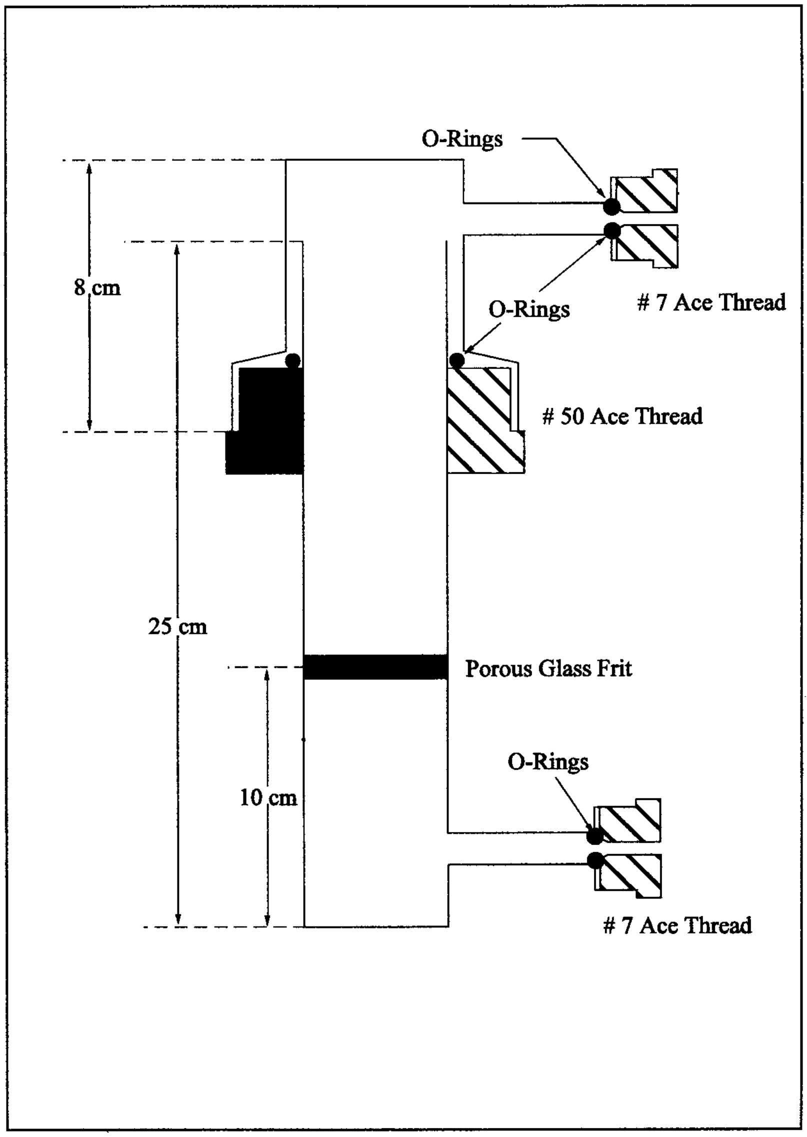


Figure 25D-2. Purging Lance.


O-Rings
8 cm
O-Rings
7 Ace Thread
50 Ace Thread
25 cm
Porous Glass Frit
O-Rings
10 cm
7 Ace Thread

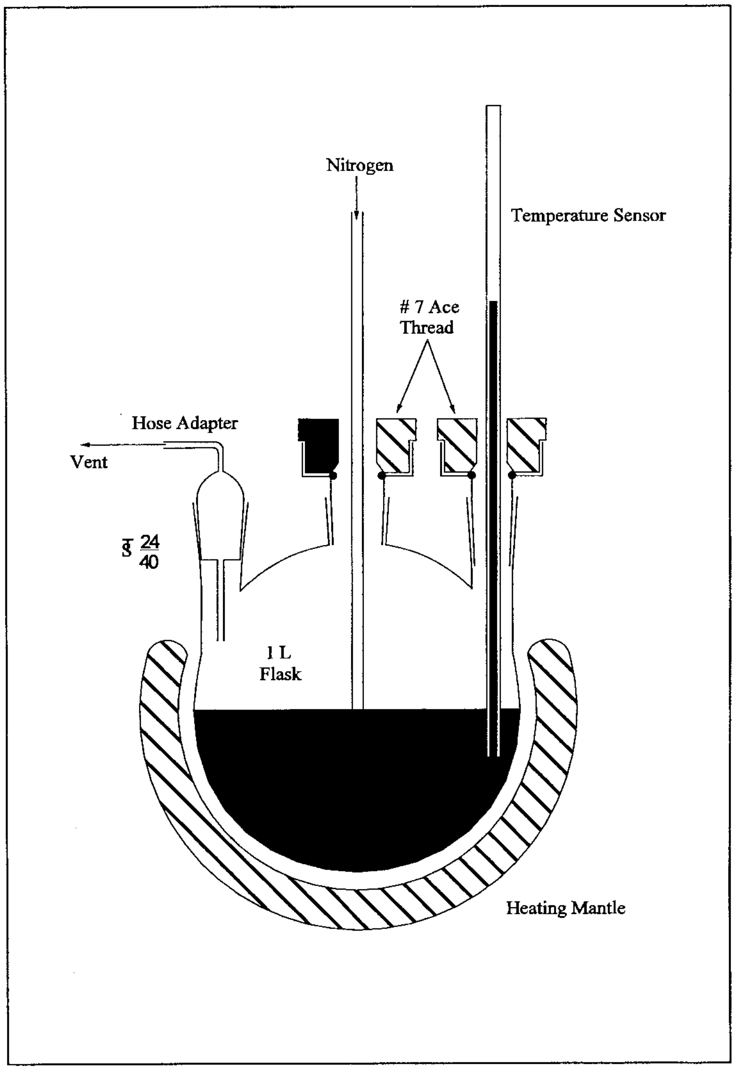


Figure 25D-4. Schematic of PEG Cleaning System.

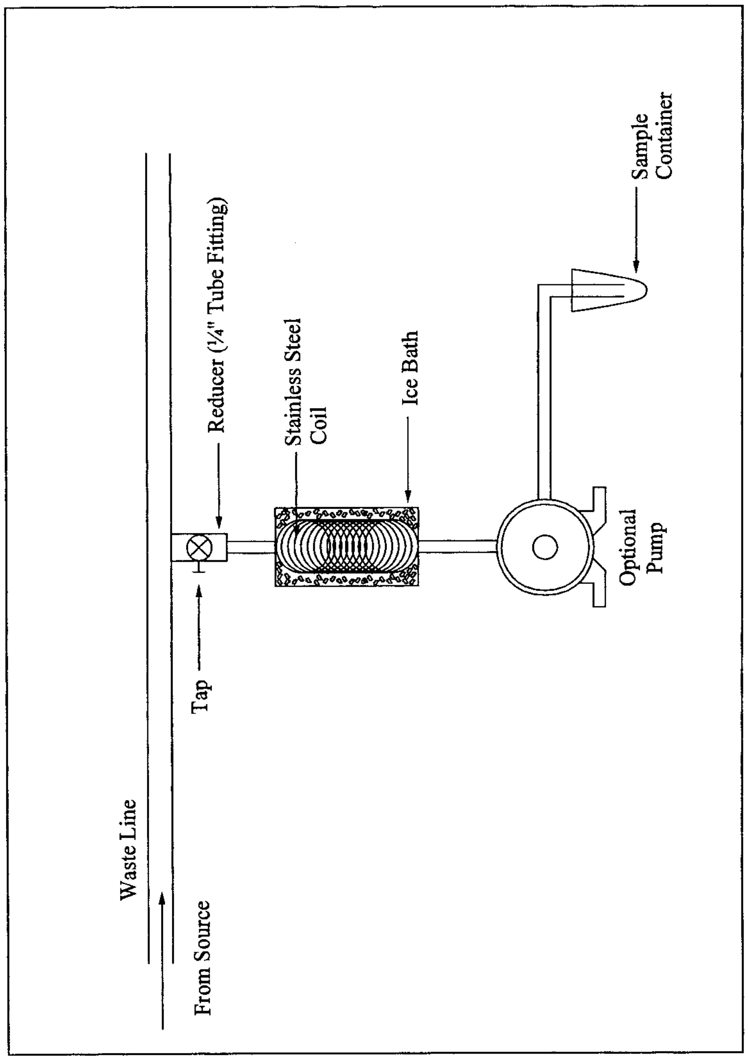


Figure 25D-5. Schematic of Sampling Apparatus.

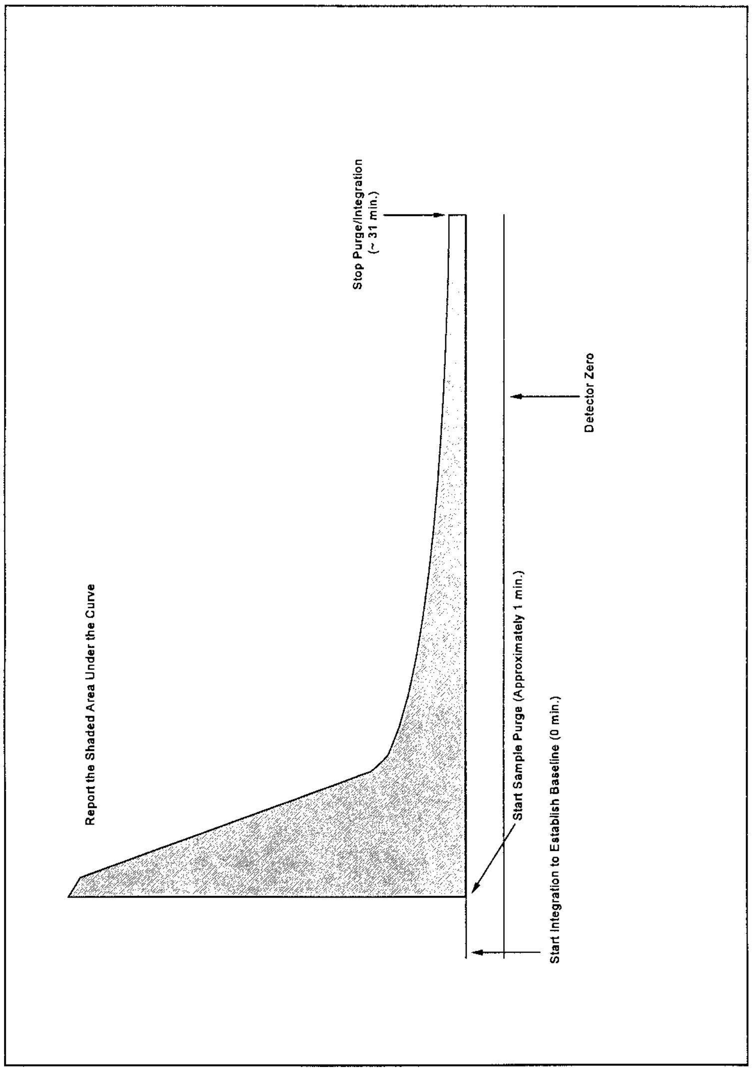


Figure 25D-6. Example Integration of Either Detector.

METHOD 25E—DETERMINATION OF VAPOR PHASE ORGANIC CONCENTRATION IN WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) nor by those who are unfamiliar with source sampling because knowledge beyond the scope of this presentation is required. This method is not inclusive with respect to specifications (*e.g.*, reagents and standards) and calibration procedures. Some material is incorporated by reference from other methods. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 106, part 61, Appendix B, and Method 18, part 60, Appendix A.

1.0 Scope and Application

1.1 Applicability. This method is applicable for determining the vapor pressure of waste cited by an applicable regulation.

1.2 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 The headspace vapor of the sample is analyzed for carbon content by a headspace analyzer, which uses an FID.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 The analyst shall select the operating parameters best suited to the requirements for a particular analysis. The analyst shall produce confirming data through an adequate supplemental analytical technique and have the data available for review by the Administrator.

5.0 Safety [Reserved]

6.0 Equipment and Supplies

6.1 Sampling. The following equipment is required:

6.1.1 Sample Containers. Vials, glass, with butyl rubber septa, Perkin-Elmer Corporation Numbers 0105–0129 (glass vials), B001–0728 (gray butyl rubber septum, plug style), 0105–0131 (butyl rubber septa), or equivalent. The seal must be made from butyl rubber. Silicone rubber seals are not acceptable.

6.1.2 Vial Sealer. Perkin-Elmer Number 105–0106, or equivalent.

6.1.3 Gas-Tight Syringe. Perkin-Elmer Number 00230117, or equivalent.

6.1.4 The following equipment is required for sampling.

6.1.4.1 Tap.

6.1.4.2 Tubing. Teflon, 0.25-in. ID.

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1.4.3 Cooling Coil. Stainless steel (304), 0.25 in.-ID, equipped with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Balanced Pressure Headspace Sampler. Perkin-Elmer HS–6, HS–100, or equivalent, equipped with a glass bead column instead of a chromatographic column.

6.2.2 FID. An FID meeting the following specifications is required.

6.2.2.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.2.

6.2.2.2 Range. A full scale range of 1 to 10,000 parts per million (ppm) propane (C_3H_8). Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.3 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the output of the detector.

6.2.4 Temperature Sensor. Capable of reading temperatures in the range of 30 to 60 °C (86 to 140 °F) with an accuracy of ±0.1 °C (±0.2 °F).

7.0 Reagents and Standards

7.1 Analysis. The following items are required for analysis.

7.1.1 Hydrogen (H_2). Zero grade hydrogen, as required by the FID.

7.1.2 Carrier Gas. Zero grade nitrogen, containing less than 1 ppm carbon (C) and less than 1 ppm carbon dioxide.

7.1.3 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2 Calibration and Linearity Check.

7.2.1 Stock Cylinder Gas Standard. 100 percent propane. The manufacturer shall: (a) Certify the gas composition to be accurate to ±3 percent or better (see section 7.2.1.1); (b) recommend a maximum shelf life over which the gas concentration does not change by greater than ±5 percent from the certified value; and (c) affix the date of gas cylinder preparation, certified propane concentration, and recommended maximum shelf life to the cylinder before shipment to the buyer.

7.2.1.1 Cylinder Standards Certification. The manufacturer shall certify the concentration of the calibration gas in the cylinder by (a) directly analyzing the cylinder and (b) calibrating his analytical procedure on the day of cylinder analysis. To calibrate his analytical procedure, the manufacturer shall use, as a minimum, a three-point calibration curve.

7.2.1.2 Verification of Manufacturer's Calibration Standards. Before using, the manufacturer shall verify each calibration standard by (a) comparing it to gas mixtures prepared in accordance with the procedure described in section 7.1 of Method 106 of Part 61, Appendix B, or by (b) calibrating it against Standard Reference Materials (SRM's) prepared by the National Bureau of Standards, if such SRM's are available. The agreement between the initially determined concentration value and the verification concentration value must be within ±5 percent. The manufacturer must reverify all calibration standards on a time interval consistent with the shelf life of the cylinder standards sold.

8.0 Sampling Collection, Preservation, Storage, and Transport

8.1 Install a sampling tap to obtain a sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to

the atmosphere). Assemble the sampling apparatus as shown in Figure 25E–1.

8.2 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.3 After purging, stop the sample flow and transfer the Teflon sampling tube to a sample container. Sample at a flow rate such that the temperature of the waste is <10 °C (<50 °F). Fill the sample container halfway (±5 percent) and cap it within 5 seconds. Store immediately in a cooler and cover with ice.

8.4 Alternative sampling techniques may be used upon the approval of the Administrator.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
10.2, 10.3	FID calibration and response check	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Use the procedures in sections 10.2 to calibrate the headspace analyzer and FID and check for linearity before the system is first placed in operation, after any shutdown longer than 6 months, and after any modification of the system.

10.2 Calibration and Linearity. Use the procedures in section 10 of Method 18 of Part 60, Appendix A, to prepare the standards and calibrate the flowmeters, using propane as the standard gas. Fill the calibration standard vials halfway (±5 percent) with deionized water. Purge and fill the airspace with calibration standard. Prepare a minimum of three concentrations of calibration standards in triplicate at concentrations that will bracket the applicable cutoff. For a cutoff of 5.2 kPa (0.75 psi), prepare nominal concentrations of 30,000, 50,000, and 70,000 ppm as propane. For a cutoff of 27.6 kPa (4.0 psi), prepare nominal concentrations of 200,000, 300,000, and 400,000 ppm as propane.

10.2.1 Use the procedures in section 11.3 to measure the FID response of each standard. Use a linear regression analysis to calculate the values for the slope (k) and the y-intercept (b). Use the procedures in sections 12.3 and 12.2 to test the calibration and the linearity.

10.3 Daily FID Calibration Check. Check the calibration at the beginning and at the end of the daily runs by using the following procedures. Prepare 2 calibration standards at the nominal cutoff concentration using the procedures in section 10.2. Place one at the beginning and one at the end of the daily run. Measure the FID response of the daily calibration standard and use the values for k and b from the most recent calibration to calculate the concentration of the daily standard. Use an equation similar to 25E–2 to calculate the percent difference between the daily standard and C_s. If the difference is within 5 percent, then the previous values for k and b can be used. Otherwise, use the procedures in section 10.2 to recalibrate the FID.

11.0 Analytical Procedures

11.1 Allow one hour for the headspace vials to equilibrate at the temperature specified in the regulation. Allow the FID to warm up until a stable baseline is achieved on the detector.

11.2 Check the calibration of the FID daily using the procedures in section 10.3.

11.3 Follow the manufacturer's recommended procedures for the normal operation of the headspace sampler and FID.

11.4 Use the procedures in sections 12.4 and 12.5 to calculate the vapor phase organic vapor pressure in the samples.

11.5 Monitor the output of the detector to make certain that the results are being properly recorded.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A = Measurement of the area under the response curve, counts.

b = y-intercept of the linear regression line.

C_a = Measured vapor phase organic concentration of sample, ppm as propane.

C_{ma} = Average measured vapor phase organic concentration of standard, ppm as propane.

C_m = Measured vapor phase organic concentration of standard, ppm as propane.

C_s = Calculated standard concentration, ppm as propane.

k = Slope of the linear regression line.

P_{bar} = Atmospheric pressure at analysis conditions, mm Hg (in. Hg).

P* = Organic vapor pressure in the sample, kPa (psi).

PD = Percent difference between the average measured vapor phase organic concentration (C_m) and the calculated standard concentration (C_s).

RSD = Relative standard deviation.

β = 1.333×10^{-7} kPa/[(mm Hg)(ppm)], (4.91×10^{-7} psi/[(in. Hg)(ppm)])

12.2 Linearity. Use the following equation to calculate the measured standard concentration for each standard vial.

$$C_m = kA + b \qquad \text{Eq. 25E-1}$$

12.2.1 Calculate the average measured standard concentration (C_{ma}) for each set of triplicate standards and use the following equation to calculate PD between C_{ma} and C_s. The instrument linearity is acceptable if the PD is within five for each standard.

$$PD = \frac{C_s - C_{ma}}{C_s} \times 100 \qquad \text{Eq. 25E-2}$$

12.3. Relative Standard Deviation (RSD). Use the following equation to calculate the RSD for each triplicate set of standards.

$$RSD = \frac{100}{C_{ma}} \sqrt{\frac{\sum \left(C_m - C_{ma}\right)^2}{2}} \qquad \text{Eq. 25E-3}$$

The calibration is acceptable if the RSD is within five for each standard concentration.

12.4 Concentration of organics in the headspace. Use the following equation to calculate the concentration of vapor phase organics in each sample.

$$C_a = kA + b \qquad \text{Eq. 25E-4}$$

12.5 Vapor Pressure of Organics in the Headspace Sample. Use the following equation to calculate the vapor pressure of organics in the sample.

$$P^* = \beta P_{bar} C_a \qquad \text{Eq. 25E-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. ‘‘Determination of Solvent Vapor Concentrations by Total Combustion Analysis: a Comparison of Infared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. ‘‘Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) p. 25.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

Sunstone Solar Project 5
Draft Habitat Mitigation Plan

Prepared for

PINEGATE
RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 5, LLC

Prepared by

TETRA TECH

October 2025

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List of Tables

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1.0 Introduction

Sunstone Solar 5, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 5 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 200 MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities and the anticipated phasing of construction are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Habitat Mitigation Plan (HMP) describes how the Certificate Holder will mitigate for unavoidable wildlife habitat disturbance from Facility construction and therefore, in conjunction with Exhibit P of the Application for Site Certificate (ASC[2]), demonstrates how the Certificate Holder will construct and operate the Facility consistent with the Oregon Department of Fish and Wildlife (ODFW) Fish and Wildlife Habitat Mitigation Policy, Oregon Administrative Rule (OAR) 635-415-0025. The Certificate Holder conducted habitat categorization surveys and other biological studies that inform habitat categorization in accordance with the ODFW Fish and Wildlife Habitat Mitigation Policy and avoided and minimized impacts to wildlife and habitat as described in Exhibit P of the ASC. The actual disturbance acres and associated mitigation needs will be determined based on the final design and included in an updated HMP prior to construction. If disturbance to all wildlife habitats (i.e., habitat categories 2 through 5) are avoided during final design, no habitat mitigation plan would be required and in lieu of an updated HMP prior to construction, the Certificate Holder would provide a figure depicting wildlife habitat avoidance for this Facility phase.

2.0 Temporary and Permanent Disturbance

Construction and operation of the Facility will result in both permanent and temporary disturbance to wildlife and their habitats, although the disturbance has been minimized considerably as described in Exhibit P of the ASC. Due to the multi-year construction schedule of the Facility, both permanent and temporary disturbance to fish and wildlife habitat will occur in phases over this time period.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

[2] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

Permanent disturbance areas are those that will be converted from the existing condition to a different condition for the life of the Facility. The entire area within the fence is considered permanently disturbed and includes all solar components. Although it is considered permanently disturbed, vegetation within the solar array area fence will be retained and/or planted following construction and as a result there will be residual value of these areas to wildlife.

Temporary disturbance areas include underground collector lines and transmission lines outside the solar array area fence, as well as temporary disturbance around the outside perimeter fencing. Restoration of the temporary disturbance areas will occur following construction, as will revegetation within portions of the solar array area fence line not occupied by permanent infrastructure. The duration of temporary disturbance to habitat will vary by habitat subtype. For example, the recovery period for temporarily disturbed agricultural areas could be as short as 1 to 3 years and grasslands generally recover within 3 to 7 years. The Certificate Holder will restore temporary disturbance areas consistent with the Draft Revegetation Plan; therefore, temporary disturbance will be mitigated through successful implementation of the Draft Revegetation Plan (Attachment P-4 to Exhibit P; updated for RFA 1, see Attachment 6).

Table 1 lists the acres that will be permanently or temporarily disturbed by Facility construction based on the permitted design, organized by habitat category and subtype. These habitats are described in Exhibit P of the ASC and in biological survey reports attached to Exhibit P (Exhibit P, Attachment P-1). Table 1 will be updated prior to construction to reflect the final disturbance acreage by habitat subtype for the final layout.

Table 1. Temporary and Permanent Disturbance by Habitat Category and Habitat Subtype

Habitat Category	Habitat Subtype	Disturbance (Acres)[1]	
		Permanent	Temporary
2	Eastside Grasslands	<0.1	0.4
	Category 2 Habitat Subtotal	**<0.1**	**0.4**
4	Eastside Grasslands	17.9	2.7
	Intermittent or Ephemeral Streams	-	<0.1
	Category 4 Habitat Subtotal	**17.9**	**2.7**
5	Eastside Grasslands	13.8	2.1
	Intermittent or Ephemeral Streams	-	<0.1
	Category 5 Habitat Subtotal	**13.8**	**2.1**
6	Orchards, Vineyards, Wheat Fields, Other Row Crops	3,069.3	25.8
	Urban and Mixed Environs	2.0	0.8
	Category 6 Habitat Subtotal	**3,071.3**	**26.6**
	Grand Total	**3,103.0**	**31.8**

Note: Totals in this table may not sum correctly due to rounding; "-" means no disturbance while <0.1 means greater than zero but less than 0.05 acre disturbance.

1. Disturbance acres were calculated based on the layout permitted in the ASC and will be updated prior to construction.

3.0 Methods for Calculating Mitigation

Table 2 shows the methods for calculating mitigation required for permanent disturbance based on the permitted layout. No mitigation is proposed for temporary disturbance beyond habitat revegetation. No mitigation is required for disturbance to Category 6 areas.

Prior to construction of the Facility, the Certificate Holder will provide an estimate, in tabular format, of permanent disturbance acres and mitigation ratios shown in Table 2 to provide an updated estimate of mitigation needs.

Table 2. Mitigation Calculation

Habitat Category	Permanent Disturbance (acres)[1]	Mitigation Ratio[2]	Mitigation Need	Mitigation Description
4	17.9	1:1	17.9	The mitigation goal for Category 4 habitat is to provide no net loss in quantity or quality. Mitigation can be in-kind or out-of-kind, in-proximity or off-proximity mitigation.
5	13.8	0.5:1	6.9	The mitigation goal for Category 5 habitat is to provide net benefit in habitat quantity or quality. The mitigation strategy is actions that improve habitat conditions.
Grand Total	-	-	**24.8**	--

1. Acres of permanent disturbance requiring mitigation, which excludes habitat types and categories with less than a 0.05 acre mitigation need as well as Category 6 areas.
2. Acres mitigation per acres disturbed.

4.0 Mitigation

The Certificate Holder proposes to contribute funding to supplement ongoing conservation work being conducted by The Nature Conservancy (TNC) in Morrow County to meet mitigation needs of the Facility. This funding will allow additional conservation actions to occur that would not otherwise be conducted and would therefore benefit wildlife in the area. Supplementing existing conservation efforts will provide a greater benefit to wildlife across the landscape than creating a new easement not connected to an existing conservation area with known wildlife use. TNC identified the Lindsay Prairie Preserve, located less than 2 miles west of the Facility, as a potentially suitable site for Facility mitigation. The Lindsay Prairie Preserve is a 376-acre site owned by TNC since 1987 that is protected for restoration and preservation of native vegetation and wildlife. The preserve is a mix of grasslands and sagebrush communities that supports a large and consistent population of Washington ground squirrel (WAGS; *Urocitellus washingtoni*). In August 2018, a wildfire burned approximately 111 acres of the preserve, removing nearly all the sagebrush (*Artemisia tridentata*) and bitterbrush (*Purshia tridentata*) shrubs from the affected area. Thus, the site would benefit from habitat enhancements focused on restoring habitat that burned in 2018.

4.1 Site Description

According to TNC, habitat within the Lindsay Prairie Preserve is considered Category 1 per the ODFW Fish and Wildlife Habitat Mitigation Policy due to the presence of WAGS (personal communication with Jen Langevin, TNC Columbia Basin Program Manager, December 28, 2023). If WAGS were not present at the site, the habitat alone would be considered Category 2 native perennial grassland. TNC collected vegetation data in 2021 in two macroplots within the proposed mitigation area; at that time, cheatgrass (*Bromus tectorum*) was in less than 50 percent of the 1-meter plots, while perennial grasses, such as bluebunch wheatgrass (*Pseudoroegneria spicata*), was in greater than 85 percent of plots and Sandberg bluegrass (*Poa secunda*) was in greater than 98 percent of plots. The dominant grass observed was Sandberg bluegrass, with a diverse forb community also present, including the following species: milkvetch species (*Astragalus purshii* and *Astragalus lentiginous*), woolly plantain (*Plantago patagonica*), lomatium species (*Lomatium macrocarpum* and *Lomatium triternatum*), pussytoes (*Antennaria dimorpha*), phlox (*Phlox longifolia*), flax (*Linum lewisii*), slender hawksbeard (*Crepius atribarba*), and shaggy fleabane (*Erigeron pumilis*). Non-native or introduced forb species were present at a much lower percent frequency compared to native forb species. These data were collected 3 years after the wildfire in 2018 demonstrating a plant community resilient to disturbances such as wildfire, a unique trait in the local area.

4.2 Habitat Enhancements

As described in Section 3.0 above, approximately 18 acres of habitat mitigation are needed for Facility impacts to Category 4 habitat (goal of no net loss) and 7 acres of habitat mitigation are needed for Facility disturbance to Category 5 habitat (goal of net benefit). Typically, mitigation for disturbance to Category 5 habitat includes less uplift or enhancement effort than mitigation for Category 4 habitat, given that Category 5 habitat does not have a no net loss goal. However, due to the few total number of acres needed for Facility mitigation, TNC requested that all mitigation acreage be considered Category 4 for the purpose of performing habitat enhancements to simplify logistics of mitigation implementation. Therefore, proposed mitigation habitat enhancements include treatment of the entire mitigation area at a level consistent with Category 4 mitigation goals, as described below.

Mitigation proposed to be conducted at the Lindsay Prairie Preserve includes funding of chemical purchase and application for annual grass treatment and planting shrub plugs as follows:

- Treatment 1 (Year 1): fall aerial application of imazapic (i.e., Plateau) and indaziflam (i.e., Rejuvra) to reduce competition from invasive annual grasses.
- Treatment 2 (Year 1): winter planting of sagebrush and bitterbrush plugs at 300 shrubs per acre. Exact species ratios will be determined prior to mitigation implementation.
    - In TNC's experience performing restoration at the Naval Weapons Systems Training Facility - Boardman and at the Boardman Conservation Area, the average survival of sagebrush plugs is about 50 percent and establishment of bitterbrush is extremely challenging with a survival rate significantly lower than sagebrush. Therefore, TNC

proposed two times the ideal number of shrubs per acre to account for this anticipated survival rate.

- Treatment 3 (Year 3, 4, or 5): follow-up aerial application of Plateau and Rejuvra to continue a reduction in competition of invasive annual grasses to allow shrubs to become established.

Mitigation for both Category 4 and Category 5 habitat can be in-kind or out-of-kind, and in-proximity or off-proximity mitigation as defined by the ODFW Habitat Mitigation Policy. This proposed mitigation would provide in-kind and in-proximity mitigation considering the Facility would disturb grassland habitat and this mitigation would provide uplift to grassland habitat and considering the mitigation site's close proximity to the Facility. By mitigating both Category 4 and 5 habitat disturbance with treatments sufficient to meet the ODFW mitigation goal for Category 4 habitat and including shrub plantings in addition to herbicide application to address the local need for post-fire shrub recovery at the Lindsay Prairie Preserve, the Certificate Holder is going above and beyond the minimum mitigation need for Facility disturbance under the ODFW Habitat Mitigation Policy.

5.0 Monitoring

The treatment area would be monitored for 5 to 6 years to document pre- and post-treatment conditions. This monitoring would be designed to document changes in species diversity and composition. Monitoring would be funded by the Certificate Holder and conducted by the TNC or its contractors and the results of monitoring would be reported to ODFW and the Oregon Department of Energy (ODOE) following each monitoring effort.

To document pre- and post-treatment conditions, baseline monitoring would be conducted during the growing season in the area to be treated in Year 0, followed by post-treatment monitoring during the growing season in Years 1 through 5, and possibly 6 (depending on the timing of the third treatment). Monitoring would occur for at least one-year post-application of the third treatment. TNC established long-term vegetation monitoring macroplots on the Lindsay Prairie Preserve where frequency data are collected. Two of these plots are within the proposed mitigation area (i.e., treatment area) and could be utilized for a portion of the monitoring protocol to determine the efficacy of the herbicide treatments. Prior to construction, the Certificate Holder will provide ODOE and ODFW with a copy of the monitoring protocol, which will be developed in coordination with TNC and subject to ODOE approval. Following ODOE approval, this plan will be amended to incorporate the monitoring protocol.

The mitigation treatments would be considered successful when all treatments have been performed and documented in accordance with the methods described in this HMP.

After initial monitoring of treatments is complete in Year 5 or 6, the Certificate Holder will continue to monitor the site every 5 years thereafter in years divisible by five for the life of the Facility to confirm the site is being maintained at the same habitat category or better as compared to the baseline condition of the mitigation area. This reporting will serve to demonstrate the Facility's mitigation needs are being met throughout the life of the Facility. If the habitat quality of the mitigation area shows evidence of decline the Certificate Holder will investigate the cause of the decline and consult with ODOE and ODFW to develop appropriate adaptive management measures to restore baseline habitat quality.

6.0 Legal Instrument

Prior to construction, the Certificate Holder will provide a map of the mitigation area to ODOE along with a copy of the legal agreement between TNC and the Certificate Holder that describes the scope of mitigation work and the legally enforceable mechanism to ensure implementation of mitigation consistent with the ODFW Habitat Mitigation Policy. The legal instrument will include assurance of durability for the life of the Facility to ensure the mitigation property will remain habitat if TNC ceases to own or manage the land prior to decommissioning of the Facility. The legal instrument will also contain an assurance that the land covered under the agreement will not be used to satisfy any other mitigation obligations other than those pertaining to this Facility. The final mitigation acreage, location, and treatments will be based on final Facility habitat disturbance and mitigation site conditions at the time of implementation and be sufficient to satisfy the ODFW Habitat Mitigation Policy Goals for disturbance to Category 4 and 5 habitat. This HMP will be updated, in coordination with ODOE, to reflect any changes in mitigation prior to construction of any Facility phase as described in Section 7.0, below, and consistent with the legal agreement between the TNC and the Certificate Holder at that time.

7.0 Amendment of the HMP

The HMP may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

Sunstone Solar Project 5
Draft Noxious Weed Control Plan

Prepared for

PINEGATE RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 5, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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Appendices

1.0 Introduction

Sunstone Solar 5, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 5 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Noxious Weed Control Plan has been prepared to comply with Oregon Administrative Rule 660-033-0130 (38)(h)(D), which states, in regard to photovoltaic solar power generation facilities, that:

> "C*onstruction or maintenance activities will not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. This provision may be satisfied by the submittal and county approval of a weed control plan prepared by an adequately qualified individual that includes a long-term maintenance agreement. The approved plan shall be attached to the decision as a condition of approval*."

Noxious weeds are non-native, aggressive plants with the potential to cause significant damage to native ecosystems and/or cause significant economic losses. Noxious weeds are opportunistic plant species that readily flourish in disturbed areas, are difficult to control, and thereby can compete with and/or prevent native plant species from re-establishing. Notably, the likelihood of introduction or explosion of noxious weeds is correlated with new disturbances in a region, such as large-scale construction projects. In addition, noxious weed species can adversely affect the structure, composition, and success of revegetation efforts associated with construction-related temporary disturbances.

The intent of this Plan is to provide clear methods to prevent the introduction and spread of designated noxious weeds from the construction and operation of the Facility, control existing populations of noxious weeds within construction areas, and monitor the success of efforts to prevent and control noxious weeds. The Certificate Holder and its contractors will be responsible for implementing the methods detailed in this Plan.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

Prior to construction, the Certificate Holder shall finalize this plan by completing the following:

- Conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform pre-construction weed treatment.
- Develop final noxious weed monitoring methods in consultation with ODOE and incorporate as an amendment to this plan upon ODOE approval.
- Update Table 2 in consultation with ODOE and the Morrow County Weed Department.
- Provide records demonstrating all personnel have been trained on noxious weed control.
- Provide evidence that existing noxious weed infestations have been identified and treated in a manner consistent with Morrow County recommendations.
- Consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern.

2.0 Regulatory Framework

2.1 State of Oregon

In Oregon, a noxious weed is defined under Oregon Revised Statutes (ORS) 569.175 as "a terrestrial, aquatic, or marine plant designated by the State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.". Noxious weeds have been declared by ORS 569.350 as a menace to public welfare, and control of these plants is the responsibility of private landowners and operators, as well as county, state, and federal governments.

The Oregon State Weed Board (OSWB) was created by the Oregon Department of Agriculture (ODA) under ORS 569.600. OSWB provides recommendations for noxious weed control at the state-level and is responsible for updating the State Noxious Weed List. The OSWB and the ODA classify noxious weeds in Oregon in accordance with the ODA Noxious Weed Policy and Classification System (ODA 2024). There are three designations under the State's system:

- **A Listed Weed:** A weed of known economic importance that occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent.
    - **Recommended Action:** Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed:** A weed of economic importance that is regionally abundant but may have limited distribution in some counties.

  - **Recommended Action:** Limited to intensive control at the state, county, or regional level as determined on a site-specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.

- **T-Designated Weed:** A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

2.2 Morrow County

The Morrow County Code Enforcement Ordinance establishes procedures for enforcing Morrow County Code through the authority granted to general law counties by ORS Chapter 203. Section 11 of the county Code Enforcement Ordinance, updated on July 5, 2021, establishes Morrow County as a weed control district, defines what is considered a noxious weed or weed of economic importance, identifies the responsibility of private landowners to control weeds, and outlines the authority of the weed control district and Morrow County Weed Program Manager/Inspector to administer and enforce weed control in the ordinance (Morrow County 2021).

Morrow County has its own weed classification system that differs from the state. Morrow County defines two classifications of weeds (Morrow County 2025):

- **Noxious Weeds - "A List":** Any plant that is determined by the weed advisory board and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land, or property under provisions of Oregon State Statute and thus mandated for control.
- **Weeds of Economic Importance - "B List":** Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

2.3 State and County Weed Lists

The ODA lists 46 Class A species and 88 Class B species for the state of Oregon, 19 of which are T-designated (ODA 2024; Appendix A). Morrow County specifically recognizes 36 species of noxious weeds (Appendix B; Morrow County 2025). Although not all the Morrow County listed noxious weeds noted in Appendix B occur in the vicinity of the Facility, the Certificate Holder and its contractors should be aware of the entire list while monitoring and controlling weeds. Noxious weeds known to occur in the vicinity of the site boundary are discussed in Section 3.0.

3.0 Noxious Weeds Identified at the Facility

In June, 2022 Tetra Tech completed rare plant and habitat categorization surveys within and adjacent to the original Sunstone Solar Project site boundary[2]. During those surveys, four listed noxious weed species were documented, including three ODA-listed noxious weed species and four Morrow County listed species noxious weed species. Table 1 lists the noxious weed species observed, their noxious weed designation (i.e., status), and the frequency of observations. Locations of these noxious weeds documented during surveys are included in Exhibit P, Attachment P-1 of the ASC[3]. Three of the four noxious weed species observed were state and/or County “B” listed weeds (Table 1; Morrow County 2025, ODA 2024). One species, rush skeletonweed (*Chondrilla juncea*), is an “A” List Weed in Morrow County and a state “T”-designated weed, meaning that ODA has targeted this species for prevention and control (Morrow County 2025; ODA 2024). Note that only two of these noxious weed species observations are located within the Sunstone Solar Project 5/Facility site boundary (i.e., Rush skeletonweed and Cereal rye [*Secale cereale]*), however, due to the likelihood that all documented species could be found at the Facility in the future, they are retained for awareness and noxious weed prevention purposes.

Cereal rye was abundant in the previously disturbed areas outside of active crop fields and was generally found in previously disturbed ground. Rush skeletonweed was found in isolated small populations or single individuals on the hillside between active cropland and a gravel county road. Puncturevine (*Tribulus terrestris*) and jointed goatgrass (*Aegilops cylindrica*) were found in the highly disturbed border in between active cropland and roads. The Certificate Holder will conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform management actions. The Certificate Holder may coordinate with landowners regarding noxious weed presence. Identified noxious weed infestations will be treated prior to construction.

Table 1. Noxious Weeds Observed during Surveys in 2022

Scientific Name	Common Name	Oregon State Status[1]	Morrow County Status[1]	Frequency
Aegilops cylindrica	Jointed goatgrass	B	B	Few small patches.
Chondrilla juncea	Rush skeletonweed	B*, T	A	Occasional single plants.
Secale cereale	Cereal rye	Not listed	B	Scattered large-sized patches.
Tribulus terrestris	Puncturevine	B*	B	Few small to large-sized patches.
1. Definitions for state and county noxious weed status are provided in Sections 2.1 and 2.2, respectively. Species marked with a (*) are targeted for biocontrol (ODA 2024).				

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[2] Site Certificate for the Sunstone Solar Project, November 18, 2024.

[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

In addition to noxious weeds, cheatgrass, an invasive annual grass, was identified in grassland habitats within the site boundary. While this species is not listed as a noxious weed by the state or county, it and other invasive annual grasses can adversely impact habitat and can increase fire risk. To address these issues and maintain compliance with the requirements of the Revegetation Plan required under Condition PRE-FW-01, the certificate holder will monitor the spread of these species as explained in Section 4.3 and 4.4.

4.0 Noxious Weed Management

This section of this Plan describes the steps the Certificate Holder will take to prevent and control the establishment and spread of noxious weed species during both construction and operation of the Facility. Noxious weed control methods for the Facility described in this Plan have been developed utilizing information from the ODA Noxious Weed Control Program and the Morrow County Weed Department.

The management of noxious weeds will be considered throughout all stages of construction and operation of the Facility and will include:

- **Prevention:** Implementing measures to prevent the spread of noxious weeds during construction, operation, and maintenance activities.
- **Treatment:** Treating noxious weed populations with their appropriate control methods, at appropriate time intervals.
- **Monitoring:** Assessing noxious weed changes within the Facility site boundary over time and ensuring that legacy as well as new weed populations are not increasing their distributions.

The Certificate Holder's objective is to prevent the introduction of new noxious weed populations and the spread of existing noxious weed populations. The methods described below will be implemented to minimize the spread of noxious weeds during construction activities. New noxious weeds detected during post-construction revegetation will be considered a result of construction activities and will be controlled accordingly.

4.1 Prevention

Prior to the start of construction, all personnel will be trained on the importance of noxious weed control. As part of start-up activities, and to help facilitate the avoidance of existing infestations and identification of new infestations, the Certificate Holder or their construction contractor will provide information and training to all construction personnel regarding noxious weed identification and prevention strategies. Operations and maintenance personnel will be similarly informed. The importance of preventing the spread of noxious weeds in areas not currently infested and controlling the proliferation of noxious weeds already present within or near the Facility will be emphasized.

The Certificate Holder will implement the following best management practices to minimize the spread of noxious weeds during construction activities, revegetation efforts, and operation and maintenance activities. The following practices center around ensuring that noxious weed seeds or reproductive plant fragments are not unintentionally dispersed within or outside of the Facility boundaries by personnel or their vehicles. These practices allow for responsible movement around sites with noxious weeds already present, and ensure that new populations or species are not accidentally introduced into the Facility boundaries.

- Flagging and treating areas of noxious weed infestations prior to construction to alert construction personnel;
- Limiting vehicle access to designated routes, whether existing roads or newly constructed roads, and the outer limits of construction disturbances per the final design for the Facility;
- Limiting vehicle traffic in noxious weed-infested areas;
- Cleaning construction vehicles each time they enter or exit the Facility at a wash station located inside the Facility at vehicle ingress/egress points;
- Cleaning vehicles and equipment associated with ground disturbance and movement of topsoil utilizing a mobile wash station after performing work in noxious weed-infested areas and prior to performing work in non-infested areas;
- Where feasible, not moving topsoil and other soils from noxious weed infested areas outside of the infested areas and returning them to their previous location during reclamation activities;
- Treating soils from infested areas with a pre-emergent herbicide prior to initiation of revegetation efforts;
- Providing information regarding target noxious weed species at the operations and maintenance buildings;
- Treating noxious weeds via biological, mechanical or chemical control (see Section 4.2);
- Preventing conditions favorable for noxious weed germination and spread by revegetating temporarily disturbed areas as soon as practicable;
- Monitoring areas of disturbance for noxious weeds after construction (see Section 4.3), during the normal course of revegetation maintenance of temporary workspaces, and implementing control measures as appropriate;
- Revegetating the site with appropriate, local native seed or native plants; when these are not available, non-invasive, and non-persistent non-native species may be used; and
- Ensuring that seed and straw mulch used for site rehabilitation and revegetation are certified free of noxious weed seed and propagules.

4.2 Treatment

Control of noxious weeds and other invasive weed species will be implemented through biological, mechanical, chemical, or biological control measures. The control method used will depend on the

weed species and size of infestation, time of year, proximity to intact native habitats, and resources available (Tu et al. 2003). Generally, mechanical control is best suited for small infestations of tap-rooted weeds that can be hand pulled or large occurrences in areas where mowing or soil disturbance is acceptable. Chemical control is used for most occurrences of perennial weeds with rhizomes or stolons and large occurrences of any weed in areas where mowing or soil disturbance are not recommended. Successful noxious weed control programs typically combine mechanical and chemical treatment strategies (USEPA 2008).

The Certificate Holder will be responsible for hiring a qualified contractor to implement the treatment of noxious weeds. The Certificate Holder will ensure that noxious weed management actions will be conducted by specialists with the following qualifications:

- Experience in native plant, non-native and invasive plants, and noxious weed identification;
- Experience in noxious weed mapping;
- If chemical control is used, specialists must possess a Commercial or Public Pesticide Applicator License from the ODA or possess an Immediately Supervised Pesticide Trainee License and be supervised by a licensed applicator;
- Training in noxious weed management or Integrated Pest Management with an emphasis in noxious weeds;
- Experience in coordination with agencies and private landowners; and
- No recent (within one year) violations on the contractor’s record.

Existing noxious weed populations will be prevented from expanding in size and density and will not be spread to new sites. Existing populations of A listed noxious weeds will be eliminated. If it is determined that noxious weeds have invaded areas immediately adjacent to the Facility (e.g., areas visible just beyond the outer limits of construction disturbances associated with the Facility or along access roads) as a result of construction, the Certificate Holder will contact the landowner and seek approval to treat those noxious weed populations.

Long-term weed control methods will be described in a long-term monitoring plan as described in Section 4.3. The main factor in long-term weed control is successful revegetation with non-weedy species as described in the Draft Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). If feasible, long-term management of vegetation within the Facility solar array fence line may include prescriptive sheep and goat grazing by an authorized contractor, if approved by Morrow County, ODFW and ODOE. As noted above, short-term noxious weed control will be done through mechanical or chemical treatment. However, it will be important to ensure that the short-term treatment does not affect the establishment of the native perennial cover that will help provide the long-term control. Additionally, early detection and control of small noxious weed populations before they can expand into larger populations is extremely important for successful weed control efforts.

Noxious weed control will continue for the life of the Facility to meet the identified success criteria described in Section 4.3. Supplemental seeding of desirable species may be needed to meet and/or

maintain compliance with success criteria. Fertilizer application will be limited in areas treated for noxious weeds, as fertilizer can stimulate the growth of noxious weeds, and the timing of revegetation activities will need to be coordinated with noxious weed treatments.

4.2.1 Biological

Biological control involves the use of prescribed insects, fungi and livestock to control noxious weeds to achieve management objectives. Biological control methods are typically targeted to a specific species or plant to control its persistence. They are also used for maintenance in targeted areas for vegetation management control in height and density that includes mitigating fire risk and erosion. Biological control is environmentally friendly and should be the first consideration when applicable.

4.2.2 Mechanical Treatment

Mechanical treatment will be the preferred method of treatment for existing noxious weed populations where appropriate within the boundaries of the Facility. Mechanical control methods rely on removal of plants, seed heads, and/or cutting roots with a shovel or other hand tools or equipment that can be used to remove, mow, or disc noxious weed populations. Hand removal of plants is also included under this treatment method. Mechanical methods are useful for smaller, isolated populations of noxious weeds in areas of sensitive habitats. Additionally, hand removal of small infestations can minimize soil disturbance, allowing desirable species to remain and limiting conditions favorable for noxious weeds.

For some large noxious weed occurrences, mowing, tilling, discing, or other mechanical techniques may be used to reduce thatch prior to chemical application so that herbicide can more effectively make contact with the target species. However, some rhizomatous plants can spread by discing or tillage. In addition, rush skeletonweed, which was identified near the Facility (Section 3.0), can reproduce vegetatively from small segments of root, and discing or tilling can facilitate the spread of this species. As such, implementation of discing will be species-specific and avoided in areas where rush skeletonweed individuals have been found.

If tilling or discing is employed in areas that will be revegetated following construction, subsequent seeding will be conducted to re-establish desirable vegetative cover that will stabilize the soils and slow the potential re-invasion of noxious weeds. Discing, tilling, or other mechanical treatments that disturb the soil surface within native habitats will also be avoided in favor of herbicide application, which is an effective means of reducing the size of noxious weed populations as well as preventing the establishment of new infestations. Previously unbroken ground or fallow areas should not be tilled or rod-weeded to maintain native biocrusts and prevent exposing weed seeds.

4.2.3 Chemical Treatment

Chemical control can effectively remove noxious weeds through use of selective herbicide when mechanical control is not feasible. The specific herbicide used and the timing of application will be

chosen based on the specific noxious weed being treated, as appropriate herbicides differ between species and types of plants (i.e., dicots such as rush skeletonweed versus monocots such as jointed goatgrass). Example treatment methods, as well as the recommended timing of treatments for the four target noxious weeds identified within the Facility, are summarized in Table 2. The status of herbicide approval (e.g., confirming herbicides are approved for use by the U.S. Environmental Protection Agency [EPA] and ODA) will be checked annually.

Prior to construction and every fall season during facility operation, the Certificate Holder or its contractor will consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern, to allow for adaptive weed management given changes in weed control effectiveness from noxious weed species tolerance to herbicide treatment over time. Results of the consultation shall be reported in the Certificate Holder's annual monitoring report. Any alternative control methods can be proposed by the Certificate Holder or its contractors after consulting with the Morrow County Weed Department and included in the Certificate Holder's annual monitoring report.

Herbicides will be applied on identified, treatable, noxious weed infestations. The Certificate Holder or their contractors will coordinate with the Morrow County Weed Department to determine which populations are treatable and will notify landowners of proposed herbicide use on their lands prior to application. If a noxious weed population is deemed to be untreatable (e.g., too widespread and established in an area to successfully control), the Certificate Holder will implement the applicable prevention measures discussed in Section 4.1, except for treatment with herbicides.

Table 2. Example Treatment for Target Noxious Weed Species

Scientific Name	Common Name	Treatment Method and Timing
Aegilops cylindrica	Jointed goatgrass	**Glyphosate** – Apply to actively growing plants emerged before bolt stage (i.e., stage of growth where growth is focused on seed development versus leaf development). • Rate: 0.38 to 0.75 lb ae/a[1] **Imazapic –** Apply pre-emergence in fall. Due to the residual effect of this herbicide, it will not be used in areas to be revegetated. • Rate: 0.063 to 0.188 lb/a[1] **Sulfometuron** – Apply in fall or in late winter before jointed goatgrass is 3 inches tall. • Rate: 1 to 1.5 oz ai/a (1.33 to 2 oz/a)[1]
Chondrilla juncea	Rush skeletonweed	**2,4-D or MCPA –** Apply to rosettes in the spring immediately before or during bolting. • Rate: 2 lb ae/a[1] **Aminopyralid (Milestone) –** Spring or fall when rosettes are present. • Rate: 1.75 oz ae/a (7 fluid oz/a Milestone)[1] **Clopyralid –** Apply to rosettes in fall or up to early bolting in spring. • Rate: 0.25 to 0.375 lb ae/a (0.66 to 1 pint/a)[1]

Scientific Name	Common Name	Treatment Method and Timing
		Picloram – Apply from late fall to early spring. For best results, apply just before or during bolting. • Rate: 1 lb ae/a[1]
Secale cereale	Cereal rye	Postemergence, non-selective herbicides such as glyphosate can control cereal rye. Glyphosate does not provide residual weed control, so any plants that emerge after treatment will not be controlled. Other herbicides that have found to provide control include Clethodim, Hexazinone, Rimsulfuron, Sethoxydim, and Sulfometuron.
Tribulus terrestris	Puncturevine	**2,4-D amine or 2,4-D LV ester–** Apply every 3 weeks during growing season or when new seedlings appear. • Rate: 1 to 2 lb ae in 10 to 20 gal water for spot treatments **Bentazon (Basagran) + imazamox (Raptor)–** Apply to small, actively growing puncture vine • Rate: 0.75 to 1 lb ai/A bentazon + 0.031 lb ai/a imazamox (4 oz/A Raptor) **Bromacil + diuron–** Apply before weeds emerge. • Rate: 8 lb ai/A (10 lb/a)[1] **Chlorsulfuron–** Apply late fall or late winter preemergence to growth. Needs moisture to activate. • Rate: 1 oz ai/a (1.5 oz/a)[1] **Fomesafen –** Apply pre- and postemergence, depending on crop. • Rate: 1 to 2 pints/A (0.25 to 0.5 lb ai/a)[1] **Imazapic –** Apply early postemergence when plants are cracking. • Rate: 0.125 to 0.188 lb ai/a[1] **Indaziflam –** Apply at least several weeks prior to expected germination of puncture vine. Apply to dry soils when rain is not expected for at least 48 hours. Can be successfully applied several months in advance of weed germination. • Rate: Grazed areas 0.046 to 0.065 lb ai/a (3.5 to 5 oz/a Rejuvra); areas not grazed or cut for hay 0.046 to 0.09 lb ai/A (3.5 to 7 oz/a Rejuvra). Use lower rates only where weed pressure is light and shorter period of residual activity is desired. **Norflurazon –** Apply in fall to spring, before puncture vine emerges. • Rate: Refer to label. Adjust rates depending on soil texture and organic matter **Paraquat –** Apply as a postemergence spray to puncture vine foliage • Rate: 0.38 to 0.49 lb ai/a[1] •

Sources: DiTomaso e al. 2013; LCNWCB 2022; Prather and Peachey 2022.

[1] a = acre; ae = acid equivalent; ai = active ingredient; lb= pound; oz = ounces

4.2.3.1 Herbicide Application and Handling

Herbicide application will occur within the appropriate season and during the appropriate timeframe to achieve desired results, as approved by ODOE and the county weed departments. Herbicide application will adhere to EPA and ODA standards. Only those herbicides that are approved by the EPA and ODA will be used. In general, application of herbicides will not occur when the following conditions exists:

- Wind velocity exceeds 15 miles per hour for granular application, or exceeds 10 miles per hour for liquid applications;
- Snow or ice covers the foliage of target species; or
- Adverse weather conditions are forecasted within the next few days.

Hand application methods (e.g., backpack spraying) may be used in roadless areas or in rough terrain. Vehicle-mounted sprayers (e.g., handgun, boom, and injector) will be used mainly in open areas that are readily accessible by vehicle. Calibration checks of equipment will be conducted prior to spraying activities, as well as periodically throughout use, to ensure that appropriate application rates are achieved.

Herbicides will be transported to the Facility daily with the following stipulations:

- Only the quantity needed for that day's work will be transported.
- Concentrate will be transported in approved containers only, and in a manner that will prevent spilling, stored separately from food, clothing, and safety equipment.
- Mixing will be done off-site and at a distance greater than 200 feet from open or flowing water, wetlands, or other sensitive species' habitat. No herbicides will be applied at these areas unless authorized by the appropriate regulatory agencies.
- All herbicide equipment and containers will be inspected daily for leaks.
- Herbicides use will be in accordance with all manufacture's label recommendations and warnings.

4.2.3.2 Herbicide Spills and Cleanups

All appropriate precautions will be taken to avoid herbicide spills. In the event of a spill, cleanup will be immediate. Contractors will keep spill kits in their vehicles and in an appropriate storage shed to allow for quick and effective response to spills. Items included in the spill kit will be:

- Protective clothing and gloves;
- Adsorptive clay, "kitty litter," or other commercial adsorbent;
- Plastic bags and a bucket;
- A shovel;
- A fiber brush and screw-in handle;
- A dustpan;

- Caution tape;
- Highway flares (use on existing hard-top roads only); and
- Detergent.

Response to an herbicide spill will vary with the size and location of the spill, but general procedures include:

- Stopping the leak;
- Containing the spilled material;
- Traffic control;
- Dressing the clean-up team in protective clothing;
- Cleaning up and removing the spilled herbicide, as well as the contaminated adsorptive material and soil; and
- Transporting the spilled herbicide and contaminated material to an authorized disposal site.

4.2.3.3 Herbicide Spill Reporting

All herbicide contractors will have readily available copies of the appropriate material safety data sheets for the herbicides used at their disposal and will keep copies of the material safety data sheets in the application vehicle. If an herbicide spill of any size occurs, the appropriate agency and spill coordinators will be notified promptly. In case of a spill into wetlands and waterbodies, the appropriate federal, state, and county agencies will be notified immediately. All herbicide spills equal to or greater than 200 pounds or 25 gallons of pesticide residue will be reported to the Oregon Emergency Response System in accordance with applicable laws and requirements (OAR 340-142-0050; ODEQ 2024). The Certificate Holder will report all herbicide spills to ODOE by phone or email within 24 hours with follow up reporting as appropriate.

4.3 Monitoring

Weed inspections will occur across the entire Facility through visual inspection of the site while driving and/or walking. Final monitoring methods will be determined in consultation with ODOE prior to construction and will be incorporated as an amendment to this plan upon ODOE approval. Monitoring will be conducted by a qualified botanist or weed specialist and will begin in the first growing season after seeding. Monitoring for noxious weeds and other undesirable weed species will occur at least five times per year including in the spring, June, July, and August for summer annuals and in the fall during the first two years following construction to capture the different life cycles of noxious weed species. This will allow real-time assessment of weed growth and inform proactive weed control measures to prevent large scale infestations. Frequent checks during early revegetation efforts will enable the Certificate Holder to respond to new weed infestations in a timely manner and ensure the success of the site's revegetation. These inspections will be used to inform ongoing weed control efforts.

The initial monitoring survey will be scheduled slightly before herbicide application, as applicable, to identify any noxious weed species within the areas to be treated, with a focus on target noxious weed species observed prior to construction (Table 1), or other populations of target noxious weeds not previously observed.

Monitoring will assess the success of noxious weed treatments and will document any new noxious weed infestations observed. During the first two years following construction, the Certificate Holder will meet with ODOE and the Morrow County Weed Department at least once per season to provide updates on weed infestations and control measures at the Facility. These results will also be summarized in annual monitoring reports that describe the treatments performed, treatment success, make recommendations to improve treatment success (if necessary), and note any new target noxious weed species or emergence. Reports will be submitted to the Oregon Department of Energy (ODOE), Oregon Department of Fish and Wildlife (ODFW), and Morrow County annually.

Based on the success of control efforts after the second year of monitoring, the Certificate Holder will consult with ODOE and ODFW to determine if the monitoring cycle can be reduced for years three to five. After five years of monitoring, the Certificate Holder will design a long-term weed control plan in consultation with ODOE and the Morrow County Weed Department. The Certificate Holder will maintain ongoing communication with individual landowners, the Morrow County Weed Department, and ODOE regarding noxious weeds within the Facility. Landowners may also contact the Certificate Holder directly to report the presence of noxious weeds related to Facility activity. The Certificate Holder will control the noxious weeds on a case-by-case basis and prepare a summary of measures taken for that landowner. During the operational period of the Facility, the Certificate Holder will control noxious weeds as described in the long-term weed control plan. The Certificate Holder will report the investigator's findings and recommendations regarding weed control in the Facility's annual report required per OAR 345-026-0080.

The following contact information for the Morrow County Weed Program Manager will be used and updated as needed:

Corey Sweeney, Weed Program Manager
Morrow County Public Works
365 West Highway 74
Lexington, OR 97839
(541) 989-9502
mcweed@co.morrow.or.us

4.4 Success Criteria

Success criteria outlined below are designed to demonstrate compliance with OAR 660-033-0130(38)(D) to prevent the introduction and spread of noxious weed species. In each annual monitoring report, the Certificate Holder will include an assessment of whether the Facility is meeting or trending toward meeting the noxious weed control success criteria. Compliance with the Facility Site Certificate will be demonstrated through documentation of meeting these success criteria for the life of the Facility.

- Class A and Class B noxious weed presence within the solar array fence line will not exceed 15 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Class T noxious weed presence within the solar array fence line will not exceed 5 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Invasive Annual Grasses and other Undesirable Species will not exceed more then 50 percent cover within any 1 acre area or more than 30 percent cover within the solar array fence line.
- During revegetation of temporary disturbance areas outside of the solar array fence line presence and cover of noxious weeds is 75 percent or less than that of the reference site.

5.0 Roles and Responsibilities

The Certificate Holder is the overall responsible party for construction and operation of the Facility and implementation of the noxious weed management activities described in this Plan. However, the Certificate Holder may use contractors to complete tasks associated with noxious weed management and monitoring. Example responsible parties and their roles may include:

Monitoring Contractor

- Perform site visits to document noxious weed occurrences.
- Provide summary memo after each visit to Certificate Holder's operations manager outlining findings and treatment recommendations.
- Communicate directly with Weed Management Contractor and provide maps, and photos of noxious weed species locations to Weed Management Contractor.
- Communicate with Morrow County Weed Program Manager, and ODA about noxious weed survey findings and treatment plans.
- Prepare annual report for the Facility describing noxious weed monitoring findings and treatments.
- Organize and attend quarterly calls with the Certificate Holder and Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Certificate Holder Site Manager

- Communicate findings and recommendations from Monitoring Contractor to the Weed Management Contractor.
- Document the work performed by the Weed Management Contractor and provide documentation to Monitoring Contractor. Documentation should include type and quantity

of herbicides applied, dates applied, and any associated EPA/U.S. Department of Environmental Quality licensing/documentation of chemicals used.

- Reviews annual reports to ensure all treatments performed by the Weed Management Contractor are documented.
- Maintain landowner communications, providing guidance to the Monitoring Contractor and Weed Management Contractor regarding landowner restrictions/requests for performing noxious weed monitoring/treatment on their properties.
- Attend quarterly calls with Monitoring Contractor and the Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Weed Management Contractor

- Review Monitoring Contractor memos describing noxious weed occurrences and recommendations and plan appropriate treatment to address those issues.
- Communicate treatment plan to the Certificate Holder.
- Maintain records of when, where, and what type of noxious weed treatments are being performed.
- Maintain all appropriate documentation of chemicals applied. Shares documentation during the quarterly calls with the Certificate Holder and Monitoring Contractor, and prior to Annual Report preparation.
- Attend quarterly calls with Monitoring Contractor and Certificate Holder.

Morrow County

- Review Monitoring Contractor memos describing weed occurrences and recommendations.
- Attend quarterly calls and provide recommendations.

6.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE. This Plan may also be amended periodically as the Certificate Holder continues to evaluate and modify, as needed, agricultural dual use activities at the Facility.

7.0 References

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Appendix A: Oregon State Noxious Weed List

OREGON
DEPARTMENT OF
AGRICULTURE

Noxious Weed Policy and Classification System
2024

Noxious Weed Control Program

Address: 635 Capitol Street NE, Salem, Oregon 97301

Phone: (503) 986-4625   **Fax:** (503) 986-4786

www.oregon.gov/ODA/programs/Weeds/Pages/AboutWeeds.aspx

Mission Statement

To protect Oregon’s natural resources and agricultural economy from the invasion and proliferation of invasive noxious weeds.

Program Overview

The Oregon Department of Agriculture (ODA) Noxious Weed Control Program provides statewide leadership for coordination and management of state listed noxious weeds. The state program focuses on noxious weed control efforts by implementing early detection and rapid response projects for new invasive noxious weeds, implementing biological control, implementing statewide inventory and survey, assisting the public and cooperators through technology transfer and noxious weed education, maintaining noxious weed data and maps for priority listed noxious weeds, and assisting land managers and cooperators with integrated weed management projects. The Noxious Weed Control Program also supports the Oregon State Weed Board (OSWB) with administration of the OSWB Grant Program, developing statewide management objectives, developing weed risk assessments, and maintaining the state noxious weed list.

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Noxious Weed Control Policy and Classification System

Definition

“Noxious weed” means a terrestrial, aquatic or marine plant designated by the Oregon State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.

Noxious weeds have become so thoroughly established and are spreading so rapidly on private, state, county, and federally owned lands, that they have been declared by ORS 569.350 to be a menace to public welfare. Steps leading to eradication, where possible, and intensive control are necessary. It is further recognized that the responsibility for eradication and intensive control rests not only on the private landowner and operator, but also on the county, state, and federal governments.

Weed Control Policy

Therefore, it shall be the policy of ODA to:

1. Assess non-native plants through risk assessment processes and make recommendations to the Oregon State Weed Board for potential listing.
2. Rate and classify weeds at the state level.
3. Prevent the establishment and spread of listed noxious weeds.
4. Encourage and implement the control or containment of infestations of listed noxious weed species and, if possible, eradicate them.
5. Develop and manage a biological weed control program.
6. Increase awareness of potential economic losses and other undesirable effects of existing and newly invading noxious weeds, and to act as a resource center for the dissemination of information.
7. Encourage and assist in the organization and operation of noxious weed control programs with government agencies and other weed management entities.
8. Develop partnerships with county weed control districts, universities, and other cooperators in the development of control methods.
9. Conduct statewide noxious weed surveys and weed control efficacy studies.

Weed Classification System

The purpose of this Classification System is to:

1. Act as the ODA’s official guideline for prioritizing and implementing noxious weed control projects.
2. Assist the ODA in the distribution of available funds through the Oregon State Weed Board to assist county weed programs, cooperative weed management groups, private landowners, and other weed management entities.
3. Serve as a model for private and public sectors in developing noxious weed classification systems that aid in setting effective noxious weed control strategies.

Criteria for Determining Economic and Environmental Significance

Detrimental Effects

1. A plant species that causes or has the potential to cause severe negative impacts to Oregon’s agricultural economy and natural resources.
2. A plant species that has the potential to or does endanger native flora and fauna by its encroachment into forest, range, aquatic and conservation areas.
3. A plant species that has the potential or does hamper the full utilization and enjoyment of recreational areas.
4. A plant species that is poisonous, injurious, or otherwise harmful to humans and/or animals.

Plant Reproduction

1. A plant that reproduces by seed capable of being dispersed over wide areas or that is long-lived, or produced in large numbers.
2. A plant species that reproduces and spreads by tubers, creeping roots, stolons, rhizomes, or other natural vegetative means.

Distribution

1. A weed of known economic importance which occurs in Oregon in small enough infestations to make eradication/containment possible; or not known to occur, but its presence in neighboring states makes future occurrence seem imminent.
2. A weed of economic or ecological importance and of limited distribution in Oregon.
3. A weed that has not infested the full extent of its potential habitat in Oregon.

Difficulty of Control

A plant species that is not easily controlled with current management practices such as chemical, cultural, biological, and physical methods.

Noxious Weed Control Classification Definitions

Noxious weeds, for the purpose of this system, shall be listed as either A or B, and may also be designated as T, which are priority targets for control, as directed by the Oregon State Weed Board.

- **A Listed Weed**:
  A weed of known economic importance which occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent (Table I).
  Recommended action: Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.

- **B Listed Weed**:
  A weed of economic importance which is regionally abundant, but which may have limited distribution in some counties (Table II).
  Recommended action: Limited to intensive control at the state, county or regional level as determined on a site specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.

- **T-Designated Weed (T)**:
  A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

Weed Biological Control

Oregon implements biological control, or “biocontrol” as part of its integrated pest management approach to managing noxious weeds. This is the practice of using host-specific natural enemies such as insects or pathogens to control noxious weeds. The Oregon Department of Agriculture Noxious Weed Program has adopted the International Code of Best Practices for biological control of weeds. Only safe, effective, and federally-approved natural enemies will be used for biocontrol.

Table I: A Listed Weeds

Common Name	Scientific Name
African rue	*Peganum harmala*
Camelthorn	*Alhagi pseudalhagi*
Cape-ivy	*Delairea odorata*
Coltsfoot	*Tussilago farfara*
Common frogbit	*Hydrocharis morsus-ranae*
Cordgrass	
Common	*Spartina anglica*
Dense-flowered	*Spartina densiflora*
Saltmeadow	*Spartina patens*
Smooth	*Spartina alterniflora*
Delta arrowhead	*Sagittaria platyphyla*
European water chestnut	*Trapa natans*
Flowering rush	*Butomus umbellatus*
Garden yellow loosestrife	*Lysimachia vulgaris*
Giant hogweed	*Heracleum mantegazzianum*
Goatgrass	
Barbed	*Aegilops triuncialis*
Ovate	*Aegilops ovata*
Goatsrue	*Galega officinalis*
Hawkweed	
King-devil	*Hieracium piloselloides*
Mouse-ear	*Hieracium pilosella*
Orange	*Hieracium aurantiacum*
Yellow	*Hieracium floribundum*
Hoary alyssum	*Berteroa incana*
Hydrilla	*Hydrilla verticillata*
Japanese dodder	*Cuscuta japonica*
Kudzu	*Pueraria lobata*
Matgrass	*Nardus stricta*
Oblong spurge	*Euphorbia oblongata*
Palmer amaranth	*Amaranthus palmeri*
Paterson's curse	*Echium plantagineum*
Purple nutsedge	*Cyperus rotundus*
Ravennagrass	*Saccharum ravennae*
Squarrose knapweed	*Centaurea virgata*

(Continued) Table I: A Listed Weeds

Common Name	Scientific Name
Starthistle	
Iberian	*Centaurea iberica*
Purple	*Centaurea calcitrapa*
Thistle	
Plumeless	*Carduus acanthoides*
Smooth distaff	*Carthamus baeticus*
Taurian	*Onopordum tauricum*
Turkish	*Carduus cinereus*
Welted (curly plumeless)	*Carduus crispus*
Woolly distaff	*Carthamus lanatus*
Water soldiers	*Stratiotes aloides*
West Indian spongeplant	*Limnobium laevigatum*
White bryonia	*Bryonia alba*
Yellow floating heart	*Nymphoides peltata*
Yellowtuft	*Alyssum murale, A. corsicum*

Table II: B Listed Weeds

Common Name	Scientific Name
Armenian (Himalayan) blackberry	*Rubus armeniacus (R. procerus, R. discolor)*
Biddy-biddy	*Acaena novae-zelandiae*
Broom	
French*****	*Genista monspessulana*
Portuguese (T)	*Cytisus striatus*
Scotch*****	*Cytisus scoparius*
Spanish	*Spartium junceum*
Butterfly bush	*Buddleja davidii (B. variabilis)*
Common bugloss (T)	*Anchusa officinalis*
Common crupina **(T)**	*Crupina vulgaris*
Common reed	*Phragmities australis ssp. australis*
Common viper's bugloss (T)	*Echium vulgare*
Cutleaf teasel	*Dipsacus laciniatus*
Dyer's woad (T)	*Isatis tinctoria*
English hawthorn	*Crataegus monogyna*
Eurasian watermilfoil	*Myriophyllum spicatum*
False brome	*Brachypodium sylvaticum*
Field bindweed	*Convolvulus arvensis*
Garlic mustard (T)	*Alliaria petiolata*
Geranium	
Herb Robert	*Geranium robertianum*
Shiny leaf	*Geranium lucidum*
Giant reed (T)	*Arundo donax*
Gorse***** (T)	*Ulex europaeus*
Halogeton	*Halogeton glomeratus*
Houndstongue	*Cynoglossum officinale*

* Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Indigo bush	*Amorpha fruticosa*
Ivy	
Atlantic	*Hedera hibernica*
English	*Hedera helix*
Jointed goatgrass	*Aegilops cylindrica*
Jubata grass	*Cortaderia jubata*
Knapweed	
Diffuse*****	*Centaurea diffusa*
Meadow*****	*Centaurea pratensis*
Russian*****	*Acroptilon repens*
Spotted*****	*Centaurea stoebe (C. maculosa)*
Knotweed	
Bohemian*****	*Fallopia x bohemica*
Giant*****	*Fallopia sachalinensis (Polygonum)*
Himalayan	*Polygonum polystachyum*
Japanese*****	*Fallopia japonica (Polygonum)*
Kochia	*Kochia scoparia*
Lesser celandine	*Ranunculus ficaria*
Meadow hawkweed (T)	*Pilosella caespitosum (Hieracium)*
Mediterranean sage*	*Salvia aethiopis*
Medusahead rye	*Taeniatherum caput-medusae*
Old man's beard	*Clematis vitalba*
Parrot feather	*Myriophyllum aquaticum*
Perennial peavine	*Lathyrus latifolius*
Perennial pepperweed (T)	*Lepidium latifolium*
Pheasant's eye	*Adonis aestivalis*
Pine echium (T)	*Echium pininana*
Poison hemlock*****	*Conium maculatum*
Policeman's helmet	*Impatiens glandulifera*
Primrose-willow	
Large-flower (T)	*Ludwigia grandiflora*
Water primrose (T)	*Ludwigia hexapetala*
Floating (T)	*Ludwigia peploides*

*Biocontrol (See page 4) (T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Puncturevine*****	*Tribulus terrestris*
Purple loosestrife*****	*Lythrum salicaria*
Ribbongrass (T)	*Phalaris arundinacea var. Picta*
Rose	
Dog	*Rosa canina*
Sweetbriar	*Rosa rubiginosa*
Rush skeletonweed***** (T)	*Chondrilla juncea*
Saltcedar***** (T)	*Tamarix ramosissima*
Small broomrape	*Orabanche minor*
South American waterweed	*Egeria densa (Elodea)*
Spanish heath	*Erica lusitanica*
Spurge laurel	*Daphne laureola*
Spurge	
Leafy***** (T)	*Euphorbia esula*
Myrtle	*Euphorbia myrsinites*
St. Johnswort	*Hypericum perforatum*
Sulfur cinquefoil	*Potentilla recta*
Swainsonpea	*Sphaerophysa salsula*
Tansy ragwort***** (T)	*Senecio jacobaea (Jacobaea vulgaris)*
Thistle	
Bull	*Cirsium vulgare*
Canada*****	*Cirsium arvense*
Italian	*Carduus pycnocephalus*
Milk	*Silybum marianum*
Musk	*Carduus nutans*
Scotch	*Onopordum acanthium*
Slender-flowered	*Carduus tenuiflorus*
Toadflax	
Dalmatian*****	*Linaria dalmatica*
Yellow*****	*Linaria vulgaris*
Tree of heaven	*Ailanthus altissima*

*Biocontrol (See page 4)   (T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Ventenata grass	*Ventenata dubia*
Whitetop	
Hairy	*Lepidium pubescens*
Lens-podded	*Lepidium chalepensis*
Whitetop (hoary cress)*	*Lepidium draba*
Yellow archangel	*Lamiastrum galeobdolon*
Yellow flag iris	*Iris pseudacorus*
Yellow nutsedge	*Cyperus esculentus*
Yellow starthistle*	*Centaurea solstitialis*

*Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

Appendix B: Morrow County Noxious Weed List

Morrow County Weed List:

NOXIOUS WEEDS

Noxious Weeds – "A" List" – Any plant that is determined by the weed advisory board, and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land or property under provisions of Oregon State Statute and thus mandated for control.

Rush Skeletonweed

Yellow Starthistle

Tansy Ragwort

Yellow Toadflax

Dalmatian Toadflax

Mediterranean Sage

Leafy Spurge

Spikeweed

Musk Thistle

Scotch Thistle

Purple Loosestrife

Common Crupina

Whitetop (Hoary Cress)

Houndstongue

Flowering Rush

Yellow Flag Iris

Plumeless Thistle

WEEDS OF ECONOMIC IMPORTANCE

Weeds of Economic Importance – “B” List – Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

Poison Hemlock

Canada Thistle

Jointed Goatgrass

St. Johnswort

Perennial Sowthistle

Field Bindweed

Cereal Rye

Johnsongrass

Russian Knapweed

Diffuse Knapweed

Spotted Knapweed

Field Dodder

Water Hemlock

Medusahead Rye

Puncturevine

Kochia

Perennial Pepperweed

Myrtle Spurge

Ventenata

Morrow County Weed Advisory Board

The Morrow Soil and Water Conservation District Board also serves as the Weed Advisory Board

Sunstone Solar Project 5
Draft Revegetation and Reclamation Plan

Prepared for

Sunstone Solar 5, LLC

Prepared by

Tetra Tech, Inc.

October 2025

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1.0 Introduction

Sunstone Solar 5, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 5 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon (Figure 1). The proposed Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 200 MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Revegetation and Reclamation Plan (Plan) has been prepared to guide revegetation of areas temporarily disturbed during construction of the Facility, as well as revegetation within the solar array fence in compliance with Site Certificate Conditions PRE-FW-01 and PRE-SP-01. This Plan will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE), the Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Agriculture (ODA), and Morrow County Weed Department to reflect the final layout of the Facility.

Prior to construction, this Plan shall be finalized based on the following:

1. Certificate Holder shall finalize the Plan based on disturbance associated with the final design/layout by disturbance level and habitat type and category.
2. Certificate Holder shall develop and incorporate maps showing anticipated construction disturbance levels along with the total acreage and major activities associated with each level.
3. Certificate Holder shall update Table 1 prior to construction to reflect the disturbance acreage by habitat subtype for the final layout.
4. Certificate Holder shall provide the number and location of reference sites to be utilized during short- and long-term monitoring of temporary disturbance areas for review and approval by ODOE in consultation with ODFW.
5. Certificate Holder shall develop and incorporate revegetation methods for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department.
6. Certificate Holder shall develop and incorporate monitoring disturbance areas in consultation with ODOE.

Prior to construction, the following shall be completed:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

1. Certificate Holder shall provide shapefiles showing anticipated construction disturbance levels at the site as a submittal to ODOE.
2. Certificate Holder shall provide the revegetation and seeding contractor's qualifications and scope of work as a submittal to ODOE.
3. Certificate Holder shall conduct pre-construction habitat surveys at the approved reference sites for the purpose of collecting baseline quantitative data (vascular plant species present, native/non-native species present, percent cover of dominant species, percent cover of state and county listed noxious weed, and evidence of disturbance).
4. Certificate Holder shall submit baseline soil compaction sample locations and baseline compaction results to ODOE.
5. Certificate Holder shall hold a kick-off meeting with their environmental contractor, construction contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
6. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the construction contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.

Prior to initiation of revegetation, the following shall be completed:

1. Certificate Holder shall hold a kick-off meeting with their environmental contractor, revegetation and seeding contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
2. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the revegetation and seeding contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.
3. Certificate Holder shall complete post-construction soil compaction testing and submit results for review and approval to ODOE.

Throughout construction, revegetation, and operation activities, the Certificate Holder will take appropriate actions to prevent the spread of state and county listed noxious weeds. A stand-alone Draft Noxious Weed Control Plan has also been prepared (see Exhibit P, Attachment P-3[2]; updated for RFA 1, see Attachment 6), which contains information on state and Morrow County listed noxious weeds, noxious weeds observed during surveys, and treatment and monitoring of noxious weeds.

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[2] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

2.0 Site Description

The Facility includes a 4,402-acre site boundary within which all Facility components will be located. The Facility lies within the Columbia Plateau Ecoregion at elevations from 1,050 to 1,365 feet. The Facility is sited entirely on private land, which primarily consists of agriculture land used for growing dryland wheat. Native vegetation within the site boundary has been modified primarily through agricultural conversion, but also through the introduction of exotic grasses and other non-native vegetation.

Habitat mapping and categorization of the site boundary were conducted for the Facility in 2022. Habitat types within the site boundary include Agriculture, Pasture, and Mixed Environs (habitat subtype: Orchards, Vineyards, Wheat Fields, Other Row Crops); Developed (habitat subtype: Urban and Mixed Environs); Upland Grassland, Shrub-steppe, and Shrubland (habitat subtypes: Eastside Grasslands), and Open Water-Lakes, Rivers, Streams (habitat subtype: Intermittent or Ephemeral Streams). Details on habitat types, subtypes, and categories can be found in Exhibit P of the Facility's ASC, especially Attachment P-1 which contains the biological survey reports. Details on potential disturbance to habitat from construction and operation of the Facility, as well as avoidance and minimization measures, can be found in the ASC Exhibits P and Q[3].

3.0 Description of Disturbance

Construction of the Facility will result in temporary and permanent disturbance (see Exhibits C[4] and P). Section 3.1.1 (below) details the acres of each habitat subtype that will be temporarily and permanently disturbed during construction and operation of the Facility.

All areas within the solar array fence are considered a permanent disturbance and will be revegetated for the purposes of site stabilization to reduce erosion, dust pollution, and topsoil depletion, and to reduce potential for invasion by noxious and invasive plants. The entire solar array fence will occupy approximately 3,103 acres. As noted above, this area is considered permanently disturbed; however, vegetation within the solar array fence will be retained and/or revegetated and this area would be reclaimed upon retirement.

Temporary disturbance will occur in areas outside the solar array fence that will be disturbed during construction activities, but which will not be occupied by permanent facilities. Temporary disturbance will occur in association with the construction of aboveground and underground collector and transmission lines, new roads, and perimeter fence.

Prior to construction, a crosswalk of the final version of this Plan will be prepared for use by the construction contractor to facilitate Plan implementation and ensure ground disturbance is minimized to the extent practicable. A kick-off meeting with the Certificate Holder, their

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[3] Complete Application for Site Certificate, Exhibit Q, May 16, 2024.
[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

environmental contractor, construction contractor, and ODOE will be held at least 14 days prior to construction. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify that anticipated disturbance levels are followed to the extent possible and will document any variances and justifications for those variances for ODOE review.

3.1 Disturbance Levels

Revegetation needs will be determined by a combination of disturbance level and existing vegetative cover. Disturbance levels will primarily be determined by site conditions such as slope, gradient, and existing vegetation. Disturbance levels are defined as follows:

Level 1 - Mowing: Mowing is used to conserve vegetative resources within a facility while mitigating risk of fire and facilitating construction activities. Vegetation will be limited to a height of 12 inches and mowed to no less than 6 inches during construction. Mowing to no less than 6 inches protects perennial grass crowns and allows grasses to regenerate. Depending on facility objectives, vegetation can be allowed to reach a normal height or kept trimmed to a height between 6 inches and the plant's full height potential. Crushing of vegetation will be minimal and this disturbance level is designed to have a minimal impact on existing vegetation. This method is least likely to result in invasions of undesirable plant species.

Level 2 – Overland Drive and Crush: Disturbance caused by accessing a facility without significantly modifying the landscape. Vegetation is crushed to the ground, but no surface soil is removed so root structures are left intact. Even though vegetation may be damaged or destroyed, the surface soil and seed bank remain in place. Some crushed vegetation will likely sprout after disturbance ceases. These activities would result in minimal to moderate disturbance. This type of disturbance will result in a faster recovery time for vegetation compared to Levels 3 and 4. Soil seed banks remain largely in place, perennial vegetation can grow back, and minimal external efforts are necessary. This method is less likely to result in invasions of undesirable plant species compared to Levels 3 and 4.

Level 3 – Clear and Cut: Disturbance caused by accessing the facility including having to remove all vegetation in order to improve or provide suitable access for other equipment. All vegetation is removed, soils are compacted, and the root zone or soil A-horizon may be disturbed, but no sub-surface soil is removed. Clear and cut activities would result in moderate disturbance. This type of disturbance will result in moderate recovery times for vegetation. This method has a moderate risk for invasion of undesirable plant species. An example is imprinting to crush vegetation down into the soil or incidental grading and smoothing of surface soils.

Level 4 – Clear and Cut with Soil Removal: Disturbance is caused by removing all vegetation in the impact zone, soils are compacted, and surface soil and subsoil are displaced. These activities result in heavy disturbance. This type of disturbance results in an extensive recovery time for vegetation, and is most likely to lead to invasions of undesirable plant species, which can result in lengthy and expensive control efforts. Includes disc-and-roll construction, and other traditional construction methods where soils are disturbed and no vegetation is left intact. This category includes all work requiring the segregation and replacement of topsoils.

3.1.1 Facility Disturbance

To the maximum extent practicable, Level 1 and Level 2 disturbance will be used during Facility construction. Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable, although construction vehicles driving across the site may affect existing root systems by compacting soils. Grading within solar arrays will be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically, but not exclusively, 10 percent maximum on North slopes and 15 percent maximum in other directions). Areas where the slope and gradient are within panel and racking tolerances will only be graded in road, inverter, and energy storage footprints where possible. Preservation of existing root systems will minimize soil erosion, providing both improved compliance with stormwater and dust management requirements, facilitate revegetation success, and preserve soil productivity for future agricultural use. Construction will be coordinated and sequenced to the extent practicable with landowners to maintain land in current production and weed control until just prior to construction. This will avoid land being left unmanaged and minimize weed issues that can complicate revegetation.

Prior to construction, the Certificate Holder will provide maps and shapefiles showing anticipated construction disturbance levels at the Facility, along with total acreage and major activities associated with each level. This will serve to demonstrate the Certificate Holder's avoidance and minimization of ground disturbing activities to the extent practicable.

Table 1 presents the estimated maximum acreage of temporary and permanent disturbance to habitat subtypes associated with Facility construction and operation based on the permitted layout. Table 1 will be updated prior to construction to reflect the final disturbance acreage by habitat subtype for the final layout. Figures depicting the location of Facility infrastructure are included in Exhibit C, and a figure depicting habitat subtypes within the site boundary is available in Exhibit P.

Table 1. Maximum Temporary and Permanent Disturbance by Habitat Subtype

ODFW Habitat Category	Habitat Subtype	Permanent Disturbance (Acres)[1, 2]	Temporary Disturbance (Acres) [1]
2	Eastside Grasslands	<0.1	0.4
4	Intermittent or Ephemeral Streams	-	<0.1
4	Eastside Grasslands	17.9	2.7
5	Eastside Grasslands	13.8	2.1
	Intermittent or Ephemeral Streams	-	<0.1
	Category 2, 4, and 5 Habitat Subtotal	**31.7**	**5.2**
6	Orchards, Vineyards, Wheat Fields, Other Row Crops	3,069.3	25.8
	Urban and Mixed Environs	2.0	0.8
	Category 6 Habitat Subtotal	**3,071.3**	**26.6**
	Grand Total[1]	**3,103.0**	**31.8**

ODFW Habitat Category	Habitat Subtype	Permanent Disturbance (Acres)[1, 2]	Temporary Disturbance (Acres) [1]

Note: Totals in this table may not appear to sum correctly due to rounding. "-" means no disturbance while <0.1 means greater than zero but less than 0.05 acre disturbance.

1. Additional details associated with temporary and permanent disturbances are provided in Exhibit C of the ASC. Disturbances were calculated based on the layout permitted in the ASC and will be updated prior to construction based on an updated layout.
2. Acres of permanent disturbance includes the entire area within the solar array area fence including the footprints of all solar components and supporting facilities, as well as the areas outside of the footprint of permanent components and facilities (e.g., areas underneath and between rows of solar panels).

4.0 Reclamation and Revegetation Methods

This plan addresses revegetation methods for temporary disturbance to agricultural lands and wildlife habitat, as well as revegetation and vegetation management of lands within the solar array fence. Revegetation of temporarily disturbed developed habitat (i.e., Urban and Mixed Environs habitat subtype) will be determined on a case-by-case basis and is not covered further in this plan. Temporary disturbances to agricultural habitat (i.e., Orchards, Vineyards, Wheat Fields, Other Row Crops habitat subtype) will be restored as described in Section 4.5.1. The Certificate Holder will restore temporarily disturbed areas by re-establishing slope, surface stability, and drainage features, as needed, followed by soil preparation and seeding. Soil preparation and seeding techniques are described below.

Revegetation will begin as soon as feasible after completion of each construction phase. Seeding and planting will be done in a timely manner and in the appropriate season to facilitate germination and establishment of seeded species.

Prior to construction, final revegetation methods will be developed for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department and will be incorporated as an amendment to this Plan upon ODOE approval.

4.1 Roles and Responsibilities

A construction contractor qualified to perform revegetation and seeding will be responsible for implementing measures in the National Pollutant Discharge Elimination System (NPDES) 1200-C permit, as well as revegetation activities discussed herein during and immediately after construction. A qualified botanist or revegetation specialist will be responsible for monitoring and reporting on revegetation success. Remedial revegetation actions, if needed during the operation phase, will be performed by a qualified contractor. The Certificate Holder will be responsible for ensuring that all contractors perform work in accordance with permit requirements and all agreed upon methods for revegetation.

The goal of this Plan is to increase the probability of revegetation success, reduce early weed establishment, reduce erosion and dust pollution, protect topsoil for future agricultural use in permanent disturbance areas, and ensure no loss of habitat quality for temporary disturbances to wildlife habitat. To ensure this goal is met, the Certificate Holder will ensure that the contractor selected for revegetation will be a qualified revegetation and seeding contractor with demonstrated experience in the Columbia Plateau. Options for contracting and managing this work include:

- Having the construction contractor subcontract revegetation work out to a qualified revegetation and seeding contractor. The contract will stipulate the Certificate Holder's right to dictate the timing, methods, and management of seeding.
- Contracting directly with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.
- Having the environmental contractor contract with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.

The revegetation and seeding contractor's qualifications and scope of work will be provided as a submittal to ODOE prior to construction. Additionally, a crosswalk of the final version of this Plan will be prepared for use by the revegetation and seeding contractor prior to initiation of revegetation to facilitate Plan implementation. A kick-off meeting with the Certificate Holder, their environmental contractor, revegetation and seeding contractor, and ODOE will be held at least 14 days prior to initiation of revegetation activities. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify seeding methods and timing requirements are followed appropriately and will document any variances and the justifications for those variances. Monitoring and follow-up will be provided as described in Section 6.0 to ensure oversight and increase the probability of revegetation success.

4.2 Soil Reclamation

Soil scientists use a soil penetrometer to field measure subsurface compaction in soil. This tool measures resistance (pressure) to the advance of a cone-tipped rod with a T-handle, vertically through the soil column. The metric intends to measure soil compaction that can inhibit the ability of plants to penetrate the soil. An operator pushes the penetrometer rod with a cone base into the ground with consistent force. A pressure gauge records pressure in pounds per square inch (psi), equaling levels of resistance at differing soil layers. Resistance is measured at 3-inch intervals until the meter goes above 300 psi, which is a level of soil compaction most roots cannot penetrate. For this test compaction would be measured at 3, 6, 9, and 12 inches if the soils allow. Soil compaction testing must be completed in spring or late fall when soils are at field capacity (approximately 24 hours after a soaking rain). Baseline soil compaction measurements will be taken prior to construction. Baseline soil compaction sample locations and baseline compaction results will be submitted to ODOE prior to construction.

1. Baseline and post-construction soil compaction measurements and testing must be done in conditions favorable to soil testing (e.g. non-saturated or frozen soils).
2. Baseline soil compaction measurements will be documented and established by using the above protocol, or other protocol as approved by ODOE, to establish baseline soil conditions within temporary disturbance areas.

3. Recordation of the baseline soil plots must be represented on a map based on final Facility design.
4. Post-construction soil compaction testing following the above protocols must be completed in spring or late fall when soil conditions are favorable to soil testing (non-saturated or frozen soils). Compaction testing will occur after soil stockpiles are replaced and grading is complete but prior to initiation of revegetation activities.
5. If soil monitoring demonstrates that soils are compacted more than 300 psi, then remediation activities must be completed prior to initiation of revegetation activities. See Section 4.3 below, the Facility NPDES 1200-C permit, and applicable Site Certificate Conditions.

In addition, in areas where soil is removed during construction, the following measures will be taken where appropriate:

- During construction, excavated topsoil will be stockpiled separately from subsoil and replaced in proper order with topsoil on the surface to maintain soil productivity. Stockpiled soil will be put back in place prior to revegetation activities.
- Soils will be stabilized during construction using the appropriate best management practices as determined by the onsite stormwater pollution prevention plan implementor.
- Soil preparation will involve standard, commonly used methods (i.e. tracking, decompaction, and tilling), and will consider all relevant site-specific factors, including slope, size of area, and erosion potential. Soils will be de-compacted if necessary to create a uniform seedbed using an agricultural disc, soil ripper, or similar equipment. Additional details regarding soil preparation are in Section 4.3.
- Topsoil and other soils from noxious weed infested areas will not be moved outside of the infested areas and will be returned to their previous location during reclamation activities to eliminate the transport of weed seeds, roots, or rhizomes.
- Soils from weed-infested areas will be treated with a non-persistent, pre-emergent herbicide prior to initiation of revegetation efforts, depending on site-specific conditions.
- Prior to final regrade and revegetation efforts, any weeds that have grown during periods of construction dormancy should be treated as described in the Noxious Weed Control Plan.
- The construction contractor will use appropriate erosion and sediment control practices (i.e., seeded or unseeded hydromulch, tackifier, weed-free erosion control blankets, weed-free or locally sourced straw mulch) to maintain topsoil during construction in both temporary and permanent disturbance areas.

4.3 Site Preparation

Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable. Areas where the slope and gradient are within the solar panel and racking tolerances will receive minimal grading, with grading in those areas limited to the roads, inverter, and energy storage footprints. In areas where soil is removed during construction, the Certificate Holder will demonstrate adequate soil stabilization to prevent erosion and dust pollution. The following measures will be taken where appropriate:

- Site preparation will take into account all relevant site-specific factors, including slope, size of area, and erosion potential.
- Areas of severe machine or vehicle tracking that would hinder seeding success and are unnecessary for soil stabilization will be regraded.
- In the spring, fall or winter of the year prior to when construction would occur, areas of high erosion risk (e.g., slopes, areas with low vegetative cover) should be seeded with a non-invasive, non-persistent cover crop such as triticale to stabilize soils.
- If soils are not suitable for revegetation, soil amendments may be required. Any imported topsoil, if required, will be demonstrated to be suitable for vegetative success.
- Where soil compaction testing demonstrates that soils are compacted greater than 300 psi, soils will be mechanically scarified (e.g., tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction, to maintain soil productivity, and reduce the potential for erosion on compacted soils. Dry soils should be de-compacted using an agricultural disc, soil ripper, or similar equipment.
- Prior to seeding and/or planting of revegetation areas, soils will be prepared into a firm, fine-textured seedbed that is relatively free of debris. Shallow tilling with a disc, followed by a harrow or drag if necessary, can typically achieve this. If replaced soil is too soft, then seeds may be buried too deep to properly germinate; a roller or culti-packer should be used to pack down the soil.
- In non-cropland temporary disturbance areas, site complexity will be considered during soil preparation. For instance, it may be desirable to purposely create an uneven, patchy site that allows for depressions and other microsites that result in small variations in aspect and moisture holding to promote complexity.
- Seeded areas will be temporarily stabilized to facilitate establishment. This can be accomplished by application of seedless, certified weed-free hydromulch containing a tackifier or straw mulch crimping. Alternate methods may be proposed by the revegetation and seeding contractor but will require prior written approval by ODOE and must provide demonstrated success in sites with similar wind and soil conditions.
- The Certificate Holder or a designated construction contractor will use mulching and other appropriate practices, as required by the anticipated NPDES 1200-C permit, to control erosion and sediment during construction and revegetation work.

4.4 Revegetation of Permanent Disturbance Areas

During construction, the Certificate Holder will implement site stabilization measures, including seeding of all disturbed areas according to the Certificate Holder's anticipated NPDES 1200-C permit. Approximately 6 months prior to commercial operation of each phase of construction, the Certificate Holder will meet with ODFW, ODOE, and Morrow County Weed Department personnel to review the actual extent and conditions of disturbed areas and confirm the revegetation methods to be implemented.

As portions of the Facility are prepared for installation of Facility components (i.e., grading is complete), but prior to installation, all areas with less than 70 percent vegetative cover should be seeded with a non-invasive, non-persistent cover crop. The cover crop will be selected based on the time of year and site conditions; for example, winter wheat or sterile triticale can be seeded from fall to early spring, while peas should be seeded in spring. Tillage radish and sunflowers can be seeded in spring to break up compaction but are not suitable options for soil stability. A cover crop will stabilize soils and suppress noxious weed infestations to reduce erosion and facilitate revegetation of desired plant species.

Following the completion of each construction phase, permanent disturbance areas will be reseeded with a mix of native or non-invasive, non-native grasses and forbs as appropriate based on disturbance level and actual site conditions (see Section 4.4). All seeds will be obtained from a reputable supplier in compliance with the Oregon Seed Law (OAR 603-056). The final seed mix for permanent disturbance areas will include low growing grasses and pollinator-friendly forbs compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Table 3 in Section 4.7 includes an example of low-growing seed mix for permanent disturbance areas.

4.5 Revegetation of Temporary Disturbance Areas

4.5.1 Agricultural Lands

Temporarily disturbed agricultural lands will be reseeded with the appropriate crop or maintained as fallow in consultation with the landowner or farm operator. The Certificate Holder will consult with the landowner or farm operator to determine the seed mix, application methods, and rates for seed and fertilizer. Success of cropland revegetation will have been achieved when production of the revegetated area is comparable to that of adjacent, non-disturbed croplands of the same type.

Agricultural lands will be reseeded to match the timing of the crop rotation on adjacent cropland to facilitate easy harvest and re-establish the appropriate crop rotation. Agricultural lands that will be seeded in the year that construction is complete can be temporarily hydromulched or otherwise stabilized until seeding can occur in the fall; agricultural lands that will be fallow for a year (i.e., fallow rather than reseeded the year construction is complete) will be planted with a cover crop (dependent on timing of construction closeout) or have continued stabilization with hydromulch, straw mulch crimping, or other best management practices through the fallow year.

Soil compaction as a result of construction activity is a concern for restoring agricultural soils to their pre-construction productivity. Within temporary disturbance areas, the Certificate Holder will excavate and store topsoil separately from subsoil, so that topsoil is replaced and restored appropriately. During post-construction revegetation of temporary disturbance to agricultural lands, the Certificate Holder will loosen agricultural soil by mechanical scarification (tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction. Soil amendment, by addition of organic matter (e.g., compost), may also be necessary to alleviate compaction.

Success determination will involve consultation with the landowner or farm operator, and the Certificate Holder will report to ODOE on the success of agricultural land revegetation efforts. Noxious weed control is necessary for successful revegetation of agricultural lands and will be implemented per the methods described in the Draft Noxious Weed Control Plan (Exhibit P, Attachment P-3; updated for RFA 1, see Attachment 6).

4.5.2 Wildlife Habitat

During construction, the Certificate Holder will implement site stabilization measures, including seeding of temporarily disturbed areas according to the Certificate Holder's anticipated NPDES 1200-C permit. Approximately 6 months prior to commercial operation of each phase of construction, the Certificate Holder will meet with ODFW, ODOE, and Morrow County Weed Department personnel to review the actual extent and conditions of temporarily disturbed areas, confirm the revegetation methods to be implemented, and to revisit reference sites as necessary.

Following each construction phase, all areas, with the exception of temporarily disturbed agricultural lands, will be seeded with a mix of native or non-invasive, non-native grasses and forbs (see Section 4.7). All seeds will be obtained from a reputable supplier in compliance with the Oregon Seed Law (OAR 603-056). The methods used and timing of planting will be appropriate to the seed mixes, weather conditions, and site conditions (including area size, slope, and erosion potential) based upon consultation with ODOE, ODFW, ODA, and the Morrow County Weed Department.

Seed mixes may include species selected to enhance soil health, such as nitrogen-fixing species, if determined to be appropriate based on coordination with ODOE, ODA, and ODFW. Including these species in the seed mix would help the other plant species thrive and increase long-term survival of desired species. Additionally, the seed mixes include species intended to provide broader ecosystem benefits, such as pollinator species, that will benefit the surrounding landscape. The seed mix for temporarily disturbed areas outside of the solar array fence will include taller native species of grasses and pollinator-friendly forbs to increase overall site biodiversity and increase benefits to wildlife and pollinators. Using native or non-invasive non-native pollinator-friendly plants as ground cover under solar panels can also help recharge groundwater, reduce erosion, and improve soil carbon sequestration (Neal and Atre 2020).

4.6 Seeding Methods

The seeding method and timing of planting will be appropriate to the seed mixes (see Section 4.7), weather conditions (e.g., precipitation, wind speed, temperature, etc.), and site conditions (including area size, slope, and erosion potential) based upon consultation with ODOE, ODA, ODFW, the Morrow County Weed Department, and the seed supplier. Seeding from late September to

March is typically recommended; however, the Certificate Holder will consult with ODOE, ODFW, ODA, Morrow County Weed Department, and/or the seed supplier to determine the optimal timing for seed application based on climatic conditions of the particular year when construction and revegetation efforts are implemented.

Common seed application methods that may be used for revegetation are broadcast seeding, drill seeding, imprint seeding, and hydroseeding; each of these are discussed further below. Other seeding methods may be proposed for review and approval prior to revegetation efforts.

4.6.1 Broadcast Seeding

Broadcast seeding is the application of seed directly to the ground surface. This method may be chosen for areas with shallow and rocky soils, and the type of broadcast spreader would depend on the size of the area to be seeded and the terrain. Broadcast seeding may be completed before or after panel and fence installation.

In this method, the seed mix is typically broadcast at a rate of 20 to 24 pounds pure live seed per acre, or twice the recommended rate for drill seeding; this rate may be adjusted depending on the recommendation of the actual seed supplier and agencies. When feasible, due to the seasonality of when planting can occur, the entire area will be seeded after grading is complete but before placement of Facility components, providing more flexibility in seed application. In those instances where seeding occurs prior to installation of components, follow-up seeding will occur in areas temporarily disturbed by installation and any areas that are deficient in vegetation from the first round of seeding. Immediately following seed application, hydromulch or certified weed-free straw would be applied. Broadcast seeding will not be employed if winds exceed 5 miles per hour. If certified weed-free straw is unavailable, the Certificate Holder or a designated construction contractor will identify a local source of straw. The local source of the straw will be approved by the county weed master and ODFW prior to purchase. This straw will either be crimped into the ground or applied with a tackifier.

4.6.2 Drill Seeding

Drill seeding can be used for larger areas with deeper soils and moderate to gentle terrain to accommodate mechanical equipment. This method provides the advantage of planting the seed at a uniform depth and may provide better soil to seed contact. Drill seeding plants seeds using an agricultural or range seed drill at a rate of 12 to 14 pounds pure live seed per acre, per discussions with a seed supplier and ODFW. The rate may be adjusted depending on the recommendations of the actual seed supplier. Drill seeding will be difficult after Facility components have been installed so it will primarily be used if seeding occurs after grading is complete but before components are installed or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.3 Imprint Seeding

Imprint seeding is a no-till drill seeding method used to restore grasslands in areas with low annual precipitation. Seeds will be sown at 20 to 24 pounds pure live seed per acre or according to application rates recommended by the seed supplier. The seeder consists of a heavy metal drum roller with V-shaped, angled teeth and a seed agitator box. The teeth create V-shaped troughs with a depth of 4-7 inches to collect rainwater. The rolling drum presses the seed into the soil, insuring good seed-to-soil contact. The troughs collect rainwater for seed germination and seedling growth. Imprint seeders can be used on steep slopes and generally do not require seed bed preparation before seeding. Seeding can occur on soils with light to moderate vegetative cover, with vegetation acting as a mulch to prevent soil erosion until seedlings are established. Imprint seeders do not work well in areas with shrubs or heavy vegetation cover. Heavily compacted soils may need to be ripped or de-compacted before seeding. Imprint seeding will be difficult after solar components have been installed, so it will primarily be used if seeding occurs after grading is complete but before components are installed, or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.4 Hydroseeding

Hydroseeding is a method of hydraulically applying seeds, stabilizers, and soil amendments to the surface of the soil. Hydroseeding is most applicable for areas where drill or broadcast seeding machinery cannot access; this usually includes steeper sloped or narrow terrain but can be used in all terrains. Hydroseeding is feasible after panel installation but before the Facility is fenced. Soil bed preparation is also crucial for growth success and frequently includes tracking perpendicular to the slope to create micro conditions for seed. Flat grading and compaction are not recommended. Seeding rates increase by 30 to 50 percent of broadcast seeding rates (i.e., 30 pounds pure live seed per acre) per consultation with the seed supplier and ODFW. Prior to hydroseeding the tackifier and fertilizer, if included, will be reviewed and approved in consultation with ODOE. Fertilizer should not be used when hydroseeding wildlife habitat.

4.7 Seed Mixes

Two seed mixes are proposed for revegetation efforts: one for revegetation of temporary disturbance areas outside the solar array fence, and one for revegetation of permanent disturbance areas within the solar array fence. Tables 2 and 3 present example seed mixes that would be considered for revegetation. However, the number of seed mixes and composition of final seed mixes will be determined in consultation with ODOE and ODFW and will be based on pre-construction conditions and availability of seed at the time of procurement.

Grassland Seed Mix #1 would be appropriate for revegetation of temporarily disturbed areas outside the solar array fence, with the exception of areas that would be returned to agricultural production following construction (as noted in Section 4.5.1). The example seed mix is presented in Table 2 and contains a mixture of native grasses and native, pollinator-friendly forbs. This seed mix includes a mixture of deep-rooted grasses and flowering plants as these types of species can

capture and filter stormwater, build topsoil, and provide food sources and for native insects (Davis 2021). Forbs included in this seed mix were also chosen based on their bloom period. Including plants that flower throughout the growing season provides a continuous source of nectar and pollen and can attract a variety of pollinators (NRCS 2011).

Table 2. Example Grassland Seed Mix #1

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Bluebunch wheatgrass[1]	*Pseudoroegneria spicata*	35
	Sandberg's bluegrass[2]	*Poa secunda* ssp. *secunda*	15
	Bottlebrush squirreltail	*Elymus elymoides*	10
	Needle-and-thread grass[3]	*Hesperostipa comata*	10
Forbs	Low gumweed	*Grindelia nana*	5
	Hoary aster	*Dieteria* (*Machaeranthera*) *canescens*	5
	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Munro's globemallow[4]	*Sphaeralcea munroana*	5
	Western blue flax	*Linum lewisii*	5
	Yarrow	*Achillea millefolium*	5

1. An alternative to bluebunch wheatgrass is Snake River wheatgrass (*Elymus wawawaiensis*; also sold as "Secar" bluebunch wheatgrass).
2. An alternative to Sandberg's bluegrass is big bluegrass (*Poa secunda* subsp. *juncifolia*; also sold as *P. ampla*).
3. Alternatives to needle-and-thread grass include the non-native bunchgrasses crested wheatgrass (*Agropyron cristatum*) and sheep/hard fescue (*Festuca ovina/F. trachyphylla*).
4. An alternative to Munro's globemallow is blanketflower (*Gaillardia aristata*)

A second grassland seed mix, Grassland Seed Mix #2, is suggested for post-construction revegetation within the solar array fence, including areas that previously consisted of agricultural lands. The example seed mix presented in Table 3 contains a mixture of low-growing native and non-native grasses and native and non-native pollinator friendly forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Similar to Grassland Seed Mix #1, this seed mix includes a mixture of deep-rooted grasses and flowering plants that flower throughout the growing season.

Table 3. Example Grassland Seed Mix #2

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Sandberg's bluegrass	*Poa secunda* ssp. *secunda*	35
	Bottlebrush squirreltail, common squirreltail	*Elymus elymoides* ssp. *elymoides*	15
	Desert fescue[1]	*Vulpia microstachys*	10
	Thurber's needlegrass	*Eriocoma (Achnatherum) thurberianum*	10

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Forbs	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Bigseed bisuitroot[2]	*Lomatium macrocarpum*	5
	Erigeron/fleabane	*Erigeron filifolius, E. linearis,* or *E. pumilus*	5
	Oregon sunshine	*Eriophyllum lanatum*	5
	Snow buckwheat	*Eriogonum niveum*	5
	Wollypod milkvetch	*Astragalus purshii*	5

1. Alternatives to desert fescue are sixweeks fescue (*Vulpia octoflora*) or sheep/hard fescue (*Festuca ovina*/*F. trachyphylla*).
2. An alternative to bigseed biscuitroot is longleaf phlox (*Phlox longifolia*).

4.8 Revegetation Methods by Disturbance Level

Revegetation methods for each disturbance level were developed to tailor revegetation to specific conditions (Table 4). Revegetation should follow soil reclamation, site preparation, and seeding methods described in Sections 4.2 through 4.7.

Table 4. Revegetation Methods by Disturbance Level

Disturbance Level	Soil Reclamation	Site Preparation	Seeding
1 – Mowing	Ensure vegetation remains intact.	Retain existing vegetation root systems to prevent erosion. Control weeds.	Seed if necessary to achieve success criteria
2 – Overland Drive and Crush	Measure soil compaction in areas of high vehicle traffic.	Retain existing vegetation root systems and/or mulch to prevent erosion. Decompact soil in areas of high vehicle traffic if necessary. Control weeds.	Seed if necessary to achieve success criteria
3 – Clear and Cut	Measure soil compaction.	Mulch to prevent erosion. Decompact soil if necessary. Control weeds.	Required
4 – Clear and Cut with Soil Removal	Measure soil compaction. Stockpile topsoil separately from subsoil and stabilize during construction.	Mulch to prevent erosion. Decompact soil. Regrade and replace subsoil then topsoil prior to seeding. Control weeds.	Required

5.0 Revegetation Documentation

Records will be kept of revegetation efforts in all temporary and permanent disturbance areas. Records will include:

- Date construction phase was completed;
- Acreage of each disturbance level;
- Description and photos of the affected area;
- Date revegetation was initiated;
- Description of the revegetation effort, including methods and timing;
- Supporting figures representing the location, acres affected, and pre-disturbance condition of the revegetation area; and
- Confirmation from the landowner that temporary disturbances in cropland have been satisfactorily restored.

The Certificate Holder will meet with ODOE at least 14 days prior to initiation of revegetation efforts. The Certificate Holder will update ODOE with these records monthly as revegetation work occurs and will provide ODOE with copies of these records along with submission of the monitoring report that is required by the Site Certificate.

6.0 Monitoring

6.1 Monitoring of Permanent Disturbance Areas

In accordance with the Certificate Holder’s anticipated NPDES 1200-C permit all areas within the solar array fence must be revegetated to stabilize soils for the purposes of erosion and dust pollution control. Pursuant to OAR 345-022-0022, construction and operation of the Facility must not result in significant adverse impacts to soils, including but not limited to, erosion. Pursuant to MCZO 3.010.K.3.f.(3), construction or maintenance activities shall not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. Therefore, monitoring is required to demonstrate compliance with the above site stabilization and weed control requirements. The Certificate Holder will monitor permanent disturbance areas to assess the following:

- Dominant species composition;
- Relative cover of desirable and undesirable forbs and grasses;
- Percent cover of bare soil;
- Degree of erosion;
- Presence noxious weeds; and
- Qualitative assessment of overall vigor of vegetation within revegetated areas.

Monitoring will be conducted by a qualified botanist or revegetation specialist and will begin within 60 days of the completion of initial site revegetation. Permanent disturbance areas will be monitored using a meander survey. During the meander survey, the surveyor will walk within the solar array fence and document the assessment items listed above using photos and spatial data collection. Areas of erosion and significant patches of bare soil will be mapped and photographed. The surveyor will record dominant species, overall percent cover of forbs and grasses, and general notes about plant vigor.

Monitoring will be conducted at least once per season during the first year following construction. After the first complete year of monitoring, the Certificate Holder will consult with ODOE to determine if the monitoring cycle can be reduced based on revegetation progress. After five years of monitoring, the Certificate Holder will design a long-term monitoring plan in consultation with ODOE.

6.1.1 Success Criteria

Success criteria outlined below will demonstrate compliance with the soil protection standard (OAR 345-022-0022); NPDES 1200-C permit requirements; and the requirements of MCZO 3.010.K.3.f.(4):

- Establish uniform (i.e., evenly distributed, without large bare areas) perennial, non-invasive vegetation that provides 70 percent or more cover on all exposed areas.

Requirements of the soil protection standard and MCZO 3.010.K.3.f.(4) apply to the construction and operation of the Facility. Therefore, the Certificate Holder shall maintain compliance with revegetation success criteria for all areas within the solar array fence for the life of the Facility. In each monitoring report, the Certificate Holder will include an assessment of whether the area within the solar array fence is meeting or trending toward meeting the revegetation success criteria. Final determination of whether the Certificate Holder is in compliance with the revegetation obligations will be made by ODOE. Remedial actions and/or additional monitoring for areas may be required in areas that have been determined by ODOE not to have met the success criteria.

6.1.2 Reporting

Monitoring reports will be prepared and submitted to ODOE once per season during the first year following construction. After the first year of monitoring is complete, the reporting cycle will be modified to align with the new monitoring cycle determined in consultation with ODOE. The first monitoring report will include a detailed description and timeline of revegetation methods that were implemented including species, amounts, and locations of seed applications and dates revegetation work was performed.

Each monitoring report will include:

- GIS maps of revegetation areas and disturbance levels;
- Monitoring methods;
- Local climatic data (i.e., precipitation, temperature) for the monitoring month and year and percent deviation from the historical average;

- Results of monitoring efforts;
- The investigator's assessment of whether the revegetated areas are trending toward meeting the success criteria;
- Assessments of factors impacting the ability of revegetated area to trend towards meeting the success criteria; and
- Recommendations for adaptive management, if any.

6.2 Monitoring of Temporary Disturbance Areas

Following implementation of revegetation efforts, the Certificate Holder will monitor temporary disturbance areas that have been revegetated as described in this section, unless the landowner converted an area to a use that precludes meeting revegetation success criteria. Qualitative monitoring of revegetated temporary disturbance areas will be conducted at least once per season during the first year post-construction to identify any issues that may affect the success of revegetation such as erosion or weed occurrences. After the first complete year of monitoring, the Certificate Holder will consult with ODOE to determine if the monitoring cycle can be reduced based on revegetation progress. After 5 years of monitoring, the Certificate Holder will design a long-term monitoring plan in consultation with ODOE. This may include remedial actions and/or additional monitoring for areas that have been determined by ODOE, in consultation with ODFW, not to have met the success criteria.

Quantitative monitoring of temporarily disturbed wildlife habitat will be conducted by a qualified botanist or revegetation specialist annually (preferably in May or June) for 5 years beginning the first growing season following initial seeding. Quantitative monitoring methods are described in Section 6.2.2.

6.2.1 Reference and Revegetation Transects

Paired 50-meter reference and revegetation transects will be established for each temporarily disturbed wildlife habitat subtype and category with more than 0.5 acres of temporary disturbance to quantitatively measure progress towards meeting success criteria. Revegetation transects within each habitat subtype will be selected using a stratified randomization process based on existing habitat mapping. Reference transects are intended to represent target conditions for the revegetation effort. Vegetation cover on revegetation transects will be compared with vegetation cover on the associated reference transect to measure the success of revegetation activities. During each assessment, revegetated areas will be compared to reference transects based on success criteria defined in Section 6.2.3.

Transect locations and/or lengths may need to be adjusted to account for linear features whose disturbance footprint may be too narrow or too short to meaningfully place a transect. The number of reference and revegetation transects were determined as follows:

- Less than 0.5 acres of temporary disturbance = 0 sites

- 0.6 to 5 acres of temporary disturbance = 1 site
- 6 to 10 acres of temporary disturbance = 2 sites
- For each additional 10 acres of disturbance, one additional site will be added (e.g., 11-20 acres of disturbance = 3 sites, 21-30 acres = 4 sites, etc.)

Revegetation and reference transects within each habitat subtype and category will be selected using existing habitat mapping. Additional transect locations will be developed as alternates in case one of the selected transect locations is deemed unacceptable during the first revegetation monitoring effort.

6.2.2 Quantitative Monitoring Methods

Quantitative monitoring of temporarily disturbed wildlife habitat will be conducted annually (preferably in May or June) for a total of 5 years beginning the first growing season following initial seeding. After 5 years of monitoring, the Certificate Holder will design a long-term monitoring plan in consultation with ODOE. This may include remedial actions and/or additional monitoring for areas that have been determined by ODOE, in consultation with ODFW, not to have met the success criteria. Revegetation efforts may in some cases be deemed to have failed, and additional mitigation may be proposed in such cases to compensate for loss of wildlife habitat, while revegetation and weed control would continue to apply but without application of success criteria.

During each assessment, vegetation will be measured quantitatively using the line-point intercept (LPI) method combined with a belt transect to document species richness (Elzinga et al. 1998; MacKinnon et al. 2011). The LPI method is described in detail in the Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems, Volume I (Herrick et al. 2021). The surveyor will drop a narrow pin perpendicular to the ground at 1-meter intervals along a 50-meter transect and record up to four plant species that intercept the pin in order of interception, as well as the soil surface type (bare ground, litter, rock, moss, or biotic crust) where the pin touches the ground. Once all 50 points have been collected, the surveyor will walk back along the transect and record any species within 1 meter on either side of the transect that were not documented previously. The surveyor will take a photo from the transect start point, looking down the length of the transect.

Following field surveys, foliar cover will be determined by multiplying the number of top hits for each species by two. Cover of bare ground will be determined by counting every point in which bare ground was recorded as a surface type and no plants were intercepted and multiply this number by two. Species richness will be determined by counting all the unique species that were recorded at a point or along the belt transect.

6.2.3 Success Criteria

In each monitoring report, the Certificate Holder will include an assessment of whether the temporarily disturbed revegetated areas are meeting or trending toward meeting the success criteria. Revegetation areas would be deemed successfully revegetated when the success criteria outlined below are met. Success criteria were based on pre-disturbance conditions observed during habitat mapping conducted for the Facility (Exhibit P, Attachment P-1). Final determination of whether the Certificate Holder has met the revegetation obligations will be made by ODOE, in consultation with ODFW.

Temporarily disturbed areas will be deemed successfully revegetated when the habitat quality at a monitoring site is equal to or surpasses the habitat quality at the associated reference site, as follows:

- **Native Forbs:** Cover of native and desirable (i.e., species included in seed mixes and/or native species that have naturally colonized) forbs will be at least 75 percent of the reference site within 5 years. Richness of native and desirable forbs will be at least equal to the richness of native forbs measured on the reference site within 5 years.
- **Native and Desirable Grasses:** Cover and richness of native and desirable (i.e., species included in seed mixes and/or native species that have naturally colonized) grass species will be at least 85 percent of the reference site within 5 years.
- **Noxious Weeds:** Presence and cover of noxious weeds is 75 percent or less than that of the reference site.

6.2.4 Reporting

Monitoring reports will be prepared and submitted to ODOE once per season during the first year following construction. Each report will be delivered within the same season that the monitoring was conducted. After the first year of monitoring is complete, the reporting cycle will be modified to align with the new monitoring cycle determined in consultation with ODOE. The first monitoring report will include a detailed description and timeline of revegetation methods that were implemented including species, amounts, and locations of the seed applications and dates revegetation work was performed.

Each monitoring report will include:

- GIS maps of revegetation areas and disturbance levels;
- Monitoring methods;
- Local climatic data (i.e., precipitation, temperature) for the monitoring month and year and percent deviation from the historical average;
- Results of monitoring efforts;
- Photos of sample plots and representative overview photos of restoration areas;
- The investigator’s assessment of whether the revegetated areas are trending toward meeting the success criteria;
- Assessments of factors impacting the ability of revegetated area to trend towards meeting the success criteria; and
- Recommendations for adaptive management, if any.

6.3 Adaptive Management

After each revegetation monitoring visit in either temporary or permanent disturbance areas, the Certificate Holder's qualified investigator will report to the Certificate Holder regarding the revegetation progress of each revegetation area. If applicable, the investigator will make recommendations to the Certificate Holder for reseeding, weed control, or other remedial measures for areas that are not showing progress toward achieving revegetation success. The investigator will provide a description of factors that may be contributing to the lack of revegetation success. The Certificate Holder will include the investigator's recommendations for adaptive management and the measures taken in the next monitoring report. ODOE may require reseeding or other remedial measures in cases where success criteria have not been met.

If a revegetation area is damaged by wildfire during the first 5 years following initial seeding, the Certificate Holder will amend this Plan, subject to ODOE approval, to restore the damaged area. The Certificate Holder will continue to monitor and report on revegetation progress during the remainder of the 5-year period. The Certificate Holder will report to ODOE and ODFW the area impacted by the fire (with a map or figure) within 72 hours of discovery.

6.4 Soil Reclamation Monitoring

Soil measurements conducted per Section 4.2 shall be evaluated to determine whether soils within disturbance areas have compaction readings of greater than 300 psi. If results show soils have compaction readings of greater than 300 psi, then remediation activities must be completed before revegetation can begin. Prior to initiation of revegetation, the Certificate Holder will provide the results of soil compaction testing to ODOE.

7.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

8.0 References

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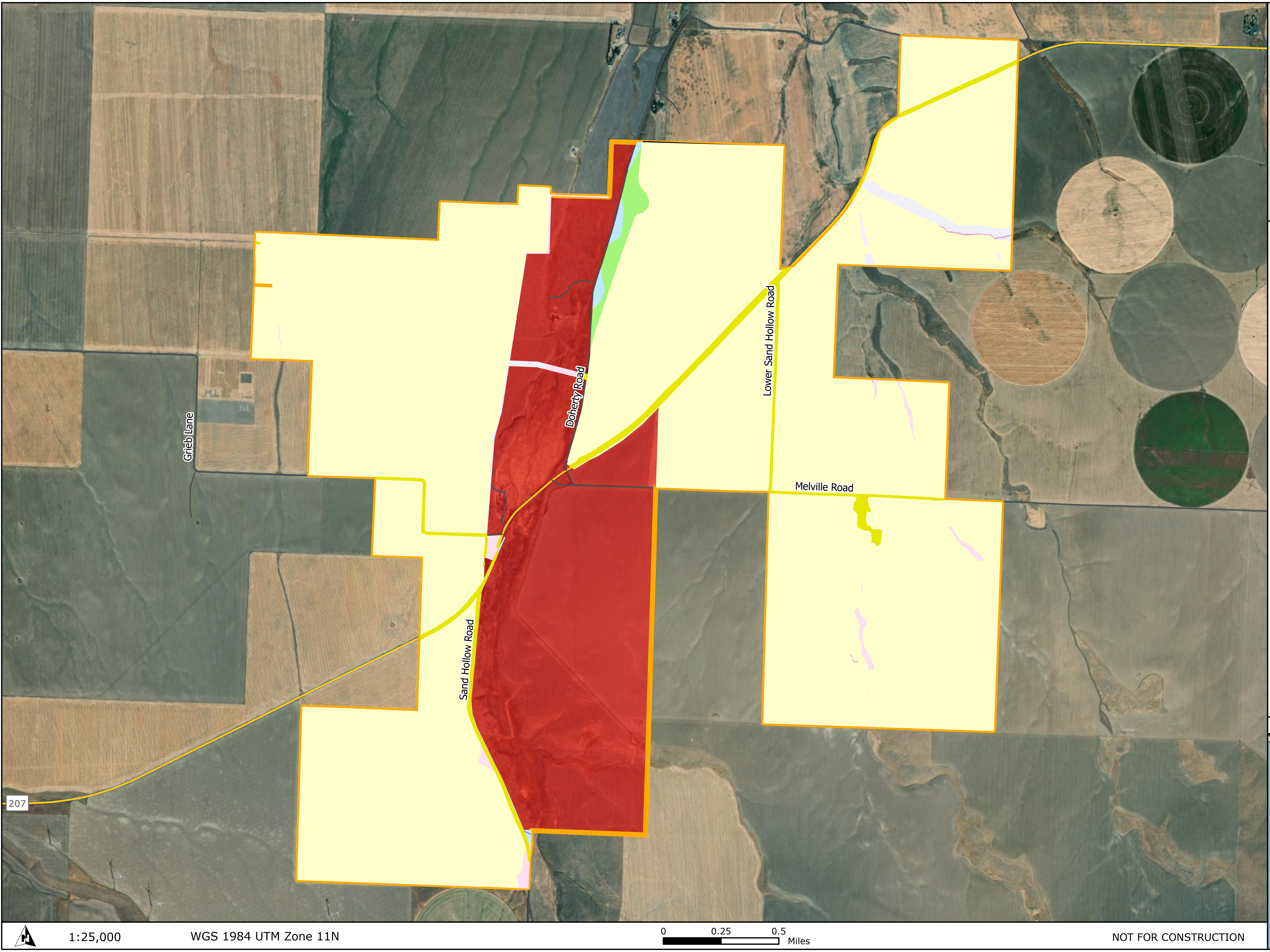
Figure

Sunstone Solar Project

Figure 1
Sunstone Solar Project 5

MORROW COUNTY, OR



🟧 SS 5 Site Boundary
🟥 Excluded from Development
☐ Permitted Fenceline
— State Highway
— Local Roads

Habitat Subtypes by Category

Category 2
🟩 Eastside Grasslands

Category 3
🟦 Sagebrush Shrub-steppe

Category 4
⬜ Eastside Grasslands
🟪 Intermittent or Ephemeral Stream

Category 5
⬜ Eastside Grasslands
🟪 Intermittent or Ephemeral Stream

Category 6
🟨 Orchards, Vineyards, Wheat Fields, Other Row Crop
🟨 Urban and Mixed Environs

TETRA TECH
PINEGATE RENEWABLES

Reference Map

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Sunstone Solar Project 5
Draft Wildlife Monitoring Plan

Prepared for

PINEGATE
RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 5, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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1.0 Introduction

Sunstone Solar 5, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 5 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities and the anticipated phasing of construction are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Wildlife Monitoring Plan (WMP) describes wildlife monitoring the Certificate Holder will conduct during operation of the Facility. This WMP has the following components:

1. Raptor nest surveys
2. Washington ground squirrel (WAGS; *Urocitellus washingtoni)* monitoring
3. Wildlife Reporting and Handling System (WRHS)
4. Data reporting

This WMP will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE) and the Oregon Department of Fish and Wildlife (ODFW) and will be updated as needed to reflect the final layout of the Facility.

2.0 Raptor Nest Surveys

The objectives of raptor nest surveys are: (1) to count raptor nests on the ground or above ground at the Facility; and (2) to determine whether there are noticeable changes in nesting activity in the local populations of raptor species, with particular focus on Swainson's hawks (*Buteo swainsoni*), the only state sensitive raptor species documented nesting during baseline surveys.

The Certificate Holder will conduct long-term ground-based monitoring of nests identified during the baseline raptor nest surveys, as well as any other nests identified subsequently. The ground-based surveys will be used to evaluate nest success by gathering data on nest occupancy. The Certificate Holder will employ qualified personnel to perform raptor nest surveys.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

2.1 Initial Monitoring

The first monitoring season will be in the first full raptor nesting season after the commercial operating date. During the first monitoring season, the surveyor will conduct one ground survey for raptor nests in late May or early June and additional surveys as described in this section. The ground surveys will be conducted within the site boundary to determine nest occupancy.

All nests discovered during the anticipated pre-construction surveys and any nests discovered during post-construction surveys, whether active or inactive, will be given identification numbers. Global Positioning System (GPS) coordinates will be recorded for each nest. Locations of inactive nests will be recorded because they could become occupied during future years.

After the first monitoring season, the surveyor will analyze this one year of data compared to the baseline data. The Certificate Holder will provide a summary of the first-year results in the monitoring report described in Section 5.0.

2.2 Long-Term Monitoring

The surveyor will conduct raptor nest surveys at 5-year intervals for the life of the Facility.[2] The surveyor will conduct long-term raptor nest surveys following the methods described in Section 2.3 every 5 years after the first monitoring season in years divisible by 5. This may result in a greater than 5-year period between the initial monitoring season and the first long-term monitoring season (e.g., if the initial monitoring season is 2028, the first long-term monitoring season would be 2035 rather than 2033). During each long-term monitoring event biologists will visit all previously identified nest locations in addition to searching the survey area for new nest sites.

In conducting long-term surveys, the surveyor will follow the same survey protocols as the initial survey (Section 2.3), unless the Certificate Holder proposes alternative protocols that are approved by ODOE. In developing an alternative protocol, the Certificate Holder will consult with ODFW and ODOE and will take into consideration other raptor nest monitoring conducted in adjacent or overlapping areas.

The Certificate Holder will analyze the data to identify any trends in the number of raptor breeding attempts the Facility supports and the success of those attempts. The Certificate Holder will submit a report after each year of long-term raptor nest surveys.

2.3 Monitoring Protocol

Qualifications of surveyors: Surveys and nest monitoring will be conducted by professional, qualified biologists with a relevant academic background and sufficient field experience pertaining to avian biology and species identification.

Survey period: Occupancy surveys will be conducted between March 1 and May 31. The survey period may be extended in consultation with ODFW and ODOE.

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[2] As used in this plan, "life of the Facility" means continuously until the Facility is restored and the site certificate is terminated in accordance with OAR 345-027-0110.

Survey area: The survey area will be limited to leased parcels within the Site Boundary, where surveyor access is granted. Surveys will be performed from public roads and project roads, or from participating landowner parcels only, as site conditions safely permit (e.g. snow, mud).

Survey protocol: Biologists will conduct a ground-based search for raptor nest activity using binoculars and/or spotting scopes to search potential nest sites. Previously identified nests will be surveyed to determine the occupancy status of nests. New nests that are discovered will also be surveyed and visited in future monitoring years. A log will be kept to track nest occupancy status on all nests. ArcGIS Online or similar GIS program will be used to locate and track the nests.

Data collection: Data collected during the survey will include, at a minimum, the location, occupancy status, occupying species, activity observed, and condition of each nest.

<u>Nest Location:</u> Nest/Burrow Identification Number: Existing IDs will be used where possible in addition to corresponding GPS waypoint numbers.

<u>Occupying Species:</u> Using four-letter American Ornithologists' Union codes (e.g., SWHA = Swainson's hawk).

<u>Raptor Activity:</u>

- Adult Present: Proximity of the adult to the nest (e.g., on nest, nearby, or unknown).
- Eggs or Young: Number of eggs or young observed.
- Nest Substrate: Structure in which nest was located (e.g., broadleaf tree, cut bank, transmission pole, etc.).
- Nest Height: Height relative to the structure it is on (e.g., on top of transmission pole, 3/4 of height of tree).

<u>Nest Condition:</u> To assess nest condition the following criteria will be used:

- No Longer Present: For nests that are no longer present.
- Unknown: The nest cannot be found, was not surveyed, or the nest is present, but because of its location a determination cannot be made.
- Excellent: Defined cup or nest bowl with a well-maintained rim; adult or young present.
- Good: Nest bowl intact and rim defined; minor repair needed for nest to be used; margins of nest in loose configuration, minor slumping occurring.
- Fair: Nest bowl intact and nest not dilapidated; but needs significant repair in order to be used; material is slumping or sliding.

- Poor: Loose structure of nest bowl still present; nest walls and side falling out; nest is in need of

  major repair to be used.
- Remnant: Nest bowl not defined; scant material remaining and not usable unless fully rebuilt.

Determination of active nests: Nest occupancy status will be determined using the definitions below.

Active: Defined by the presence of one or more eggs, dependent young, or adults on the nest in the past 10 days during the breeding season, including the period when adults are displaying courtship behaviors and are building or adding to the nest in preparation for egg-laying.

Potentially Active: There is not observable activity during the visit, but active status cannot be confirmed.

Inactive: The inactive status will only be determined if the nest is observed for at least one hour each time over the course of two consecutive visits separated by at least one day.

3.0 Washington Ground Squirrel Monitoring

No WAGS were detected during baseline surveys, but any new colonies that are detected incidentally during other surveys, such as raptor nest monitoring, will be documented and the extent of those colonies delineated and included in future WAGS monitoring and reporting activities.

If any incidental WAGS are detected, the Certificate Holder will employ qualified personnel to monitor these locations every 5 years thereafter in years divisible by five for the life of the Facility (i.e., on the same monitoring schedule as the raptor nest surveys). The survey area will include the colonies (i.e., groups of active burrows) and a buffer of 785 feet in suitable habitat, if accessible. The surveyors will walk linear transects spaced 165 to 230 feet (50 to 70 meters) apart two times between February 15 and May 31. Surveys of each location will be spaced at least 2 weeks apart. Surveyors will record locations of activity centers and colony boundaries using a sub-meter accuracy GPS unit; approximate number of burrows; and representative photographs of burrows and scat. Surveyors will describe habitat characteristics at each location and note any noticeable land use or habitat changes that may have occurred since detection.

After each survey, the Certificate Holder will report the results to ODFW and ODOE and will include maps of the areas surveyed and detection locations. WAGS surveys will not be conducted if there are barriers to WAGS dispersal (i.e., active agriculture fields, highways, perennial waterbodies) or no suitable habitat.

4.0 Wildlife Reporting and Handling System

The Certificate Holder will document fatalities found during routine maintenance activities and any other incidentally detected fatalities. However, systematic post-construction fatality monitoring studies are not likely to produce significant findings or provide meaningful data on impacts based on the attributes of this Facility (especially relative to the costs that they incur to implement) as described below, and therefore no systematic post-construction fatality monitoring study is proposed for the Facility nor is one needed to meet the standards under Oregon Administrative Rule (OAR) 345-022-0060. In a December 2023 meeting with the Certificate Holder and ODOE, ODFW stated they are not requesting a post-construction fatality monitoring study for the Facility. If evidence of significant fatality events is detected by operations and maintenance (O&M) staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring and adaptive management.

Although mortality at the Facility due to collision with infrastructure is possible, as it is with most human development (e.g., buildings), the available literature on avian mortality at utility-scale photovoltaic solar energy sites suggests that mortality at these facilities is comparatively low (Walston et al. 2016, Loss et al. 2014, Kosciuch et al. 2020, Smith et al. 2021). In Oregon, results of a fatality study at a 56-MW photovoltaic facility near Prineville detected only three bird fatalities, only two of which were native birds (i.e., a horned lark [*Eremophila alpestris*] and a dark-eyed junco [*Junco hyemalis*]), during 1 year of standardized searches (ODOE 2020). These results suggest that large fatality events are unlikely at photovoltaic solar facilities in the region but that low numbers of fatalities of common ground-dwelling bird species could be detected at the Facility (ODOE 2020), and may be similar to background mortality levels. Post-construction fatality monitoring studies conducted at utility-scale photovoltaic solar facilities to date have reported lower fatality rates compared to other human development types, with fatalities in general primarily composed of resident ground-nesting birds.

In contrast to wind energy development, impacts to wildlife from photovoltaic solar development are primarily associated with habitat loss rather than direct mortality from collisions. The Facility is located almost entirely on wheat fields, and impacts to wildlife habitat will be minimal, restricted primarily to small tracts of disturbed grasslands. This habitat will be mitigated in accordance with ODFW’s Habitat Mitigation Policy (OAR 635-415-0025), as described in the Facility’s Exhibit P and Habitat Mitigation Plan (Attachment P-2 to Exhibit P; updated for RFA 1, see Attachment 6). The Certificate Holder will adhere to standard best management practices including following Avian Powerline Interaction Committee guidelines for minimizing avian collisions and electrocutions (APLIC 2006, 2012), primarily burying the medium voltage collector line system, and implementing down-shield lighting for permanent lighting at the substations and O&M buildings, and identifying a licensed local wildlife rehabilitator capable of responding to the Facility in the event of injured wildlife. Based on coordination with ODFW, the Certificate Holder will additionally install flight diverters on the overhead collector line that crosses Sand Hollow. The Certificate Holder will use wildlife-friendly fencing that does not include a top strand. Thus, the Facility has already minimized the risk of avian collision fatalities, based on known risk factors such as lighting (Gehring et al. 2009; Kerlinger et al. 2010; USFWS 2012, 2013).

Additionally, post-construction fatality monitoring is not necessary for the Certificate Holder to meet the standards under OAR 345-022-0060 (i.e., that the design, construction and operation of the facility, taking into account mitigation, are consistent with the general fish and wildlife habitat mitigation goals and standards of OAR 635-415-0025, ODFW's Fish and Wildlife Habitat Mitigation Policy) because the mitigation goals and standards relate to fish and wildlife habitat quality and quantity rather than fatalities of fish and wildlife individuals. OAR 635-415-0025 goals and standards for impacts to Category 2, 3, 4, and 5 habitat (i.e., the habitat categories addressed in the Facility's Habitat Mitigation Plan) include avoidance and, where impacts are unavoidable, mitigation to achieve the goal of no net loss of either habitat quantity or quality (Category 2, 3 and 4 habitat) and/or a net benefit in habitat quantity or quality (Category 2 and 5 habitat). Fatality monitoring, in itself, does not improve or maintain habitat quantity or quality, nor would the results of monitoring affect the habitat mitigation ratios or the size of the mitigation need described in the Facility's Habitat Mitigation Plan attached to Exhibit P and Attachment 6 for RFA 1. Therefore, a systematic post-construction fatality monitoring study is not necessary for the Energy Facility Siting Council (EFSC) to determine that the Facility is consistent with OAR 635-415-0025

Although standardized fatality searches will not be implemented, all incidentally detected fatalities will be reported in the WRHS. The WRHS is a program for O&M staff to report wildlife (including bird and bat) casualties found during operation of the Facility. O&M staff will be trained in the methods needed to carry out this program. This monitoring program includes the initial response, handling, and reporting of bird and bat carcasses discovered incidental to maintenance operations ("incidental finds"). Approximately 10 permanent O&M staff are anticipated to be on-site for Facility operations and be responsible for WRHS program implementation. If a battery energy storage system is installed, additional workers will be on-site, but they will likely be contract employees and will not be included in WRHS program implementation. As part of routine O&M activities, O&M staff will visit each inverter pad approximately every 6 months to visually inspect equipment. If evidence of significant fatality events is detected by O&M staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring.

All carcasses discovered by O&M staff will be photographed and recorded. If O&M staff find a carcass at the Facility, they will notify qualified personnel who will identify the carcass. If the qualified personnel determines that a carcass is a state or federally threatened or endangered or otherwise protected species, agency reporting procedures and timelines specified in Section 5.0 shall be followed. Information recorded for each carcass and reported to ODFW and ODOE will include the location, date of discovery, species if known, as well as any evidence that might assist in determination of cause of death, such as evidence of electrocution, vehicular strike, wire strike, predation, or disease. Based on coordination with ODFW, feather spots[3] will be documented if

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[3] Feather spots are defined as at least 5 tail feathers, or 2 primary feathers, or a total of at least 10 feathers with no attached bone or tissue, within 5 meters of each other (CEC and CDFG 2007).

found as well, consistent with industry standards; however, feather spots will not necessarily be attributed to a Facility-caused fatality (personal communication with J. Thompson, ODFW, December 13, 2023). Fatalities documented by O&M staff will be reported to ODOE and ODFW annually, as described in Section 5.0.

Prior to construction, the Certificate Holder will develop and implement a protocol for handling injured birds. Any injured native birds found at the Facility may be carefully captured by trained qualified personnel and transported to a qualified rehabilitation specialist approved by ODOE. Alternatively, the Certificate Holder may contact a qualified rehabilitation specialist approved by ODOE to respond to injured wildlife. Blue Mountain Wildlife (https://bluemountainwildlife.org/, 541.278.0215), located in Pendleton, Oregon, has confirmed the ability to respond to injured native wildlife, especially migratory birds, at the Facility (Lynn Tompkins, personal communication, April 11, 2023). The Certificate Holder will pay costs, if any, charged for time and expenses related to care and rehabilitation of injured native birds found on the site, unless the cause of injury is clearly demonstrated to be unrelated to Facility operations.

5.0 Data Reporting

The Certificate Holder will report wildlife monitoring methods, data, and data analysis to ODOE for each calendar year in which wildlife monitoring occurs. Monitoring data include raptor nest survey data, WAGS monitoring data (if applicable), and WRHS data. The Certificate Holder may include the reporting of wildlife monitoring data and analysis in the annual report required under OAR 345-026-0080 or submit this information as a separate document at the same time the annual report is submitted. In addition, the Certificate Holder will provide to ODOE data or records generated in carrying out this WMP upon request by ODOE.

The Certificate Holder will notify the U.S. Fish and Wildlife Service and ODFW if any federal or state endangered or threatened species are killed or injured at the Facility within 24 hours of species identification.

6.0 Plan Amendment

This WMP may be amended from time to time by agreement of the Certificate Holder and EFSC. Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this WMP. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

7.0 References

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Inadvertent Discovery Plan

Sunstone Solar Project 5

Morrow County, Oregon

October 2025

Author:
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Prepared for

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1.0 INTRODUCTION

Pine Gate Renewables (PGR) proposes to construct and operate the approved Sunstone Solar Project 5 (Facility), a solar energy generation facility with related or supporting facilities including an energy storage system on private lands in Morrow County, Oregon. PGR seeks a Site Certificate through the Oregon Department of Energy (ODOE), Oregon Energy Facility Siting Council (EFSC or Council) for the Facility. The Facility will include an up to 200-megawatt (MW) solar project, battery energy storage system, and related or supporting facilities in Morrow County, Oregon. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1). The approved solar facility siting area (Facility site boundary) is located on privately owned agricultural land with areas of sage brush near the drainages and along Sand Hollow Canyon.

To meet the requirements for site certification, PGR must develop an Inadvertent Discovery Plan (IDP) for monitoring construction activities and responding to the discovery of archaeological resources or buried human remains.

2.0 CULTURAL RESOURCES IN THE PROJECT AREA

The entirety of the Facility site boundary and a 2-mile viewshed was surveyed for cultural resources, including pedestrian surveys along with subsurface shovel probing within the Facility site boundary. A total of five archaeological site were identified in the Facility site boundary. All have been recommended as not eligible for listing on the National Register of Historic Places (NRHP). In addition, one historic site is identified in the Facility site boundary. The historic site is eligible for listing on the NRHP.

Prior to construction, PGR will develop a Monitoring Plan that incorporates this IDP and includes necessary staff, agency, and tribal contact information once determined. This plan should include monitoring protocols and staffing roles and incorporate input from the CTUIR.

3.0 PROCEDURES FOR THE DISCOVERY OF ARCHAEOLOGICAL RESOURCES

If any staff, contractors, or subcontractors, including archaeological and/or tribal monitors, believe that they have encountered cultural or archaeological remains of any kind, all work at and adjacent to the discovery shall immediately cease. The area of work stoppage will be adequate to provide for the security, protection, and integrity of the archaeological discovery. A cultural resource discovery may be pre-contact period or historic period in age and consist of (but not limited to):

- Areas of charcoal or charcoal-stained soil and stones;
- Stone tools or waste flakes (i.e., an arrowhead or stone chips);

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

- Bone, burned rock, or shell, whether or not seen in association with stone tools or chips;
- Clusters of tin cans, ceramics, flat glass, or bottles; and
- Concentrations of brick, railway tracks, or logging or agricultural equipment.

In the event unrecorded archaeological resources are identified during the construction or operation of the Sunstone Solar Project 5, work within 100 feet of the find shall be halted and directed away from the discovery until a Qualified Archaeologist[2] assesses the resource and its significance for inclusion on the NRHP. This assessment will include coordination with the CTUIR. (A wider avoidance area will be required for human remains; see below.) The archaeologist, in coordination with ODOE, the SHPO, Facility personnel, CTUIR, and the landowner, shall make the necessary plans for treatment of the finds and for the evaluation and mitigation of impacts if the finds are found to be eligible for listing on the NRHP.

A Qualified Archaeologist will determine if the resources are archaeological and greater than 50 years old. If the archaeologist believes that the discovery is a cultural resource, he or she in coordination with the PGR Construction Manager will establish a 100-foot avoidance buffer to protect the discovery site where construction activities will be suspended until treatment of the discovery can be determined. Vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery site or avoidance area. Any newly discovered archaeological resource will be considered eligible to the NRHP until determined otherwise. Work in the immediate area will not resume until treatment of the discovery has been completed.

If archaeological artifacts are observed during construction, the Qualified Archaeologist will ensure proper documentation and assessment of any discovered cultural resources. All precontact and historic cultural material discovered during project construction will be recorded by the archaeologist in SHPO’s online archaeological site form database. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/sediment descriptions will be prepared for subsurface exposure. Discovery locations will be documented on scaled site plans and site location maps.

If the Qualified Archaeologist in consultation with the SHPO and CTUIR determines that the discovery is an NRHP-eligible cultural resource, they will consult to determine appropriate treatment to be presented and agreed upon in a Memorandum of Agreement (MOA) or other appropriate documentation. Mitigation measures will be developed in consultation with PGR, ODOE, SHPO, CTUIR, and the landowner, and could include avoidance through redesign, conducting data recovery, and/or relocating materials. Treatment measures performed may include protecting in place or data recovery such as mapping, photography, limited probing, and sample collection, or other activity deemed appropriate through an MOA or other appropriate documentation.

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[2] *Qualified Archaeologist* - means a person with qualifications meeting the federal secretary of the interior's standards for a Professional Archaeologist . An individual who has: (A) A post-graduate degree in archaeology, anthropology, history, classics or other germane discipline with a specialization in archaeology, or a documented equivalency of such a degree; (B) Twelve weeks of supervised experience in basic archaeological field research, including both survey and excavation and four weeks of laboratory analysis or curating; and (C) Has designed and executed an archaeological study, as evidenced by a Master of Arts or Master of Science thesis, or report equivalent in scope and quality, dealing with archaeological field research.

If human remains are inadvertently discovered, ODOE, SHPO, the Legislative Commission on Indian Services (LCIS), and CTUIR will decide when construction may continue at the discovery location. Where cultural resources are encountered during construction, but additional project effects to the resources are not anticipated, Facility construction may continue while documentation and assessment of the cultural resources proceed. If continued construction is likely to cause additional impacts to such resources, Facility activities within a radius of 100 feet of the discovery will cease until the Qualified Archaeologist has documented the site, evaluated its significance in consultation with CTUIR, and assessed potential effects to the site.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the discovery of the cultural resource, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 100 foot buffer—work may continue outside of this buffer.
3) Notify PGR Project Manager and ODOE (see Attachment A).
4) Construction Manager will need to contact a Qualified Archaeologist to assess the find.
5) If archaeologist determines the find is an archaeological site or object, contact SHPO. If it is determined to *not* be archaeological, you may continue work.

4.0 PROCEDURES FOR THE DISCOVERY OF HUMAN REMAINS

If human remains and/or associated grave goods are inadvertently encountered during Project activities, the Oregon State legislature protocol[3] for inadvertent discovery of human remains will be followed (Oregon State Legislature 2025). All activity that may cause further disturbance to the remains shall cease and the area secured and protected from further disturbance. A 200-foot avoidance buffer will be utilized for human remains and associated grave goods until appropriate treatment is completed. The presence of skeletal remains will be immediately reported to the County Medical Examiner, Oregon State Police, SHPO, and LCIS. The remains will not be touched, moved, or further disturbed. The County Medical Examiner or LCIS State Physical Anthropologist will assume jurisdiction over the human skeletal remains and determine whether those remains are forensic or non-forensic. If the remains are non-forensic, then they will report that finding to SHPO and the State Physical Anthropologist with the LCIS, who will then take jurisdiction over the remains and will notify CTUIR.

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[3] https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

Although excavation work in the immediate area of a human remains find will not resume until assessment has been completed, excavation work may continue in other parts of the Facility that have been surveyed for cultural resources. Due to the sensitive nature of such a find, human remains should never be left unattended. No work will resume in the area of a human remains discovery until written authorization has been received from the LCIS and SHPO.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the inadvertent discovery, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 60-meter/200-foot buffer, then work may continue outside of this buffer with caution.
3) Cover remains from view and protect them from damage or exposure, restrict access, and leave in place until directed otherwise. Do not take photographs. Do not speak to the media.
4) Notify (refer to Attachment A for contact information):
    - PGR Project Manager
    - ODOE
    - Oregon State Police **DO NOT CALL 911**
    - SHPO
    - LCIS State Physical Anthropologist
    - CTUIR and other appropriate Native American Tribes determined by LCIS

5) If the site is determined not to be a crime scene by the Oregon State Police, do not move anything! The remains will continue to be secured in place along with any associated funerary objects, and protected from weather, water runoff, and shielded from view.
6) Do not resume any work in the buffered area until a plan is developed and carried out between ODOE, SHPO, LCIS, and appropriate Native American Tribes and you are directed that work may proceed.

5.0 CONFIDENTIALITY

The Facility and employees shall make their best efforts, in accordance with federal and state law, to ensure that its personnel and contractors keep the discovery confidential. The media, or any third-party member or members of the public are not to be contacted or have information regarding the discovery, and any public or media inquiry is to be reported to ODOE. Prior to any release, the responsible agencies and Tribes shall concur on the amount of information, if any, to be released to the public.

To protect fragile, vulnerable, or threatened sites, the National Historic Preservation Act, as amended (Section 304 [16 U.S.C. 470s-3]), and Oregon State law (Oregon Revised Statute 192.501(11)) establishes that the location of archaeological sites, both on land and underwater, shall be confidential.

6.0 REFERENCES

Oregon State Legislature

2025 Electronic document accessed July 2025, https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

ATTACHMENT A: CONTACTS

1. Pine Gate Renewables

Project Manager	To be determined prior to construction

2. Cultural Resource Contacts

Qualified Archaeologist	Lara Rooke, Tetra Tech (425) 217 7625 (Cell)
Oregon SHPO State Archaeologist	John Pouley (503) 480-9164
State Physical Anthropologist, LCIS	Dr. Elissa Bullion (971) 707-1372 or (503) 986-1067

3. Agency Contacts

ODOE	Christopher Clark (503) 871-7254
Oregon State Police	Craig Heuberger (503) 731-0079 or (503) 731-3030 (dispatch)
Morrow County Medical Examiner	(541) 676-5421

4. Tribal Contacts

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Sunstone Solar Project 5

Draft Construction Wildfire Mitigation Plan

Sunstone Solar Project 5
October 2025

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 5, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

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List of Tables

Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 5, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
EMP	Emergency Management Plan
Facility	Sunstone Solar Project 5
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 5, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 5 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) is attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described in this plan, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final Construction WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During construction, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to construction of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115, if significantly different from Final Order on ASC and the Request for Amendment 1.

4.0 Inspection and Management

OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;

4.1 Vegetation Management

The Certificate Holder and contractor(s) will maintain vegetation within the Site Boundary and will also maintain a defensible space clearance along Facility features. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

The following best management practices to minimize fire risk from vehicle travel and fueling activities would be implemented at the site during construction:

- The movement of vehicles will be planned and managed to minimize fire risk.
- The contractor(s) will be responsible for identifying and marking paths for all off-road vehicle travel. All off-road vehicle travel will be required to stay on the identified paths. No off-road vehicle travel will be permitted while working alone. Travel off road or parking in vegetated areas will be restricted during fire season.
- Areas with grass that are as tall or taller than the exhaust system of a vehicle must be wetted before vehicles travel through it.
- Workers will be instructed to shut off the engine of any vehicle that gets stuck, and periodically inspect the area adjacent to the exhaust system for evidence of ignition of vegetation. Stuck vehicles will be pulled out rather than “rocked” free and the area will be inspected again after the vehicle has been moved.
- All combustion engines (including but not limited to off road vehicles, chainsaws, and generators) will be equipped with a spark arrester that meets U.S. Forest Service Standard 5100-1.
- The contractor(s) will designate a location for field fueling operations at the temporary construction yards. Any fueling of generators, pumps, etc. shall take place at this location only.
- Fuel containers, if used, shall remain in a vehicle or equipment trailer, parked at a designated location alongside a county right-of-way. No fuel containers shall be in the vehicles that exit the right-of-way except the five-gallon container that is required for the water truck pump.
- Smoking shall only be allowed in designated smoking areas at the Facility.

5.0 Preventative and Minimization Actions for Wildfire Risk

OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;

5.1 Preventative Actions

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads[3]. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present. See Exhibit U[4] for additional discussion of Project fire prevention measures and coordination with local emergency responders.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during construction of the Facility, as applicable.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

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[3] Complete Application for Site Certificate, Exhibit D, May 16, 2024.

[4] Complete Application for Site Certificate, Exhibit U, May 16, 2024.

5.2.2 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fore spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high risk locations, designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.3 Emergency Management Plan

The EMP will be prepared prior to construction by the Certificate Holder and construction contractor and will contain policies and procedures for preparing for and responding to a range of potential emergencies, including fires. Implementation of the EMP will ensure risks to public health and safety and risks to emergency responders are minimized. Any potential fires inside the solar array will be controlled by trained staff who will be able to access the Facility around the clock. These measures will help keep external fires out or internal fires in. The EMP will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The plan will also specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, a construction kickoff meeting to discuss emergency planning, and invitations to observe any emergency drill conducted at the Facility.

In addition to the emergency responses to be stipulated in the EMP, personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

Another safety mitigation measure is to have available on site during construction is a water truck, water buffalo, or tank with minimum 500 gallon capacity.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

The Certificate Holder will track the industry groups and applicable design standards outlined in Table 2 to identify future technologies or best practices that could be implemented at the Facility.

Table 2: Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the O&M building and the substation enclosure.	Remodeling to the O&M and enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

Reference	Description	Method
1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/. 2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf. 3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.		

7.0 References

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1.0 Introduction

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This Wildfire Mitigation Plan (Plan) was attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described above, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers, (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire, (to the extent emergency service information is available),
- Identify and provide maps of:

---

[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.
[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs, battery components, and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During operation, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires and how to safely respond to fires involving BESS components. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment Update

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to operation of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115.

4.0 Inspection and Management

OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;

4.1 Facility Inspections

Facility components will be inspected quarterly. The supervisory, control, and data acquisition (SCADA) system collects operating and performance data from the Facility as a whole and allows remote operation. The Certificate Holder will monitor the Facility components, such as the substation and solar arrays, 24 hours a day, 7 days a week including shutdown capabilities. These operational monitoring and maintenance measures are also discussed in Section 4.0.

The battery energy storage system may consist of either zinc-based batteries or lithium-ion (Li-ion) batteries and will be stored in completely contained, leak-proof modules. The modules will be stored on a concrete pad to capture any leaks that may occur. Operations and maintenance (O&M) employees will conduct inspections of the battery energy storage systems according to the manufacturer's recommendations, which are assumed to be monthly inspections.

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Section 2.7.1 of Exhibit B summarizes the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected.

Table 2 below provides draft operational inspections for electrical facility components from similar types of facilities. As part of finalizing the final operational WMP, the Certificate Holder may update this table as applicable to facility equipment, standards, and inspections.

Table 2: Draft Operational Inspections for Electrical Components

Inspection	Procedure	Standard	Time frame
Solar Inverter	Visual inspection of inverter and surrounding area.	SPCC Plan[1] Manufacturer's maintenance recommendations	Monthly SPCC Bi-annual Preventative Maintenance
Substation	Visual inspection of MPT, Avian Power Line Interaction Committee (APLIC) measures, and surrounding area.	Manufacturer's maintenance recommendations APLIC[2]	Monthly Yearly (APLIC)
BESS	Visual inspection of BESS, PCS, and surrounding areas	SPCC Plan Manufacturer's maintenance recommendations	Monthly

Inspection	Procedure	Standard	Time frame
Overhead electrical lines	Visual inspection of components, grounding, APLIC measures, vertical clearance distance between conductor and vegetation.	National Energy reliability Corporation (NERC)[3] APLIC	Bi-annual
1. The Operational Spill Prevention, Control, and Countermeasure Plan for the facility will require these components to be inspected monthly for spills. During these inspections, Operational Staff will also visually inspect the component and surrounding area. 2. The Certificate Holder will develop an inspection checklist and program of electrical equipment based on manufacturer's recommendations for individual components. 3. Vegetation maintenance standard FAC-003-0 .			

4.2 Vegetation Management

Vegetation within areas temporarily disturbed during construction of the Facility, as well as revegetation of areas within the solar array fence line area, will be revegetated as outlined in the Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4[3]; updated for RFA 1, see Attachment 6). As noted in the Revegetation and Reclamation Plan, areas within the solar array fence line area will be revegetated with a mixture of low-growing grasses and forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). In addition, vegetation within the solar array fence line area will be managed as needed to reduce fuels for fire. This would include mowing vegetation under solar panels periodically, if required. The Certificate Holder will also maintain a 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

A physical vegetation survey assessment of the fenced area will be completed at least twice a year to monitor for vegetation clearances, maintain fire breaks, as applicable, and monitor for wildfire hazards. One of the vegetation survey assessments will occur in May or June, prior to the start of the dry season, a time when wildfire risk begins to become heightened. The survey will be conducted by the Site Operations Manager and will be used to assess the frequency of any upcoming vegetation maintenance required and identify areas that may need additional attention. The Site Operations Manager will visually assess and document vegetation height, abundance, and areas where vegetation should not be present such as crushed rock bed around collector substations. The vegetation survey assessment will determine that clearances and fire breaks (vegetative clearance areas and areas determined to remain clear to act as permanent fire breaks or areas where temporary fire breaks may be deployed in the event of a fire) are satisfactory, and if not, the mitigation procedures will be implemented (e.g., vegetation management) to ensure clearances and fire breaks are satisfactory The vegetation survey will document::

- Location of observations

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[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

- Species
- Estimated growth rate
- Abundance
- Clearance / Setbacks
- Risk of fire hazard

Additional vegetation surveys may be required throughout the season based on seasonally heightened fire risk. Vegetation Maintenance procedures and BMPs will be followed during operation of the Facility to ensure that vegetation does not grow in a manner that blocks or reduces solar radiation reaching the solar panels and reduce the risk of starting a fire. Vegetation control will employ best management practices (BMPs) and techniques that are most appropriate for the local environment. BMPs may include physical vegetation control such as mowing. Noxious weeds within the site boundary will be controlled in accordance with the Noxious Weed Control Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). Efforts will be made to minimize the use of herbicides and only herbicides approved for use by the U.S. Environmental Protection Agency and Oregon Department of Agriculture will be used. Herbicides used for vegetation management of the site will be selected and used in a manner that fully complies with all applicable laws and regulations.

Vegetation within the fence line and below the solar arrays will be maintained to a height of 18 inches and provide a minimum of 24-inch clear distance to any exposed electrical cables. Exposed electrical wires should be running under the solar panels at the midpoint or higher than the center of the panel. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present.

Ongoing vegetation management to ensure that vegetation does not grow in these graveled areas is outlined in Table 3.

Table 3. Vegetation Management Procedures by Facility Component

Vegetation Management	Procedure	Standard	Time Frame
Solar Inverter	Herbicide application on gravel pad around inverter to prevent vegetation growth.	Institute of Electrical and Electronics Engineers (IEEE) 80[1] National Electrical Code (NEC) 70[2]	Yearly, depending on vegetation condition.
Substation	Herbicide application on substation gravel pad. Highly compacted gravel foundations of substation are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.

Vegetation Management	Procedure	Standard	Time Frame
Battery energy storage system	Herbicide application on gravel pad surrounding the battery energy storage system. Highly compacted gravel foundations of the battery energy storage system are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.
Overhead electrical lines	Mow vegetation to achieve clearance requirements between conductor and ground.	North American Electric Reliability Corporation (NERC)[3]	Yearly, depending on vegetation condition.
1. IEEE (2015) 2. NFPA (2023) 3. NERC (2009)			

5.0 Preventative and Minimization Actions for Wildfire Risk

> *OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;*

5.1 Preventative Actions and Design Features

The Certificate Holder will minimize risk of operation of the facility causing wildfire by implementing a number of systems and procedures. During O&M activities, these will include requirements to conduct welding or metal cutting only in areas cleared of vegetation, and maintaining emergency firefighting equipment on-site. Employees will keep vehicles on roads and off dry grassland when feasible during the dry months of the year, unless such activities are required for emergency purposes, in which case fire precautions will be observed. Fire extinguishers and shovels will be kept in all vehicles. On-site employees will also receive training on fire prevention and response and have on-site fire extinguishers to respond to small fires. In the event of a large fire, emergency responders will be dispatched.

The Certificate Holder will minimize risk of Facility components causing wildfire through preventative actions. In the design of the Facility, the Certificate Holder will implement the design considerations and best practices outlined in Table 4 to minimize electrical fire risk from facility components.

Table 4. Design Considerations for Fire Safety by Facility Component

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Electrical connections by qualified electricians	X	X	X	X
Inspections for mechanical integrity prior to energizations	X	X	X	X

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Lighting protection	X	X	X	X
Corrosion protection	X	X	X	X
Strain relief of connecting cabling	X	X	X	X
Protection against moisture	X	X	X	X
Grounding systems	X	X	X	X
Safety setback from structures	X[1]	X[1]	X[1]	X[2]
Technology specific design standards	X[3]	X[4]	X[5]	X[3]

1. Graveled inside structure's perimeter fence with additional 3-foot gravel setback outside of structure's perimeter fence
2. Vertical and horizontal clearances from structures depends on voltage of conductor.
3. NFPA 70 (.NFPA 2023).
4. IEEE 979 (IEEE 2012).
5. NFPA 1, Chapter 52 (NFPA 2021).

During Facility operations, the areas within the site boundary that are subject to a heightened risk of wildfire include the solar array areas. The solar array areas will have low-growing vegetation maintained below the solar arrays during the operational period of the Facility. Measures for reducing the risk of fire ignition and reducing the risk of equipment damage were a wildfire to occur are discussed further in Section 3.0, including the Facility’s vegetation management program (see Section 3.2), and through the emergency response procedures that will be described in the Emergency Management Plan (EMP). The EMP will be developed for the Facility and is outlined below in Section 4.2.5. The collector substation area, transformer pads, and the permanent, fenced parking and storage area will have reduced risk for fire due to the fact that these areas will have a gravel base with no vegetation within a 10-foot perimeter to reduce fire risk.

The Facility components will meet National Electrical Code and Institute of Electrical and Electronics Engineers standards and will not pose a significant fire risk. The solar array will have shielded electrical cabling, as required by applicable code, to prevent electrical fires. In addition, the collector system and substation will have redundant surge arrestors to deactivate the Facility during unusual operational events that could start fires. The collector substation and the switchyard will have also sufficient spacing between equipment to prevent the spread of fire.

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. A 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary will be maintained. The areas immediately around the O&M buildings, substations, and battery energy storage system will be graveled, with no vegetation present. See Exhibit U for additional discussion of Project fire prevention measures and

coordination with local emergency responders. Vegetation free areas such as gravel pads or base and facility perimeter and interior roads act as a permanent fire break which could minimize the spread of fires on site or impacts from an external wildfire.

Smoke/fire detectors will be placed around the site that will be tied to the SCADA system and will contact local firefighting services. This communication system allows each solar string, battery energy storage system, and substation to be monitored by a SCADA system, accessed through both the SCADA control room in the substations or remotely. This system monitors these components for variables such as meteorological conditions, critical operating parameters, and power output. The solar array is controlled and monitored via the SCADA system and can be controlled remotely. SCADA software is tuned specifically to the needs of each project by the solar module manufacturer or a third-party SCADA vendor. This system will be monitored 24/7 by a remote operations center.

The Certificate Holder proposes to construct either a direct current–coupled distributed battery energy storage system (located throughout the solar array fence line area at the inverter and transformer sites) or alternating current–coupled battery energy storage system (concentrated in a single location within the solar array fence). The system as a whole will use a series of self-contained containers located within the solar array fence line area. The containers may have their own additional fencing, to be determined prior to construction. Each container will be placed on a concrete foundation. Regardless of the battery technology selected, the containers are estimated to require up to 0.2 to 0.4 acre each with a total of 2,491 containers. Each container is rated for outdoor environments and holds the batteries and a battery management system.

The Facility will use either Li-ion batteries or zinc batteries to store up to 200 MW alternating current of power over a 6-hour discharge duration (1,200 megawatt-hours alternating current) (ASC Exhibit C, Figure C-2[4]).

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Additionally, zinc batteries will have fans and a heating unit for climate control.

The following paragraphs summarize the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected. The chemicals used in Li-ion batteries are generally nontoxic but do present a flammability hazard. Li-ion systems would also include a fire prevention system and cooling units placed either on top of the containers or along the side. Li-ion batteries are susceptible to overheating and typically require cooling systems dedicated to each battery energy storage system enclosure, especially at the utility scale (Jeevarajan et al. 2022). The gas released by an overheating Li-ion cell is mainly carbon dioxide but may also include carbon monoxide, methane, ethylene, and propylene (Jeevarajan et al. 2022).

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[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

The Certificate Holder will implement the following fire prevention and control methods to minimize fire and safety risks for the Li-ion batteries proposed for the battery energy storage system:

- The batteries will be stored in completely contained, leak-proof modules.
- Ample working space will be provided around the battery energy storage system for maintenance and safety purposes.
- Off-site, 24-hour monitoring of the battery energy storage system will be implemented and will include shutdown capabilities.
- Transportation of Li-ion batteries is subject to 49 Code of Federal Regulations (CFR) 173.185 – Department of Transportation Pipeline and Hazardous Material Administration. This regulation contains requirements for prevention of a dangerous evolution of heat; prevention of short circuits; prevention of damage to the terminals; and prevention of batteries coming into contact with other batteries or conductive materials. Adherence to the requirements and regulations, personnel training, safe interim storage, and segregation from other potential waste streams will minimize any public hazard related to transport, use, or disposal of batteries.
- Design of the battery energy storage system will be in accordance with applicable Underwriters Laboratories (UL; specifically, 1642, 1741, 1973, 9540A), National Electric Code, and National Fire Protection Association (specifically 855) standards, which require rigorous industry testing and certification related to fire safety and/or other regulatory requirements applicable to battery storage at the time of construction.
- Additionally, the Certificate Holder will employ the following design practices, as applicable to the available technology and design at time of construction:
    - Use of Li-ion phosphate battery chemistry that does not release oxygen when it decomposes due to temperature;
    - Employment of an advanced and proven battery management system;
    - Qualification testing of battery systems in accordance with UL 9540A (UL Solutions 2025);
    - Employment of Fike fire control panels with 24-hour battery backup at every battery container;
    - Installation of fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems in every battery container;
    - Installation of doors that are equipped with a contact that will shut down the battery container if opened;
    - Installation of fire extinguishing and thermal insulation sheets between each individual battery cell;

  - Implementation of locks and fencing to prevent entry of unauthorized personnel;
  - Installation of remote power disconnect switches; and
  - Clear and visible signs to identify remote power disconnect switches.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during operations of the Facility.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

5.2.2 Electrical Safety Program

All operational workers will be trained in electrical safety and the specific hazards of the Facility. This training will address:

- Minimum experience requirements to work on different types of electrical components;
- Electrical equipment testing and troubleshooting;
- Switching system;
- Provisions for entering high voltage areas (e.g., substation);
- Minimum approach distances; and
- Required personal protective equipment.

5.2.3 Lock Out/Tag Out Program

During maintenance activities, electrical equipment will be de-energized and physically locked or tagged in the de-energized positions to inadvertent events that could result in arc flash.

5.2.4 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fire spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high-risk locations, as designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.5 Emergency Management Plan

Emergency Management will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The final WMP will specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, annual meetings to discuss emergency planning, protocols for how to respond to electrical fires and safely respond to a fire involving BESS components, and invitations to observe any emergency drill conducted at the Facility.

At the beginning of Facility operations, a copy of the site plan indicating the arrangement of the Facility structures, access points, and fire breaks will be provided to the local fire district.

Personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

During times of heightened wildfire risk, a water truck, water buffalo, or tank with minimum 500 gallon capacity will be stationed at the site during operations and maintenance activities.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the amended site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

This Plan will be updated by the Certificate Holder every 5 years. Updates to this Plan will account for changes in local fire protection agency personnel and changes in best practices for minimizing and mitigating fire risk. It is recommended to consult with Morrow County, the local fire department, and the Morrow County Emergency Manager.

After each 5-year review, a copy of the updated plans will be provided to the Oregon Department of Energy with the annual compliance report required under OAR 345-026-008(2).

Every 5 years, the Certificate Holder will review wildfire risk and update this Plan for the site boundary. Evaluation of wildfire risk will be consistent with the requirements of OAR 345-022-0115(1) using current data from reputable sources.

The Certificate Holder may consider revisions to this Plan at its sole discretion to incorporate future best practices or emerging technology depending on whether the new technology is cost effective and suitable for the site conditions. The Certificate Holder will track the industry groups and applicable design standards outlined in Table 5 to identify future technologies or best practices that could be implemented at the Facility.

Table 5. Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the O&M building and the substation enclosure.	Remodeling to the O&M and enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/.
2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf.
3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.

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Sunstone Solar Project 6

Sunstone Solar Project 6
Draft Fugitive Dust Control Plan

Prepared for

Sunstone Solar 6, LLC

Prepared by

Tetra Tech, Inc.

October 2025

Table of Contents

List of Attachments

1.0 Introduction

This Fugitive Dust Control Plan (Plan) has been developed by Sunstone Solar 6, LLC (Certificate Holder), a subsidiary of Pine Gate Renewables, LLC, for the approved Sunstone Solar Project 6 (Facility) in Morrow County, Oregon. The purpose of this Plan is to reduce fugitive dust emissions associated with construction-related activities of a photovoltaic energy generation facility with up to 200 megawatts (MW) alternating current and related or supporting facilities, as well as a 1,200 MW-hour distributed battery energy storage system. The majority of the site consists of a mix of fallow fields and fields in small grain production, primarily dryland wheat; no farmlands within the site boundary receive irrigation (the application of water to land for purposes of growing agricultural products; Sunstone Solar 2024). This Plan summarizes the sources of and regulatory issues that relate to fugitive dust emissions; identifies responsibilities, monitoring, and training; and provides reasonable available control methods for fugitive dust in a table for easy reference in the field (Attachment 1).

This is an owner-imposed Plan that is expected to be implemented, maintained, and adaptively managed by the selected contractor throughout all phases of construction. The performance criteria and suggested measures identified in this Plan are minimums, and the contractor is expected to identify and implement additional measures as needed to fully meet all regulatory and public safety performance criteria. As identified in this Plan, the contractor may propose alternative approaches for consideration by the owner.

1.1 Fugitive Dust Sources

The Natural Resources Conservation Service (NRCS) Web Soil Survey identified five major soil types within the project area (NRCS 2025). Approximately 56 percent of the site is composed of Warden silt loam, which is moderately or severely susceptible to erosion from ground disturbance, wind, and vehicle traffic on unpaved roads due to its composition of hemic organic soil materials and very fine sand (NRCS 2025, NRCS 2011). Additionally, 38 percent of the site is composed of Ritzville silt loam, which is also moderately or severely susceptible to erosion from ground disturbance, wind, and vehicle traffic due to its composition of silt and fibric organic material (NRCS 2025, NRCS 2011). Due to their composition, the retention of moisture in these sediments is thus restricted. Furthermore, these sediment particles have a low resistance to dust propagation and would be transported or drift to adjacent lands due to the lack of water through irrigation; thus, these soils are considered at high risk for fugitive dust.

Fugitive dust can arise from a variety of construction and operational activities associated with solar development. The sources can be grouped into three general categories: dust created from ground-disturbing activities such as clearing and grading, dust created from wind action on bare soils and stockpiles such as those not fully stabilized post-construction with either vegetation or a tackifier, and dust created from traffic on unpaved roads. Sediment is the basis for fugitive dust, meaning that sediment particles can become fugitive dust if they are windborne. Therefore, the thresholds for treating sediment and erosion on the site will be similar if not the same as the thresholds for treating fugitive dust. Maintaining existing vegetation and root systems is the single most effective method for avoiding fugitive dust and sediment. Where existing vegetation and root systems are disturbed, quickly reestablishing vegetation is critical.

1.2 Regulatory Compliance

Fugitive dust is a source of particulate matter with a mean diameter less than 10 microns (PM_{10}) which is one of the seven air pollutants the U.S. Environmental Protection Agency (EPA) regulates under the National Ambient Air Quality Standards (NAAQS). To a lesser extent, fugitive dust is a source of particulate matter with a mean diameter less than 2.5 microns ($PM_{2.5}$), which has proposed regulations pending under NAAQS. These soil particles are very small, can remain suspended in the air for long periods of time, and are easily inhaled into the lungs. Increased risks of death and disease have been linked to periods of high outdoor PM_{10} and $PM_{2.5}$ concentrations. These fine particles can potentially be lifted thousands of feet into the atmosphere and transported across continents and oceans creating global health, ecological, and climate change impacts.

The EPA shares responsibility with the Oregon Department of Environmental Quality (ODEQ) for the implementation of Clean Air Act (CAA) criteria in Oregon. ODEQ implements the CAA rules under the EPA-approved Oregon Administrative Rules (Chapter 340, Division 21 General Emission Standards for Particulate Matter). Fugitive dust is the primary concern related to the CAA at the Project. Fugitive dust is defined by ODEQ as dust that visibly leaves the project site for a period of more than **18 seconds in a 6-minute period,** determined by the attached EPA Method 22 (ODEQ 2019) at the downwind property boundary (Oregon Administrative Rules [OAR] 340-208-0210 (2)-a and -b).

The ODEQ Rule 340-208-0210 contains the following requirements for fugitive dust:

- Reasonable precautions must be taken to prevent particulate matter from becoming airborne. This includes, but is not limited to, the use of water or other chemicals to control dust during construction, on unpaved roads, and during the transport of materials; enclosure of materials stockpiles and covering of open-body trucks; and prompt removal from paved streets of earth or other material.
- If fugitive dust is discovered, ODEQ may require the Facility to cease work until the fugitive dust emissions are controlled. Emissions are considered controlled when fugitive dust is no longer leaving the Facility site for more than 18 seconds in a 6-minute period.

Further, ODEQ Rule 340-208-0300 specifies that it is prohibited to cause or allow any air contaminants (e.g., fugitive dust) to create a nuisance. If ODEQ determines that a nuisance has been created, the agency may pursue informal or formal enforcement actions to abate the nuisance.

A National Pollutant Discharge Elimination System Construction Stormwater Discharge Permit (Oregon 1200-C Construction Stormwater Permit), pursuant to Oregon Revised Statutes 468.050 and Section 402 of the federal Clean Water Act, will be obtained from ODEQ. This permit requires the permit holder to "Prevent wind-blown soil and dust from areas with exposed soil through the appropriate application of water or other dust suppression techniques to control the generation of pollutants that could be discharged in stormwater from the site" (Section 2.2.9) and requires permit holders to implement measures including monitoring, record keeping, reporting of exceedances, and installation, maintenance, and adaptive management of best management practices (BMPs) to control both stormwater and fugitive dust discharges. Implementation of these measures is intended to reduce fugitive dust to a negligible impact and ensure compliance with applicable air quality regulations.

The Morrow County Code regulates nuisances through the Oregon State Statute Chapter 203. Controlling fugitive dust emissions is required to avoid creating a public nuisance, which is defined as "any thing, substance, or act that is a threat to the public health, safety or welfare" (Morrow County Code Enforcement Ordinance ORD-2021-4).

2.0 Fugitive Dust Control Plan

2.1 Responsibility

The expectation is that the Contractor will implement and adaptively manage this Plan, controlling fugitive dust emissions and meeting all regulatory and public safety performance criteria throughout construction. As described in Section 1.2 above, the holder of the Oregon 1200-C permit is required to control fugitive dust emissions, including ensuring compliance by all subcontractors and outside service providers.

If the Certificate Holder identifies that the regulatory and public safety performance criteria are not being met, the Certificate Holder will implement enforcement measures, including but not limited to:

- Issuance of a Non-Conformance and/or Non-Compliance Report.
- Contractor to prepare and submit a corrective action plan.
- Contractor to document corrective actions taken and performance criteria met.
- Partial or full stoppage of work on site through activation of shut-down clause in contract.
- At the Certificate Holder's sole discretion, an outside contractor may be contracted to implement corrective actions, to be reimbursed by the Contractor.

Additionally, the Certificate Holder may establish a Community Action Council to create an open and ongoing pathway for communication with stakeholders for the Project, including controlling fugitive dust emissions and avoiding the creation of nuisances. The Community Action Council could include representatives from the Morrow County Commissioners' Office, Morrow County Planning Department, Oregon Department of Transportation, and neighboring landowners. The Contractor will work with the Certificate Holder to determine whether this Community Action Council will be established, and if so, the details of its establishment.

2.2 Monitoring

As required by the 1200-C permit, the permit holder will perform visual monitoring and recordkeeping by a Certified Erosion and Sediment Control or Storm Water Quality Inspector (inspector). The Contractor's construction site manager and inspector will be responsible for ensuring that the measures in this Plan are implemented, monitored, and adaptively managed, and that any exceedances are immediately reported to the Certificate Holder.

The visual monitoring required by the 1200-C permit must occur at least once every 14 calendar days. However, because OAR 340-208-0210 restricts visible fugitive emissions on a continuous standard to a maximum of 18 seconds in a given 6-minute period, and because fugitive dust emissions may provide an immediate public safety concern in this location, this Plan requires that fugitive dust be monitored and controlled on an ongoing basis.

Monitoring for fugitive dust emissions shall include:

- Use of EPA Method 22 (ODEQ 2019; see Attachment 2) as specified in OAR 340-208-0210, at least once a day.
- The observation shall be performed during times of peak construction activity at the downwind property boundary.
- Recording of observations in a fugitive dust inspection log that is kept on site and shall be available digitally to the Certificate Holder. This log shall include all information required in EPA Method 22 and shall also include photos and/or video taken during the observation period to document conditions.
- Installation and operation of a weather station, recording (at a minimum) wind speed and direction.

Triggers for additional, more frequent monitoring will include:

- Observation of visible fugitive dust emissions by Contractor, agency, or the Certificate Holder staff.
- Request by a member of the Community Action Council established by the Certificate Holder.
- Wind speeds greater than 15 miles per hour.
- Receipt of complaints or concerns through the Project Dust Control Hotline.

2.3 Training

EPA Method 22 (ODEQ 2019) does not require a specific certification, but it is necessary that the person responsible for observations completed for this method be knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in the references cited in Method 22 (EPA 2019) or from the lecture portion of the EPA Method 9 certification course. The Contractor shall document in the inspection log how the person responsible for observations meets this requirement.

Construction workers will attend a Worker Environmental Awareness Program training prior to conducting construction activities. This training will include a summary of fugitive dust control measures included in this Plan and the responsibilities of personnel working on the Facility related to fugitive dust control.

2.4 Fugitive Dust Prevention and Management

This document and the attached table are intended to provide guidance to construction personnel on measures intended to minimize impacts and control fugitive dust emissions during construction. It is the responsibility of the Contractor to monitor and adaptively manage the site to maintain compliance with all local, state, and federal requirements. Additionally, this Plan is supplemental to the Contractor's Erosion and Sediment Control Plan and does not substitute for any requirements of ODEQ or other agencies.

This Plan is performance-based. As shown in the flow chart in Figure 1, if fugitive dust emissions in excess of the ODEQ criteria of **18 seconds in a 6-minute period** occur, the Contractor shall:

- Implement adaptive management actions, including altering work operations and/or pause work until the fugitive dust emissions are controlled.
- Document that fugitive dust emissions have been controlled, including monitoring with EPA Method 22.
- In addition to any reporting requirements required in the 1200-C permit, report noncompliance incidents and adaptive management actions taken by the Certificate Holder within 24 hours of occurrence.

The Contractor shall maintain and implement this Plan during all phases of construction. The table in Attachment 1 provides suggested Reasonable Available Control Measures (RACMs) for anticipated fugitive dust sources based on industry-standard BMPs and reasonable precautions specified in the Oregon 1200-C permit, ODEQ's Construction Stormwater Best Management Practices Manual (Manual) (ODEQ 2021), and OAR 340-208-0210. Supplemental RACMs are identified in the table in case initial RACMs are not effective in controlling fugitive dust or are not feasible to implement (Attachment 1).

The Contractor shall identify and implement additional RACMs as needed to control fugitive dust emissions. Additionally, the Contractor may propose alternative approaches and RACMs for controlling fugitive dust. This proposal shall be made in writing and is subject to the approval of the Certificate Holder.

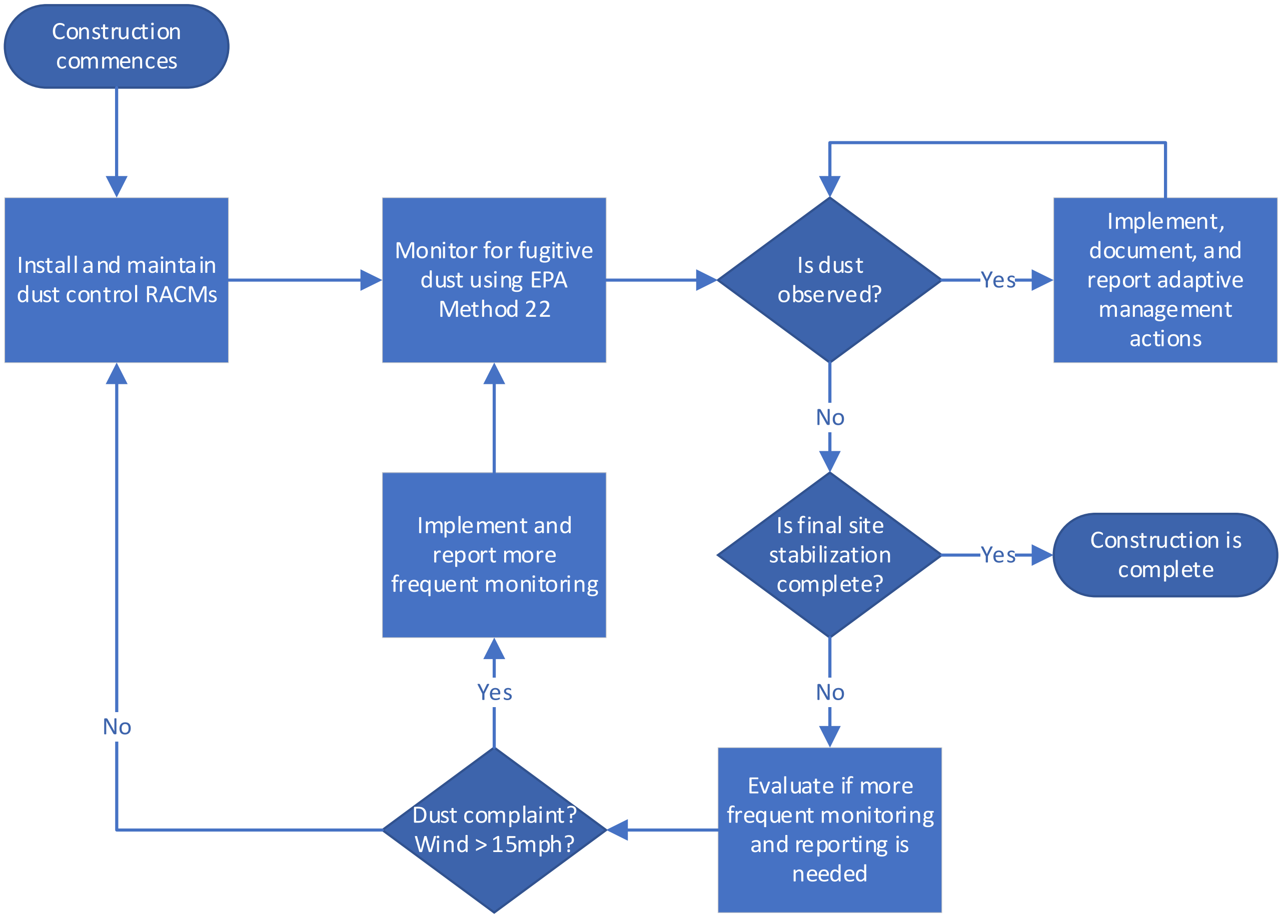

Figure 1. Dust Control Plan Flow Chart

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Attachment 1: Fugitive Dust Sources and Reasonable Available Control Measures

Fugitive Dust Sources and Reasonable Available Control Measures

Construction Phase	RACM(s)	Supplemental RACM(s)
All Phases of Construction	Daily fugitive dust monitoring and record keeping.	Increase frequency of monitoring.
	Prominent display of Dust Control Hotline signs, providing direct access to the Contractor's site manager or inspector.	If established, proactive engagement with Community Action Council.
	If established, Worker Environmental Awareness Program training for all construction employees.	Additional trainings and refreshers for employees.
	Maintain stockpile of BMPs on site, including sufficient palliatives for a single treatment of all site access roads and sufficient palliatives, mulch, and/or hydromulch for a minimum of 25 percent of the total disturbed area, and machinery for application.	Increase stockpile of palliatives, mulch, and/or hydromulch and add additional BMPs.
	Documentation and reporting of adaptive management actions.	Development and submittal of revised Fugitive Dust Control Plan.
Site Access	Install and maintain stabilized construction entrances at ingress/egress locations and restrict traffic to these locations.	Add additional construction entrance BMPs (e.g., wheel wash).
	Daily sweeping up of sediment from paved surfaces utilizing vacuum sweeper with HEPA filtration.	Increase sweeper frequency.
	Access roads shall be graveled.	Road maintenance and reapplication of gravel.
	Access roads will be stabilized with water or palliative sufficient to eliminate visible and sustained dust from vehicular travel and wind erosion. Reapply stabilization as necessary to maintain dust-free condition.	If water is unavailable or ineffective, or if water use is limited by any agency or regulation, access roads will be stabilized with longer-lasting palliatives.
	Restrict construction traffic to established and stabilized access routes.	Install fencing or barricades to prevent traffic outside of established routes.
	Limit traffic speeds to 15 miles per hour on stabilized unpaved roads within the site as long as such speeds do not create significant visible dust emissions. Traffic speed signs shall be displayed prominently at all site entrances and exits.	Limit traffic speeds within the site to 5 or 10 miles per hour.

Construction Phase	RACM(s)	Supplemental RACM(s)
Clearing, Grading, and Unstable Surfaces	Maintain the natural topography and vegetation of the site to the extent possible, including by limited grading and limited establishment of temporary access roads.	Reduce area being actively worked and stabilize unworked areas.
	Phase construction to expose the minimum amount of soil necessary.	Increase construction phasing to further minimize exposed soil.
	Leave existing vegetation intact to the extent possible.	Utilize mowing and rolling techniques to maintain plant root systems for soil stabilization.
	Minimize disturbance areas and soil exposure to the maximum extent feasible.	Limit work to a portion of the disturbed area until all disturbed areas receive temporary or final stabilization.
	When wind speeds exceed 15 miles per hour, minimize new disturbances to the extent possible and/or mobilize additional water trucks or palliatives to minimize fugitive dust from exposed surfaces.	Stop all ground disturbing activities and apply additional dust control measures until measures are effective or wind speeds slow and fugitive emissions stop.
	Separate and cover topsoil.	Increase maintenance frequency for topsoil cover. Combine methods, such as mulch plus tackifier.
	Stabilize exposed soils within the timeframes established in the 1200-C permit. Stabilize exposed soils in stages based on site conditions and weather.	Stabilize exposed soils more frequently, even if additional work is anticipated within the timeframe established in the 1200-C permit. Reapply stabilization measures following any additional disturbances.
	Temporarily stabilize exposed surfaces to prohibit significant and sustained visible fugitive dust from wind erosion. Utilize BMPs such as mulch, hydromulch with or without seeds, tackifier, spreading stone or gravel, and trackwalking.	Combine stabilization methods, such as mulch plus tackifier, or trackwalking plus hydromulch. Increase frequency of maintenance of stabilization.
	Seed exposed surfaces during the appropriate season with approved temporary or permanent seed mixes.	Reapply seed to newly disturbed areas or areas with poor germination. Use temporary seeding even if additional work is anticipated before final stabilization. Use irrigation to enhance seeding success.
	Gate seals should be tight on dump trucks. Soil load shall be kept below 6 inches of the freeboard of the truck. Drop heights shall be minimized when loaders dump soil into trucks.	Cover haul trucks with a tarp or other suitable cover.

Attachment 2: EPA Method 22

State of Oregon Department of Environmental Quality

OAR 340-208-0210

EPA Method 22

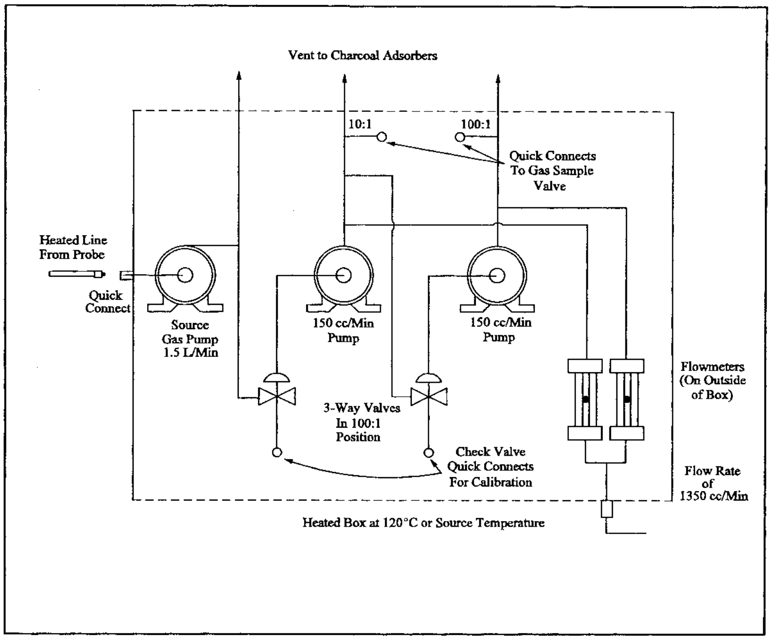


Figure 18-13. Schematic Diagram of the Heated Box Required for Dilution of Sample Gas.

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST

[Respond with initials or number as appropriate]

1. Presurvey data:
    A. Grab sample collected .... ☐ ______
        B. Grab sample analyzed for composition .... ☐ ______
        Method GC .... ☐ ______
            GC/MS .... ☐ ______
            Other .... ☐ ______
    C. GC-FID analysis performed .... ☐ ______
2. Laboratory calibration data:
    A. Calibration curves prepared .... ☐ ______
        Number of components .... ☐ ______
        Number of concentrations/component (3 required). ☐ ______
    B. Audit samples (optional):
    Analysis completed .... ☐ ______
    Verified for concentration .... ☐ ______
    OK obtained for field work .... ☐ ______
3. Sampling procedures:
    A. Method:
        Bag sample .... ☐ ______
        Direct interface .... ☐ ______
        Dilution interface .... ☐ ______
    B. Number of samples collected .... ☐ ______
4. Field Analysis:
    A. Total hydrocarbon analysis performed .... ☐ ______
    B. Calibration curve prepared .... ☐ ______
        Number of components .... ☐ ______
        Number of concentrations per component (3 required). ☐ ______

Gaseous Organic Sampling and Analysis Data

Date ____________________________

Location ____________________________

Plant ____________________________

GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST (RESPOND WITH INITIALS OR NUMBER AS APPROPRIATE)

1. Pre-survey data	Date
A. Grab sample collected	______
B. Grab sample analyzed for composition	______
Method GC	______
GC/MS	______
Other____________________	______
C. GC–FID analysis performed	______
2. Laboratory calibration curves prepared	______
A. Number of components	______
B. Number of concentrations per component (3 required)	______
C. OK obtained for field work	______
3. Sampling procedures.	
A. Method.	
Bag sample	______
Direct interface	______
Dilution interface	______
B. Number of samples collected	______
4. Field Analysis.	
A. Total hydrocarbon analysis performed	______
B. Calibration curve prepared	______
Number of components	______
Number of concentrations per component (3 required)	______

Figure 18–14. Sampling and Analysis Sheet

[36 FR 24877, Dec. 23, 1971]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting appendix A–6 to part 60, see the List of CFR sections Affected, which appears in the Finding Aids section of the printed volume and at *www.fdsys.gov.*

APPENDIX A–7 TO PART 60—TEST METHODS 19 THROUGH 25E

Method 19—Determination of sulfur dioxide removal efficiency and particulate, sulfur dioxide and nitrogen oxides emission rates

Method 20—Determination of nitrogen oxides, sulfur dioxide, and diluent emissions from stationary gas turbines

Method 21—Determination of volatile organic compound leaks

Method 22—Visual determination of fugitive emissions from material sources and smoke emissions from flares

Method 23—Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans From Stationary Sources

Method 24—Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

Method 24A—Determination of volatile matter content and density of printing inks and related coatings

Method 25—Determination of total gaseous nonmethane organic emissions as carbon

Method 25A—Determination of total gaseous organic concentration using a flame ionization analyzer

Method 25B—Determination of total gaseous organic concentration using a nondispersive infrared analyzer

Method 25C—Determination of nonmethane organic compounds (NMOC) in MSW landfill gases

Method 25D—Determination of the Volatile Organic Concentration of Waste Samples

Method 25E—Determination of Vapor Phase Organic Concentration in Waste Samples

The test methods in this appendix are referred to in §60.8 (Performance Tests) and §60.11 (Compliance With Standards and Maintenance Requirements) of 40 CFR part 60, subpart A (General Provisions). Specific uses of these test methods are described in the standards of performance contained in the subparts, beginning with Subpart D.

Within each standard of performance, a section title ''Test Methods and Procedures'' is provided to: (1) Identify the test methods to be used as reference methods to the facility subject to the respective standard and (2) identify any special instructions or conditions to be followed when applying a method to the respective facility. Such instructions (for example, establish sampling rates, volumes, or temperatures) are to be used either in addition to, or as a substitute for procedures in a test method. Similarly, for sources subject to emission monitoring requirements, specific instructions pertaining to any use of a test method as a reference method are provided in the subpart or in Appendix B.

Inclusion of methods in this appendix is not intended as an endorsement or denial of their applicability to sources that are not subject to standards of performance. The methods are potentially applicable to other sources; however, applicability should be confirmed by careful and appropriate evaluation of the conditions prevalent at such sources.

The approach followed in the formulation of the test methods involves specifications for equipment, procedures, and performance. In concept, a performance specification approach would be preferable in all methods because this allows the greatest flexibility to the user. In practice, however, this approach is impractical in most cases because performance specifications cannot be established. Most of the methods described herein, therefore, involve specific equipment specifications and procedures, and only a few methods in this appendix rely on performance criteria.

Minor changes in the test methods should not necessarily affect the validity of the results and it is recognized that alternative and equivalent methods exist. section 60.8 provides authority for the Administrator to specify or approve (1) equivalent methods, (2) alternative methods, and (3) minor changes in the methodology of the test methods. It should be clearly understood that unless otherwise identified all such methods and changes must have prior approval of the Administrator. An owner employing such methods or deviations from the test methods without obtaining prior approval does so at the risk of subsequent disapproval and retesting with approved methods.

Within the test methods, certain specific equipment or procedures are recognized as being acceptable or potentially acceptable and are specifically identified in the methods. The items identified as acceptable options may be used without approval but must be identified in the test report. The potentially approvable options are cited as ''subject to the approval of the Administrator'' or as ''or equivalent.'' Such potentially approvable techniques or alternatives may be used at the discretion of the owner without prior approval. However, detailed descriptions for applying these potentially approvable techniques or alternatives are not provided in the test methods. Also, the potentially approvable options are not necessarily acceptable in all applications. Therefore, an owner electing to use such potentially approvable techniques or alternatives is responsible for: (1) assuring that the techniques or alternatives are in fact applicable and are properly executed; (2) including a written description of the alternative method in the test report (the written method must be clear and must be capable of being performed without additional instruction, and the degree of detail should be similar to the detail contained in the test methods); and (3) providing any rationale or supporting data necessary to show the validity of the alternative in the particular application. Failure to meet these requirements can result in the Administrator's disapproval of the alternative.

METHOD 19—DETERMINATION OF SULFUR DIOXIDE REMOVAL EFFICIENCY AND PARTICULATE MATTER, SULFUR DIOXIDE, AND NITROGEN OXIDE EMISSION RATES

1.0 Scope and Application

1.1 Analytes. This method provides data reduction procedures relating to the following pollutants, but does not include any sample collection or analysis procedures.

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X), including:		
Nitric oxide (NO)	10102–43–9	N/A
Nitrogen dioxide (NO_2)	10102–44–0.	
Particulate matter (PM)	None assigned	N/A
Sulfur dioxide (SO_2)	7499–09–05	N/A

1.2 Applicability. Where specified by an applicable subpart of the regulations, this method is applicable for the determination of (a) PM, SO_2, and NO_X emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions.

2.0 Summary of Method

2.1 Emission Rates. Oxygen (O_2) or carbon dioxide (CO_2) concentrations and appropriate F factors (ratios of combustion gas volumes to heat inputs) are used to calculate pollutant emission rates from pollutant concentrations.

2.2 Sulfur Reduction Efficiency and SO_2 Removal Efficiency. An overall SO_2 emission reduction efficiency is computed from the efficiency of fuel pretreatment systems, where applicable, and the efficiency of SO_2 control devices.

2.2.1 The sulfur removal efficiency of a fuel pretreatment system is determined by fuel sampling and analysis of the sulfur and heat contents of the fuel before and after the pretreatment system.

2.2.2 The SO_2 removal efficiency of a control device is determined by measuring the SO_2 rates before and after the control device.

2.2.2.1 The inlet rates to SO_2 control systems (or, when SO_2 control systems are not used, SO_2 emission rates to the atmosphere) are determined by fuel sampling and analysis.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety [Reserved]

6.0 Equipment and Supplies [Reserved]

7.0 Reagents and Standards [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transport [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedures [Reserved]

12.0 Data Analysis and Calculations

12.1 Nomenclature

B_{wa} = Moisture fraction of ambient air, percent.

B_{ws} = Moisture fraction of effluent gas, percent.

%C = Concentration of carbon from an ultimate analysis of fuel, weight percent.

C_d = Pollutant concentration, dry basis, ng/scm (lb/scf)

$\%CO_{2d}$,$\%CO_{2w}$ = Concentration of carbon dioxide on a dry and wet basis, respectively, percent.

C_w = Pollutant concentration, wet basis, ng/scm (lb/scf).

D = Number of sampling periods during the performance test period.

E = Pollutant emission rate, ng/J (lb/million Btu).

E_a = Average pollutant rate for the specified performance test period, ng/J (lb/million Btu).

E_{ao}, E_{ai} = Average pollutant rate of the control device, outlet and inlet, respectively, for the performance test period, ng/J (lb/million Btu).

E_{bi} = Pollutant rate from the steam generating unit, ng/J (lb/million Btu)

E_{bo} = Pollutant emission rate from the steam generating unit, ng/J (lb/million Btu).

E_{ci} = Pollutant rate in combined effluent, ng/J (lb/million Btu).

E_{co} = Pollutant emission rate in combined effluent, ng/J (lb/million Btu).

E_d = Average pollutant rate for each sampling period (*e.g.*, 24-hr Method 6B sample or 24-hr fuel sample) or for each fuel lot (*e.g.*, amount of fuel bunkered), ng/J (lb/million Btu).

E_{di} = Average inlet SO_2 rate for each sampling period d, ng/J (lb/million Btu)

E_g = Pollutant rate from gas turbine, ng/J (lb/million Btu).

E_{ga} = Daily geometric average pollutant rate, ng/J (lbs/million Btu) or ppm corrected to 7 percent O_2.

E_{jo},E_{ji} = Matched pair hourly arithmetic average pollutant rate, outlet and inlet, respectively, ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

E_h = Hourly average pollutant, ng/J (lb/million Btu).

E_{hj} = Hourly arithmetic average pollutant rate for hour ''j,'' ng/J (lb/million Btu) or ppm corrected to 7 percent O_2.

EXP = Natural logarithmic base (2.718) raised to the value enclosed by brackets.

F_d, F_w, F_c = Volumes of combustion components per unit of heat content, scm/J (scf/million Btu).

GCV = Gross calorific value of the fuel consistent with the ultimate analysis, kJ/kg (Btu/lb).

GCV_p, GCV_r = Gross calorific value for the product and raw fuel lots, respectively, dry basis, kJ/kg (Btu/lb).

%H = Concentration of hydrogen from an ultimate analysis of fuel, weight percent.

H = Total number of operating hours for which pollutant rates are determined in the performance test period.

H_b = Heat input rate to the steam generating unit from fuels fired in the steam generating unit, J/hr (million Btu/hr).

H_g = Heat input rate to gas turbine from all fuels fired in the gas turbine, J/hr (million Btu/hr).

%H_2O = Concentration of water from an ultimate analysis of fuel, weight percent.

H_r = Total numbers of hours in the performance test period (*e.g.*, 720 hours for 30-day performance test period).

K = Conversion factor, 10^{-5} (kJ/J)/(%) [10^6 Btu/million Btu].

K_c = (9.57 scm/kg)/% [(1.53 scf/lb)/%].

K_{cc} = (2.0 scm/kg)/% [(0.321 scf/lb)/%].

K_{hd} = (22.7 scm/kg)/% [(3.64 scf/lb)/%].

K_{hw} = (34.74 scm/kg)/% [(5.57 scf/lb)/%].

K_n = (0.86 scm/kg)/% [(0.14 scf/lb)/%].

K_o = (2.85 scm/kg)/% [(0.46 scf/lb)/%].

K_s = (3.54 scm/kg)/% [(0.57 scf/lb)/%].

K_w = (1.30 scm/kg)/% [(0.21 scf/lb)/%].

ln = Natural log of indicated value.

L_p,L_r = Weight of the product and raw fuel lots, respectively, metric ton (ton).

%N = Concentration of nitrogen from an ultimate analysis of fuel, weight percent.

N = Number of fuel lots during the averaging period.

n = Number of fuels being burned in combination.

n_d = Number of operating hours of the affected facility within the performance test period for each E_d determined.

n_t = Total number of hourly averages for which paired inlet and outlet pollutant rates are available within the 24-hr midnight to midnight daily period.

%O = Concentration of oxygen from an ultimate analysis of fuel, weight percent.

%O_{2d}, %O_{2w} = Concentration of oxygen on a dry and wet basis, respectively, percent.

P_s = Potential SO_2 emissions, percent.

%R_f = SO_2 removal efficiency from fuel pretreatment, percent.

%R_g = SO_2 removal efficiency of the control device, percent.

%R_{ga} = Daily geometric average percent reduction.

%R_o = Overall SO_2 reduction, percent.

%S = Sulfur content of as-fired fuel lot, dry basis, weight percent.

S_e = Standard deviation of the hourly average pollutant rates for each performance test period, ng/J (lb/million Btu).

%S_f = Concentration of sulfur from an ultimate analysis of fuel, weight percent.

S_i = Standard deviation of the hourly average inlet pollutant rates for each performance test period, ng/J (lb/million Btu).

S_o = Standard deviation of the hourly average emission rates for each performance test period, ng/J (lb/million Btu).

%S_p, %S_r = Sulfur content of the product and raw fuel lots respectively, dry basis, weight percent.

$t_{0.95}$ = Values shown in Table 19–3 for the indicated number of data points n.

X_k = Fraction of total heat input from each type of fuel k.

12.2 Emission Rates of PM, SO_2, and NO_X. Select from the following sections the applicable procedure to compute the PM, S_{O2}, or NO_X emission rate (E) in ng/J (lb/million Btu). The pollutant concentration must be in ng/scm (lb/scf) and the F factor must be in scm/J (scf/million Btu). If the pollutant concentration (C) is not in the appropriate units, use Table 19–1 in section 17.0 to make the proper conversion. An F factor is the ratio of the gas volume of the products of combustion to the heat content of the fuel. The dry F factor (F_d) includes all components of combustion less water, the wet F factor (F_w) includes all components of combustion, and the carbon F factor (F_c) includes only carbon dioxide.

NOTE: Since F_w factors include water resulting only from the combustion of hydrogen in the fuel, the procedures using F_w factors are not applicable for computing E from steam generating units with wet scrubbers or with other processes that add water (*e.g.*, steam injection).

12.2.1 Oxygen-Based F Factor, Dry Basis. When measurements are on a dry basis for both O (%O_{2d}) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_d \frac{20.9}{\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-1}$$

12.2.2 Oxygen-Based F Factor, Wet Basis. When measurements are on a wet basis for both O_2 (%O_{2w}) and pollutant (C_w) concentrations, use either of the following:

12.2.2.1 If the moisture fraction of ambient air (B_{wa}) is measured:

$$E = C_w F_w \frac{20.9}{\left[20.9\left(1 - B_{wa}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-2}$$

Instead of actual measurement, B_{wa} may be estimated according to the procedure below.

NOTE: The estimates are selected to ensure that negative errors will not be larger than −1.5 percent. However, positive errors, or over-estimation of emissions by as much as 5 percent may be introduced depending upon the geographic location of the facility and the associated range of ambient moisture.

12.2.2.1.1 B_{wa} = 0.027. This value may be used at any location at all times.

12.2.2.1.2 B_{wa} = Highest monthly average of B_{wa} that occurred within the previous calendar year at the nearest Weather Service Station. This value shall be determined annually and may be used as an estimate for the entire current calendar year.

12.2.2.1.3 B_{wa} = Highest daily average of Bwa that occurred within a calendar month at the nearest Weather Service Station, calculated from the data from the past 3 years. This value shall be computed for each month and may be used as an estimate for the current respective calendar month.

12.2.2.2 If the moisture fraction (B_{ws}) of the effluent gas is measured:

$$E = C_w F_d \frac{20.9}{\left[20.9\left(1 - B_{ws}\right) - \%O_{2w}\right]} \qquad \text{Eq. 19-3}$$

12.2.3 Oxygen-Based F Factor, Dry/Wet Basis.

12.2.3.1 When the pollutant concentration is measured on a wet basis (C_w) and O_2 concentration is measured on a dry basis ($\%O_{2d}$), use the following equation:

$$E = \frac{\left(C_w F_d\right)\left(20.9\right)}{\left(1 - B_{ws}\right)\left(20.9 - \%O_{2d}\right)} \qquad \text{Eq. 19-4}$$

12.2.3.2 When the pollutant concentration is measured on a dry basis (C_d) and the O_2 concentration is measured on a wet basis ($\%O_{2w}$), use the following equation:

$$E = \frac{C_d F_d 20.9}{\dfrac{\left(20.9 - \%O_{2w}\right)}{\left(1 - B_{ws}\right)}} \qquad \text{Eq. 19-5}$$

12.2.4 Carbon Dioxide-Based F Factor, Dry Basis. When measurements are on a dry basis for both CO_2 ($\%CO_{2d}$) and pollutant (C_d) concentrations, use the following equation:

$$E = C_d F_c \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-6}$$

12.2.5 Carbon Dioxide-Based F Factor, Wet Basis. When measurements are on a wet basis for both CO_2 ($\%CO_{2w}$) and pollutant (C_w) concentrations, use the following equation:

$$E = C_w F_c \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-7}$$

12.2.6 Carbon Dioxide-Based F Factor, Dry/Wet Basis.

12.2.6.1 When the pollutant concentration is measured on a wet basis (C_w) and CO_2 concentration is measured on a dry basis ($\%CO_{2d}$), use the following equation:

$$E = \frac{C_w F_c}{\left(1 - B_{ws}\right)} \frac{100}{\%CO_{2d}} \qquad \text{Eq. 19-8}$$

12.2.6.2 When the pollutant concentration is measured on a dry basis (C_d) and CO_2 concentration is measured on a wet basis ($\%CO_{2w}$), use the following equation:

$$E = C_d F_c \left(1 - B_{ws}\right) \frac{100}{\%CO_{2w}} \qquad \text{Eq. 19-9}$$

12.2.7 Direct-Fired Reheat Fuel Burning. The effect of direct-fired reheat fuel burning (for the purpose of raising the temperature of the exhaust effluent from wet scrubbers to above the moisture dew-point) on emission rates will be less than 1.0 percent and, therefore, may be ignored.

12.2.8 Combined Cycle-Gas Turbine Systems. For gas turbine-steam generator combined cycle systems, determine the emissions from the steam generating unit or the percent reduction in potential SO_2 emissions as follows:

12.2.8.1 Compute the emission rate from the steam generating unit using the following equation:

$$E_{bo} = E_{co} + \frac{H_g}{H_b}\left(E_{co} - E_g\right) \qquad \text{Eq. 19-10}$$

12.2.8.1.1 Use the test methods and procedures section of 40 CFR Part 60, Subpart GG to obtain E_{co} and E_g. Do not use F_w factors for determining E_g or E_{co}. If an SO_2 control device is used, measure E_{co} after the control device.

12.2.8.1.2 Suitable methods shall be used to determine the heat input rates to the steam generating units (H_b) and the gas turbine (H_g).

12.2.8.2 If a control device is used, compute the percent of potential SO_2 emissions (P_s) using the following equations:

$$E_{bi} = E_{ci} - \frac{H_g}{H_b}\left(E_{ci} - E_g\right) \qquad \text{Eq. 19-11}$$

$$P_s = 100\left(1 - \frac{E_{bo}}{E_{bi}}\right) \qquad \text{Eq. 19-12}$$

NOTE: Use the test methods and procedures section of Subpart GG to obtain E_{ci} and E_g. Do not use F_w factors for determining E_g or E_{ci}.

12.3 F Factors. Use an average F factor according to section 12.3.1 or determine an applicable F factor according to section 12.3.2. If combined fuels are fired, prorate the applicable F factors using the procedure in section 12.3.3.

12.3.1 Average F Factors. Average F factors (F_d, F_w, or F_c) from Table 19–2 in section 17.0 may be used.

12.3.2 Determined F Factors. If the fuel burned is not listed in Table 19–2 or if the owner or operator chooses to determine an F factor rather than use the values in Table 19–2, use the procedure below:

12.3.2.1 Equations. Use the equations below, as appropriate, to compute the F factors:

$$F_d = \frac{K\left(K_{hd}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O\right)}{GCV} \qquad \text{Eq. 19-13}$$

$$F_w = \frac{K\left[K_{hw}\%H + K_c\%C + K_s\%S + K_n\%N - K_o\%O + K_w\%H_2O\right]}{GCV_w} \qquad \text{Eq. 19-14}$$

$$F_c = \frac{K\left(K_{cc}\%C\right)}{GCV} \qquad \text{Eq. 19-15}$$

NOTE: Omit the $\%H_2O$ term in the equations for F_w if %H and %O include the unavailable hydrogen and oxygen in the form of H_2O.)

12.3.2.2 Use applicable sampling procedures in section 12.5.2.1 or 12.5.2.2 to obtain samples for analyses.

12.3.2.3 Use ASTM D 3176–74 or 89 (all cited ASTM standards are incorporated by reference—see § 60.17) for ultimate analysis of the fuel.

12.3.2.4 Use applicable methods in section 12.5.2.1 or 12.5.2.2 to determine the heat content of solid or liquid fuels. For gaseous fuels, use ASTM D 1826–77 or 94 (incorporated by reference—see § 60.17) to determine the heat content.

12.3.3 F Factors for Combination of Fuels. If combinations of fuels are burned, use the following equations, as applicable unless otherwise specified in an applicable subpart:

$$F_d = \sum_{k=1}^{n}\left(X_k F_{dk}\right) \qquad \text{Eq. 19-16}$$

$$F_w = \sum_{k=1}^{n}\left(X_k F_{wk}\right) \qquad \text{Eq. 19-17}$$

$$F_c = \sum_{k=1}^{n}\left(X_k F_{ck}\right) \qquad \text{Eq. 19-18}$$

12.4 Determination of Average Pollutant Rates.

12.4.1 Average Pollutant Rates from Hourly Values. When hourly average pollutant rates (E_h), inlet or outlet, are obtained (*e.g.*, CEMS values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{1}{H}\sum_{j=1}^{n} E_{hj} \qquad \text{Eq. 19-19}$$

12.4.2 Average Pollutant Rates from Other than Hourly Averages. When pollutant rates are determined from measured values representing longer than 1-hour periods (*e.g.*, daily fuel sampling and analyses or Method 6B values), or when pollutant rates are determined from combinations of 1-hour and longer than 1-hour periods (*e.g.*, CEMS and Method 6B values), compute the average pollutant rate (E_a) for the performance test period (*e.g.*, 30 days) specified in the applicable regulation using the following equation:

$$E_a = \frac{\sum_{j=1}^{D}\left(n_d E_d\right)_j}{\sum_{j=1}^{D} n_{dj}} \qquad \text{Eq. 19-20}$$

12.4.3 Daily Geometric Average Pollutant Rates from Hourly Values. The geometric average pollutant rate (E_{ga}) is computed using the following equation:

$$E_{ga} = \exp\left[\frac{1}{n_t}\sum_{j=1}^{n_t}\left[\ln\left(E_{hj}\right)\right]\right] \qquad \text{Eq. 19-21}$$

12.5 Determination of Overall Reduction in Potential Sulfur Dioxide Emission.

12.5.1 Overall Percent Reduction. Compute the overall percent SO_2 reduction ($\%R_o$) using the following equation:

$$\%R_o = 100\left[1.0 - \left(1.0 - \frac{\%R_f}{100}\right)\left(1.0 - \frac{\%R_g}{100}\right)\right] \qquad \text{Eq. 19-22}$$

12.5.2 Pretreatment Removal Efficiency (Optional). Compute the SO_2 removal efficiency from fuel pretreatment ($\%R_f$) for the averaging period (*e.g.*, 90 days) as specified in the applicable regulation using the following equation:

$$\%R_f = 100\left[1.0 - \frac{\sum_{j=1}^{N}\left(\frac{\%S_{pj}}{GCV_{pj}}\right)L_{pj}}{\sum_{j=1}^{N}\left(\frac{\%S_{rj}}{GCV_{rj}}\right)L_{rj}}\right] \qquad \text{Eq. 19-23}$$

NOTE: In calculating $\%R_f$, include %S and GCV values for all fuel lots that are not pretreated and are used during the averaging period.

12.5.2.1 Solid Fossil (Including Waste) Fuel/Sampling and Analysis.

NOTE: For the purposes of this method, raw fuel (coal or oil) is the fuel delivered to the desulfurization (pretreatment) facility. For oil, the input oil to the oil desulfurization process (*e.g.*, hydrotreatment) is considered to be the raw fuel.

12.5.2.1.1 Sample Increment Collection. Use ASTM D 2234–76, 96, 97a, or 98 (incorporated by reference—see §60.17), Type I, Conditions A, B, or C, and systematic spacing. As used in this method, systematic spacing is intended to include evenly spaced increments in time or increments based on equal weights of coal passing the collection area. As a minimum, determine the number and weight of increments required per gross sample representing each coal lot according to Table 2 or Paragraph 7.1.5.2 of ASTM D 2234. Collect one gross sample for each lot of raw coal and one gross sample for each lot of product coal.

12.5.2.1.2 ASTM Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of product coal is the weight of product coal from one type of raw coal. The lot size of raw coal is the weight of raw coal used to produce one lot of product coal. Typically, the lot size is the weight of coal processed in a 1-day (24-hour) period. If more than one type of coal is treated and produced in 1 day, then gross samples must be collected and analyzed for each type of coal. A coal lot size equaling the 90-day quarterly fuel quantity for a steam generating unit may be used if representative sampling can be conducted for each raw coal and product coal.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.1.3 Gross Sample Analysis. Use ASTM D 2013–72 or 86 to prepare the sample, ASTM D 3177–75 or 89 or ASTM D 4239–85, 94, or 97 to determine sulfur content (%S), ASTM D 3173–73 or 87 to determine moisture content, and ASTM D 2015–77 (Reapproved 1978) or 96, D 3286–85 or 96, or D 5865–98 or 10 to determine gross calorific value (GCV) (all standards cited are incorporated by reference—see §60.17 for acceptable versions of the standards) on a dry basis for each gross sample.

12.5.2.2 Liquid Fossil Fuel-Sampling and Analysis. See Note under section 12.5.2.1.

12.5.2.2.1 Sample Collection. Follow the procedures for continuous sampling in ASTM D 270 or D 4177–95 (incorporated by reference—see §60.17) for each gross sample from each fuel lot.

12.5.2.2.2 Lot Size. For the purpose of section 12.5.2 (fuel pretreatment), the lot size of a product oil is the weight of product oil from one pretreatment facility and intended as one shipment (ship load, barge load, etc.). The lot size of raw oil is the weight of each crude liquid fuel type used to produce a lot of product oil.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

12.5.2.2.3 Sample Analysis. Use ASTM D 129–64, 78, or 95, ASTM D 1552–83 or 95, or ASTM D 4057–81 or 95 to determine the sulfur content (%S) and ASTM D 240–76 or 92 (all standards cited are incorporated by reference—see §60.17) to determine the GCV of each gross sample. These values may be assumed to be on a dry basis. The owner or operator of an affected facility may elect to determine the GCV by sampling the oil combusted on the first steam generating unit operating day of each calendar month and then using the lowest GCV value of the three GCV values per quarter for the GCV of all oil combusted in that calendar quarter.

12.5.2.3 Use appropriate procedures, subject to the approval of the Administrator, to determine the fraction of total mass input derived from each type of fuel.

12.5.3 Control Device Removal Efficiency. Compute the percent removal efficiency ($\%R_g$) of the control device using the following equation:

$$\%R_g = 100\left(1.0 - \frac{E_{ao}}{E_{ai}}\right) \qquad \text{Eq. 19-24}$$

12.5.3.1 Use continuous emission monitoring systems or test methods, as appropriate, to determine the outlet SO_2 rates and, if appropriate, the inlet SO_2 rates. The rates may be determined as hourly (E_h) or other sampling period averages (E_d). Then, compute the average pollutant rates for the performance test period (E_{ao} and E_{ai}) using the procedures in section 12.4.

12.5.3.2 As an alternative, as-fired fuel sampling and analysis may be used to determine inlet SO_2 rates as follows:

12.5.3.2.1 Compute the average inlet SO_2 rate (E_{di}) for each sampling period using the following equation:

$$E_{di} = K\frac{\%S}{GCV} \qquad \text{Eq. 19-25}$$

Where:

$$K = 2\times10^{7}\left(\frac{\text{ng } SO_2}{\%S}\right)\left(\frac{(\text{kJ})}{\text{J}}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^{4}\left(\frac{\text{lb } SO_2}{\%S}\right)\left(\frac{\text{Btu}}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4 to determine the average inlet SO_2 rate for the performance test period (E_{ai}).

12.5.3.2.2 Collect the fuel samples from a location in the fuel handling system that provides a sample representative of the fuel bunkered or consumed during a steam generating unit operating day. For the purpose of as-fired fuel sampling under section 12.5.3.2 or section 12.6, the lot size for coal is the weight of coal bunkered or consumed during each steam generating unit operating day. The lot size for oil is the weight of oil supplied to the ‘‘day’’ tank or consumed during each steam generating unit operating day. For reporting and calculation purposes, the gross sample shall be identified with the calendar day on which sampling began. For steam generating unit operating days when a coal-fired steam generating unit is operated without coal being added to the bunkers, the coal analysis from the previous ‘‘as bunkered’’ coal sample shall be used until coal is bunkered again. For steam generating unit operating days when an oil-fired steam generating unit is operated without oil being added to the oil ‘‘day’’ tank, the oil analysis from the previous day shall be used until the ‘‘day’’ tank is filled again. Alternative definitions of fuel lot size may be used, subject to prior approval of the Administrator.

12.5.3.2.3 Use ASTM procedures specified in section 12.5.2.1 or 12.5.2.2 to determine %S and GCV.

12.5.4 Daily Geometric Average Percent Reduction from Hourly Values. The geometric average percent reduction ($\%R_{ga}$) is computed using the following equation:

$$\%R_{ga} = 100\left[1 - \text{EXP}\left(\frac{1}{n_t}\sum_{j=1}^{n_t} 1\text{n}\frac{E_{jo}}{E_{ji}}\right)\right] \qquad \text{Eq. 19-26}$$

NOTE: The calculation includes only paired data sets (hourly average) for the inlet and outlet pollutant measurements.

12.6 Sulfur Retention Credit for Compliance Fuel. If fuel sampling and analysis procedures in section 12.5.2.1 are being used to determine average SO_2 emission rates (E_{as}) to the atmosphere from a coal-fired steam generating unit when there is no SO_2 control device, the following equation may be used to adjust the emission rate for sulfur retention credits (no credits are allowed for oil-fired systems) (E_{di}) for each sampling period using the following equation:

$$E_{di} = 0.97K \frac{\%S}{GDV} \qquad \text{Eq. 19-27}$$

Where:

$$K = 2\times10^7\left(\frac{\text{ng } SO_2}{\%S}\right)\left(\frac{kJ}{J}\right)\left(\frac{1}{\text{kg coal}}\right)\left[2\times10^4\left(\frac{\text{lb } SO_2}{\%S}\right)\left(\frac{Btu}{\text{million Btu}}\right)\left(\frac{1}{\text{lb coal}}\right)\right]$$

After calculating E_{di}, use the procedures in section 12.4.2 to determine the average SO_2 emission rate to the atmosphere for the performance test period (E_{ao}).

12.7 Determination of Compliance When Minimum Data Requirement Is Not Met.

12.7.1 Adjusted Emission Rates and Control Device Removal Efficiency. When the minimum data requirement is not met, the Administrator may use the following adjusted emission rates or control device removal efficiencies to determine compliance with the applicable standards.

12.7.1.1 Emission Rate. Compliance with the emission rate standard may be determined by using the lower confidence limit of the emission rate (E_{ao}*) as follows:

$$E_{ao}^{*} = E_{ao} - t_{0.95} S_o \qquad \text{Eq. 19-28}$$

12.7.1.2 Control Device Removal Efficiency. Compliance with the overall emission reduction ($\%R_o$) may be determined by using the lower confidence limit of the emission rate (E_{ao}*) and the upper confidence limit of the inlet pollutant rate (E_{ai}*) in calculating the control device removal efficiency ($\%R_g$) as follows:

$$\%R_g = 100\left(1.0 - \frac{E_{ao}^{*}}{E_{ai}^{*}}\right) \qquad \text{Eq. 19-29}$$

$$E_{ai}^{*} = E_{ai} + t_{0.95} S_i \qquad \text{Eq. 19-30}$$

12.7.2 Standard Deviation of Hourly Average Pollutant Rates. Compute the standard deviation (S_e) of the hourly average pollutant rates using the following equation:

$$S_e = \sqrt{\frac{1}{H} - \frac{1}{H_r}}\sqrt{\frac{\sum_{j=1}^{H}\left(E_{hj} - E_a\right)^2}{H-1}} \qquad \text{Eq. 19-31}$$

Equation 19–19 through 19–31 may be used to compute the standard deviation for both the outlet (S_o) and, if applicable, inlet (S_i) pollutant rates.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References [Reserved]

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION

From	To	Multiply by
g/scm	ng/scm	10^9
mg/scm	ng/scm	10^6
lb/scf	ng/scm	1.602×10^{13}

TABLE 19–1—CONVERSION FACTORS FOR CONCENTRATION—Continued

From	To	Multiply by
ppm SO_2	ng/scm	2.66×10^6
ppm NO_X	ng/scm	1.912×10^6
ppm SO_2	lb/scf	1.660×10^{-7}
ppm NO_X	lb/scf	1.194×10^{-7}

TABLE 19–2—F FACTORS FOR VARIOUS FUELS[1]

Fuel Type	F_d		F_w		F_c	
	dscm/J	dscf/10^6 Btu	wscm/J	wscf/10^6 Btu	scm/J	scf/10^6 Btu
Coal:						
Anthracite[2]	2.71×10^{-7}	10,100	2.83×10^{-7}	10,540	0.530×10^{-7}	1,970
Bituminus[2]	2.63×10^{-7}	9,780	2.86×10^{-7}	10,640	0.484×10^{-7}	1,800
Lignite	2.65×10^{-7}	9,860	3.21×10^{-7}	11,950	0.513×10^{-7}	1,910
Oil[3]	2.47×10^{-7}	9,190	2.77×10^{-7}	10,320	0.383×10^{-7}	1,420
Gas:.						
Natural	2.34×10^{-7}	8,710	2.85×10^{-7}	10,610	0.287×10^{-7}	1,040
Propane	2.34×10^{-7}	8,710	2.74×10^{-7}	10,200	0.321×10^{-7}	1,190
Butane	2.34×10^{-7}	8,710	2.79×10^{-7}	10,390	0.337×10^{-7}	1,250
Wood	2.48×10^{-7}	9,240			0.492×10^{-7}	1,830
Wood Bark	2.58×10^{-7}	9,600			0.516×10^{-7}	1,920
Municipal	2.57×10^{-7}	9,570			0.488×10^{-7}	1,820
Solid Waste						

[1] Determined at standard conditions: 20 °C (68 °F) and 760 mm Hg (29.92 in Hg)

[2] As classified according to ASTM D 388.

[3] Crude, residual, or distillate.

TABLE 19–3—VALUES FOR $T_{0.95}$*

n[1]	$t_{0.95}$	n[1]	$t_{0.95}$	n[1]	$t_{0.95}$
2	6.31	8	1.89	22–26	1.71
3	2.42	9	1.86	27–31	1.70
4	2.35	10	1.83	32–51	1.68
5	2.13	11	1.81	52–91	1.67
6	2.02	12–16	1.77	92–151	1.66
7	1.94	17–21	1.73	152 or more	1.65

[1] The values of this table are corrected for n-1 degrees of freedom. Use n equal to the number (H) of hourly average data points.

METHOD 20—DETERMINATION OF NITROGEN OXIDES, SULFUR DIOXIDE, AND DILUENT EMISSIONS FROM STATIONARY GAS TURBINES

1.0 Scope and Application

What is Method 20?

Method 20 contains the details you must follow when using an instrumental analyzer to determine concentrations of nitrogen oxides, oxygen, carbon dioxide, and sulfur dioxide in the emissions from stationary gas turbines. This method follows the specific instructions for equipment and performance requirements, supplies, sample collection and analysis, calculations, and data analysis in the methods listed in section 2.0.

1.1 Analytes. What does this method determine?

Analyte	CAS No.	Sensitivity
Nitrogen oxides (NO_X) as nitrogen dioxide:	10102–43–9	Typically <2% of Calibration Span.
Nitric oxide (NO)	10102–44–0	
Nitrogen dioxide NO_2.		
Diluent oxygen (O_2) or carbon dioxide (CO_2)		Typically <2% of Calibration Span.
Sulfur dioxide (SO_X)	7446–09–5	Typically <2% of Calibration Span.

1.2 Applicability. When is this method required? The use of Method 20 may be required by specific New Source Performance Standards, Clean Air Marketing rules, and State Implementation Plans and permits where

measuring SO_2, NO_X, CO_2, and/or O_2 concentrations in stationary gas turbines emissions are required. Other regulations may also require its use.

1.3 Data Quality Objectives. How good must my collected data be? Refer to section 1.3 of Method 7E.

2.0 Summary of Method

In this method, NO_X, O_2 (or CO_2), and SO_X are measured using the following methods found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 3A—Determination of Oxygen and Carbon Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(c) Method 6C—Determination of Sulfur Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(d) Method 7E—Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure).

(e) Method 19—Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates.

3.0 Definitions

Refer to section 3.0 of Method 7E for the applicable definitions.

4.0 Interferences

Refer to section 4.0 of Methods 3A, 6C, and 7E as applicable.

5.0 Safety

Refer to section 5.0 of Method 7E.

6.0 Equipment and Supplies

The measurement system design is shown in Figure 7E–1 of Method 7E. Refer to the appropriate methods listed in section 2.0 for equipment and supplies.

7.0 Reagents and Standards

Refer to the appropriate methods listed in section 2.0 for reagents and standards.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling Site and Sampling Points. Follow the procedures of section 8.1 of Method 7E. For the stratification test in section 8.1.2, determine the diluent-corrected pollutant concentration at each traverse point.

8.2 Initial Measurement System Performance Tests. You must refer to the appropriate methods listed in section 2.0 for the measurement system performance tests as applicable.

8.3 Interference Check. You must follow the procedures in section 8.3 of Method 3A or 6C, or section 8.2.7 of Method 7E (as appropriate).

8.4 Sample Collection. You must follow the procedures of section 8.4 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

8.5 Post-Run System Bias Check, Drift Assessment, and Alternative Dynamic Spike Procedure. You must follow the procedures of sections 8.5 and 8.6 of the appropriate methods listed in section 2.0. A test run must have a duration of at least 21 minutes.

9.0 Quality Control

Follow quality control procedures in section 9.0 of Method 7E.

10.0 Calibration and Standardization

Follow the procedures for calibration and standardization in section 10.0 of Method 7E.

11.0 Analytical Procedures

Because sample collection and analysis are performed together (see section 8), additional discussion of the analytical procedure is not necessary.

12.0 Calculations and Data Analysis

You must follow the procedures for calculations and data analysis in section 12.0 of the appropriate method listed in section 2.0. Follow the procedures in section 12.0 of Method 19 for calculating fuel-specific F factors, diluent-corrected pollutant concentrations, and emission rates.

13.0 Method Performance

The specifications for the applicable performance checks are the same as in section 13.0 of Method 7E.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures

Refer to section 16.0 of the appropriate method listed in section 2.0 for alternative procedures.

17.0 References

Refer to section 17.0 of the appropriate method listed in section 2.0 for references.

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Refer to section 18.0 of the appropriate method listed in section 2.0 for tables, diagrams, flowcharts, and validation data.

METHOD 21—DETERMINATION OF VOLATILE ORGANIC COMPOUND LEAKS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile Organic Compounds (VOC).	No CAS number assigned.

1.2 Scope. This method is applicable for the determination of VOC leaks from process equipment. These sources include, but are not limited to, valves, flanges and other connections, pumps and compressors, pressure relief devices, process drains, open-ended valves, pump and compressor seal system degassing vents, accumulator vessel vents, agitator seals, and access door seals.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A portable instrument is used to detect VOC leaks from individual sources. The instrument detector type is not specified, but it must meet the specifications and performance criteria contained in section 6.0. A leak definition concentration based on a reference compound is specified in each applicable regulation. This method is intended to locate and classify leaks only, and is not to be used as a direct measure of mass emission rate from individual sources.

3.0 Definitions

3.1 *Calibration gas* means the VOC compound used to adjust the instrument meter reading to a known value. The calibration gas is usually the reference compound at a known concentration approximately equal to the leak definition concentration.

3.2 *Calibration precision* means the degree of agreement between measurements of the same known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration.

3.3 *Leak definition concentration* means the local VOC concentration at the surface of a leak source that indicates that a VOC emission (leak) is present. The leak definition is an instrument meter reading based on a reference compound.

3.4 *No detectable emission* means a local VOC concentration at the surface of a leak source, adjusted for local VOC ambient concentration, that is less than 2.5 percent of the specified leak definition concentration. that indicates that a VOC emission (leak) is not present.

3.5 *Reference compound* means the VOC species selected as the instrument calibration basis for specification of the leak definition concentration. (For example, if a leak definition concentration is 10,000 ppm as methane, then any source emission that results in a local concentration that yields a meter reading of 10,000 on an instrument meter calibrated with methane would be classified as a leak. In this example, the leak definition concentration is 10,000 ppm and the reference compound is methane.)

3.6 *Response factor* means the ratio of the known concentration of a VOC compound to the observed meter reading when measured using an instrument calibrated with the reference compound specified in the applicable regulation.

3.7 *Response time* means the time interval from a step change in VOC concentration at the input of the sampling system to the time at which 90 percent of the corresponding final value is reached as displayed on the instrument readout meter.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Pollutants. Several of the compounds, leaks of which may be determined by this method, may be irritating or corrosive to tissues (*e.g.*, heptane) or may be toxic (*e.g.*, benzene, methyl alcohol). Nearly all are fire hazards. Compounds in emissions should be determined through familiarity with the source. Appropriate precautions can be found in reference documents, such as reference No. 4 in section 16.0.

6.0 Equipment and Supplies

A VOC monitoring instrument meeting the following specifications is required:

6.1 The VOC instrument detector shall respond to the compounds being processed. Detector types that may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption, and photoionization.

6.2 The instrument shall be capable of measuring the leak definition concentration specified in the regulation.

6.3 The scale of the instrument meter shall be readable to ±2.5 percent of the specified leak definition concentration.

6.4 The instrument shall be equipped with an electrically driven pump to ensure that a sample is provided to the detector at a constant flow rate. The nominal sample flow rate, as measured at the sample probe tip, shall be 0.10 to 3.0 l/min (0.004 to 0.1 ft^3/min) when the probe is fitted with a glass wool plug or filter that may be used to prevent plugging of the instrument.

6.5 The instrument shall be equipped with a probe or probe extension or sampling not to exceed 6.4 mm (¼ in) in outside diameter,

with a single end opening for admission of sample.

6.6 The instrument shall be intrinsically safe for operation in explosive atmospheres as defined by the National Electrical Code by the National Fire Prevention Association or other applicable regulatory code for operation in any explosive atmospheres that may be encountered in its use. The instrument shall, at a minimum, be intrinsically safe for Class 1, Division 1 conditions, and/or Class 2, Division 1 conditions, as appropriate, as defined by the example code. The instrument shall not be operated with any safety device, such as an exhaust flame arrestor, removed.

7.0 Reagents and Standards

7.1 Two gas mixtures are required for instrument calibration and performance evaluation:

7.1.1 Zero Gas. Air, less than 10 parts per million by volume (ppmv) VOC.

7.1.2 Calibration Gas. For each organic species that is to be measured during individual source surveys, obtain or prepare a known standard in air at a concentration approximately equal to the applicable leak definition specified in the regulation.

7.2 Cylinder Gases. If cylinder calibration gas mixtures are used, they must be analyzed and certified by the manufacturer to be within 2 percent accuracy, and a shelf life must be specified. Cylinder standards must be either reanalyzed or replaced at the end of the specified shelf life.

7.3 Prepared Gases. Calibration gases may be prepared by the user according to any accepted gaseous preparation procedure that will yield a mixture accurate to within 2 percent. Prepared standards must be replaced each day of use unless it is demonstrated that degradation does not occur during storage.

7.4 Mixtures with non-Reference Compound Gases. Calibrations may be performed using a compound other than the reference compound. In this case, a conversion factor must be determined for the alternative compound such that the resulting meter readings during source surveys can be converted to reference compound results.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Instrument Performance Evaluation. Assemble and start up the instrument according to the manufacturer's instructions for recommended warmup period and preliminary adjustments.

8.1.1 Response Factor. A response factor must be determined for each compound that is to be measured, either by testing or from reference sources. The response factor tests are required before placing the analyzer into service, but do not have to be repeated at subsequent intervals.

8.1.1.1 Calibrate the instrument with the reference compound as specified in the applicable regulation. Introduce the calibration gas mixture to the analyzer and record the observed meter reading. Introduce zero gas until a stable reading is obtained. Make a total of three measurements by alternating between the calibration gas and zero gas. Calculate the response factor for each repetition and the average response factor.

8.1.1.2 The instrument response factors for each of the individual VOC to be measured shall be less than 10 unless otherwise specified in the applicable regulation. When no instrument is available that meets this specification when calibrated with the reference VOC specified in the applicable regulation, the available instrument may be calibrated with one of the VOC to be measured, or any other VOC, so long as the instrument then has a response factor of less than 10 for each of the individual VOC to be measured.

8.1.1.3 Alternatively, if response factors have been published for the compounds of interest for the instrument or detector type, the response factor determination is not required, and existing results may be referenced. Examples of published response factors for flame ionization and catalytic oxidation detectors are included in References 1–3 of section 17.0.

8.1.2 Calibration Precision. The calibration precision test must be completed prior to placing the analyzer into service and at subsequent 3-month intervals or at the next use, whichever is later.

8.1.2.1 Make a total of three measurements by alternately using zero gas and the specified calibration gas. Record the meter readings. Calculate the average algebraic difference between the meter readings and the known value. Divide this average difference by the known calibration value and multiply by 100 to express the resulting calibration precision as a percentage.

8.1.2.2 The calibration precision shall be equal to or less than 10 percent of the calibration gas value.

8.1.3 Response Time. The response time test is required before placing the instrument into service. If a modification to the sample pumping system or flow configuration is made that would change the response time, a new test is required before further use.

8.1.3.1 Introduce zero gas into the instrument sample probe. When the meter reading has stabilized, switch quickly to the specified calibration gas. After switching, measure the time required to attain 90 percent of the final stable reading. Perform this test sequence three times and record the results. Calculate the average response time.

8.1.3.2 The instrument response time shall be equal to or less than 30 seconds. The instrument pump, dilution probe (if any), sample probe, and probe filter that will be used

during testing shall all be in place during the response time determination.

8.2 Instrument Calibration. Calibrate the VOC monitoring instrument according to section 10.0.

8.3 Individual Source Surveys.

8.3.1 Type I—Leak Definition Based on Concentration. Place the probe inlet at the surface of the component interface where leakage could occur. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained. Leave the probe inlet at this maximum reading location for approximately two times the instrument response time. If the maximum observed meter reading is greater than the leak definition in the applicable regulation, record and report the results as specified in the regulation reporting requirements. Examples of the application of this general technique to specific equipment types are:

8.3.1.1 Valves. The most common source of leaks from valves is the seal between the stem and housing. Place the probe at the interface where the stem exits the packing gland and sample the stem circumference. Also, place the probe at the interface of the packing gland take-up flange seat and sample the periphery. In addition, survey valve housings of multipart assembly at the surface of all interfaces where a leak could occur.

8.3.1.2 Flanges and Other Connections. For welded flanges, place the probe at the outer edge of the flange-gasket interface and sample the circumference of the flange. Sample other types of nonpermanent joints (such as threaded connections) with a similar traverse.

8.3.1.3 Pumps and Compressors. Conduct a circumferential traverse at the outer surface of the pump or compressor shaft and seal interface. If the source is a rotating shaft, position the probe inlet within 1 cm of the shaft-seal interface for the survey. If the housing configuration prevents a complete traverse of the shaft periphery, sample all accessible portions. Sample all other joints on the pump or compressor housing where leakage could occur.

8.3.1.4 Pressure Relief Devices. The configuration of most pressure relief devices prevents sampling at the sealing seat interface. For those devices equipped with an enclosed extension, or horn, place the probe inlet at approximately the center of the exhaust area to the atmosphere.

8.3.1.5 Process Drains. For open drains, place the probe inlet at approximately the center of the area open to the atmosphere. For covered drains, place the probe at the surface of the cover interface and conduct a peripheral traverse.

8.3.1.6 Open-ended Lines or Valves. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.7 Seal System Degassing Vents and Accumulator Vents. Place the probe inlet at approximately the center of the opening to the atmosphere.

8.3.1.8 Access door seals. Place the probe inlet at the surface of the door seal interface and conduct a peripheral traverse.

8.3.2 Type II—''No Detectable Emission''. Determine the local ambient VOC concentration around the source by moving the probe randomly upwind and downwind at a distance of one to two meters from the source. If an interference exists with this determination due to a nearby emission or leak, the local ambient concentration may be determined at distances closer to the source, but in no case shall the distance be less than 25 centimeters. Then move the probe inlet to the surface of the source and determine the concentration as outlined in section 8.3.1. The difference between these concentrations determines whether there are no detectable emissions. Record and report the results as specified by the regulation. For those cases where the regulation requires a specific device installation, or that specified vents be ducted or piped to a control device, the existence of these conditions shall be visually confirmed. When the regulation also requires that no detectable emissions exist, visual observations and sampling surveys are required. Examples of this technique are:

8.3.2.1 Pump or Compressor Seals. If applicable, determine the type of shaft seal. Perform a survey of the local area ambient VOC concentration and determine if detectable emissions exist as described in section 8.3.2.

8.3.2.2 Seal System Degassing Vents, Accumulator Vessel Vents, Pressure Relief Devices. If applicable, observe whether or not the applicable ducting or piping exists. Also, determine if any sources exist in the ducting or piping where emissions could occur upstream of the control device. If the required ducting or piping exists and there are no sources where the emissions could be vented to the atmosphere upstream of the control device, then it is presumed that no detectable emissions are present. If there are sources in the ducting or piping where emissions could be vented or sources where leaks could occur, the sampling surveys described in section 8.3.2 shall be used to determine if detectable emissions exist.

8.3.3 Alternative Screening Procedure.

8.3.3.1 A screening procedure based on the formation of bubbles in a soap solution that is sprayed on a potential leak source may be used for those sources that do not have continuously moving parts, that do not have surface temperatures greater than the boiling point or less than the freezing point of the soap solution, that do not have open

areas to the atmosphere that the soap solution cannot bridge, or that do not exhibit evidence of liquid leakage. Sources that have these conditions present must be surveyed using the instrument technique of section 8.3.1 or 8.3.2.

8.3.3.2 Spray a soap solution over all potential leak sources. The soap solution may be a commercially available leak detection solution or may be prepared using concentrated detergent and water. A pressure sprayer or squeeze bottle may be used to dispense the solution. Observe the potential leak sites to determine if any bubbles are formed. If no bubbles are observed, the source is presumed to have no detectable emissions or leaks as applicable. If any bubbles are observed, the instrument techniques of section 8.3.1 or 8.3.2 shall be used to determine if a leak exists, or if the source has detectable emissions, as applicable.

9.0 Quality Control

Section	Quality control measure	Effect
8.1.2	Instrument calibration precision check	Ensure precision and accuracy, respectively, of instrument response to standard.
10.0	Instrument calibration.	

10.0 Calibration and Standardization

10.1 Calibrate the VOC monitoring instrument as follows. After the appropriate warmup period and zero internal calibration procedure, introduce the calibration gas into the instrument sample probe. Adjust the instrument meter readout to correspond to the calibration gas value.

NOTE: If the meter readout cannot be adjusted to the proper value, a malfunction of the analyzer is indicated and corrective actions are necessary before use.

11.0 Analytical Procedures [Reserved]

12.0 Data Analyses and Calculations [Reserved]

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Dubose, D.A., and G.E. Harris. Response Factors of VOC Analyzers at a Meter Reading of 10,000 ppmv for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81051. September 1981.

2. Brown, G.E., *et al.* Response Factors of VOC Analyzers Calibrated with Methane for Selected Organic Compounds. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–022. May 1981.

3. DuBose, D.A. *et al.* Response of Portable VOC Analyzers to Chemical Mixtures. U.S. Environmental Protection Agency, Research Triangle Park, NC. Publication No. EPA 600/2–81–110. September 1981.

4. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 22—VISUAL DETERMINATION OF FUGITIVE EMISSIONS FROM MATERIAL SOURCES AND SMOKE EMISSIONS FROM FLARES

NOTE: This method is not inclusive with respect to observer certification. Some material is incorporated by reference from Method 9.

1.0 Scope and Application

This method is applicable for the determination of the frequency of fugitive emissions from stationary sources, only as specified in an applicable subpart of the regulations. This method also is applicable for the determination of the frequency of visible smoke emissions from flares.

2.0 Summary of Method

2.1 Fugitive emissions produced during material processing, handling, and transfer operations or smoke emissions from flares are visually determined by an observer without the aid of instruments.

2.2 This method is used also to determine visible smoke emissions from flares used for combustion of waste process materials.

2.3 This method determines the amount of time that visible emissions occur during the observation period (*i.e.*, the accumulated emission time). This method does not require that the opacity of emissions be determined. Since this procedure requires only the determination of whether visible emissions occur and does not require the determination of opacity levels, observer certification according to the procedures of Method 9 is not required. However, it is necessary that the observer is knowledgeable with respect to the general procedures for determining the presence of visible emissions. At a minimum, the observer must be trained and knowledgeable regarding the effects of background contrast, ambient lighting, observer position relative

to lighting, wind, and the presence of uncombined water (condensing water vapor) on the visibility of emissions. This training is to be obtained from written materials found in References 1 and 2 or from the lecture portion of the Method 9 certification course.

3.0 Definitions

3.1 *Emission frequency* means the percentage of time that emissions are visible during the observation period.

3.2 *Emission time* means the accumulated amount of time that emissions are visible during the observation period.

3.3 *Fugitive emissions* means emissions generated by an affected facility which is not collected by a capture system and is released to the atmosphere. This includes emissions that (1) escape capture by process equipment exhaust hoods; (2) are emitted during material transfer; (3) are emitted from buildings housing material processing or handling equipment; or (4) are emitted directly from process equipment.

3.4 *Observation period* means the accumulated time period during which observations are conducted, not to be less than the period specified in the applicable regulation.

3.5 *Smoke emissions* means a pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission.

4.0 Interferences

4.1 Occasionally, fugitive emissions from sources other than the affected facility (*e.g.*, road dust) may prevent a clear view of the affected facility. This may particularly be a problem during periods of high wind. If the view of the potential emission points is obscured to such a degree that the observer questions the validity of continuing observations, then the observations shall be terminated, and the observer shall clearly note this fact on the data form.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment

6.1 Stopwatches (two). Accumulative type with unit divisions of at least 0.5 seconds.

6.2 Light Meter. Light meter capable of measuring illuminance in the 50 to 200 lux range, required for indoor observations only.

7.0 Reagents and Supplies [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transfer [Reserved]

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

11.1 Selection of Observation Location. Survey the affected facility, or the building or structure housing the process to be observed, and determine the locations of potential emissions. If the affected facility is located inside a building, determine an observation location that is consistent with the requirements of the applicable regulation (*i.e.*, outside observation of emissions escaping the building/structure or inside observation of emissions directly emitted from the affected facility process unit). Then select a position that enables a clear view of the potential emission point(s) of the affected facility or of the building or structure housing the affected facility, as appropriate for the applicable subpart. A position at least 4.6 m (15 feet), but not more than 400 m (0.25 miles), from the emission source is recommended. For outdoor locations, select a position where the sunlight is not shining directly in the observer's eyes.

11.2 Field Records.

11.2.1 Outdoor Location. Record the following information on the field data sheet (Figure 22–1): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record also the estimated wind speed, wind direction, and sky condition. Sketch the process unit being observed, and note the observer location relative to the source and the sun. Indicate the potential and actual emission points on the sketch.

11.2.2 Indoor Location. Record the following information on the field data sheet (Figure 22–2): Company name, industry, process unit, observer's name, observer's affiliation, and date. Record as appropriate the type, location, and intensity of lighting on the data sheet. Sketch the process unit being observed, and note the observer location relative to the source. Indicate the potential and actual fugitive emission points on the sketch.

11.3 Indoor Lighting Requirements. For indoor locations, use a light meter to measure the level of illumination at a location as close to the emission source(s) as is feasible. An illumination of greater than 100 lux (10 foot candles) is considered necessary for proper application of this method.

11.4 Observations.

11.4.1 Procedure. Record the clock time when observations begin. Use one stopwatch to monitor the duration of the observation

period. Start this stopwatch when the observation period begins. If the observation period is divided into two or more segments by process shutdowns or observer rest breaks (see section 11.4.3), stop the stopwatch when a break begins and restart the stopwatch without resetting it when the break ends. Stop the stopwatch at the end of the observation period. The accumulated time indicated by this stopwatch is the duration of observation period. When the observation period is completed, record the clock time. During the observation period, continuously watch the emission source. Upon observing an emission (condensed water vapor is not considered an emission), start the second accumulative stopwatch; stop the watch when the emission stops. Continue this procedure for the entire observation period. The accumulated elapsed time on this stopwatch is the total time emissions were visible during the observation period (*i.e.,* the emission time.)

11.4.2 Observation Period. Choose an observation period of sufficient length to meet the requirements for determining compliance with the emission standard in the applicable subpart of the regulations. When the length of the observation period is specifically stated in the applicable subpart, it may not be necessary to observe the source for this entire period if the emission time required to indicate noncompliance (based on the specified observation period) is observed in a shorter time period. In other words, if the regulation prohibits emissions for more than 6 minutes in any hour, then observations may (optional) be stopped after an emission time of 6 minutes is exceeded. Similarly, when the regulation is expressed as an emission frequency and the regulation prohibits emissions for greater than 10 percent of the time in any hour, then observations may (optional) be terminated after 6 minutes of emission are observed since 6 minutes is 10 percent of an hour. In any case, the observation period shall not be less than 6 minutes in duration. In some cases, the process operation may be intermittent or cyclic. In such cases, it may be convenient for the observation period to coincide with the length of the process cycle.

11.4.3 Observer Rest Breaks. Do not observe emissions continuously for a period of more than 15 to 20 minutes without taking a rest break. For sources requiring observation periods of greater than 20 minutes, the observer shall take a break of not less than 5 minutes and not more than 10 minutes after every 15 to 20 minutes of observation. If continuous observations are desired for extended time periods, two observers can alternate between making observations and taking breaks.

11.5 Recording Observations. Record the accumulated time of the observation period on the data sheet as the observation period duration. Record the accumulated time emissions were observed on the data sheet as the emission time. Record the clock time the observation period began and ended, as well as the clock time any observer breaks began and ended.

12.0 Data Analysis and Calculations

If the applicable subpart requires that the emission rate be expressed as an emission frequency (in percent), determine this value as follows: Divide the accumulated emission time (in seconds) by the duration of the observation period (in seconds) or by any minimum observation period required in the applicable subpart, if the actual observation period is less than the required period, and multiply this quotient by 100.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

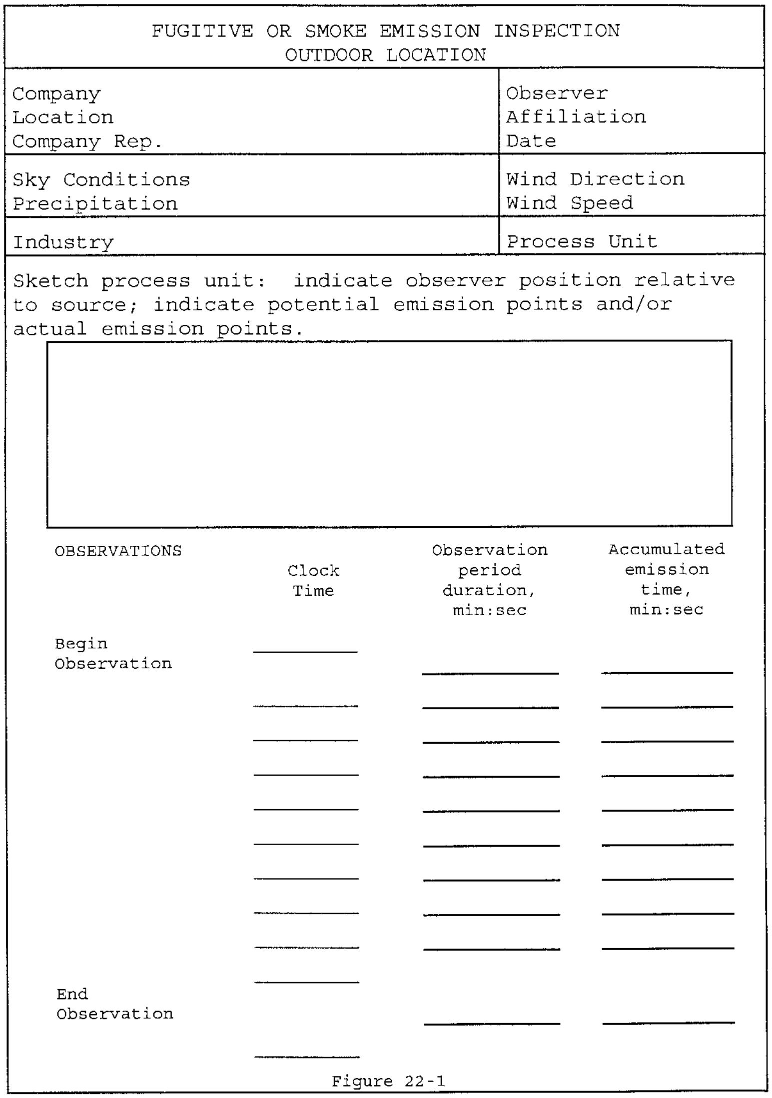
15.0 Waste Management [Reserved]

16.0 References

1. Missan, R., and A. Stein. Guidelines for Evaluation of Visible Emissions Certification, Field Procedures, Legal Aspects, and Background Material. EPA Publication No. EPA–340/1–75–007. April 1975.

2. Wohlschlegel, P., and D.E. Wagoner. Guideline for Development of a Quality Assurance Program: Volume IX—Visual Determination of Opacity Emissions from Stationary Sources. EPA Publication No. EPA–650/4–74–005i. November 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data



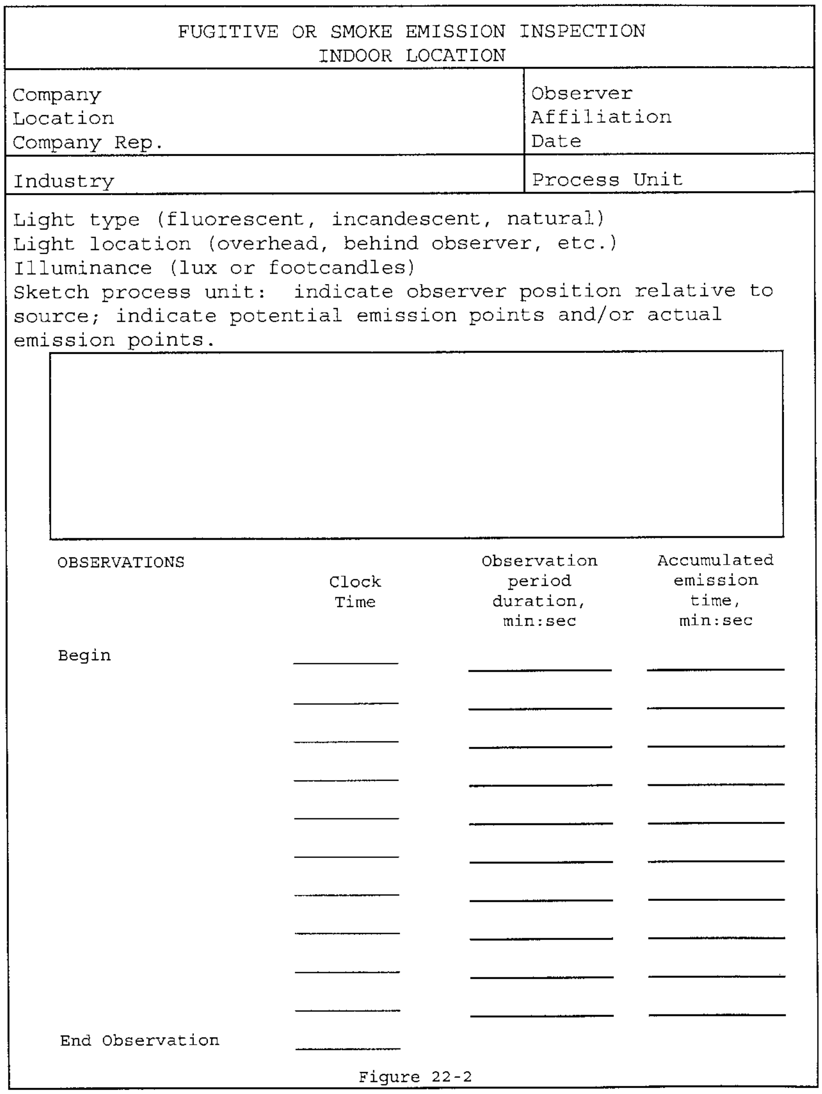
FUGITIVE OR SMOKE EMISSION INSPECTION
OUTDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Sky Conditions Precipitation	Wind Direction Wind Speed
Industry	Process Unit

Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin Observation			
End Observation			

Figure 22-1



FUGITIVE OR SMOKE EMISSION INSPECTION
INDOOR LOCATION

Company Location Company Rep.	Observer Affiliation Date
Industry	Process Unit

Light type (fluorescent, incandescent, natural)
Light location (overhead, behind observer, etc.)
Illuminance (lux or footcandles)
Sketch process unit: indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS	Clock Time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
	________	________	________
End Observation	________		

Figure 22-2

METHOD 23—DETERMINATION OF POLYCHLORINATED DIBENZO-P-DIOXINS AND POLYCHLORINATED DIBENZOFURANS FROM STATIONARY SOURCES

1. Applicability and Principle

1.1 Applicability. This method is applicable to the determination of polychlorinated dibenzo-p-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) from stationary sources.

1.2 Principle. A sample is withdrawn from the gas stream isokinetically and collected in the sample probe, on a glass fiber filter, and on a packed column of adsorbent material. The sample cannot be separated into a particle vapor fraction. The PCDD's and

PCDF's are extracted from the sample, separated by high resolution gas chromatography, and measured by high resolution mass spectrometry.

2. Apparatus

2.1 Sampling. A schematic of the sampling train used in this method is shown in Figure 23–1. Sealing greases may not be used in assembling the train. The train is identical to that described in section 2.1 of Method 5 of this appendix with the following additions:

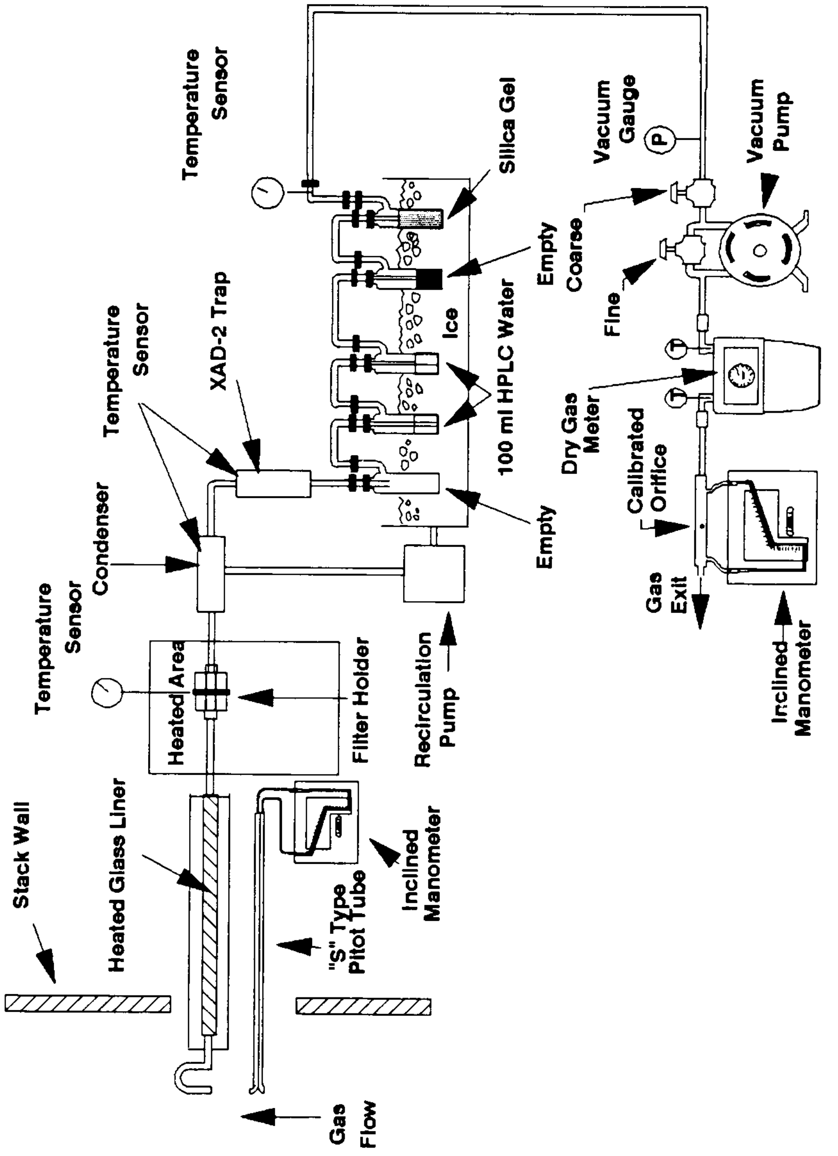


Figure 23.1 Sampling train

2.1.1 Nozzle. The nozzle shall be made of nickel, nickel-plated stainless steel, quartz, or borosilicate glass.

2.1.2 Sample Transfer Lines. The sample transfer lines, if needed, shall be heat traced, heavy walled TFE (½ in. OD with ⅛ in. wall) with connecting fittings that are capable of forming leak-free, vacuum-tight connections without using sealing greases. The line shall be as short as possible and must be maintained at 120 °C.

2.1.1 Filter Support. Teflon or Teflon-coated wire.

2.1.2 Condenser. Glass, coil type with compatible fittings. A schematic diagram is shown in Figure 23–2.

2.1.3 Water Bath. Thermostatically controlled to maintain the gas temperature exiting the condenser at <20 °C (68 °F).

2.1.4 Adsorbent Module. Glass container to hold the solid adsorbent. A shematic diagram is shown in Figure 23–2. Other physical configurations of the resin trap/condenser assembly are acceptable. The connecting fittings shall form leak-free, vacuum tight seals. No sealant greases shall be used in the sampling train. A coarse glass frit is included to retain the adsorbent.

2.2 Sample Recovery.

2.2.1 Fitting Caps. Ground glass, Teflon tape, or aluminum foil (Section 2.2.6) to cap off the sample exposed sections of the train.

2.2.2 Wash Bottles. Teflon, 500-ml.

2.2.3 Probe-Liner Probe-Nozzle, and Filter-Holder Brushes. Inert bristle brushes with precleaned stainless steel or Teflon handles. The probe brush shall have extensions of stainless steel or Teflon, at least as long as the probe. The brushes shall be properly sized and shaped to brush out the nozzle, probe liner, and transfer line, if used.

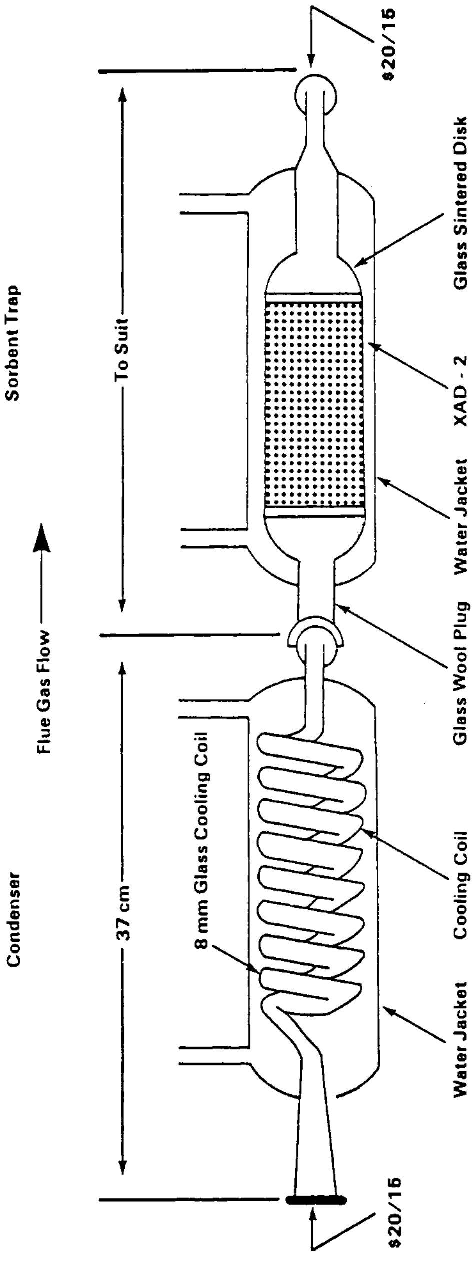


Figure 23.2. Condenser and adsorbent trap

2.2.4 Filter Storage Container. Sealed filter holder, wide-mouth amber glass jar with Teflon-lined cap, or glass petri dish.

2.2.5 Balance. Triple beam.

2.2.6 Aluminum Foil. Heavy duty, hexane-rinsed.

2.2.7 Storage Container. Air-tight container to store silica gel.

2.2.8 Graduated Cylinder. Glass, 250-ml with 2-ml graduation.

2.2.9 Glass Sample Storage Container. Amber glass bottle for sample glassware washes, 500- or 1000-ml, with leak free Teflon-lined caps.

2.3 Analysis.

2.3.1 Sample Container. 125- and 250-ml flint glass bottles with Teflon-lined caps.

2.3.2 Test Tube. Glass.

2.3.3 Soxhlet Extraction Apparatus. Capable of holding 43 × 123 mm extraction thimbles.

2.3.4 Extraction Thimble. Glass, precleaned cellulosic, or glass fiber.

2.3.5 Pasteur Pipettes. For preparing liquid chromatographic columns.

2.3.6 Reacti-vials. Amber glass, 2-ml, silanized prior to use.

2.3.7 Rotary Evaporator. Buchi/Brinkman RF–121 or equivalent.

2.3.8 Nitrogen Evaporative Concentrator. N-Evap Analytical Evaporator Model III or equivalent.

2.3.9 Separatory Funnels. Glass, 2-liter.

2.3.10 Gas Chromatograph. Consisting of the following components:

2.3.10.1 Oven. Capable of maintaining the separation column at the proper operating temperature ±°C and performing programmed increases in temperature at rates of at least 40 °C/min.

2.3.10.2 Temperature Gauge. To monitor column oven, detector, and exhaust temperatures ±1 °C.

2.3.10.3 Flow System. Gas metering system to measure sample, fuel, combustion gas, and carrier gas flows.

2.3.10.4 Capillary Columns. A fused silica column, 60 × 0.25 mm inside diameter (ID), coated with DB–5 and a fused silica column, 30 m × 0.25 mm ID coated with DB–225. Other column systems may be used provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

2.3.11 Mass Spectrometer. Capable of routine operation at a resolution of 1:10000 with a stability of ±5 ppm.

2.3.12 Data System. Compatible with the mass spectrometer and capable of monitoring at least five groups of 25 ions.

2.3.13 Analytical Balance. To measure within 0.1 mg.

3. Reagents

3.1 Sampling.

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Standard Method D 2986–71 (Reapproved 1978) (incorporated by reference—see §60.17).

3.1.1.1 Precleaning. All filters shall be cleaned before their initial use. Place a glass extraction thimble and 1 g of silica gel and a plug of glass wool into a Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Place no more than 50 filters in the thimble onto the silica gel bed and top with the cleaned glass wool. Charge the Soxhlet with toluene and reflux for 16 hours. After extraction, allow the Soxhlet to cool, remove the filters, and dry them under a clean N_2 stream. Store the filters in a glass petri dish sealed with Teflon tape.

3.1.2 Adsorbent Resin. Amberlite XAD–2 resin. Thoroughly cleaned before initial use.

3.1.2.1 Cleaning Procedure. This procedure may be carried out in a giant Soxhlet extractor. An all-glass filter thimble containing an extra-course frit is used for extraction of XAD–2. The frit is recessed 10–15 mm above a crenelated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass wool plug and a stainless steel ring because it floats on methylene chloride. This process involves sequential extraction in the following order.

Solvent	Procedure
Water	Initial rinse: Place resin in a beaker, rinse once with water, and discard. Fill with water a second time, let stand overnight, and discard.
Water	Extract with water for 8 hours.
Methanol	Extract for 22 hours.
Methylene Chloride	Extract for 22 hours.
Toluene	Extract for 22 hours.

3.1.2.2 Drying.

3.1.2.2.1 Drying Column. Pyrex pipe, 10.2 cm ID by 0.6 m long, with suitable retainers.

3.1.2.2.2 Procedure. The adsorbent must be dried with clean inert gas. Liquid nitrogen from a standard commercial liquid nitrogen cylinder has proven to be a reliable source of large volumes of gas free from organic contaminants. Connect the liquid nitrogen cylinder to the column by a length of cleaned copper tubing, 0.95 cm ID, coiled to pass through a heat source. A convenient heat source is a water-bath heated from a steam line. The final nitrogen temperature should only be warm to the touch and not over 40 °C. Continue flowing nitrogen through the adsorbent until all the residual solvent is removed. The flow rate should be sufficient to gently agitate the particles but not so excessive as the cause the particles to fracture.

3.1.2.3 Quality Control Check. The adsorbent must be checked for residual toluene.

3.1.2.3.1 Extraction. Weigh 1.0 g sample of dried resin into a small vial, add 3 ml of toluene, cap the vial, and shake it well.

3.1.2.3.2 Analysis. Inject a 2 µl sample of the extract into a gas chromatograph operated under the following conditions:

Column: 6 ft × 1/8 in stainless steel containing 10 percent OV–101 on 100/120 Supelcoport.
Carrier Gas: Helium at a rate of 30 ml/min.
Detector: Flame ionization detector operated at a sensitivity of 4×10^{-11} A/mV.
Injection Port Temperature: 250 °C.
Detector Temperature: 305 °C.
Oven Temperature: 30 °C for 4 min; programmed to rise at 40 °C/min until it reaches 250 °C; return to 30 °C after 17 minutes.

Compare the results of the analysis to the results from the reference solution. Prepare the reference solution by injection 2.5 µl of methylene chloride into 100 ml of toluene. This corresponds to 100 µg of methylene chloride per g of adsorbent. The maximum acceptable concentration is 1000 µg/g of adsorbent. If the adsorbent exceeds this level, drying must be continued until the excess methylene chloride is removed.

3.1.2.4 Storage. The adsorbent must be used within 4 weeks of cleaning. After cleaning, it may be stored in a wide mouth amber glass container with a Teflon-lined cap or placed in one of the glass adsorbent modules tightly sealed with glass stoppers. If precleaned adsorbent is purchased in sealed containers, it must be used within 4 weeks after the seal is broken.

3.1.3 Glass Wool. Cleaned by sequential immersion in three aliquots of methylene chloride, dried in a 110 °C oven, and stored in a methylene chloride-washed glass jar with a Teflon-lined screw cap.

3.1.4 Water. Deionized distilled and stored in a methylene chloride-rinsed glass container with a Teflon-lined screw cap.

3.1.5 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175 °C (350 °F) for two hours. New silica gel may be used as received. Alternately other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.6 Chromic Acid Cleaning Solution. Dissolve 20 g of sodium dichromate in 15 ml of water, and then carefully add 400 ml of concentrated sulfuric acid.

3.2 Sample Recovery.

3.2.2 Acetone. Pesticide quality.

3.2.2 Methylene Chloride. Pesticide qualtity.

3.2.3 Toluene. Pesticide quality.

3.3 Analysis.

3.3.1 Potassium Hydroxide. ACS grade, 2-percent (weight/volume) in water.

3.3.2 Sodium Sulfate. Granulated, reagent grade. Purify prior to use by rinsing with methylene chloride and oven drying. Store the cleaned material in a glass container with a Teflon-lined screw cap.

3.3.3 Sulfuric Acid. Reagent grade.

3.3.4 Sodium Hydroxide. 1.0 N. Weigh 40 g of sodium hydroxide into a 1-liter volumetric flask. Dilute to 1 liter with water.

3.3.5 Hexane. Pesticide grade.

3.3.6 Methylene Chloride. Pesticide grade.

3.3.7 Benzene. Pesticide Grade.

3.3.8 Ethyl Acetate.

3.3.9 Methanol. Pesticide Grade.

3.3.10 Toluene. Pesticide Grade.

3.3.11 Nonane. Pesticide Grade.

3.3.12 Cyclohexane. Pesticide Grade.

3.3.13 Basic Alumina. Activity grade 1, 100–200 mesh. Prior to use, activate the alumina by heating for 16 hours at 130 °C before use. Store in a desiccator. Pre-activated alumina may be purchased from a supplier and may be used as received.

3.3.14 Silica Gel. Bio-Sil A, 100–200 mesh. Prior to use, activate the silica gel by heating for at least 30 minutes at 180 °C. After cooling, rinse the silica gel sequentially with methanol and methylene chloride. Heat the rinsed silica gel at 50 °C for 10 minutes, then increase the temperature gradually to 180 °C over 25 minutes and maintain it at this temperature for 90 minutes. Cool at room temperature and store in a glass container with a Teflon-lined screw cap.

3.3.15 Silica Gel Impregnated with Sulfuric Acid. Combine 100 g of silica gel with 44 g of concentrated sulfuric acid in a screw capped glass bottle and agitate thoroughly. Disperse the solids with a stirring rod until a uniform mixture is obtained. Store the mixture in a glass container with a Teflon-lined screw cap.

3.3.16 Silica Gel Impregnated with Sodium Hydroxide. Combine 39 g of 1 N sodium hydroxide with 100 g of silica gel in a screw capped glass bottle and agitate thoroughly. Disperse solids with a stirring rod until a uniform mixture is obtained. Store the mixture in glass container with a Teflon-lined screw cap.

3.3.17 Carbon/Celite. Combine 10.7 g of AX–21 carbon with 124 g of Celite 545 in a 250-ml glass bottle with a Teflon-lined screw cap. Agitate the mixture thoroughly until a uniform mixture is obtained. Store in the glass container.

3.3.18 Nitrogen. Ultra high purity.

3.3.19 Hydrogen. Ultra high purity.

3.3.20 Internal Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading "Internal Standards" in 10 ml of nonane.

3.3.21 Surrogate Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading "Surrogate Standards" in 10 ml of nonane.

3.3.22 Recovery Standard Solution. Prepare a stock standard solution containing the

isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading ''Recovery Standards'' in 10 ml of nonane.

4. Procedure

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation.

4.1.1.1 Cleaning Glassware. All glass components of the train upstream of and including the adsorbent module, shall be cleaned as described in section 3A of the ''Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.'' Special care shall be devoted to the removal of residual silicone grease sealants on ground glass connections of used glassware. Any residue shall be removed by soaking the glassware for several hours in a chromic acid cleaning solution prior to cleaning as described above.

4.1.1.2 Adsorbent Trap. The traps must be loaded in a clean area to avoid contamination. They may not be loaded in the field. Fill a trap with 20 to 40 g of XAD–2. Follow the XAD–2 with glass wool and tightly cap both ends of the trap. Add 100 µl of the surrogate standard solution (section 3.3.21) to each trap.

4.1.1.3 Sample Train. It is suggested that all components be maintained according to the procedure described in APTD–0576. Alternative mercury-free thermometers may be used if the thermometers are, at a minimum, equivalent in terms of performance or suitably effective for the specific temperature measurement application.

4.1.1.4 Silica Gel. Weigh several 200 to 300 g portions of silica gel in an air tight container to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel may be weighed directly in its impinger or sampling holder just prior to sampling.

4.1.1.5 Filter. Check each filter against light for irregularities and flaws or pinhole leaks. Pack the filters flat in a clean glass container.

4.1.2 Preliminary Determinations. Same as section 4.1.2 of Method 5.

4.1.3 Preparation of Collection Train.

4.1.3.1 During preparation and assembly of the sampling train, keep all train openings where contamination can enter, sealed until just prior to assembly or until sampling is about to begin.

NOTE: Do not use sealant grease in assembling the train.

4.1.3.2 Place approximately 100 ml of water in the second and third impingers, leave the first and fourth impingers empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fifth impinger.

4.1.3.3 Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

4.1.3.4 Assemble the train as shown in Figure 23–1.

4.1.3.5 Turn on the adsorbent module and condenser coil recirculating pump and begin monitoring the adsorbent module gas entry temperature. Ensure proper sorbent temperature gas entry temperature before proceeding and before sampling is initiated. It is extremely important that the XAD–2 adsorbent resin temperature never exceed 50 °C because thermal decomposition will occur. During testing, the XAD–2 temperature must not exceed 20 °C for efficient capture of the PCDD's and PCDF's.

4.1.4 Leak-Check Procedure. Same as Method 5, section 4.1.4.

4.1.5 Sample Train Operation. Same as Method 5, section 4.1.5.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Seal the nozzle end of the sampling probe with Teflon tape or aluminum foil.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe. Remove the probe from the train and close off both ends with aluminum foil. Seal off the inlet to the train with Teflon tape, a ground glass cap, or aluminum foil.

Transfer the probe and impinger assembly to the cleanup area. This area shall be clean and enclosed so that the chances of losing or contaminating the sample are minimized. Smoking, which could contaminate the sample, shall not be allowed in the cleanup area.

Inspect the train prior to and during disassembly and note any abnormal conditions, e.g., broken filters, colored impinger liquid, etc. Treat the samples as follows:

4.2.1 Container No. 1. Either seal the filter holder or carefully remove the filter from the filter holder and place it in its identified container. Use a pair of cleaned tweezers to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the container any particulate matter and filter fibers which adhere to the filter holder gasket, by using a dry inert bristle brush and a sharp-edged blade. Seal the container.

4.2.2 Adsorbent Module. Remove the module from the train, tightly cap both ends, label it, cover with aluminum foil, and store it on ice for transport to the laboratory.

4.2.3 Container No. 2. Quantitatively recover material deposited in the nozzle, probe transfer lines, the front half of the filter holder, and the cyclone, if used, first, by

brushing while rinsing three times each with acetone and then, by rinsing the probe three times with methylene chloride. Collect all the rinses in Container No. 2.

Rinse the back half of the filter holder three times with acetone. Rinse the connecting line between the filter and the condenser three times with acetone. Soak the connecting line with three separate portions of methylene chloride for 5 minutes each. If using a separate condenser and adsorbent trap, rinse the condenser in the same manner as the connecting line. Collect all the rinses in Container No. 2 and mark the level of the liquid on the container.

4.2.4 Container No. 3. Repeat the methylene chloride-rinsing described in section 4.2.3 using toluene as the rinse solvent. Collect the rinses in Container No. 3 and mark the level of the liquid on the container.

4.2.5 Impinger Water. Measure the liquid in the first three impingers to within ±1 ml by using a graduated cylinder or by weighing it to within ±0.5 g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

Discard the liquid after measuring and recording the volume or weight.

4.2.7 Silica Gel. Note the color of the indicating silica gel to determine if it has been completely spent and make a mention of its condition. Transfer the silica gel from the fifth impinger to its original container and seal. If a moisture determination is made, follow the applicable procedures in sections 8.7.6.3 and 11.2.3 of Method 5 to handle and weigh the silica gel. If moisture is not measured, the silica gel may be disposed.

5. Analysis

All glassware shall be cleaned as described in section 3A of the ‘‘Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.’’ All samples must be extracted within 30 days of collection and analyzed within 45 days of extraction.

5.1 Sample Extraction.

5.1.1 Extraction System. Place an extraction thimble (section 2.3.4), 1 g of silica gel, and a plug of glass wool into the Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Remove the extraction thimble from the extraction system and place it in a glass beaker to catch the solvent rinses.

5.1.2 Container No. 1 (Filter). Transfer the contents directly to the glass thimble of the extraction system and extract them simultaneously with the XAD–2 resin.

5.1.3 Adsorbent Cartridge. Suspend the adsorbent module directly over the extraction thimble in the beaker (See section 5.1.1). The glass frit of the module should be in the up position. Using a Teflon squeeze bottle containing toluene, flush the XAD–2 into the thimble onto the bed of cleaned silica gel. Thoroughly rinse the glass module catching the rinsings in the beaker containing the thimble. If the resin is wet, effective extraction can be accomplished by loosely packing the resin in the thimble. Add the XAD–2 glass wool plug into the thimble.

5.1.4 Container No. 2 (Acetone and Methylene Chloride). Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus, at a temperature of less than 37 °C. Rinse the sample container three times with small portions of methylene chloride and add these to the concentrated solution and concentrate further to near dryness. This residue contains particulate matter removed in the rinse of the train probe and nozzle. Add the concentrate to the filter and the XAD–2 resin in the Soxhlet apparatus described in section 5.1.1.

5.1.5 Extraction. Add 100 µl of the internal standard solution (Section 3.3.20) to the extraction thimble containing the contents of the adsorbent cartridge, the contents of Container No. 1, and the concentrate from section 5.1.4. Cover the contents of the extraction thimble with the cleaned glass wool plug to prevent the XAD–2 resin from floating into the solvent reservoir of the extractor. Place the thimble in the extractor, and add the toluene contained in the beaker to the solvent reservoir. Pour additional toluene to fill the reservoir approximately ⅔ full. Add Teflon boiling chips and assemble the apparatus. Adjust the heat source to cause the extractor to cycle three times per hour. Extract the sample for 16 hours. After extraction, allow the Soxhlet to cool. Transfer the toluene extract and three 10-ml rinses to the rotary evaporator. Concentrate the extract to approximately 10 ml. At this point the analyst may choose to split the sample in half. If so, split the sample, store one half for future use, and analyze the other according to the procedures in sections 5.2 and 5.3. In either case, use a nitrogen evaporative concentrator to reduce the volume of the sample being analyzed to near dryness. Dissolve the residue in 5 ml of hexane.

5.1.6 Container No. 3 (Toluene Rinse). Add 100 µl of the Internal Standard solution (section 3.3.2) to the contents of the container. Concentrate the sample to a volume of about 1–5 ml using the rotary evaporator apparatus at a temperature of less than 37 °C. Rinse the sample container apparatus at a temperature of less than 37 °C. Rinse the sample container three times with small portions of toluene and add these to the concentrated solution and concentrate further to near dryness. Analyze the extract separately according to the procedures in sections 5.2 and 5.3, but concentrate the solution in a rotary evaporator apparatus rather than a nitrogen evaporative concentrator.

5.2 Sample Cleanup and Fractionation.

5.2.1 Silica Gel Column. Pack one end of a glass column, 20 mm × 230 mm, with glass wool. Add in sequence, 1 g silica gel, 2 g of sodium hydroxide impregnated silica gel, 1 g silica gel, 4 g of acid-modified silica gel, and 1 g of silica gel. Wash the column with 30 ml of hexane and discard it. Add the sample extract, dissolved in 5 ml of hexane to the column with two additional 5-ml rinses. Elute the column with an additional 90 ml of hexane and retain the entire eluate. Concentrate this solution to a volume of about 1 ml using the nitrogen evaporative concentrator (section 2.3.7).

5.2.2 Basic Alumina Column. Shorten a 25-ml disposable Pasteur pipette to about 16 ml. Pack the lower section with glass wool and 12 g of basic alumina. Transfer the concentrated extract from the silica gel column to the top of the basic alumina column and elute the column sequentially with 120 ml of 0.5 percent methylene chloride in hexane followed by 120 ml of 35 percent methylene chloride in hexane. Discard the first 120 ml of eluate. Collect the second 120 ml of eluate and concentrate it to about 0.5 ml using the nitrogen evaporative concentrator.

5.2.3 AX–21 Carbon/Celite 545 Column. Remove the botton 0.5 in. from the tip of a 9-ml disposable Pasteur pipette. Insert a glass fiber filter disk in the top of the pipette 2.5 cm from the constriction. Add sufficient carbon/celite mixture to form a 2 cm column. Top with a glass wool plug. In some cases AX–21 carbon fines may wash through the glass wool plug and enter the sample. This may be prevented by adding a celite plug to the exit end of the column. Rinse the column in sequence with 2 ml of 50 percent benzene in ethyl acetate, 1 ml of 50 percent methylene chloride in cyclohexane, and 2 ml of hexane. Discard these rinses. Transfer the concentrate in 1 ml of hexane from the basic alumina column to the carbon/celite column along with 1 ml of hexane rinse. Elute the column sequentially with 2 ml of 50 percent methylene chloride in hexane and 2 ml of 50 percent benzene in ethyl acetate and discard these eluates. Invert the column and elute in the reverse direction with 13 ml of toluene. Collect this eluate. Concentrate the eluate in a rotary evaporator at 50 °C to about 1 ml. Transfer the concentrate to a Reacti-vial using a toluene rinse and concentrate to a volume of 200 µl using a stream of N_2. Store extracts at room temperature, shielded from light, until the analysis is performed.

5.3 Analysis. Analyze the sample with a gas chromatograph coupled to a mass spectrometer (GC/MS) using the instrumental parameters in sections 5.3.1 and 5.3.2. Immediately prior to analysis, add a 20 µl aliquot of the Recovery Standard solution from Table 1 to each sample. A 2 µl aliquot of the extract is injected into the GC. Sample extracts are first analyzed using the DB–5 capillary column to determine the concentration of each isomer of PCDD's and PCDF's (tetra-through octa-). If tetra-chlorinated dibenzofurans are detected in this analysis, then analyze another aliquot of the sample in a separate run, using the DB–225 column to measure the 2,3,7,8 tetra-chloro dibenzofuran isomer. Other column systems may be used, provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

5.3.1 Gas Chromatograph Operating Conditions.

5.3.1.1 Injector. Configured for capillary column, splitless, 250 °C.

5.3.1.2 Carrier Gas. Helium, 1–2 ml/min.

5.3.1.3 Oven. Initially at 150 °C. Raise by at least 40 °C/min to 190 °C and then at 3 °C/min up to 300 °C.

5.3.2 High Resolution Mass Spectrometer.

5.3.2.1 Resolution. 10000 m/e.

5.3.2.2 Ionization Mode. Electron impact.

5.3.2.3 Source Temperature 250 °C.

5.3.2.4 Monitoring Mode. Selected ion monitoring. A list of the various ions to be monitored is summarized in Table 3.

5.3.2.5 Identification Criteria. The following identification criteria shall be used for the characterization of polychlorinated dibenzodioxins and dibenzofurans.

1. The integrated ion-abundance ratio (M/M + 2 or M + 2/M + 4) shall be within 15 percent of the theoretical value. The acceptable ion-abundance ratio ranges for the identification of chlorine-containing compounds are given in Table 4.
2. The retention time for the analytes must be within 3 seconds of the corresponding ^{13}C-labeled internal standard, surrogate or alternate standard.
3. The monitored ions, shown in Table 3 for a given analyte, shall reach their maximum within 2 seconds of each other.
4. The identification of specific isomers that do not have corresponding ^{13}C-labeled standards is done by comparison of the relative retention time (RRT) of the analyte to the nearest internal standard retention time with reference (i.e., within 0.005 RRT units) to the comparable RRT's found in the continuing calibration.
5. The signal to noise ratio for all monitored ions must be greater than 2.5.
6. The confirmation of 2, 3, 7, 8–TCDD and 2, 3, 7, 8–TCDF shall satisfy all of the above identification criteria.
7. For the identification of PCDF's, no signal may be found in the corresponding PCDPE channels.

5.3.2.6 Quantification. The peak areas for the two ions monitored for each analyte are summed to yield the total response for each analyte. Each internal standard is used to quantify the indigenous PCDD's or PCDF's in its homologous series. For example, the $^{13}C_{12}$–2,3,7,8-tetra chlorinated dibenzodioxin is used to calculate the concentrations of all

other tetra chlorinated isomers. Recoveries of the tetra- and penta- internal standards are calculated using the $^{13}C_{12}$–1,2,3,4–TCDD. Recoveries of the hexa- through octa- internal standards are calculated using $^{13}C_{12}$–1,2,3,7,8,9–HxCDD. Recoveries of the surrogate standards are calculated using the corresponding homolog from the internal standard.

6. Calibration

Same as Method 5 with the following additions.

6.1 GC/MS System.

6.1.1 Initial Calibration. Calibrate the GC/MS system using the set of five standards shown in Table 2. The relative standard deviation for the mean response factor from each of the unlabeled analytes (Table 2) and of the internal, surrogate, and alternate standards shall be less than or equal to the values in Table 5. The signal to noise ratio for the GC signal present in every selected ion current profile shall be greater than or equal to 2.5. The ion abundance ratios shall be within the control limits in Table 4.

6.1.2 Daily Performance Check.

6.1.2.1 Calibration Check. Inject on µl of solution Number 3 from Table 2. Calculate the relative response factor (RRF) for each compound and compare each RRF to the corresponding mean RRF obtained during the initial calibration. The analyzer performance is acceptable if the measured RRF's for the labeled and unlabeled compounds for the daily run are within the limits of the mean values shown in Table 5. In addition, the ion-abundance ratios shall be within the allowable control limits shown in Table 4.

6.1.2.2 Column Separation Check. Inject a solution of a mixture of PCDD's and PCDF's that documents resolution between 2,3,7,8–TCDD and other TCDD isomers. Resolution is defined as a valley between peaks that is less than 25 percent of the lower of the two peaks. Identify and record the retention time windows for each homologous series.

Perform a similar resolution check on the confirmation column to document the resolution between 2,3,7,8 TCDF and other TCDF isomers.

6.2 Lock Channels. Set mass spectrometer lock channels as specified in Table 3. Monitor the quality control check channels specified in Table 3 to verify instrument stability during the analysis.

7. Quality Control

7.1 Sampling Train Collection Efficiency Check. Add 100 µl of the surrogate standards in Table 1 to the absorbent cartridge of each train before collecting the field samples.

7.2 Internal Standard Percent Recoveries. A group of nine carbon labeled PCDD's and PCDF's representing, the tetra-through octachlorinated homologues, is added to every sample prior to extraction. The role of the internal standards is to quantify the native PCDD's and PCDF's present in the sample as well as to determine the overall method efficiency. Recoveries of the internal standards must be between 40 to 130 percent for the tetra-through hexachlorinated compounds while the range is 25 to 130 percent for the higher hepta- and octachlorinated homologues.

7.3 Surrogate Recoveries. The five surrogate compounds in Table 2 are added to the resin in the adsorbent sampling cartridge before the sample is collected. The surrogate recoveries are measured relative to the internal standards and are a measure of collection efficiency. They are not used to measure native PCDD's and PCDF's. All recoveries shall be between 70 and 130 percent. Poor recoveries for all the surrogates may be an indication of breakthrough in the sampling train. If the recovery of all standards is below 70 percent, the sampling runs must be repeated. As an alternative, the sampling runs do not have to be repeated if the final results are divided by the fraction of surrogate recovery. Poor recoveries of isolated surrogate compounds should not be grounds for rejecting an entire set of the samples.

7.4 Toluene QA Rinse. Report the results of the toluene QA rinse separately from the total sample catch. Do not add it to the total sample.

8.0 [Reserved]

9. Calculations

Same as Method 5, section 6 with the following additions.

9.1 Nomenclature.

A_{ai} = Integrated ion current of the noise at the retention time of the analyte.

A^*_{ci} = Integrated ion current of the two ions characteristic of the internal standard i in the calibration standard.

A_{cij} = Integrated ion current of the two ions characteristic of compound i in the jth calibration standard.

A^*_{cij} = Integrated ion current of the two ions characteristic of the internal standard i in the jth calibration standard.

A_{csi} = Integrated ion current of the two ions characteristic of surrogate compound i in the calibration standard.

A_i = Integrated ion current of the two ions characteristic of compound i in the sample.

A^*_i = Integrated ion current of the two ions characteristic of internal standard i in the sample.

A_{rs} = Integrated ion current of the two ions characteristic of the recovery standard.

A_{si} = Integrated ion current of the two ions characteristic of surrogate compound i in the sample.

C_i = Concentration of PCDD or PCDF i in the sample, pg/M^3.

C_T = Total concentration of PCDD's or PCDF's in the sample, pg/M^3.

m_{ci} = Mass of compound i in the calibration standard injected into the analyzer, pg.

m_{rs} = Mass of recovery standard in the calibration standard injected into the analyzer, pg.

m_{si} = Mass of surrogate compound in the calibration standard, pg.

RRF_i = Relative response factor.

RRF_{rs} = Recovery standard response factor.

RRF_s = Surrogate compound response factor.

9.2 Average Relative Response Factor.

$$RRF_i = \frac{1}{n}\sum_{j=1}^{n}\frac{A_{cij}\, m^*_{ci}}{A^*_{cij}\, m_{ci}} \qquad \text{Eq. 23-1}$$

9.3 Concentration of the PCDD's and PCDF's.

$$C_i = \frac{m_i * A_i}{A_i * RRF_i V_{mstd}} \qquad \text{Eq. 23-2}$$

9.4 Recovery Standard Response Factor.

$$RRF_{rs} = \frac{A_{ci} * m_{rs}}{A_{rs} m_{ci} *} \qquad \text{Eq. 23-3}$$

9.5 Recovery of Internal Standards (R*).

$$R* = \frac{A_i * m_{rs}}{A_{rs} RF_{rs} m_i *} \times 100\% \qquad \text{Eq. 23-4}$$

9.6 Surrogate Compound Response Factor.

$$RRF_s = \frac{A_{ci} * m_s}{A_{cis} m_{ci} *} \qquad \text{Eq. 23-5}$$

9.7 Recovery of Surrogate Compounds (R_s).

$$R_s = \frac{A_s m_i *}{A_i * RRF_s m_s} \times 100\% \qquad \text{Eq. 23-6}$$

9.8 Minimum Detectable Limit (MDL).

$$MDL = \frac{2.5\ A_{ai} m_i *}{A_{ci} * RRF_i} \qquad \text{Eq. 23-7}$$

9.9 Total Concentration of PCDD's and PCDF's in the Sample.

$$C_{Tr} = \sum_{i=1}^{n} C_i \qquad \text{Eq. 23-8}$$

Any PCDD's or PCDF's that are reported as nondetected (below the MDL) shall be counted as zero for the purpose of calculating the total concentration of PCDD's and PCDF's in the sample.

10. Bibliography

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TABLE 1—COMPOSITION OF THE SAMPLE FORTIFICATION AND RECOVERY STANDARDS SOLUTIONS

Analyte	Concentration (pg/µl)
Internal Standards:	
^{13} C_{12}-2,3,7,8-TCDD	100
^{13} C_{12}-1,2,3,7,8-PeCDD	100
^{13} C_{12}-1,2,3,6,7,8-HxCDD	100
^{13} C_{12}-1,2,3,4,6,7,8-HpCDD	100
^{13} C_{12}-OCDD	100
^{13} C_{12}-2,3,7,8-TCDF	100
^{13} C_{12}-1,2,3,7,8-PeCDF	100
^{13} C_{12}-1,2,3,6,7,8-HxCDF	100
^{13} C_{12}-1,2,3,4,6,7,8-HpCDF	100
Surrogate Standards:	
^{37} Cl_4-2,3,7,8-TCDD	100
^{13} C_{12}-1,2,3,4,7,8-HxCDD	100
^{13} C_{12}-2,3,4,7,8-PeCDF	100
^{13} C_{12}-1,2,3,4,7,8-HxCDF	100
^{13} C_{12}-1,2,3,4,7,8,9-HpCDF	100
Recovery Standards:	
^{13} C_{12}-1,2,3,4-TCDD	500
^{13} C_{12}-1,2,3,7,8,9-HxCDD	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS

Compound	Concentrations (pg/µL)				
	Solution No.				
	1	2	3	4	5
Alternate Standard:					
^{13} C_{12}-1,2,3,7,8,9-HxCDF	2.5	5	25	250	500

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS—Continued

Compound	Concentrations (pg/μL)				
	Solution No.				
	1	2	3	4	5
Recovery Standards:					
${}^{13}C_{12}$-1,2,3,4-TCDD ..	100	100	100	100	100

TABLE 2—COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS—Continued

Compound	Concentrations (pg/μL)				
	Solution No.				
	1	2	3	4	5
${}^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100

TABLE 3—ELEMENTAL COMPOSITIONS AND EXACT MASSES OF THE IONS MONITORED BY HIGH RESOLUTION MASS SPECTROMETRY FOR PCDD'S AND PCDF'S

Descriptor No.	Accurate mass	Ion type	Elemental composition	Analyte
2	292.9825	LOCK	C_7F_{11}	PFK
	303.9016	M	$C_{12}H_4{}^{35}Cl_4O$	TCDF
	305.8987	M + 2	$C_{12}H_4{}^{35}Cl^{37}O$	TCDF
	315.9419	M	${}^{13}C_{12}H_4{}^{35}Cl_4O$	TCDF (S)
	317.9389	M + 2	${}^{13}C_{12}H_4{}^{35}Cl_3{}^{37}ClO$	TCDF (S)
	319.8965	M	$C_{12}H_4{}^{35}ClO_2$	TCDD
	321.8936	M + 2	$C_{12}H_4{}^{35}Cl_3{}^{37}ClO_2$	TCDD
	327.8847	M	$C_{12}H_4{}^{37}Cl_4O_2$	TCDD (S)
	330.9792	QC	C_7F_{13}	PFK
	331.9368	M	${}^{13}C_{12}H_4{}^{35}Cl_4O_2$	TCDD (S)
	333.9339	M + 2	${}^{13}C_{12}H_4{}^{35}Cl^{37}ClO_2$	TCDD (S)
	339.8597	M + 2	$C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PECDF
	341.8567	M + 4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O$	PeCDF
	351.9000	M + 2	${}^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF (S)
	353.8970	M + 4	${}^{13}C_{12}H_3{}^{35}Cl^{3537}Cl_2O$	PeCDF (S)
	355.8546	M + 2	$C_{12}H_3{}^{35}Cl_{3}37ClO_2$	PeCDD
	357.8516	M + 4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O_2$	PeCDD
	367.8949	M + 2	${}^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO_2$	PeCDD (S)
	369.8919	M + 4	${}^{13}C_{12}H_3{}^{35}Cl_3{}^{37}\ Cl_2O_2$	PeCDD (S)
	375.8364	M + 2	$C_{12}H_4{}^{35}Cl_5{}^{37}ClO$	HxCDPE
	409.7974	M + 2	$C_{12}H_3{}^{35}Cl_6{}^{37}ClO$	HpCPDE
3	373.8208	M + 2	$C_{12}H_{2}35Cl_5{}^{37}ClO$	HxCDF
	375.8178	M + 4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDF
	383.8639	M	${}^{13}C_{12}H_2{}^{35}Cl_6O$	HxCDF (S)
	385.8610	M + 2	${}^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO$	HxCDF (S)
	389.8157	M + 2	$C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD
	391.8127	M + 4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O_2$	HxCDD
	392.9760	LOCK	C_9F_{15}	PFK
	401.8559	M + 2	${}^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD (S)
	403.8529	M + 4	${}^{13}C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDD (S)
	445.7555	M + 4	$C_{12}H_2{}^{35}Cl_6{}^{37}Cl_2O$	OCDPE
	430.9729	QC	C_9F_{17}	PFK
4	407.7818	M + 2	$C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF
	409.7789	M + 4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O$	HpCDF
	417.8253	M	${}^{13}C_{12}H^{35}Cl_7O$	HpCDF (S)
	419.8220	M + 2	${}^{13}C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF (S)
	423.7766	M + 2	$C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD
	425.7737	M + 4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD
	435.8169	M + 2	${}^{13}C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD (S)
	437.8140	M + 4	${}^{13}C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD (S)
	479.7165	M + 4	$C_{12}H^{35}Cl_7{}^{37}Cl_2O$	NCPDE
	430.9729	LOCK	C_9F_{17}	PFK
	441.7428	M + 2	$C_{12}{}^{35}Cl_7{}^{37}ClO$	OCDF
	443.7399	M + 4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O$	OCDF
	457.7377	M + 2	$C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD
	459.7348	M + 4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD
	469.7779	M + 2	${}^{13}C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD (S)
	471.7750	M + 4	${}^{13}C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD (S)
	513.6775	M + 4	$C_{12}{}^{35}Cl_8{}^{37}Cl_2O_2$	DCDPE
	442.9728	QC	$C_{10}F_{17}$	PFK

(a) The following nuclidic masses were used:
H = 1.007825
C = 12.000000
${}^{13}C$ = 13.003355
F = 18.9984
O = 15.994915
${}^{35}Cl$ = 34.968853
${}^{37}Cl$ = 36.965903

S = Labeled Standard
QC = Ion selected for monitoring instrument stability during the GC/MS analysis.

TABLE 4—ACCEPTABLE RANGES FOR ION-ABUNDANCE RATIOS OF PCDD'S AND PCDF'S

No. of chlorine atoms	Ion type	Theoretical ratio	Control limits	
			Lower	Upper
4	M/M + 2	0.77	0.65	0.89
5	M + 2/M + 4	1.55	1.32	1.78
6	M + 2/M + 4	1.24	1.05	1.43
6[a]	M/M + 2	0.51	0.43	0.59
7[b]	M/M + 2	0.44	0.37	0.51
7	M + 2/M + 4	1.04	0.88	1.20
8	M + 2/M + 4	0.89	0.76	1.02

[a] Used only for ^{13}C-HxCDF.
[b] Used only for ^{13}C-HpCDF.

TABLE 5—MINIMUM REQUIREMENTS FOR INITIAL AND DAILY CALIBRATION RESPONSE FACTORS

Compound	Relative response factors	
	Initial calibration RSD	Daily calibration % difference
Unlabeled Analytes:		
2,3,7,8-TCDD	25	25
2,3,7,8-TCDF	25	25
1,2,3,7,8-PeCDD	25	25
1,2,3,7,8-PeCDF	25	25
2,3,4,7,8-PeCDF	25	25
1,2,4,5,7,8-HxCDD	25	25
1,2,3,6,7,8-HxCDD	25	25
1,2,3,7,8,9-HxCDD	25	25
1,2,3,4,7,8-HxCDF	25	25
1,2,3,6,7,8-HxCDF	25	25
1,2,3,7,8,9-HxCDF	25	25
2,3,4,6,7,8-HxCDF	25	25
1,2,3,4,6,7,8-HpCDD	25	25
1,2,3,4,6,7,8-HpCDF	25	25
OCDD	25	25
OCDF	30	30
Internal Standards:		
$^{13}C_{12}$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-1,2,3,7,8-PeCDD	30	30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	25	25
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	30	30
$^{13}C_{12}$-OCDD	30	30
$^{13}C_{12}$-2,3,7,8-TCDF	30	30
$^{13}C_{12}$-1,2,3,7,8-PeCDF	30	30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	30	30
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	30	30
Surrogate Standards:		
$^{37}Cl_4$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-2,3,4,7,8-PeCDF	25	25
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	25	25
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	25	25
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	25	25
Alternate Standard:		
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	25	25

METHOD 24—DETERMINATION OF VOLATILE MATTER CONTENT, WATER CONTENT, DENSITY, VOLUME SOLIDS, AND WEIGHT SOLIDS OF SURFACE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds	No CAS Number assigned
Water.	7732–18–5

1.2 Applicability. This method is applicable for the determination of volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

1.3 Precision and Bias. Intra-and inter-laboratory analytical precision statements are presented in section 13.1. No bias has been identified.

2.0 Summary of Method

2.1 Standard methods are used to determine the volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or other related surface coatings.

3.0 Definitions

3.1 *Waterborne coating* means any coating which contains more than 5 percent water by weight in its volatile fraction.

3.2 *Multicomponent coatings* are coatings that are packaged in two or more parts, which are combined before application. Upon combination a coreactant from one part of the coating chemically reacts, at ambient conditions, with a coreactant from another part of the coating.

3.3 *Ultraviolet (UV) radiation-cured coatings* are coatings which contain unreacted monomers that are polymerized by exposure to ultraviolet light.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Several of the compounds that may be contained in the coatings analyzed by this method may be irritating or corrosive to tissues (e.g., heptane) or may be toxic (e.g., benzene, methyl alcohol). Nearly all are fire hazards.

Appropriate precautions can be found in reference documents, such as Reference 3 of section 16.0.

6.0 Equipment and Supplies

The equipment and supplies specified in the ASTM methods listed in sections 6.1 through 6.6 (incorporated by reference—see § 60.17 for acceptable versions of the methods) are required:

6.1 ASTM D 1475–60, 80, or 90, Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products.

6.2 ASTM D 2369–81, 87, 90, 92, 93, or 95, Standard Test Method for Volatile Content of Coatings.

6.3 ASTM D 3792–79 or 91, Standard Test Method for Water Content of Water Reducible Paints by Direct Injection into a Gas Chromatograph.

6.4 ASTM D 4017–81, 90, or 96a, Standard Test Method for Water in Paints and Paint Materials by the Karl Fischer Titration Method.

6.5 ASTM 4457–85 91, Standard Test Method for Determination of Dichloromethane and 1,1,1-Trichloroethane in Paints and Coatings by Direct Injection into a Gas Chromatograph.

6.6 ASTM D 5403–93, Standard Test Methods for Volatile Content of Radiation Curable Materials.

6.7 ASTM D 6419–00, Test Method for Volatile Content of Sheet-Fed and Coldset Web Offset Printing Inks.

7.0 Reagents and Standards

7.1 The reagents and standards specified in the ASTM methods listed in sections 6.1 through 6.6 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 1 of section 16.0.

9.0 Quality Control

9.1 Reproducibility

NOTE: Not applicable to UV radiation-cured coatings). The variety of coatings that may be subject to analysis makes it necessary to verify the ability of the analyst and the analytical procedures to obtain reproducible results for the coatings tested. Verification is accomplished by running duplicate analyses on each sample tested (Sections 11.2 through 11.4) and comparing the results with the intra-laboratory precision statements (Section 13.1) for each parameter.

9.2 Confidence Limits for Waterborne Coatings. Because of the inherent increased imprecision in the determination of the VOC content of waterborne coatings as the weight percent of water increases, measured parameters for waterborne coatings are replaced with appropriate confidence limits (Section 12.6). These confidence limits are based on measured parameters and inter-laboratory precision statements.

10.0 Calibration and Standardization

10.1 Perform the calibration and standardization procedures specified in the ASTM methods listed in sections 6.1 through 6.6.

11.0 Analytical Procedure

Additional guidance can be found in Reference 2 of section 16.0.

11.1 Non Thin-film Ultraviolet Radiation-cured (UV radiation-cured) Coatings.

11.1.1 Volatile Content. Use the procedure in ASTM D 5403 to determine the volatile matter content of the coating except the curing test described in NOTE 2 of ASTM D 5403 is required.

11.1.2 Water Content. To determine water content, follow section 11.3.2.

11.1.3 Coating Density. To determine coating density, follow section 11.3.3.

11.1.4 Solids Content. To determine solids content, follow section 11.3.4.

11.1.5 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the equation in section 12.2. If C is less than 0.2 g and A is greater than or equal to 225 cm^2 (35 in^2) then the coating or ink is considered a thin-film UV radiation-cured coating and ASTM D 5403 is not applicable.

NOTE: As noted in section 1.4 of ASTM D 5403, this method may not be applicable to radiation curable materials wherein the volatile material is water.

11.2 Multi-component Coatings.

11.2.1 Sample Preparation.

11.2.1.1 Prepare about 100 ml of sample by mixing the components in a storage container, such as a glass jar with a screw top or a metal can with a cap. The storage container should be just large enough to hold the mixture. Combine the components (by weight or volume) in the ratio recommended by the manufacturer. Tightly close the container between additions and during mixing to prevent loss of volatile materials. However, most manufacturers mixing instructions are by volume. Because of possible error caused by expansion of the liquid when measuring the volume, it is recommended that the components be combined by weight. When weight is used to combine the components and the manufacturer's recommended ratio is by volume, the density must be determined by section 11.3.3.

11.2.1.2 Immediately after mixing, take aliquots from this 100 ml sample for determination of the total volatile content, water content, and density.

11.2.2 Volatile Content. To determine total volatile content, use the apparatus and

reagents described in ASTM D2369 (incorporated by reference; see §60.17 for the approved versions of the standard), respectively, and use the following procedures:

11.2.2.1 Weigh and record the weight of an aluminum foil weighing dish. Add 3 ±1 ml of suitable solvent as specified in ASTM D2369 to the weighing dish. Using a syringe as specified in ASTM D2369, weigh to 1 mg, by difference, a sample of coating into the weighing dish. For coatings believed to have a volatile content less than 40 weight percent, a suitable size is 0.3 + 0.10 g, but for coatings believed to have a volatile content greater than 40 weight percent, a suitable size is 0.5 ±0.1 g.

NOTE: If the volatile content determined pursuant to section 12.4 is not in the range corresponding to the sample size chosen repeat the test with the appropriate sample size. Add the specimen dropwise, shaking (swirling) the dish to disperse the specimen completely in the solvent. If the material forms a lump that cannot be dispersed, discard the specimen and prepare a new one. Similarly, prepare a duplicate. The sample shall stand for a minimum of 1 hour, but no more than 24 hours prior to being oven cured at 110 ±5 °C (230 ±9 °F) for 1 hour.

11.2.2.2 Heat the aluminum foil dishes containing the dispersed specimens in the forced draft oven for 60 min at 110 ±5 °C (230 ±9 °F). Caution—provide adequate ventilation, consistent with accepted laboratory practice, to prevent solvent vapors from accumulating to a dangerous level.

11.2.2.3 Remove the dishes from the oven, place immediately in a desiccator, cool to ambient temperature, and weigh to within 1 mg.

11.2.2.4 Run analyses in pairs (duplicate sets) for each coating mixture until the criterion in section 11.4 is met. Calculate W_V following Equation 24–2 and record the arithmetic average.

11.2.3 Water Content. To determine water content, follow section 11.3.2.

11.2.4 Coating Density. To determine coating density, follow section 11.3.3.

11.2.5 Solids Content. To determine solids content, follow section 11.3.4.

11.2.6 Exempt Solvent Content. To determine the exempt solvent content, follow section 11.3.5.

NOTE: For all other coatings (*i.e.*, water-or solvent-borne coatings) not covered by multicomponent or UV radiation-cured coatings, analyze as shown below:

11.3 Water-or Solvent-borne coatings.

11.3.1 Volatile Content. Use the procedure in ASTM D 2369 to determine the volatile matter content (may include water) of the coating.

11.3.1.1 Record the following information:

W_1 = weight of dish and sample before heating, g

W_2 = weight of dish and sample after heating, g

W_3 = sample weight, g.

11.3.1.2 Calculate the weight fraction of the volatile matter (W_v) for each analysis as shown in section 12.3.

11.3.1.3 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.1.4 Record the arithmetic average (W_v).

11.3.2 Water Content. For waterborne coatings only, determine the weight fraction of water (W_w) using either ASTM D 3792 or ASTM D 4017.

11.3.2.1 Run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement in section 13.1.

11.3.2.2 Record the arithmetic average (w_w).

11.3.3 Coating Density. Determine the density (Dc, kg/l) of the surface coating using the procedure in ASTM D 1475.

11.3.3.1 Run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement in section 13.1.

11.3.3.2 Record the arithmetic average (D_c).

11.3.4 Solids Content. Determine the volume fraction (V_s) solids of the coating by calculation using the manufacturer's formulation.

11.3.5 Exempt Solvent Content. Determine the weight fraction of exempt solvents (W_E) by using ASTM Method D4457. Run a duplicate set of determinations and record the arithmetic average (W_E).

11.4 Sample Analysis Criteria. For W_v and W_w, run duplicate analyses until the difference between the two values in a set is less than or equal to the intra-laboratory precision statement for that parameter. For D_c, run duplicate analyses until each value in a set deviates from the mean of the set by no more than the intra-laboratory precision statement. If, after several attempts, it is concluded that the ASTM procedures cannot be used for the specific coating with the established intra-laboratory precision (excluding UV radiation-cured coatings), the U.S. Environmental Protection Agency (EPA) will assume responsibility for providing the necessary procedures for revising the method or precision statements upon written request to: Director, Emissions, Monitoring, and Analysis Division, MD–14, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

12.0 Calculations and Data Analysis

12.1 Nomenclature.

A = Area of substrate, cm^2, (in^2).

C = Amount of coating or ink added to the substrate, g.

D_c = Density of coating or ink, g/cm^3 (g/in^3).

F = Manufacturer's recommended film thickness, cm (in).
W_o = Weight fraction of nonaqueous volatile matter, g/g.
W_s = Weight fraction of solids, g/g.
W_v = Weight fraction of the volatile matter, g/g.
W_w = Weight fraction of the water, g/g.

12.2 To determine if a coating or ink can be classified as a thin-film UV cured coating or ink, use the following equation:

$$C = F\,A\,D_c \qquad \text{Eq. 24-1}$$

12.3 Calculate W_v for each analysis as shown below:

$$W_v = \frac{W_1 - W_2}{W_3} \qquad \text{Eq. 24-2}$$

12.4 Nonaqueous Volatile Matter.

12.4.1 Solvent-borne Coatings.

$$W_o = W_v \qquad \text{Eq. 24-3}$$

12.4.2 Waterborne Coatings.

$$W_o = W_v - W_w \qquad \text{Eq. 24-4}$$

12.4.3 Coatings Containing Exempt Solvents.

$$W_o = W_v - W_E - W_w \qquad \text{Eq. 24-5}$$

12.5 Weight Fraction Solids.

$$W_s = 1 - W_v \qquad \text{Eq. 24-6}$$

12.6 Confidence Limit Calculations for Waterborne Coatings. To calculate the lower confidence limit, subtract the appropriate inter-laboratory precision value from the measured mean value for that parameter. To calculate the upper confidence limit, add the appropriate inter-laboratory precision value to the measured mean value for that parameter. For W_v and D_c, use the lower confidence limits; for W_w, use the upper confidence limit. Because W_s is calculated, there is no adjustment for this parameter.

13.0 Method Performance

13.1 Analytical Precision Statements. The intra-and inter-laboratory precision statements are given in Table 24–1 in section 17.0.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as specified in section 6.0, with the addition of the following:

1. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.
2. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A.

EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.

3. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

TABLE 24–1—ANALYTICAL PRECISION STATEMENTS

	Intra-laboratory	Inter-laboratory
Volatile matter content, W_v	±0.015 $\overline{W}_v$	±0.047 $\overline{W}_v$
Water content, W_w	±0.029 $\overline{W}_w$	±0.075 $\overline{W}_w$
Density, D_c	±0.001 kg/l	±0.002 kg/l

METHOD 24A—DETERMINATION OF VOLATILE MATTER CONTENT AND DENSITY OF PUBLICATION ROTOGRAVURE INKS AND RELATED PUBLICATION ROTOGRAVURE COATINGS

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Volatile organic compounds (VOC).	No CAS number assigned.

1.2 Applicability. This method is applicable for the determination of the VOC content and density of solvent-borne (solvent-reducible) publication rotogravure inks and related publication rotogravure coatings.

2.0 Summary of Method

2.1 Separate procedures are used to determine the VOC weight fraction and density of the ink or related coating and the density of the solvent in the ink or related coating. The VOC weight fraction is determined by measuring the weight loss of a known sample quantity which has been heated for a specified length of time at a specified temperature. The density of both the ink or related coating and solvent are measured by a standard procedure. From this information, the VOC volume fraction is calculated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

5.2 Hazardous Components. Some of the compounds that may be contained in the inks or related coatings analyzed by this method may be irritating or corrosive to tissues or may be toxic. Nearly all are fire hazards. Appropriate precautions can be found in reference documents, such as Reference 6 of section 16.0.

6.0 Equipment and Supplies

The following equipment and supplies are required for sample analysis:

6.1 Weighing Dishes. Aluminum foil, 58 mm (2.3 in.) in diameter by 18 mm (0.7 in.) high, with a flat bottom. There must be at least three weighing dishes per sample.

6.2 Disposable Syringe. 5 ml.

6.3 Analytical Balance. To measure to within 0.1 mg.

6.4 Oven. Vacuum oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) and an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) for 4 hours. Alternatively, a forced draft oven capable of maintaining a temperature of 120 ±2 °C (248 ±4 °F) for 24 hours.

6.5 The equipment and supplies specified in ASTM D 1475–60, 80, or 90 (incorporated by reference—see §60.17).

7.0 Reagents and Standards

7.1 The reagents and standards specified in ASTM D 1475–60, 80, or 90 are required.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Follow the sample collection, preservation, storage, and transport procedures described in Reference 4 of section 16.0.

9.0 Quality Control [Reserved]

10.0 Calibration and Standardization [Reserved]

11.0 Analytical Procedure

Additional guidance can be found in Reference 5 of section 16.0.

11.1 VOC Weight Fraction. Shake or mix the ink or related coating sample thoroughly to assure that all the solids are completely suspended. Label and weigh to the nearest 0.1 mg a weighing dish and record this weight (M_{x1}). Using a 5 ml syringe, without a needle, extract an aliquot from the ink or related coating sample. Weigh the syringe and aliquot to the nearest 0.1 mg and record this weight (M_{cy1}). Transfer 1 to 3 g of the aliquot to the tared weighing dish. Reweigh the syringe and remaining aliquot to the nearest 0.1 mg and record this weight (M_{cy2}). Heat the weighing dish with the transferred aliquot in a vacuum oven at an absolute pressure of 510 ±51 mm Hg (20 ±2 in. Hg) and a temperature of 120 ±2 °C (248 ±4 °F) for 4 hours. Alternatively, heat the weighing dish with the transferred aliquot in a forced draft oven at a temperature of 120 ±2 °C for 24 hours. After the weighing dish has cooled, reweigh it to the nearest 0.1 mg and record the weight (M_{x2}). Repeat this procedure two times for each ink or related coating sample, for a total of three samples.

11.2 Ink or Related Coating Density. Determine the density of the ink or related coating (D_c) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the ink or related coating density as the arithmetic average ($\bar{D}_c$) of the three determinations.

11.3 Solvent Density. Determine the density of the solvent (D_o) according to the procedure outlined in ASTM D 1475. Make a total of three determinations for each ink or related coating sample. Report the solvent density as the arithmetic average ($\bar{D}_o$) of the three determinations.

12.0 Calculations and Data Analysis

12.1 VOC Weight Fraction. For each determination, calculate the volatile organic content weight fraction (W_o) using the following equation:

$$W_o = \frac{M_{x1} + M_{cy1} - M_{cy2} - M_{x2}}{M_{cy1} - M_{cy2}} \qquad \text{Eq. 24A-1}$$

Make a total of three determinations. Report the VOC weight fraction as the arithmetic average ($\bar{W}_o$) of the three determinations.

12.2 VOC Volume Fraction. Calculate the volume fraction volatile organic content (V_o) using the following equation:

$$V_o = \frac{\overline{W}_o \overline{D}_c}{\overline{D}_o} \qquad \text{Eq. 24A-2}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. ASTM Designation D 1475.
2. Teleconversation. Wright, Chuck, Inmont Corporation with Reich, R., A., Radian Corporation. September 25, 1979, Gravure Ink Analysis.
3. Teleconversation. Oppenheimer, Robert, Gravure Research Institute with Burt, Rick, Radian Corporation, November 5, 1979, Gravure Ink Analysis.
4. Standard Procedure for Collection of Coating and Ink Samples for Analysis by Reference Methods 24 and 24A. EPA–340/1–91–010. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.
5. Standard Operating Procedure for Analysis of Coating and Ink Samples by Reference Methods 24 and 24A. EPA–340/1–91–011. U.S. Environmental Protection Agency, Stationary Source Compliance Division, Washington, D.C. September 1991.
6. Handbook of Hazardous Materials: Fire, Safety, Health. Alliance of American Insurers. Schaumberg, IL. 1983.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25—DETERMINATION OF TOTAL GASEOUS NONMETHANE ORGANIC EMISSIONS AS CARBON

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total gaseous nonmethane organic compounds (TGNMO)	N/A	Dependent upon analytical equipment.

1.2 Applicability.

1.2.1 This method is applicable for the determination of volatile organic compounds (VOC) (measured as total gaseous nonmethane organics (TGNMO) and reported as carbon) in stationary source emissions. This method is not applicable for the determination of organic particulate matter.

1.2.2 This method is not the only method that applies to the measurement of VOC. Costs, logistics, and other practicalities of source testing may make other test methods more desirable for measuring VOC contents of certain effluent streams. Proper judgment is required in determining the most applicable VOC test method. For example, depending upon the molecular composition of the organics in the effluent stream, a totally automated semicontinuous nonmethane organics (NMO) analyzer interfaced directly to the source may yield accurate results. This approach has the advantage of providing emission data semicontinuously over an extended time period.

1.2.3 Direct measurement of an effluent with a flame ionization detector (FID) analyzer may be appropriate with prior characterization of the gas stream and knowledge that the detector responds predictably to the organic compounds in the stream. If present, methane (CH_4) will, of course, also be measured. The FID can be used under any of the following limited conditions: (1) Where only one compound is known to exist; (2) when the organic compounds consist of only hydrogen and carbon; (3) where the relative percentages of the compounds are known or can be determined, and the FID responses to the compounds are known; (4) where a consistent mixture of the compounds exists before and after emission control and only the relative concentrations are to be assessed; or (5) where the FID can be calibrated against mass standards of the compounds emitted (solvent emissions, for example).

1.2.4 Another example of the use of a direct FID is as a screening method. If there is enough information available to provide a rough estimate of the analyzer accuracy, the FID analyzer can be used to determine the VOC content of an uncharacterized gas stream. With a sufficient buffer to account for possible inaccuracies, the direct FID can be a useful tool to obtain the desired results without costly exact determination.

1.2.5 In situations where a qualitative/quantitative analysis of an effluent stream is desired or required, a gas chromatographic FID system may apply. However, for sources emitting numerous organics, the time and expense of this approach will be formidable.

2.0 Summary of Method

2.1 An emission sample is withdrawn from the stack at a constant rate through a heated filter and a chilled condensate trap by means of an evacuated sample tank. After sampling is completed, the TGNMO are determined by independently analyzing the condensate trap and sample tank fractions and combining the analytical results. The organic content of the condensate trap fraction is determined by oxidizing the NMO to carbon dioxide (CO_2) and quantitatively collecting in the effluent in an evacuated vessel; then a portion of the CO_2 is reduced to CH_4 and measured by an FID. The organic content of the sample tank fraction is measured by injecting a portion of the sample into a gas chromatographic column to separate the NMO from carbon monoxide (CO), CO_2, and CH_4; the NMO are oxidized to CO_2, reduced to CH_4, and measured by an FID. In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 Carbon Dioxide and Water Vapor. When carbon dioxide (CO_2) and water vapor are present together in the stack, they can produce a positive bias in the sample. The magnitude of the bias depends on the concentrations of CO_2 and water vapor. As a guideline, multiply the CO_2 concentration, expressed as volume percent, times the water vapor concentration. If this product does not exceed 100, the bias can be considered insignificant. For example, the bias is not significant for a source having 10 percent CO_2 and 10 percent water vapor, but it might be significant for a source having 10 percent CO_2 and 20 percent water vapor.

4.2. Particulate Matter. Collection of organic particulate matter in the condensate trap would produce a positive bias. A filter is included in the sampling equipment to minimize this bias.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

6.1 Sample Collection. The sampling system consists of a heated probe, heated filter, condensate trap, flow control system, and sample tank (see Figure 25–1). The TGNMO sampling equipment can be constructed from commercially available components and components fabricated in a machine shop. The following equipment is required:

6.1.1 Heated Probe. 6.4-mm (¼-in.) OD stainless steel tubing with a heating system capable of maintaining a gas temperature at the exit end of at least 129 °C (265 °F). The probe shall be equipped with a temperature sensor at the exit end to monitor the gas temperature. A suitable probe is shown in Figure 25–1. The nozzle is an elbow fitting attached to the front end of the probe while the temperature sensor is inserted in the side arm of a tee fitting attached to the rear of the probe. The probe is wrapped with a suitable length of high temperature heating tape, and then covered with two layers of glass cloth insulation and one layer of aluminum foil or an equivalent wrapping.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.2 Filter Holder. 25-mm (¹⁵⁄₁₆-in.) ID Gelman filter holder with 303 stainless steel body and 316 stainless steel support screen with the Viton O-ring replaced by a Teflon O-ring.

6.1.3 Filter Heating System.

6.1.3.1 A metal box consisting of an inner and an outer shell separated by insulating material with a heating element in the inner shell capable of maintaining a gas temperature at the filter of 121 ±3 °C (250 ±5 °F). The heating box shall include temperature sensors to monitor the gas temperature immediately upstream and immediately downstream of the filter.

6.1.3.2 A suitable heating box is shown in Figure 25–2. The outer shell is a metal box that measures 102 mm × 280 mm × 292 mm (4 in. × 11 in. × 11½ in.), while the inner shell is a metal box measuring 76 mm × 229 mm × 241 mm (3 in. × 9 in. × 9½ in.). The inner box is supported by 13-mm (½-in.) phenolic rods. The void space between the boxes is filled with ceramic fiber insulation which is sealed in place by means of a silicon rubber bead around the upper sides of the box. A removable lid made in a similar manner, with a 25-mm (1-in.) gap between the parts is used to cover the heating chamber. The inner box is heated with a 250-watt cartridge heater, shielded by a stainless steel shroud. The heater is regulated by a thermostatic temperature controller which is set to maintain a gas temperature of 121 °C (250 °F) as measured by the temperature sensor upstream of the filter.

NOTE: If it is not possible to use a heating system for safety reasons, an unheated system with an in-stack filter is a suitable alternative.

6.1.4 Condensate Trap. 9.5-mm (⅜-in.) OD 316 stainless steel tubing bent into a U-shape. Exact dimensions are shown in Figure

25–3. The tubing shall be packed with coarse quartz wool, to a density of approximately 0.11 g/cm^3 before bending. While the condensate trap is packed with dry ice in the Dewar, an ice bridge may form between the arms of the condensate trap making it difficult to remove the condensate trap. This problem can be prevented by attaching a steel plate between the arms of the condensate trap in the same plane as the arms to completely fill the intervening space.

6.1.5 Valve. Stainless steel control valve for starting and stopping sample flow.

6.1.6 Metering Valve. Stainless steel valve for regulating the sample flow rate through the sample train.

6.1.7 Rate Meter. Rotameter, or equivalent, capable of measuring sample flow in the range of 60 to 100 cm^3/min (0.13 to 0.21 ft^3/hr).

6.1.8 Sample Tank. Stainless steel or aluminum tank with a minimum volume of 4 liters (0.14 ft^3).

NOTE: Sample volumes greater than 4 liters may be required for sources with low organic concentrations.

6.1.9 Mercury Manometer. U-tube manometer or absolute pressure gauge capable of measuring pressure to within 1 mm Hg in the range of 0 to 900 mm.

6.1.10 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

6.2 Condensate Recovery. The system for the recovery of the organics captured in the condensate trap consists of a heat source, an oxidation catalyst, a nondispersive infrared (NDIR) analyzer, and an intermediate collection vessel (ICV). Figure 25–4 is a schematic of a typical system. The system shall be capable of proper oxidation and recovery, as specified in section 10.1.1. The following major components are required:

6.2.1 Heat Source. Sufficient to heat the condensate trap (including probe) to a temperature of 200 °C (390 °F). A system using both a heat gun and an electric tube furnace is recommended.

6.2.2 Heat Tape. Sufficient to heat the connecting tubing between the water trap and the oxidation catalyst to 100 °C (212 °F).

6.2.3 Oxidation Catalyst. A suitable length of 9.5 mm (3⁄8-in.) OD Inconel 600 tubing packed with 15 cm (6 in.) of 3.2 mm (3⁄8-in.) diameter 19 percent chromia on alumina pellets. The catalyst material is packed in the center of the catalyst tube with quartz wool packed on either end to hold it in place.

6.2.4 Water Trap. Leak-proof, capable of removing moisture from the gas stream.

6.2.5 Syringe Port. A 6.4-mm (1⁄4-in.) OD stainless steel tee fitting with a rubber septum placed in the side arm.

6.2.6 NDIR Detector. Capable of indicating CO_2 concentration in the range of zero to 5 percent, to monitor the progress of combustion of the organic compounds from the condensate trap.

6.2.7 Flow-Control Valve. Stainless steel, to maintain the trap conditioning system near atmospheric pressure.

6.2.8 Intermediate Collection Vessel. Stainless steel or aluminum, equipped with a female quick connect. Tanks with nominal volumes of at least 6 liters (0.2 ft^3) are recommended.

6.2.9 Mercury Manometer. Same as described in section 6.1.9.

6.2.10 Syringe. 10-ml gas-tight glass syringe equipped with an appropriate needle.

6.2.11 Syringes. 10-μl and 50-μl liquid injection syringes.

6.2.12 Liquid Sample Injection Unit. 316 Stainless steel U-tube fitted with an injection septum (see Figure 25–7).

6.3 Analysis.

6.3.1 NMO Analyzer. The NMO analyzer is a gas chromatograph (GC) with backflush capability for NMO analysis and is equipped with an oxidation catalyst, reduction catalyst, and FID. Figures 25–5 and 25–6 are schematics of a typical NMO analyzer. This semicontinuous GC/FID analyzer shall be capable of: (1) Separating CO, CO_2, and CH_4 from NMO, (2) reducing the CO_2 to CH_4 and quantifying as CH_4, and (3) oxidizing the NMO to CO_2, reducing the CO_2 to CH_4 and quantifying as CH_4, according to section 10.1.2. The analyzer consists of the following major components:

6.3.1.1 Oxidation Catalyst. A suitable length of 9.5-mm (3⁄8-in.) OD Inconel 600 tubing packed with 5.1 cm (2 in.) of 19 percent chromia on 3.2-mm (1⁄8-in.) alumina pellets. The catalyst material is packed in the center of the tube supported on either side by quartz wool. The catalyst tube must be mounted vertically in a 650 °C (1200 °F) furnace. Longer catalysts mounted horizontally may be used, provided they can meet the specifications of section 10.1.2.1.

6.3.1.2 Reduction Catalyst. A 7.6-cm (3-in.) length of 6.4-mm (1⁄4-in.) OD Inconel tubing fully packed with 100-mesh pure nickel powder. The catalyst tube must be mounted vertically in a 400 °C (750 °F) furnace.

6.3.1.3 Separation Column(s). A 30-cm (1-ft) length of 3.2-mm (1⁄8-in.) OD stainless steel tubing packed with 60/80 mesh Unibeads 1S followed by a 61-cm (2-ft) length of 3.2-mm (1⁄8-in.) OD stainless steel tubing packed with 60/80 mesh Carbosieve G. The Carbosieve and Unibeads columns must be baked separately at 200 °C (390 °F) with carrier gas flowing through them for 24 hours before initial use.

6.3.1.4 Sample Injection System. A single 10-port GC sample injection valve or a group of valves with sufficient ports fitted with a sample loop properly sized to interface with the NMO analyzer (1-cc loop recommended).

6.3.1.5 FID. An FID meeting the following specifications is required:

6.3.1.5.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.2.3.

6.3.1.5.2 Range. A full scale range of 10 to 50,000 ppm CH_4. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.3.1.6 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the analytical results.

6.3.2 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 1 mm Hg.

6.3.3 Temperature Sensor. Capable of measuring the laboratory temperature within 1 °C (2 °F).

6.3.4 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

7.0 Reagents and Standards

7.1 Sample Collection. The following reagents are required for sample collection:

7.1.1 Dry Ice. Solid CO2, crushed.

7.1.2 Coarse Quartz Wool. 8 to 15 um.

7.1.3 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Method D2986–71, 78, or 95a (incorporated by reference—see §60.17). Test data from the supplier's quality control program are sufficient for this purpose.

7.2 NMO Analysis. The following gases are required for NMO analysis:

7.2.1 Carrier Gases. Helium (He) and oxygen (O_2) containing less than 1 ppm CO_2 and less than 0.1 ppm hydrocarbon.

7.2.2 Fuel Gas. Hydrogen (H_2), at least 99.999 percent pure.

7.2.3 Combustion Gas. Either air (less than 0.1 ppm total hydrocarbon content) or O_2 (purity 99.99 percent or greater), as required by the detector.

7.3 Condensate Analysis. The following are required for condensate analysis:

7.3.1 Gases. Containing less than 1 ppm carbon.

7.3.1.1 Air.

7.3.1.2 Oxygen.

7.3.2 Liquids. To conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society.

7.3.2.1 Hexane.

7.3.2.2 Decane.

7.4 Calibration. For all calibration gases, the manufacturer must recommend a maximum shelf life for each cylinder (i.e., the length of time the gas concentration is not expected to change more than ±5 percent from its certified value). The date of gas cylinder preparation, certified organic concentration, and recommended maximum shelf life must be affixed to each cylinder before shipment from the gas manufacturer to the buyer. The following calibration gases are required:

7.4.1 Oxidation Catalyst Efficiency Check Calibration Gas. Gas mixture standard with nominal concentration of 1 percent methane in air.

7.4.2 FID Linearity and NMO Calibration Gases. Three gas mixture standards with nominal propane concentrations of 20 ppm, 200 ppm, and 3000 ppm, in air.

7.4.3 CO_2 Calibration Gases. Three gas mixture standards with nominal CO_2 concentrations of 50 ppm, 500 ppm, and 1 percent, in air.

NOTE: Total NMO less than 1 ppm required for 1 percent mixture.

7.4.4 NMO Analyzer System Check Calibration Gases. Four calibration gases are needed as follows:

7.4.4.1 Propane Mixture. Gas mixture standard containing (nominal) 50 ppm CO, 50 ppm CH_4, 1 percent CO_2, and 20 ppm C_3H_8, prepared in air.

7.4.4.2 Hexane. Gas mixture standard containing (nominal) 50 ppm hexane in air.

7.4.4.3 Toluene. Gas mixture standard containing (nominal) 20 ppm toluene in air.

7.4.4.4 Methanol. Gas mixture standard containing (nominal) 100 ppm methanol in air.

8.0 Sample Collection, Preservation, Transport, and Storage

8.1 Sampling Equipment Preparation.

8.1.1 Condensate Trap Cleaning. Before its initial use and after each use, a condensate trap should be thoroughly cleaned and checked to ensure that it is not contaminated. Both cleaning and checking can be accomplished by installing the trap in the condensate recovery system and treating it as if it were a sample. The trap should be heated as described in section 11.1.3. A trap may be considered clean when the CO_2 concentration in its effluent gas drops below 10 ppm. This check is optional for traps that most recently have been used to collect samples which were then recovered according to the procedure in section 11.1.3.

8.1.2 Sample Tank Evacuation and Leak-Check. Evacuate the sample tank to 10 mm Hg absolute pressure or less. Then close the sample tank valve, and allow the tank to sit for 60 minutes. The tank is acceptable if a change in tank vacuum of less than 1 mm Hg is noted. The evacuation and leak-check may be conducted either in the laboratory or the field.

8.1.3 Sampling Train Assembly. Just before assembly, measure the tank vacuum using a mercury manometer. Record this vacuum, the ambient temperature, and the barometric pressure at this time. Close the sample tank valve and assemble the sampling

system as shown in Figure 25–1. Immerse the condensate trap body in dry ice at least 30 minutes before commencing sampling to improve collection efficiency. The point where the inlet tube joins the trap body should be 2.5 to 5 cm (1 to 2 in.) above the top of the dry ice.

8.1.4 Pretest Leak-Check. A pretest leak-check is required. Calculate or measure the approximate volume of the sampling train from the probe tip to the sample tank valve. After assembling the sampling train, plug the probe tip, and make certain that the sample tank valve is closed. Turn on the vacuum pump, and evacuate the sampling system from the probe tip to the sample tank valve to an absolute pressure of 10 mm Hg or less. Close the purge valve, turn off the pump, wait a minimum period of 10 minutes, and recheck the indicated vacuum. Calculate the maximum allowable pressure change based on a leak rate of 1 percent of the sampling rate using Equation 25–1, section 12.2. If the measured pressure change exceeds the allowable, correct the problem and repeat the leak-check before beginning sampling.

8.2 Sample Collection.

8.2.1 Unplug the probe tip, and place the probe into the stack such that the probe is perpendicular to the duct or stack axis; locate the probe tip at a single preselected point of average velocity facing away from the direction of gas flow. For stacks having a negative static pressure, seal the sample port sufficiently to prevent air in-leakage around the probe. Set the probe temperature controller to 129 °C (265 °F) and the filter temperature controller to 121 °C (250 °F). Allow the probe and filter to heat for about 30 minutes before purging the sample train.

8.2.2 Close the sample valve, open the purge valve, and start the vacuum pump. Set the flow rate between 60 and 100 cm^3/min (0.13 and 0.21 ft^3/hr), and purge the train with stack gas for at least 10 minutes.

8.2.3 When the temperatures at the exit ends of the probe and filter are within the corresponding specified ranges, check the dry ice level around the condensate trap, and add dry ice if necessary. Record the clock time. To begin sampling, close the purge valve and stop the pump. Open the sample valve and the sample tank valve. Using the flow control valve, set the flow through the sample train to the proper rate. Adjust the flow rate as necessary to maintain a constant rate (±10 percent) throughout the duration of the sampling period. Record the sample tank vacuum and flowmeter setting at 5-minute intervals. (See Figure 25–8.) Select a total sample time greater than or equal to the minimum sampling time specified in the applicable subpart of the regulations; end the sampling when this time period is reached or when a constant flow rate can no longer be maintained because of reduced sample tank vacuum.

NOTE: If sampling had to be stopped before obtaining the minimum sampling time (specified in the applicable subpart) because a constant flow rate could not be maintained, proceed as follows: After closing the sample tank valve, remove the used sample tank from the sampling train (without disconnecting other portions of the sampling train). Take another evacuated and leak-checked sample tank, measure and record the tank vacuum, and attach the new tank to the sampling train. After the new tank is attached to the sample train, proceed with the sampling until the required minimum sampling time has been exceeded.

8.3 Sample Recovery. After sampling is completed, close the flow control valve, and record the final tank vacuum; then record the tank temperature and barometric pressure. Close the sample tank valve, and disconnect the sample tank from the sample system. Disconnect the condensate trap at the inlet to the rate meter, and tightly seal both ends of the condensate trap. Do not include the probe from the stack to the filter as part of the condensate sample.

8.4 Sample Storage and Transport. Keep the trap packed in dry ice until the samples are returned to the laboratory for analysis. Ensure that run numbers are identified on the condensate trap and the sample tank(s).

9.0 Quality Control

Section	Quality control measure	Effect
10.1.1	Initial performance check of condensate recovery apparatus.	Ensure acceptable condensate recovery efficiency.
10.1.2, 10.2	NMO analyzer initial and daily performance checks.	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial Performance Checks.

10.1.1 Condensate Recovery Apparatus. Perform these tests before the system is first placed in operation, after any shutdown of 6 months or more, and after any major modification of the system, or at the frequency recommended by the manufacturer.

10.1.1.1 Carrier Gas and Auxiliary O_2 Blank Check. Analyze each new tank of carrier gas or auxiliary O_2 with the NMO analyzer to

check for contamination. Treat the gas cylinders as noncondensible gas samples, and analyze according to the procedure in section 11.2.3. Add together any measured CH_4, CO, CO_2, or NMO. The total concentration must be less than 5 ppm.

10.1.1.2 Oxidation Catalyst Efficiency Check.

10.1.1.2.1 With a clean condensate trap installed in the recovery system or a ⅛″ stainless steel connector tube, replace the carrier gas cylinder with the high level methane standard gas cylinder (Section 7.4.1). Set the four-port valve to the recovery position, and attach an ICV to the recovery system. With the sample recovery valve in vent position and the flow-control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

10.1.1.2.2 After the NDIR response has stabilized, switch the sample recovery valve from vent to collect. When the manometer or pressure gauge begins to register a slight positive pressure, open the flow-control valve. Keep the flow adjusted such that the pressure in the system is maintained within 10 percent of atmospheric pressure. Continue collecting the sample in a normal manner until the ICV is filled to a nominal gauge pressure of 300 mm Hg. Close the ICV valve, and remove the ICV from the system. Place the sample recovery valve in the vent position, and return the recovery system to its normal carrier gas and normal operating conditions. Analyze the ICV for CO_2 using the NMO analyzer; the catalyst efficiency is acceptable if the CO_2 concentration is within 2 percent of the methane standard concentration.

10.1.1.3 System Performance Check. Construct a liquid sample injection unit similar in design to the unit shown in Figure 25–7. Insert this unit into the condensate recovery and conditioning system in place of a condensate trap, and set the carrier gas and auxiliary O_2 flow rates to normal operating levels. Attach an evacuated ICV to the system, and switch from system vent to collect. With the carrier gas routed through the injection unit and the oxidation catalyst, inject a liquid sample (see sections 10.1.1.3.1 to 10.1.1.3.4) into the injection port. Operate the trap recovery system as described in section 11.1.3. Measure the final ICV pressure, and then analyze the vessel to determine the CO_2 concentration. For each injection, calculate the percent recovery according to section 12.7. Calculate the relative standard deviation for each set of triplicate injections according to section 12.8. The performance test is acceptable if the average percent recovery is 100 ±5 percent and the relative standard deviation is less than 2 percent for each set of triplicate injections.

10.1.1.3.1 50 µl hexane.

10.1.1.3.2 10 µl hexane.

10.1.1.3.3 50 µl decane.

10.1.1.3.4 10 µl decane.

10.1.2 NMO Analyzer. Perform these tests before the system is first placed in operation, after any shutdown longer than 6 months, and after any major modification of the system.

10.1.2.1 Oxidation Catalyst Efficiency Check. Turn off or bypass the NMO analyzer reduction catalyst. Make triplicate injections of the high level methane standard (Section 7.4.1). The oxidation catalyst operation is acceptable if the FID response is less than 1 percent of the injected methane concentration.

10.1.2.2 Reduction Catalyst Efficiency Check. With the oxidation catalyst unheated or bypassed and the heated reduction catalyst bypassed, make triplicate injections of the high level methane standard (Section 7.4.1). Repeat this procedure with both catalysts operative. The reduction catalyst operation is acceptable if the responses under both conditions agree within 5 percent of their average.

10.1.2.3 NMO Analyzer Linearity Check Calibration. While operating both the oxidation and reduction catalysts, conduct a linearity check of the analyzer using the propane standards specified in section 7.4.2. Make triplicate injections of each calibration gas. For each gas (*i.e.*, each set of triplicate injections), calculate the average response factor (area/ppm C) for each gas, as well as and the relative standard deviation (according to section 12.8). Then calculate the overall mean of the response factor values. The instrument linearity is acceptable if the average response factor of each calibration gas is within 2.5 percent of the overall mean value and if the relative standard deviation gas is less than 2 percent of the overall mean value. Record the overall mean of the propane response factor values as the NMO calibration response factor (RF_{NMO}). Repeat the linearity check using the CO_2 standards specified in section 7.4.3. Make triplicate injections of each gas, and then calculate the average response factor (area/ppm C) for each gas, as well as the overall mean of the response factor values. Record the overall mean of the response factor values as the CO_2 calibration response factor (RF_{CO2}). The RF_{CO2} must be within 10 percent of the RF_{NMO}.

10.1.2.4 System Performance Check. Check the column separation and overall performance of the analyzer by making triplicate injections of the calibration gases listed in section 7.4.4. The analyzer performance is acceptable if the measured NMO value for each gas (average of triplicate injections) is within 5 percent of the expected value.

10.2 NMO Analyzer Daily Calibration. The following calibration procedures shall be performed before and immediately after the

analysis of each set of samples, or on a daily basis, whichever is more stringent:

10.2.1 CO_2 Response Factor. Inject triplicate samples of the high level CO_2 calibration gas (Section 7.4.3), and calculate the average response factor. The system operation is adequate if the calculated response factor is within 5 percent of the RF_{CO2} calculated during the initial performance test (Section 10.1.2.3). Use the daily response factor (DRF_{CO2}) for analyzer calibration and the calculation of measured CO_2 concentrations in the ICV samples.

10.2.2 NMO Response Factors. Inject triplicate samples of the mixed propane calibration cylinder gas (Section 7.4.4.1), and calculate the average NMO response factor. The system operation is adequate if the calculated response factor is within 10 percent of the RF_{NMO} calculated during the initial performance test (Section 10.1.2.4). Use the daily response factor (DRF_{NMO}) for analyzer calibration and calculation of NMO concentrations in the sample tanks.

10.3 Sample Tank and ICV Volume. The volume of the gas sampling tanks used must be determined. Determine the tank and ICV volumes by weighing them empty and then filled with deionized distilled water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedure

11.1 Condensate Recovery. See Figure 25–9. Set the carrier gas flow rate, and heat the catalyst to its operating temperature to condition the apparatus.

11.1.1 Daily Performance Checks. Each day before analyzing any samples, perform the following tests:

11.1.1.1 Leak-Check. With the carrier gas inlets and the sample recovery valve closed, install a clean condensate trap in the system, and evacuate the system to 10 mm Hg absolute pressure or less. Monitor the system pressure for 10 minutes. The system is acceptable if the pressure change is less than 2 mm Hg.

11.1.1.2 System Background Test. Adjust the carrier gas and auxiliary oxygen flow rate to their normal values of 100 cc/min and 150 cc/min, respectively, with the sample recovery valve in vent position. Using a 10-ml syringe, withdraw a sample from the system effluent through the syringe port. Inject this sample into the NMO analyzer, and measure the CO_2 content. The system background is acceptable if the CO_2 concentration is less than 10 ppm.

11.1.1.3 Oxidation Catalyst Efficiency Check. Conduct a catalyst efficiency test as specified in section 10.1.1.2. If the criterion of this test cannot be met, make the necessary repairs to the system before proceeding.

11.1.2 Condensate Trap CO_2 Purge and Sample Tank Pressurization.

11.1.2.1 After sampling is completed, the condensate trap will contain condensed water and organics and a small volume of sampled gas. This gas from the stack may contain a significant amount of CO_2 which must be removed from the condensate trap before the sample is recovered. This is accomplished by purging the condensate trap with zero air and collecting the purged gas in the original sample tank.

11.1.2.2 Begin with the sample tank and condensate trap from the test run to be analyzed. Set the four-port valve of the condensate recovery system in the CO_2 purge position as shown in Figure 25–9. With the sample tank valve closed, attach the sample tank to the sample recovery system. With the sample recovery valve in the vent position and the flow control valve fully open, evacuate the manometer or pressure gauge to the vacuum of the sample tank. Next, close the vacuum pump valve, open the sample tank valve, and record the tank pressure.

11.1.2.3 Attach the dry ice-cooled condensate trap to the recovery system, and initiate the purge by switching the sample recovery valve from vent to collect position. Adjust the flow control valve to maintain atmospheric pressure in the recovery system. Continue the purge until the CO_2 concentration of the trap effluent is less than 5 ppm. CO_2 concentration in the trap effluent should be measured by extracting syringe samples from the recovery system and analyzing the samples with the NMO analyzer. This procedure should be used only after the NDIR response has reached a minimum level. Using a 10-ml syringe, extract a sample from the syringe port prior to the NDIR, and inject this sample into the NMO analyzer.

11.1.2.4 After the completion of the CO_2 purge, use the carrier gas bypass valve to pressurize the sample tank to approximately 1,060 mm Hg absolute pressure with zero air.

11.1.3 Recovery of the Condensate Trap Sample (See Figure 25–10).

11.1.3.1 Attach the ICV to the sample recovery system. With the sample recovery valve in a closed position, between vent and collect, and the flow control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

11.1.3.2 Begin auxiliary oxygen flow to the oxidation catalyst at a rate of 150 cc/min, then switch the four-way valve to the trap recovery position and the sample recovery valve to collect position. The system should now be set up to operate as indicated in Figure 25–10. After the manometer or pressure gauge begins to register a slight positive pressure, open the flow control valve. Adjust the flow-control valve to maintain atmospheric pressure in the system within 10 percent.

11.1.3.3 Remove the condensate trap from the dry ice, and allow it to warm to ambient temperature while monitoring the NDIR response. If, after 5 minutes, the CO_2 concentration of the catalyst effluent is below 10,000 ppm, discontinue the auxiliary oxygen flow to the oxidation catalyst. Begin heating the trap by placing it in a furnace preheated to 200 °C (390 °F). Once heating has begun, carefully monitor the NDIR response to ensure that the catalyst effluent concentration does not exceed 50,000 ppm. Whenever the CO_2 concentration exceeds 50,000 ppm, supply auxiliary oxygen to the catalyst at the rate of 150 cc/min. Begin heating the tubing that connected the heated sample box to the condensate trap only after the CO_2 concentration falls below 10,000 ppm. This tubing may be heated in the same oven as the condensate trap or with an auxiliary heat source such as a heat gun. Heating temperature must not exceed 200 °C (390 °F). If a heat gun is used, heat the tubing slowly along its entire length from the upstream end to the downstream end, and repeat the pattern for a total of three times. Continue the recovery until the CO_2 concentration drops to less than 10 ppm as determined by syringe injection as described under the condensate trap CO_2 purge procedure (Section 11.1.2).

11.1.3.4 After the sample recovery is completed, use the carrier gas bypass valve to pressurize the ICV to approximately 1060 mm Hg absolute pressure with zero air.

11.2 Analysis. Once the initial performance test of the NMO analyzer has been successfully completed (see section 10.1.2) and the daily CO_2 and NMO response factors have been determined (see section 10.2), proceed with sample analysis as follows:

11.2.1 Operating Conditions. The carrier gas flow rate is 29.5 cc/min He and 2.2 cc/min O_2. The column oven is heated to 85 °C (185 °F). The order of elution for the sample from the column is CO, CH_4, CO_2, and NMO.

11.2.2 Analysis of Recovered Condensate Sample. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (380 °F) as rapidly as possible. A rate of 30 °C/min (90 °F) has been shown to be adequate. Record the value obtained for the condensible organic material (C_{cm}) measured as CO_2 and any measured NMO. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average C_{cm}.

11.2.3 Analysis of Sample Tank. Perform the analysis as described in section 11.2.2, but record only the value measured for NMO (C_{tm}).

12.0 Data Analysis and Calculations

Carry out the calculations, retaining at least one extra significant figure beyond that of the acquired data. Round off figures after final calculations. All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature.

C = TGNMO concentration of the effluent, ppm C equivalent.

C_c = Calculated condensible organic (condensate trap) concentration of the effluent, ppm C equivalent.

C_{cm} = Measured concentration (NMO analyzer) for the condensate trap ICV, ppm CO_2.

C_t = Calculated noncondensible organic concentration (sample tank) of the effluent, ppm C equivalent.

C_{tm} = Measured concentration (NMO analyzer) for the sample tank, ppm NMO.

F = Sampling flow rate, cc/min.

L = Volume of liquid injected, μl.

M = Molecular weight of the liquid injected, g/g-mole.

M_c = TGNMO mass concentration of the effluent, mg C/dsm^3.

N = Carbon number of the liquid compound injected (N = 12 for decane, N = 6 for hexane).

n = Number of data points.

P_f = Final pressure of the intermediate collection vessel, mm Hg absolute.

P_b = Barometric pressure, cm Hg.

P_{ti} = Gas sample tank pressure before sampling, mm Hg absolute.

P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.

q = Total number of analyzer injections of intermediate collection vessel during analysis (where k = injection number, 1 * * * q).

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 * * * r).

r = Density of liquid injected, g/cc.

T_f = Final temperature of intermediate collection vessel, °K.

T_{ti} = Sample tank temperature before sampling, °K.

T_t = Sample tank temperature at completion of sampling, °K.

T_{tf} = Sample tank temperature after pressurizing, °K.

V = Sample tank volume, m^3.

V_t = Sample train volume, cc.

V_v = Intermediate collection vessel volume, m^3.

V_s = Gas volume sampled, dsm^3.

x_i = Individual measurements.

$\bar{x}$ = Mean value.

ΔP = Allowable pressure change, cm Hg.
Θ = Leak-check period, min.

12.2 Allowable Pressure Change. For the pretest leak-check, calculate the allowable pressure change using Equation 25–1:

$$\Delta P = 0.01 \frac{F P_b \Theta}{V_t} \qquad \text{Eq. 25-1}$$

12.3 Sample Volume. For each test run, calculate the gas volume sampled using Equation 25–2:

$$V_s = 0.3857\, V \left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}} \right) \qquad \text{Eq. 25-2}$$

12.4 Noncondensible Organics. For each sample tank, determine the concentration of nonmethane organics (ppm C) using Equation 25–3:

$$C_t = \left(\frac{\dfrac{P_{tf}}{T_{tf}}}{\dfrac{P_t}{T_t} - \dfrac{P_{ti}}{T_{ti}}} \right) \left(\frac{1}{r} \sum_{j=1}^{r} C_{tm_j} \right) \qquad \text{Eq. 25-3}$$

12.5 Condensible Organics. For each condensate trap determine the concentration of organics (ppm C) using Equation 25–4:

$$C_c = 0.3857 \frac{V_v P_f}{V_s T_f} \left(\frac{1}{q} \sum_{k=1}^{q} C_{cm_k} \right) \qquad \text{Eq. 25-4}$$

12.6 TGNMO Mass Concentration. Determine the TGNMO mass concentration as carbon for each test run, using Equation 25–5:

$$M_c = 0.4993 \left(C_t + C_c \right) \qquad \text{Eq. 25-5}$$

12.7 Percent Recovery. Calculate the percent recovery for the liquid injections to the condensate recovery and conditioning system using Equation 25–6:

$$\text{Percent Recovery} = K \frac{M\, V_v P_t C_{cm}}{L\, P\, T_f N} \qquad \text{Eq. 25-6}$$

where K = 1.604 (°K)(g-mole)(%)/(mm Hg)(ml)(m^3)(ppm).

12.8 Relative Standard Deviation. Use Equation 25–7 to calculate the relative standard deviation (RSD) of percent recovery and analyzer linearity.

$$RSD = \frac{100}{\bar{x}} \left[\frac{\sum_{i=1}^{n} \left(x_i - \bar{x} \right)^2}{n - 1} \right]^{\frac{1}{2}} \qquad \text{Eq. 25-7}$$

13.0 Method Performance

13.1 Range. The minimum detectable limit of the method has been determined to be 50 parts per million by volume (ppm). No upper limit has been established.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, A.E., S. Witz, and R.D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, MA. June 15–20, 1975.) 14 p.

2. Salo, A.E., W.L. Oaks, and R.D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, CO. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

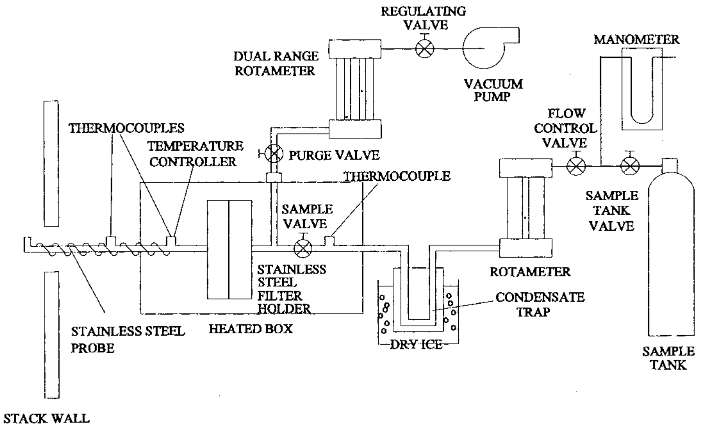


Figure 25-1. Sampling Train

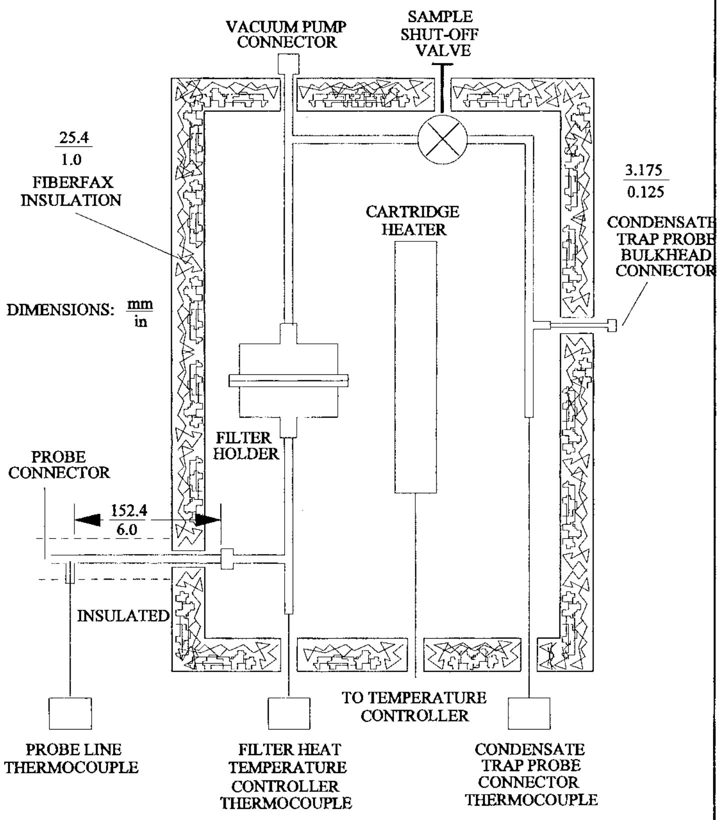


Figure 25-2. Out-of-stack Filter Box

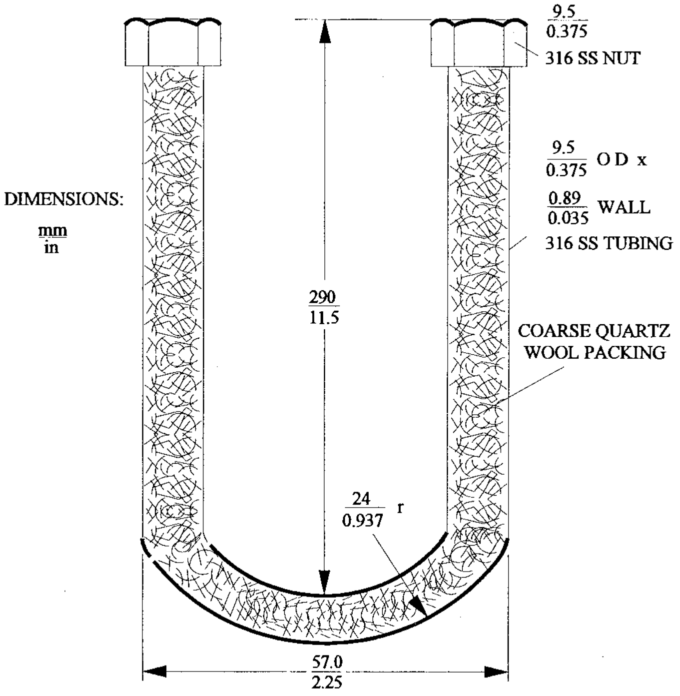


Figure 25-3. Condensate Trap

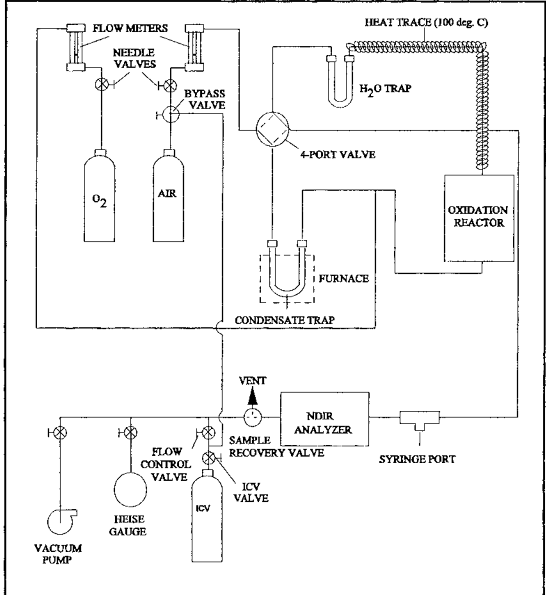


Figure 25-4. Condensate Recovery System

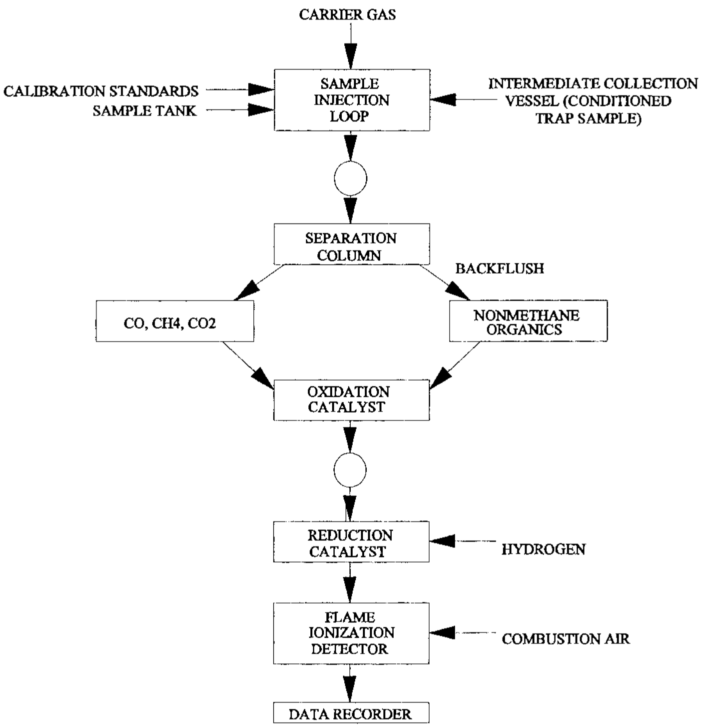


Figure 25-5. Simplified Schematic of Nonmethane Organic (NMO) Analyzer

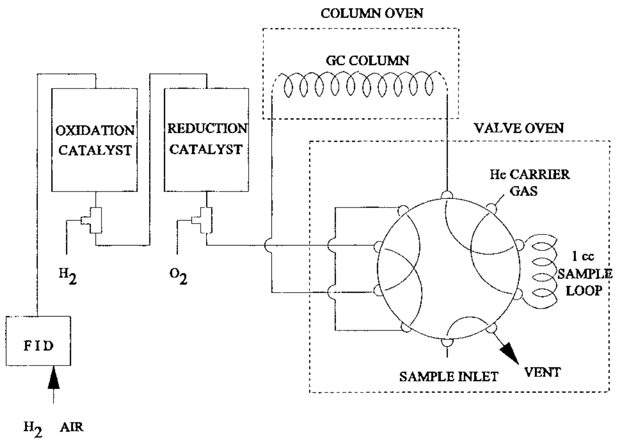


Figure 25-6. Nonmethane Organic Analyzer (NMO)

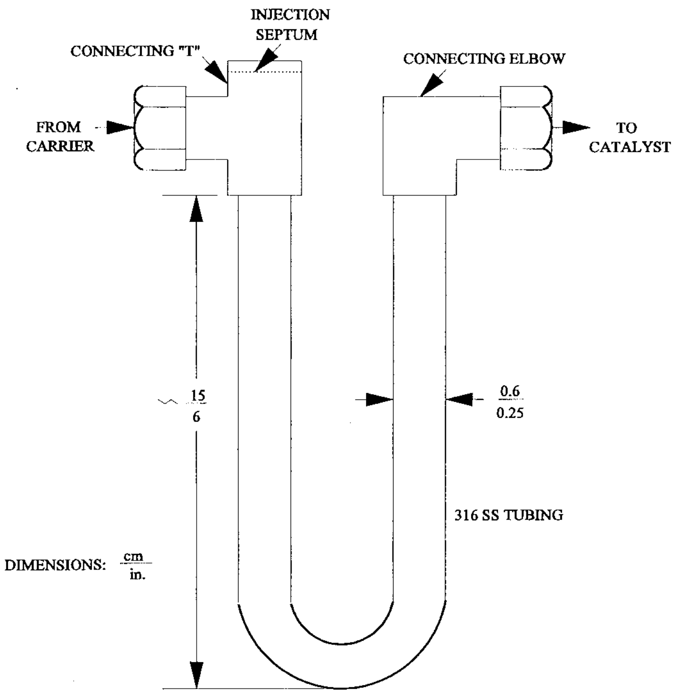
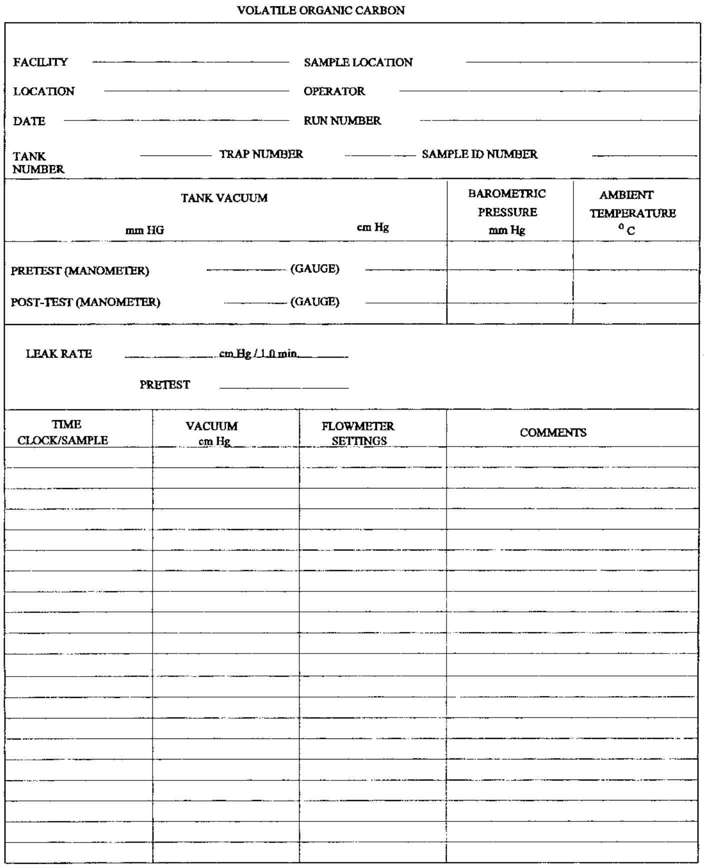


Figure 25-7. Liquid Sample Injection Unit



VOLATILE ORGANIC CARBON

FACILITY ______ SAMPLE LOCATION ______

LOCATION ______ OPERATOR ______

DATE ______ RUN NUMBER ______

TANK NUMBER ______ TRAP NUMBER ______ SAMPLE ID NUMBER ______

TANK VACUUM mm HG	cm Hg	BAROMETRIC PRESSURE mm Hg	AMBIENT TEMPERATURE $^\circ$C
PRETEST (MANOMETER) ______	(GAUGE) ______		
POST-TEST (MANOMETER) ______	(GAUGE) ______		

LEAK RATE ______ cm Hg / 1.0 min. ______

PRETEST ______

TIME CLOCK/SAMPLE	VACUUM cm Hg	FLOWMETER SETTINGS	COMMENTS

Figure 25-8. Example Field Data Form

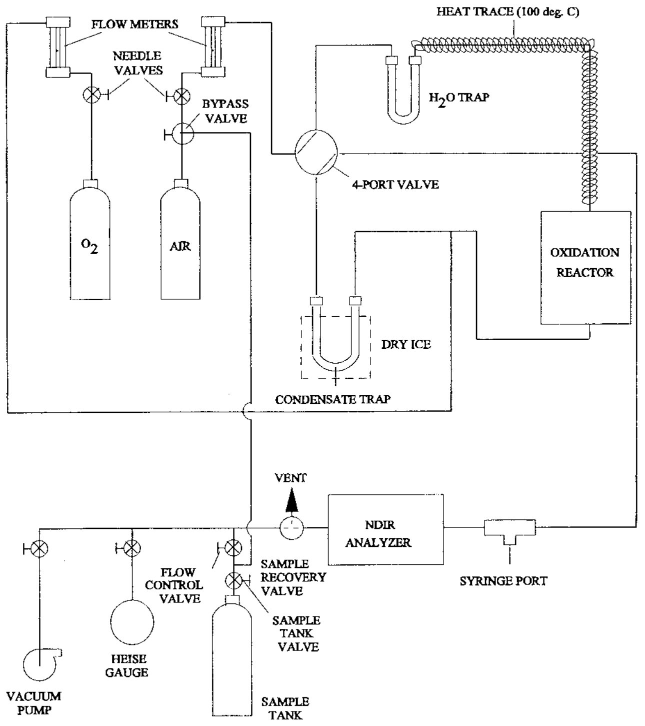


Figure 25-9. Condensate Recovery System, CO2 Purge

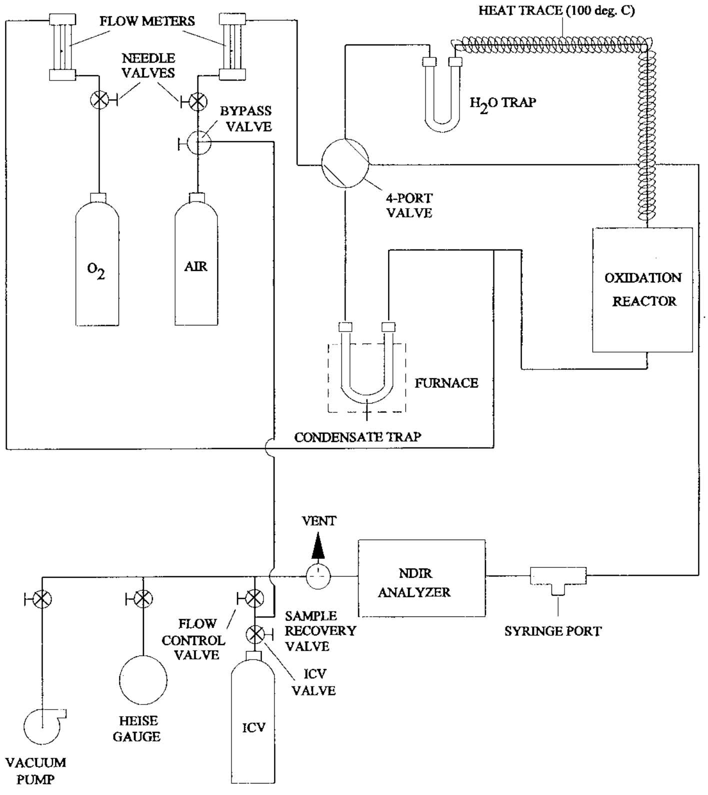


Figure 25-10. Condensate Recovery System, Collection of Trap Organics

METHOD 25A—DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A FLAME IONIZATION ANALYZER

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A gas sample is extracted from the source through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

3.1 *Calibration drift* means the difference in the measurement system response to a midlevel calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

3.2 *Calibration error* means the difference between the gas concentration indicated by the measurement system and the know concentration of the calibration gas.

3.3 *Calibration gas* means a known concentration of a gas in an appropriate diluent gas.

3.4 *Measurement system* means the total equipment required for the determination of the gas concentration. The system consists of the following major subsystems:

3.4.1 *Sample interface* means that portion of a system used for one or more of the following: sample acquisition, sample transportation, sample conditioning, or protection of the analyzer(s) from the effects of the stack effluent.

3.4.2 *Organic analyzer* means that portion of the measurement system that senses the gas to be measured and generates an output proportional to its concentration.

3.5 *Response time* means the time interval from a step change in pollutant concentration at the inlet to the emission measurement system to the time at which 95 percent of the corresponding final value is reached as displayed on the recorder.

3.6 *Span Value* means the upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the applicable emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected concentration. For convenience, the span value should correspond to 100 percent of the recorder scale.

3.7 *Zero drift* means the difference in the measurement system response to a zero level calibration gas before or after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

6.1 Measurement System. Any measurement system for total organic concentration that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 25A–1. All sampling components leading to the analyzer shall be heated ≥110 °C (220 °F) throughout the sampling period, unless safety reasons are cited (Section 5.2) The essential components of the measurement system are described below:

6.1.1 Organic Concentration Analyzer. A flame ionization analyzer (FIA) capable of meeting or exceeding the specifications of this method. The flame ionization detector block shall be heated >120 °C (250 °F).

6.1.2 Sample Probe. Stainless steel, or equivalent, three-hole rake type. Sample holes shall be 4 mm (0.16-in.) in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

6.1.3 Heated Sample Line. Stainless steel or Teflon'' tubing to transport the sample gas

to the analyzer. The sample line should be heated (≥110 °C) to prevent any condensation.

6.1.4 Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are applicable.

6.1.5 Particulate Filter. An in-stack or an out-of-stack glass fiber filter is recommended if exhaust gas particulate loading is significant. An out-of-stack filter should be heated to prevent any condensation.

6.1.6 Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

7.0 Reagents and Standards

7.1 Calibration Gases. The calibration gases for the gas analyzer shall be propane in air or propane in nitrogen. Alternatively, organic compounds other than propane can be used; the appropriate corrections for response factor must be made. Calibration gases shall be prepared in accordance with the procedure listed in Citation 2 of section 16. Additionally, the manufacturer of the cylinder should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change more than ±2 percent from the certified value. For calibration gas values not generally available (*i.e.*, organics between 1 and 10 percent by volume), alternative methods for preparing calibration gas mixtures, such as dilution systems (Test Method 205, 40 CFR Part 51, Appendix M), may be used with prior approval of the Administrator.

7.1.1 Fuel. A 40 percent H_2/60 percent N_2 gas mixture is recommended to avoid an oxygen synergism effect that reportedly occurs when oxygen concentration varies significantly from a mean value.

7.1.2 Zero Gas. High purity air with less than 0.1 part per million by volume (ppmv) of organic material (propane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

7.1.3 Low-level Calibration Gas. An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value.

7.1.4 Mid-level Calibration Gas. An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value.

7.1.5 High-level Calibration Gas. An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Selection of Sampling Site. The location of the sampling site is generally specified by the applicable regulation or purpose of the test (*i.e.*, exhaust stack, inlet line, etc.). The sample port shall be located to meet the testing requirements of Method 1.

8.2 Location of Sample Probe. Install the sample probe so that the probe is centrally located in the stack, pipe, or duct and is sealed tightly at the stack port connection.

8.3 Measurement System Preparation. Prior to the emission test, assemble the measurement system by following the manufacturer's written instructions for preparing sample interface and the organic analyzer. Make the system operable (Section 10.1).

8.4 Calibration Error Test. Immediately prior to the test series (within 2 hours of the start of the test), introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then introduce low-level and mid-level calibration gases successively to the measurement system. Record the analyzer responses for low-level and mid-level calibration gases and determine the differences between the measurement system responses and the predicted responses. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and must be replaced or repaired prior to testing. No adjustments to the measurement system shall be conducted after the calibration and before the drift check (Section 8.6.2). If adjustments are necessary before the completion of the test series, perform the drift checks prior to the required adjustments and repeat the calibration following the adjustments. If multiple electronic ranges are to be used, each additional range must be checked with a mid-level calibration gas to verify the multiplication factor.

8.5 Response Time Test. Introduce zero gas into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. Record the time from the concentration change to the measurement system response equivalent to 95 percent of the step change. Repeat the test three times and average the results.

8.6 Emission Measurement Test Procedure.

8.6.1 Organic Measurement. Begin sampling at the start of the test period, recording time and any required process information as appropriate. In particulate, note on the recording chart, periods of process interruption or cyclic operation.

8.6.2 Drift Determination. Immediately following the completion of the test period and hourly during the test period, reintroduce the zero and mid-level calibration gases, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until both the zero and calibration drift checks are made.) Record the analyzer response. If the drift values exceed the specified limits, invalidate the test results preceding the check and repeat the test following corrections to the measurement system. Alternatively, recalibrate the test measurement system as in section 8.4 and report the results using both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

NOTE: Note on the recording chart periods of process interruption or cyclic operation.

9.0 Quality Control

Method section	Quality control measure	Effect
8.4	Zero and calibration drift tests	Ensures that bias introduced by drift in the measurement system output during the run is no greater than 3 percent of span.

10.0 Calibration and Standardization

10.1 FIA equipment can be calibrated for almost any range of total organic concentrations. For high concentrations of organics (>1.0 percent by volume as propane), modifications to most commonly available analyzers are necessary. One accepted method of equipment modification is to decrease the size of the sample to the analyzer through the use of a smaller diameter sample capillary. Direct and continuous measurement of organic concentration is a necessary consideration when determining any modification design.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

12.1 Determine the average organic concentration in terms of ppmv as propane or other calibration gas. The average shall be determined by integration of the output recording over the period specified in the applicable regulation. If results are required in terms of ppmv as carbon, adjust measured concentrations using Equation 25A–1.

$$C_c = K C_{meas} \qquad \text{Eq. 25A-1}$$

Where:

C_c = Organic concentration as carbon, ppmv.

C_{meas} = Organic concentration as measured, ppmv.

K = Carbon equivalent correction factor.
= 2 for ethane.
= 3 for propane.
= 4 for butane.
= Appropriate response factor for other organic calibration gases.

13.0 Method Performance

13.1 Measurement System Performance Specifications.

13.1.1 Zero Drift. Less than ±3 percent of the span value.

13.1.2 Calibration Drift. Less than ±3 percent of span value.

13.1.3 Calibration Error. Less than ±5 percent of the calibration gas value.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Measurement of Volatile Organic Compounds—Guideline Series. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA–450/2–78–041. June 1978. p. 46–54.

2. EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards. U.S. Environmental Protection Agency, Quality Assurance and Technical Support Division. Research Triangle Park, N.C. September 1993.

3. Gasoline Vapor Emission Laboratory Evaluation—Part 2. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. EMB Report No. 75–GAS–6. August 1975.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

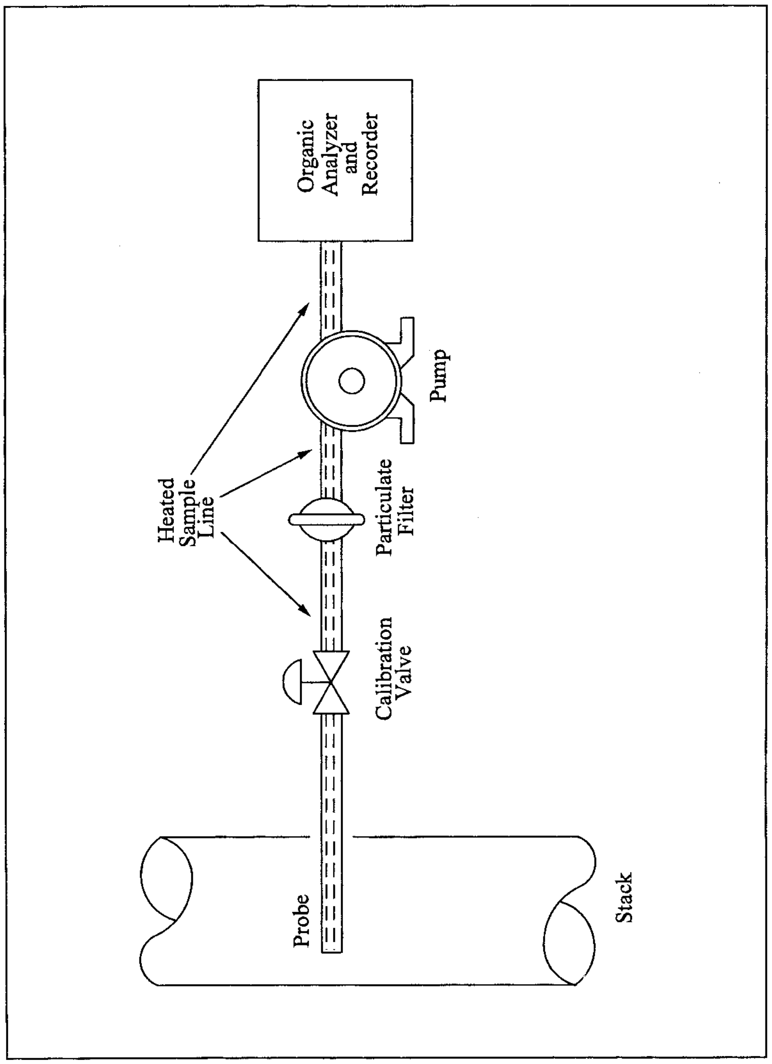


Figure 25A-1. Organic Concentration Measurement System.

METHOD 25B—DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A NONDISPERSIVE INFRARED ANALYZER

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 1, Method 6C, and Method 25A.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.	Sensitivity
Total Organic Compounds	N/A	<2% of span.

1.2 Applicability. This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes. Other organic materials may be measured using the general procedure in this method, the appropriate calibration gas, and an analyzer set to the appropriate absorption band.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a nondispersive infrared analyzer (NDIR). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

3.0 Definitions

Same as Method 25A, section 3.0.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer users manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

5.2 Explosive Atmosphere. This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

6.0 Equipment and Supplies

Same as Method 25A, section 6.0, with the exception of the following:

6.1 Organic Concentration Analyzer. A nondispersive infrared analyzer designed to measure alkane organics and capable of meeting or exceeding the specifications in this method.

7.0 Reagents and Standards

Same as Method 25A, section 7.1. No fuel gas is required for an NDIR.

8.0 Sample Collection, Preservation, Storage, and Transport

Same as Method 25A, section 8.0.

9.0 Quality Control

Same as Method 25A, section 9.0.

10.0 Calibration and Standardization

Same as Method 25A, section 10.0.

11.0 Analytical Procedure

The sample collection and analysis are concurrent for this method (see section 8.0).

12.0 Calculations and Data Analysis

Same as Method 25A, section 12.0.

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

Same as Method 25A, section 16.0.

17.0 Tables, Diagrams, Flowcharts, and Validation Data [Reserved]

METHOD 25C—DETERMINATION OF NONMETHANE ORGANIC COMPOUNDS (NMOC) IN LANDFILL GASES

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling and analytical) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should also have a thorough knowledge of EPA Method 25.

1.0 Scope and Application

1.1 Analytes.

Analyte	CAS No.
Nonmethane organic compounds (NMOC).	No CAS number assigned.

1.2 Applicability. This method is applicable to the sampling and measurement of NMOC as carbon in landfill gases (LFG).

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A sample probe that has been perforated at one end is driven or augured to a depth of 0.9 m (3 ft) below the bottom of the landfill cover. A sample of the landfill gas is extracted with an evacuated cylinder. The NMOC content of the gas is determined by

injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4); the NMOC are oxidized to CO_2, reduced to CH_4, and measured by a flame ionization detector (FID). In this manner, the variable response of the FID associated with different types of organics is eliminated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Since this method is complex, only experienced personnel should perform this test. LFG contains methane, therefore explosive mixtures may exist on or near the landfill. It is advisable to take appropriate safety precautions when testing landfills, such as refraining from smoking and installing explosion-proof equipment.

6.0 Equipment and Supplies

6.1 Sample Probe. Stainless steel, with the bottom third perforated. Teflon probe liners and sampling lines are also allowed. Non-perforated probes are allowed as long as they are withdrawn to create a gap equivalent to having the bottom third perforated. The sample probe must be capped at the bottom and must have a threaded cap with a sampling attachment at the top. The sample probe must be long enough to go through and extend no less than 0.9 m (3 ft) below the landfill cover. If the sample probe is to be driven into the landfill, the bottom cap should be designed to facilitate driving the probe into the landfill.

6.2 Sampling Train.

6.2.1 Rotameter with Flow Control Valve. Capable of measuring a sample flow rate of 100 ±10 ml/min. The control valve must be made of stainless steel.

6.2.2 Sampling Valve. Stainless steel.

6.2.3 Pressure Gauge. U-tube mercury manometer, or equivalent, capable of measuring pressure to within 1 mm Hg (0.5 in H_2O) in the range of 0 to 1,100 mm Hg (0 to 590 in H_2O).

6.2.4 Sample Tank. Stainless steel or aluminum cylinder, equipped with a stainless steel sample tank valve.

6.3 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg (5.4 in H_2O).

6.4 Purging Pump. Portable, explosion proof, and suitable for sampling NMOC.

6.5 Pilot Probe Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.1.

6.5.1 Pilot Probe. Tubing of sufficient strength to withstand being driven into the landfill by a post driver and an outside diameter of at least 6 mm (0.25 in.) smaller than the sample probe. The pilot probe shall be capped on both ends and long enough to go through the landfill cover and extend no less than 0.9 m (3 ft) into the landfill.

6.5.2 Post Driver and Compressor. Capable of driving the pilot probe and the sampling probe into the landfill. The Kitty Hawk portable post driver has been found to be acceptable.

6.6 Auger Procedure. The following are needed only if the tester chooses to use the procedure described in section 8.2.2.

6.6.1 Auger. Capable of drilling through the landfill cover and to a depth of no less than 0.9 m (3 ft) into the landfill.

6.6.2 Pea Gravel.

6.6.3 Bentonite.

6.7 NMOC Analyzer, Barometer, Thermometer, and Syringes. Same as in sections 6.3.1, 6.3.2, 6.33, and 6.2.10, respectively, of Method 25.

7.0 Reagents and Standards

7.1 NMOC Analysis. Same as in Method 25, section 7.2.

7.2 Calibration. Same as in Method 25, section 7.4, except omit section 7.4.3.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sample Tank Evacuation and Leak-Check. Conduct the sample tank evacuation and leak-check either in the laboratory or the field. Connect the pressure gauge and sampling valve to the sample tank. Evacuate the sample tank to 10 mm Hg (5.4 in H_2O) absolute pressure or less. Close the sampling valve, and allow the tank to sit for 30 minutes. The tank is acceptable if no change more than ±2 mm is noted. Include the results of the leak-check in the test report.

8.2 Sample Probe Installation. The tester may use the procedure in section 8.2.1 or 8.2.2.

8.2.1 Pilot Probe Procedure. Use the post driver to drive the pilot probe at least 0.9 m (3 ft) below the landfill cover. Alternative procedures to drive the probe into the landfill may be used subject to the approval of the Administrator's designated representative.

8.2.1.1 Remove the pilot probe and drive the sample probe into the hole left by the pilot probe. The sample probe shall extend at least 0.9 m (3 ft) below the landfill cover and shall protrude about 0.3 m (1 ft) above the landfill cover. Seal around the sampling probe with bentonite and cap the sampling probe with the sampling probe cap.

8.2.2 Auger Procedure. Use an auger to drill a hole to at least 0.9 m (3 ft) below the landfill cover. Place the sample probe in the hole and backfill with pea gravel to a level 0.6 m (2 ft) from the surface. The sample probe shall protrude at least 0.3 m (1 ft) above the landfill cover. Seal the remaining area around the probe with bentonite. Allow 24

hours for the landfill gases to equilibrate inside the augured probe before sampling.

8.2.3 Driven Probes. Closed-point probes may be driven directly into the landfill in a single step. This method may not require backfilling if the probe is adequately sealed by its insertion. Unperforated probes that are inserted in this manner and withdrawn at a distance from a detachable tip to create an open space are also acceptable.

8.3 Sample Train Assembly. Just before assembling the sample train, measure the sample tank vacuum using the pressure gauge. Record the vacuum, the ambient temperature, and the barometric pressure at this time. Assemble the sampling probe purging system as shown in Figure 25C–1.

8.4 Sampling Procedure. Open the sampling valve and use the purge pump and the flow control valve to evacuate at least two sample probe volumes from the system at a flow rate of 500 ml/min or less. Close the sampling valve and replace the purge pump with the sample tank apparatus as shown in Figure 25C–2. Open the sampling valve and the sample tank valve and, using the flow control valve, sample at a flow rate of 500 ml/min or less until either a constant flow rate can no longer be maintained because of reduced sample tank vacuum or the appropriate composite volume is attained. Disconnect the sampling tank apparatus and pressurize the sample cylinder to approximately 1,060 mm Hg (567 in. H_2O) absolute pressure with helium, and record the final pressure. Alternatively, the sample tank may be pressurized in the lab.

8.4.1 The following restrictions apply to compositing samples from different probe sites into a single cylinder: (1) Individual composite samples per cylinder must be of equal volume; this must be verified by recording the flow rate, sampling time, vacuum readings, or other appropriate volume measuring data, (2) individual composite samples must have a minimum volume of 1 liter unless data is provided showing smaller volumes can be accurately measured, and (3) composite samples must not be collected using the final cylinder vacuum as it diminishes to ambient pressure.

8.4.2 Use Method 3C to determine the percent N_2 in each cylinder. The presence of N_2 indicates either infiltration of ambient air into the landfill gas sample or an inappropriate testing site has been chosen where anaerobic decomposition has not begun. The landfill gas sample is acceptable if the concentration of N_2 is less than 20 percent. Alternatively, Method 3C may be used to determine the oxygen content of each cylinder as an air infiltration test. With this option, the oxygen content of each cylinder must be less than 5 percent.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
8.4.2	Verify that landfill gas sample contains less than 20 percent N_2 or 5 percent O_2.	Ensures that ambient air was not drawn into the landfill gas sample and gas was sampled from an appropriate location.
10.1, 10.2	NMOC analyzer initial and daily performance checks.	Ensures precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Initial NMOC Analyzer Performance Test. Same as in Method 25, section 10.1, except omit the linearity checks for CO_2 standards.

10.2 NMOC Analyzer Daily Calibration.

10.2.1 NMOC Response Factors. Same as in Method 25, section 10.2.2.

10.3 Sample Tank Volume. The volume of the gas sampling tanks must be determined. Determine the tank volumes by weighing them empty and then filled with deionized water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

11.0 Analytical Procedures

11.1 The oxidation, reduction, and measurement of NMOC's is similar to Method 25. Before putting the NMOC analyzer into routine operation, conduct an initial performance test. Start the analyzer, and perform all the necessary functions in order to put the analyzer into proper working order. Conduct the performance test according to the procedures established in section 10.1. Once the performance test has been successfully completed and the NMOC calibration response factor has been determined, proceed with sample analysis as follows:

11.1.1 Daily Operations and Calibration Checks. Before and immediately after the analysis of each set of samples or on a daily basis (whichever occurs first), conduct a calibration test according to the procedures established in section 10.2. If the criteria of the daily calibration test cannot be met, repeat

the NMOC analyzer performance test (Section 10.1) before proceeding.

11.1.2 Operating Conditions. Same as in Method 25, section 11.2.1.

11.1.3 Analysis of Sample Tank. Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO_2 in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO_2 peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 °C (383 °F) as rapidly as possible. A rate of 30 °C/min (54 °F/min) has been shown to be adequate. Record the value obtained for any measured NMOC. Return the column oven temperature to 85 °C (185 °F) in preparation for the next analysis. Analyze each sample in triplicate, and report the average as C_{tm}.

12.0 Data Analysis and Calculations

NOTE: All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

12.1 Nomenclature

B_w = Moisture content in the sample, fraction.

C_{N2} = N_2 concentration in the diluted sample gas.

C_{mN2} = Measured N_2 concentration, fraction in landfill gas.

C_{mOx} = Measured Oxygen concentration, fraction in landfill gas.

C_{Ox} = Oxygen concentration in the diluted sample gas.

C_t = Calculated NMOC concentration, ppmv C equivalent.

C_{tm} = Measured NMOC concentration, ppmv C equivalent.

P_b = Barometric pressure, mm Hg.

P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.

P_{ti} = Gas sample tank pressure after evacuation, mm Hg absolute.

P_w = Vapor pressure of H_2O (from Table 25C–1), mm Hg.

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 . . . r).

T_t = Sample tank temperature at completion of sampling, °K.

T_{ti} = Sample tank temperature before sampling, °K.

T_{tf} = Sample tank temperature after pressuring, °K.

12.2 Water Correction. Use Table 25C–1 (Section 17.0), the LFG temperature, and barometric pressure at the sampling site to calculate B_w.

$$B_w = \frac{P_w}{P_b} \qquad \text{Eq. 25C-1}$$

12.3 Nitrogen Concentration in the landfill gas. Use equation 25C–2 to calculate the measured concentration of nitrogen in the original landfill gas.

$$C_{N2} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right] C_{mN2} \qquad \text{Eq.25C-2}$$

12.4 Oxygen Concentration in the landfill gas. Use equation 25C–3 to calculate the measured concentration of oxygen in the original landfill gas.

$$C_{Ox} = \left[\frac{\left(\frac{P_{tf}}{T_{tf}}\right)}{\left(\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{ti}}{T_{ti}}\right)\right)}\right] C_{mOx} \qquad \text{Eq.25C-3}$$

12.5 You must correct the NMOC Concentration for the concentration of nitrogen or oxygen based on which gas or gases passes the requirements in section 9.1.

12.5.1 NMOC Concentration with nitrogen correction. Use Equation 25C–4 to calculate the concentration of NMOC for each sample tank when the nitrogen concentration is less than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t}-\frac{P_{ti}}{T_{ti}}\right)\left(1-\frac{99}{78}C_{N2}\right)-B_w}\frac{1}{r}\sum_{j=1}^{r} C_{tm^{(j)}} \qquad \text{Eq.25C-4}$$

12.5.2 NMOC Concentration with oxygen correction. Use Equation 25C–5 to calculate the concentration of NMOC for each sample tank if the landfill gas oxygen is less than 5 percent and the landfill gas nitrogen concentration is greater than 20 percent.

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\left(\frac{P_t}{T_t}-\frac{P_{ti}}{T_{ti}}\right)\left(1-\frac{99}{21}C_{Ox}\right)-B_w}\frac{1}{r}\sum_{j=1}^{r} C_{tm^{(j)}} \qquad \text{Eq.25C-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts. June 15–20, 1975.) 14 p.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) 25 p.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

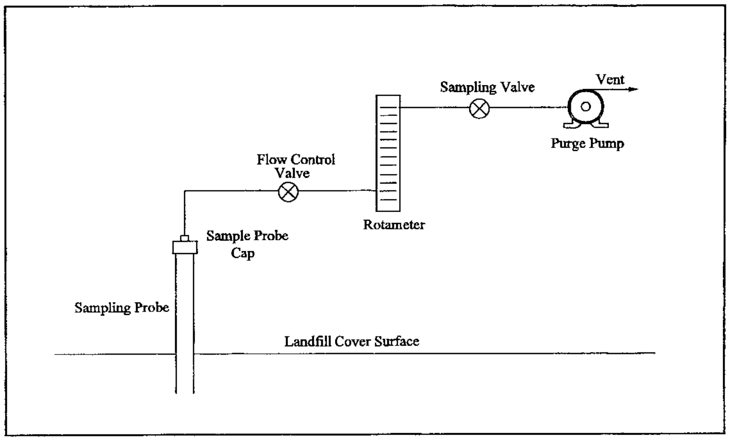


Figure 25C-1. Schematic of Sampling Probe Purging System

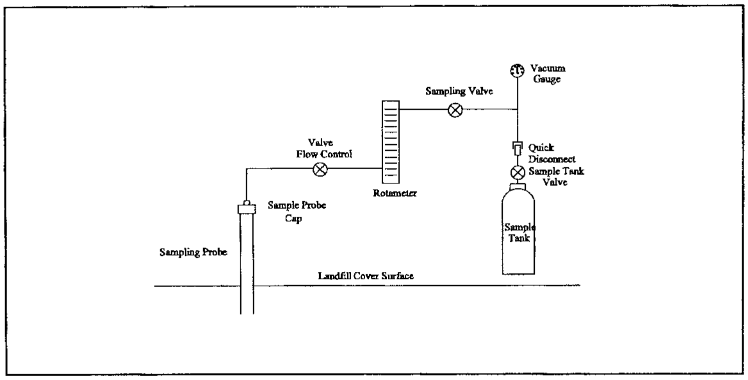


Figure 25C-2. Schematic of Sampling Train.

TABLE 25C–1—MOISTURE CORRECTION

Temperature, °C	Vapor Pressure of H_2O, mm Hg	Temperature, °C	Vapor Pressure of H_2O, mm Hg
4	6.1	18	15.5
6	7.0	20	17.5
8	8.0	22	19.8
10	9.2	24	22.4
12	10.5	26	25.2
14	12.0	28	28.3
16	13.6	30	31.8

METHOD 25D—DETERMINATION OF THE VOLATILE ORGANIC CONCENTRATION OF WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) or an electrolytic conductivity detector (ELCD) because knowledge beyond the scope of this presentation is required.

1.0 Scope and Application

1.1 Analyte. Volatile Organic Compounds. No CAS No. assigned.

1.2 Applicability. This method is applicable for determining the volatile organic (VO) concentration of a waste sample.

2.0 Summary of Method

2.1 Principle. A sample of waste is obtained at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). The sample is suspended in an organic/aqueous matrix, then heated and purged with nitrogen for 30 min. in order to separate certain organic compounds. Part of the sample is analyzed for carbon concentration, as methane, with an FID, and part of the sample is analyzed for chlorine concentration, as chloride, with an ELCD. The VO concentration is the sum of the carbon and chlorine content of the sample.

3.0 Definitions

3.1 *Well-mixed* in the context of this method refers to turbulent flow which results in multiple-phase waste in effect behaving as single-phase waste due to good mixing.

4.0 Interferences [Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1 Sampling. The following equipment is required:

6.1.1 Sampling Tube. Flexible Teflon, 0.25 in. ID (6.35 mm).

6.1.2 Sample Container. Borosilicate glass, 40-mL, and a Teflon-lined screw cap capable of forming an air tight seal.

6.1.3 Cooling Coil. Fabricated from 0.25 in (6.35 mm). ID 304 stainless steel tubing with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Purging Apparatus. For separating the VO from the waste sample. A schematic of the system is shown in Figure 25D–1. The purging apparatus consists of the following major components.

6.2.1.1 Purging Flask. A glass container to hold the sample while it is heated and purged with dry nitrogen. The cap of the purging flask is equipped with three fittings: one for a purging lance (fitting with the #7 Ace-thread), one for the Teflon exit tubing (side fitting, also a #7 Ace-thread), and a third (a 50-mm Ace-thread) to attach the base of the purging flask as shown in Figure 25D–2. The base of the purging flask is a 50-mm ID (2 in) cylindrical glass tube. One end of the tube is open while the other end is sealed. Exact dimensions are shown in Figure 25D–2.

6.2.1.2 Purging Lance. Glass tube, 6-mm OD (0.2 in) by 30 cm (12 in) long. The purging end of the tube is fitted with a four-arm bubbler with each tip drawn to an opening 1 mm (0.04 in) in diameter. Details and exact dimensions are shown in Figure 25D–2.

6.2.1.3 Coalescing Filter. Porous fritted disc incorporated into a container with the same dimensions as the purging flask. The details of the design are shown in Figure 25D–3.

6.2.1.4 Constant Temperature Chamber. A forced draft oven capable of maintaining a uniform temperature around the purging flask and coalescing filter of 75 ±2 °C (167 ±3.6 °F).

6.2.1.5 Three-way Valve. Manually operated, stainless steel. To introduce calibration gas into system.

6.2.1.6 Flow Controllers. Two, adjustable. One capable of maintaining a purge gas flow rate of 6 ±0.06 L/min (0.2 ±0.002 ft^3/min) The other capable of maintaining a calibration gas flow rate of 1–100 mL/min (0.00004–0.004 ft^3/min).

6.2.1.7 Rotameter. For monitoring the air flow through the purging system (0–10 L/min)(0–0.4 ft^3/min).

6.2.1.8 Sample Splitters. Two heated flow restrictors (placed inside oven or heated to 120 ±10 °C (248 ±18 °F)). At a purge rate of 6 L/min (0.2 ft^3/min), one will supply a constant flow to the first detector (the rest of the flow will be directed to the second sample splitter). The second splitter will split the analytical flow between the second detector and the flow restrictor. The approximate flow to the FID will be 40 mL/min (0.0014 ft^3/min) and to the ELCD will be 15 mL/min (0.0005 ft^3/min), but the exact flow must be adjusted to be compatible with the individual detector and to meet its linearity requirement. The two sample splitters will be connected to each other by 1/8′ OD (3.175 mm) stainless steel tubing.

6.2.1.9 Flow Restrictor. Stainless steel tubing, 1/8′ OD (3.175 mm), connecting the second sample splitter to the ice bath. Length is determined by the resulting pressure in the purging flask (as measured by the pressure gauge). The resulting pressure from the use of the flow restrictor shall be 6–7 psig.

6.2.1.10 Filter Flask. With one-hole stopper. Used to hold ice bath. Excess purge gas is vented through the flask to prevent condensation in the flowmeter and to trap volatile organic compounds.

6.2.1.11 Four-way Valve. Manually operated, stainless steel. Placed inside oven, used to bypass purging flask.

6.2.1.12 On/Off Valves. Two, stainless steel. One heat resistant up to 130 °C (266 °F) and placed between oven and ELCD. The other a toggle valve used to control purge gas flow.

6.2.1.13 Pressure Gauge. Range 0–40 psi. To monitor pressure in purging flask and coalescing filter.

6.2.1.14 Sample Lines. Teflon, 1/4′ OD (6.35 mm), used inside the oven to carry purge gas to and from purging chamber and to and from coalescing filter to four-way valve. Also used to carry sample from four-way valve to first sample splitter.

6.2.1.15 Detector Tubing. Stainless steel, 1/8′ OD (3.175 mm), heated to 120 ±10 °C (248 ±18 °F) . Used to carry sample gas from each sample splitter to a detector. Each piece of tubing must be wrapped with heat tape and insulating tape in order to insure that no cold spots exist. The tubing leading to the ELCD will also contain a heat-resistant on-off valve (Section 6.2.1.12) which shall also be wrapped with heat-tape and insulation.

6.2.2 Volatile Organic Measurement System. Consisting of an FID to measure the carbon concentration of the sample and an ELCD to measure the chlorine concentration.

6.2.2.1 FID. A heated FID meeting the following specifications is required.

6.2.2.1.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.1.1.

6.2.2.1.2 Range. A full scale range of 50 pg carbon/sec to 50 μg carbon/sec. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.1.3 Data Recording System. A digital integration system compatible with the FID for permanently recording the output of the detector. The recorder shall have the capability to start and stop integration at points selected by the operator or it shall be capable of the ‘‘integration by slices’’ technique (this technique involves breaking down the chromatogram into smaller increments, integrating the area under the curve for each portion, subtracting the background for each portion, and then adding all of the areas together for the final area count).

6.2.2.2 ELCD. An ELCD meeting the following specifications is required. 1-propanol must be used as the electrolyte. The electrolyte flow through the conductivity cell shall be 1 to 2 mL/min (0.00004 to 0.00007 ft^3/min).

NOTE: A ¼-in. ID (6.35 mm) quartz reactor tube is strongly recommended to reduce carbon buildup and the resulting detector maintenance.

6.2.2.2.1 Linearity. A linear response (±10 percent) over the response range as demonstrated by the procedures in section 10.1.2.

6.2.2.2.2 Range. A full scale range of 5.0 pg/sec to 500 ng/sec chloride. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.2.2.3 Data Recording System. A digital integration system compatible with the output voltage range of the ELCD. The recorder must have the capability to start and stop integration at points selected by the operator or it shall be capable of performing the ‘‘integration by slices’’ technique.

7.0 Reagents and Standards

7.1 Sampling.

7.1.1 Polyethylene Glycol (PEG). Ninety-eight percent pure with an average molecular weight of 400. Before using the PEG, remove any organic compounds that might be detected as volatile organics by heating it to 120 °C (248 °F) and purging it with nitrogen at a flow rate of 1 to 2 L/min (0.04 to 0.07 ft^3/min) for 2 hours. The cleaned PEG must be stored under a 1 to 2 L/min (0.04 to 0.07 ft^3/min) nitrogen purge until use. The purge apparatus is shown in Figure 25D–4.

7.2 Analysis.

7.2.1 Sample Separation. The following are required for the sample purging step.

7.2.1.1 PEG. Same as section 7.1.1.

7.2.1.2 Purge Gas. Zero grade nitrogen (N_2), containing less than 1 ppm carbon.

7.2.2 Volatile Organics Measurement. The following are required for measuring the VO concentration.

7.2.2.1 Hydrogen (H_2). Zero grade H_2, 99.999 percent pure.

7.2.2.2 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2.2.3 Calibration Gas. Pressurized gas cylinder containing 10 percent propane and 1 percent 1,1-dichloroethylene by volume in nitrogen.

7.2.2.4 Water. Deionized distilled water that conforms to American Society for Testing and Materials Specification D 1193–74, Type 3, is required for analysis. At the option of the analyst, the $KMnO_4$ test for oxidizable organic matter may be omitted when high concentrations are not expected to be present.

7.2.2.5 1-Propanol. ACS grade or better. Electrolyte Solution. For use in the ELCD.

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Sampling.

8.1.1 Sampling Plan Design and Development. Use the procedures in chapter nine of Reference 1 in section 16 as guidance in developing a sampling plan.

8.1.2 Single Phase or Well-mixed Waste.

8.1.2.1 Install a sampling tap to obtain the sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to the atmosphere). Assemble the sampling apparatus as shown in Figure 25D–5.

8.1.2.2 Prepare the sampling containers as follows: Pour 30 mL of clean PEG into the container. PEG will reduce but not eliminate the loss of organics during sample collection. Weigh the sample container with the screw cap, the PEG, and any labels to the nearest 0.01 g and record the weight (m_{st}). Store the containers in an ice bath until 1 hour before sampling (PEG will solidify at ice bath temperatures; allow the containers to reach room temperature before sampling).

8.1.2.3 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.1.2.4 After purging, stop the sample flow and direct the sampling tube to a preweighed sample container, prepared as described in section 8.1.2.2. Keep the tip of the tube below the surface of the PEG during sampling to minimize contact with the atmosphere. Sample at a flow rate such that the temperature of the waste is less than 10 °C (50 °F). Fill the sample container and immediately cap it (within 5 seconds) so that a minimum headspace exists in the container. Store immediately in a cooler and cover with ice.

8.1.3 Multiple-phase Waste. Collect a 10 g sample of each phase of waste generated using the procedures described in section 8.1.2 or 8.1.5. Each phase of the waste shall be analyzed as a separate sample. Calculate the weighted average VO concentration of the waste using Equation 25D–13 (Section 12.14).

8.1.4 Solid waste. Add approximately 10 g of the solid waste to a container prepared in the manner described in section 8.1.2.2, minimizing headspace. Cap and chill immediately.

8.1.5 Alternative to Tap Installation. If tap installation is impractical or impossible, fill a large, clean, empty container by submerging the container into the waste below the surface of the waste. Immediately fill a container prepared in the manner described in section 8.1.2.2 with approximately 10 g of the waste collected in the large container. Minimize headspace, cap and chill immediately.

8.1.6 Alternative sampling techniques may be used upon the approval of the Administrator.

8.2 Sample Recovery.

8.2.1 Assemble the purging apparatus as shown in Figures 25D–1 and 25D–2. The oven shall be heated to 75 ±2 °C (167 ±3.6 °F). The sampling lines leading from the oven to the detectors shall be heated to 120 ±10 °C (248 ±18 °F) with no cold spots. The flame ionization detector shall be operated with a heated block. Adjust the purging lance so that it reaches the bottom of the chamber.

8.2.2 Remove the sample container from the cooler, and wipe the exterior of the container to remove any extraneous ice, water, or other debris. Reweigh the sample container to the nearest 0.01 g, and record the weight (m_{sf}). Pour the contents of the sample container into the purging flask, rinse the sample container three times with a total of 20 mL of PEG (since the sample container originally held 30 mL of PEG, the total volume of PEG added to the purging flask will be 50 mL), transferring the rinsings to the purging flask after each rinse. Cap purging flask between rinses. The total volume of PEG in the purging flask shall be 50 mL. Add 50 mL of water to the purging flask.

9.0 Quality Control

9.1 Quality Control Samples. If audit samples are not available, prepare and analyze the two types of quality control samples (QCS) listed in Sections 9.1.1 and 9.1.2. Before placing the system in operation, after a shutdown of greater than six months, and after any major modifications, analyze each QCS in triplicate. For each detector, calculate the percent recovery by dividing measured concentration by theoretical concentration and multiplying by 100. Determine the mean percent recovery for each detector for each QCS triplicate analysis. The RSD for any triplicate analysis shall be ≤10 percent. For QCS 1 (methylene chloride), the percent recovery shall be ≥90 percent for carbon as methane, and ≥55 percent for chlorine as chloride. For QCS 2 (1,3-dichloro-2-propanol), the percent recovery shall be ≤15 percent for carbon as methane, and ≤6 percent for chlorine as chloride. If the analytical system does not meet the above-mentioned criteria for both detectors, check the system parameters (temperature, system pressure, purge rate, etc.), correct the problem, and repeat the triplicate analysis of each QCS.

9.1.1 QCS 1, Methylene Chloride. Prepare a stock solution by weighing, to the nearest 0.1 mg, 55 μL of HPLC grade methylene chloride in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 μL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze

the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 3.777×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 1, multiply mg of methylene chloride in the stock solution by 1.670×10^{-2}.

9.1.2 QCS 2, 1,3-dichloro-2-propanol. Prepare a stock solution by weighing, to the nearest 0.1 mg, 60 μL of high purity grade 1,3-dichloro-2-propanol in a tared 5 mL volumetric flask. Record the weight in milligrams, dilute to 5 mL with cleaned PEG, and inject 100 μL of the stock solution into a sample prepared as a water blank (50 mL of cleaned PEG and 60 mL of water in the purging flask). Analyze the QCS according to the procedures described in sections 10.2 and 10.3, excluding section 10.2.2. To calculate the theoretical carbon concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 7.461×10^{-3}. To calculate the theoretical chlorine concentration (in mg) in QCS 2, multiply mg of 1,3-dichloro-2-propanol in the stock solution by 1.099×10^{-2}.

9.1.3 Routine QCS Analysis. For each set of compliance samples (in this context, set is per facility, per compliance test), analyze one QCS 1 and one QCS 2 sample. The percent recovery for each sample for each detector shall be ±13 percent of the mean recovery established for the most recent set of QCS triplicate analysis (Section 9.4). If the sample does not meet this criteria, check the system components and analyze another QCS 1 and 2 until a single set of QCS meet the ±13 percent criteria.

10.0 Calibration and Standardization

10.1 Initial Performance Check of Purging System. Before placing the system in operation, after a shutdown of greater than six months, after any major modifications, and at least once per month during continuous operation, conduct the linearity checks described in sections 10.1.1 and 10.1.2. Install calibration gas at the three-way calibration gas valve. See Figure 25D–1.

10.1.1 Linearity Check Procedure. Using the calibration standard described in section 7.2.2.3 and by varying the injection time, it is possible to calibrate at multiple concentration levels. Use Equation 25D–3 to calculate three sets of calibration gas flow rates and run times needed to introduce a total mass of carbon, as methane, (m_c) of 1, 5, and 10 mg into the system (low, medium and high FID calibration, respectively). Use Equation 25D–4 to calculate three sets of calibration gas flow rates and run times needed to introduce a total chloride mass (m_{ch}) of 1, 5, and 10 mg into the system (low, medium and high ELCD calibration, respectively). With the system operating in standby mode, allow the FID and the ELCD to establish a stable baseline. Set the secondary pressure regulator of the calibration gas cylinder to the same pressure as the purge gas cylinder and set the proper flow rate with the calibration flow controller (see Figure 25D–1). The calibration gas flow rate can be measured with a flowmeter attached to the vent position of the calibration gas valve. Set the four-way bypass valve to standby position so that the calibration gas flows through the coalescing filter only. Inject the calibration gas by turning the calibration gas valve from vent position to inject position. Continue the calibration gas flow for the appropriate period of time before switching the calibration valve to vent position. Continue recording the response of the FID and the ELCD for 5 min after switching off calibration gas flow. Make triplicate injections of all six levels of calibration.

10.1.2 Linearity Criteria. Calculate the average response factor (Equations 25D–5 and 25D–6) and the relative standard deviation (RSD) (Equation 25D–10) at each level of the calibration curve for both detectors. Calculate the overall mean of the three response factor averages for each detector. The FID linearity is acceptable if each response factor is within 5 percent of the overall mean and if the RSD for each set of triplicate injections is less than 5 percent. The ELCD linearity is acceptable if each response factor is within 10 percent of the overall mean and if the RSD for each set of triplicate injections is less than 10 percent. Record the overall mean value of the response factors for the FID and the ELCD. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2 Daily Calibrations.

10.2.1 Daily Linearity Check. Follow the procedures outlined in section 10.1.1 to analyze the medium level calibration for both the FID and the ELCD in duplicate at the start of the day. Calculate the response factors and the RSDs for each detector. For the FID, the calibration is acceptable if the average response factor is within 5 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 5 percent. For the ELCD, the calibration is acceptable if the average response factor is within 10 percent of the overall mean response factor (Section 10.1.2) and if the RSD for the duplicate injection is less than 10 percent. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat sections 10.1.1 and 10.1.2.

10.2.2 Calibration Range Check.

10.2.2.1 If the waste concentration for either detector falls below the range of calibration for that detector, use the procedure outlined in section 10.1.1 to choose two calibration points that bracket the new target

concentration. Analyze each of these points in triplicate (as outlined in section 10.1.1) and use the criteria in section 10.1.2 to determine the linearity of the detector in this ''mini-calibration'' range.

10.2.2.2 After the initial linearity check of the mini-calibration curve, it is only necessary to test one of the points in duplicate for the daily calibration check (in addition to the points specified in section 10.2.1). The average daily mini-calibration point should fit the linearity criteria specified in section 10.2.1. If the calibration for either the FID or the ELCD does not meet the criteria, correct the detector/system problem and repeat the calibration procedure mentioned in the first paragraph of section 10.2.2. A mini-calibration curve for waste concentrations above the calibration curve for either detector is optional.

10.3 Analytical Balance. Calibrate against standard weights.

11.0 Analysis

11.1 Sample Analysis.

11.1.1 Turn on the constant temperature chamber and allow the temperature to equilibrate at 75 ±2 °C (167 ±3.6 °F). Turn the four-way valve so that the purge gas bypasses the purging flask, the purge gas flowing through the coalescing filter and to the detectors (standby mode). Turn on the purge gas. Allow both the FID and the ELCD to warm up until a stable baseline is achieved on each detector. Pack the filter flask with ice. Replace ice after each run and dispose of the waste water properly. When the temperature of the oven reaches 75 ±2 °C (167 ±3.6 °F), start both integrators and record baseline. After 1 min, turn the four-way valve so that the purge gas flows through the purging flask, to the coalescing filter and to the sample splitters (purge mode). Continue recording the response of the FID and the ELCD. Monitor the readings of the pressure gauge and the rotameter. If the readings fall below established setpoints, stop the purging, determine the source of the leak, and resolve the problem before resuming. Leaks detected during a sampling period invalidate that sample.

11.1.2 As the purging continues, monitor the output of the detectors to make certain that the analysis is proceeding correctly and that the results are being properly recorded. Every 10 minutes read and record the purge flow rate, the pressure and the chamber temperature. Continue the purging for 30 minutes.

11.1.3 For each detector output, integrate over the entire area of the peak starting at 1 minute and continuing until the end of the run. Subtract the established baseline area from the peak area. Record the corrected area of the peak. See Figure 25D–6 for an example integration.

11.2 Water Blank. A water blank shall be analyzed for each batch of cleaned PEG prepared. Transfer about 60 mL of water into the purging flask. Add 50 mL of the cleaned PEG to the purging flask. Treat the blank as described in sections 8.2 and 8.3, excluding section 8.2.2. Calculate the concentration of carbon and chlorine in the blank sample (assume 10 g of waste as the mass). A VO concentration equivalent to ≤10 percent of the applicable standard may be subtracted from the measured VO concentration of the waste samples. Include all blank results and documentation in the test report.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A_b = Area under the water blank response curve, counts.

A_c = Area under the calibration response curve, counts.

A_s = Area under the sample response curve, counts.

C = Concentration of volatile organics in the sample, ppmw.

C_c = Concentration of carbon, as methane, in the calibration gas, mg/L.

C_{ch} = Concentration of chloride in the calibration gas, mg/L.

C_j = VO concentration of phase j, ppmw.

DR_t = Average daily response factor of the FID, mg CH_4/counts.

Dr_{th} = Average daily response factor of the ELCD, mg Cl^-/counts.

F_j = Weight fraction of phase j present in the waste.

m_c = Mass of carbon, as methane, in a calibration run, mg.

m_{ch} = Mass of chloride in a calibration run, mg.

m_s = Mass of the waste sample, g.

m_{sc} = Mass of carbon, as methane, in the sample, mg.

m_{sf} = Mass of sample container and waste sample, g.

m_{sh} = Mass of chloride in the sample, mg.

m_{st} = Mass of sample container prior to sampling, g.

m_{VO} = Mass of volatile organics in the sample, mg.

n = Total number of phases present in the waste.

P_p = Percent propane in calibration gas (L/L).

P_{vc} = Percent 1,1-dichloroethylene in calibration gas (L/L).

Q_c = Flow rate of calibration gas, L/min.

t_c = Length of time standard gas is delivered to the analyzer, min.

W = Weighted average VO concentration, ppmw.

12.2 Concentration of Carbon, as Methane, in the Calibration Gas.

$$C_c = (19.681 \times P_p) + (13.121 \times P_{vc}) \quad \text{Eq. 25D-1}$$

12.3 Concentration of Chloride in the Calibration Gas.

$$C_{ch} = 28.998 \times P_{vc} \quad \text{Eq. 25D-2}$$

12.4 Mass of Carbon, as Methane, in a Calibration Run.

$$M_c = C_c \times Q_c \times t_c \quad \text{Eq. 25D-3}$$

12.5 Mass of Chloride in a Calibration Run.

$$m_{ch} = C_{ch} \times Q_c \times t_c \quad \text{Eq. 25D-4}$$

12.6 FID Response Factor, mg/counts.

$$DR_t = \frac{m_c}{A_c} \quad \text{Eq. 25D-5}$$

12.7 ELCD Response Factor, mg/counts.

$$DR_{th} = \frac{m_{ch}}{A_c} \quad \text{Eq. 25D-6}$$

12.8 Mass of Carbon in the Sample.

$$m_{sc} = DR_t (A_s - A_b) \quad \text{Eq. 25D-7}$$

12.9 Mass of Chloride in the Sample.

$$m_{sh} = DR_{th} (A_s - A_b) \quad \text{Eq. 25D-8}$$

12.10 Mass of Volatile Organics in the Sample.

$$m_{vo} = m_{sc} + m_{sh} \quad \text{Eq. 25D-9}$$

12.11 Relative Standard Deviation.

$$RSD = \frac{100}{\bar{x}} \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} \quad \text{Eq. 25D-10}$$

12.12 Mass of Sample.

$$m_s = m_{sf} - m_{st} \quad \text{Eq. 25D-11}$$

12.13 Concentration of Volatile Organics in Waste.

$$C = \frac{(m_{vo} \times 1000)}{m_s} \quad \text{Eq. 25D-12}$$

12.14 Weighted Average VO Concentration of Multi-phase Waste.

$$W = \sum_{j=1}^{n} F_j x \overline{C}_j \quad \text{Eq. 25D-13}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. “Test Methods for Evaluating Solid Waste, Physical/Chemistry Methods”, U.S. Environmental Protection Agency. Publication SW–846, 3rd Edition, November 1986 as amended by Update I, November 1990.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

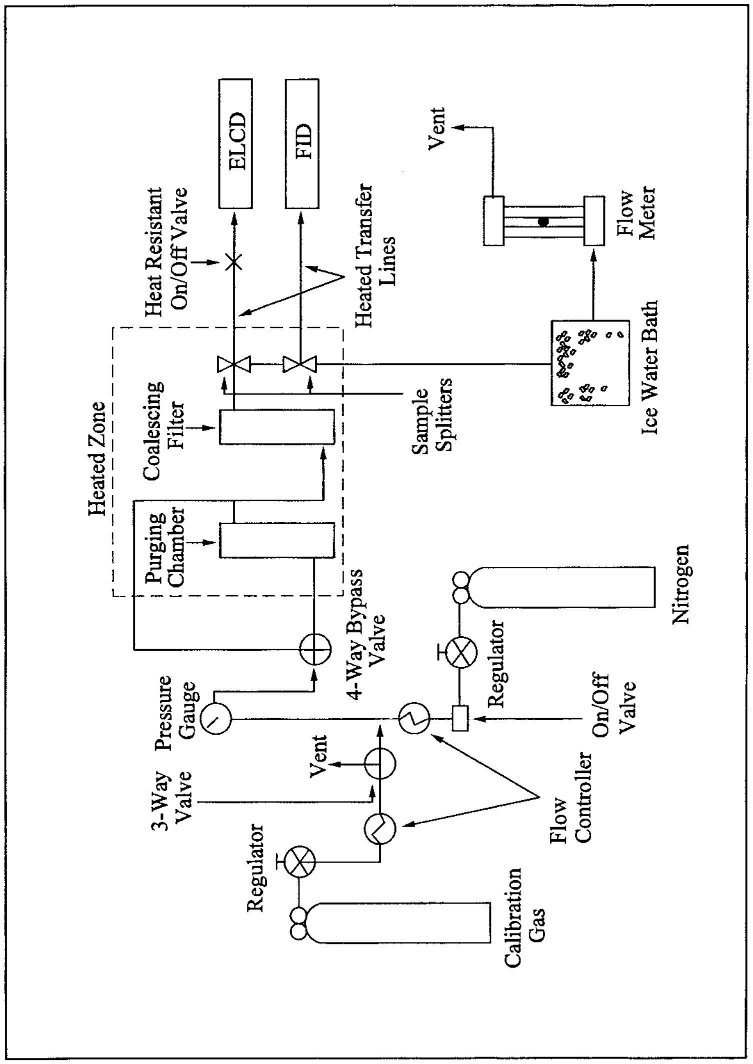


Figure 25D-1. Schematic of Purging Apparatus.

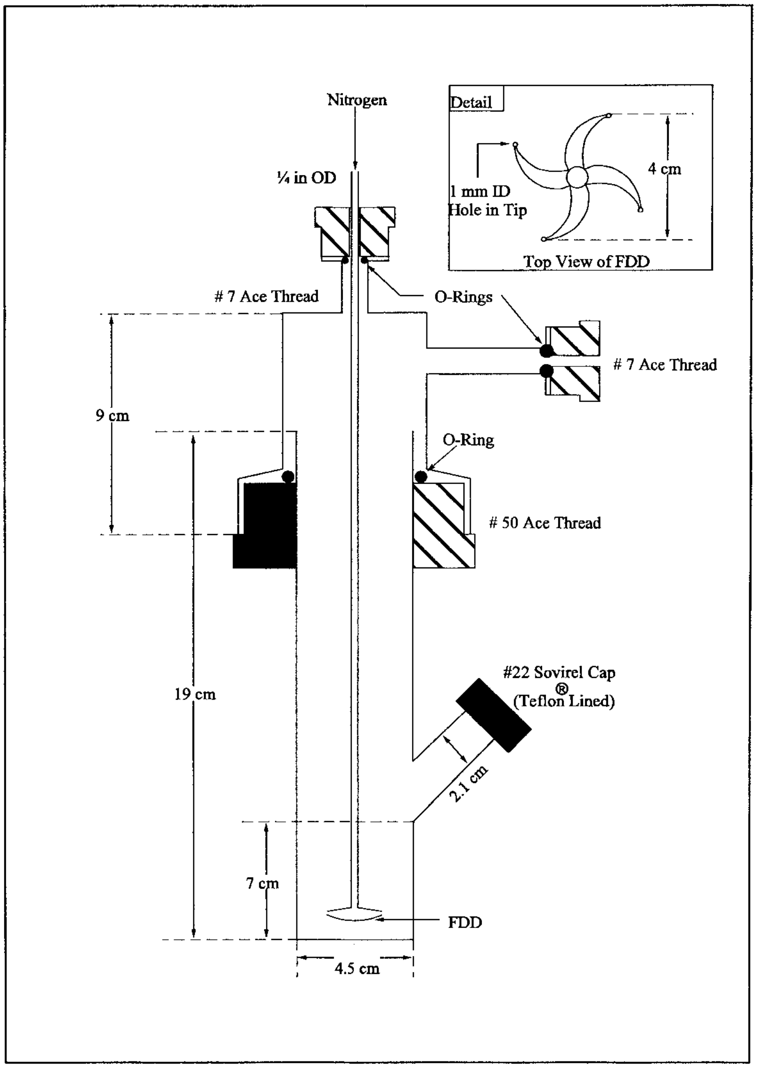
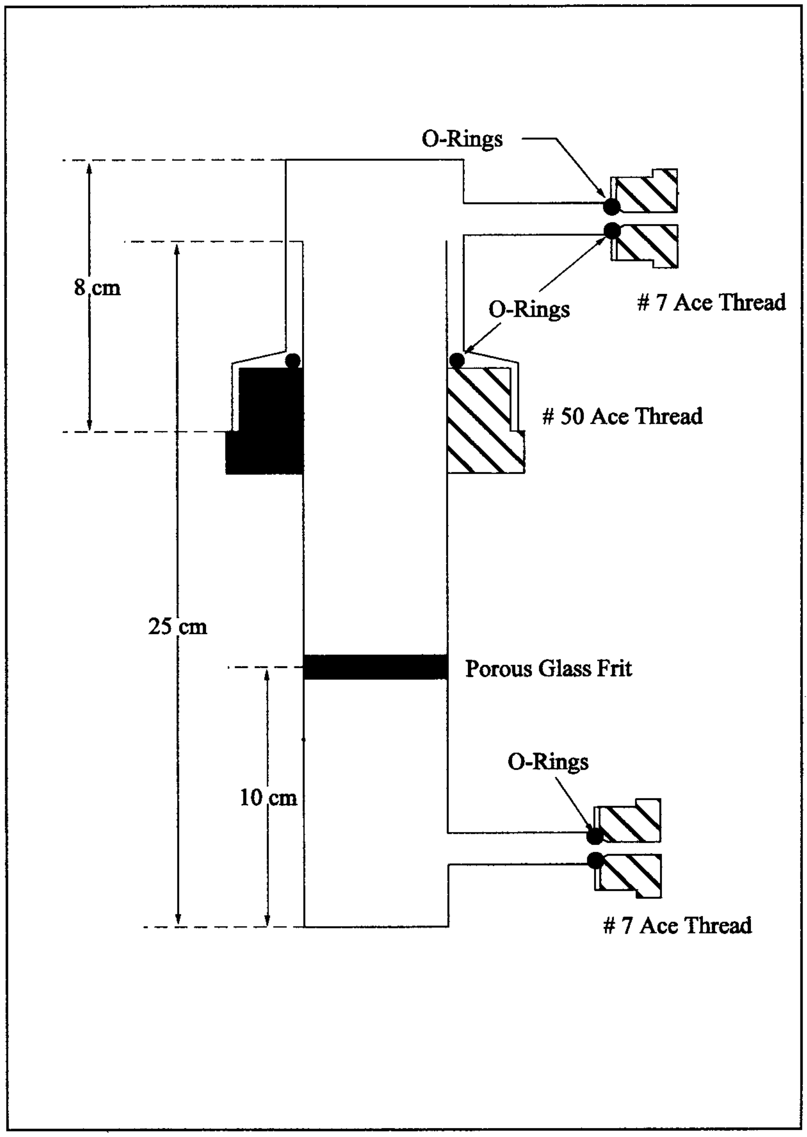


Figure 25D-2. Purging Lance.


O-Rings
8 cm
O-Rings
7 Ace Thread
50 Ace Thread
25 cm
Porous Glass Frit
O-Rings
10 cm
7 Ace Thread

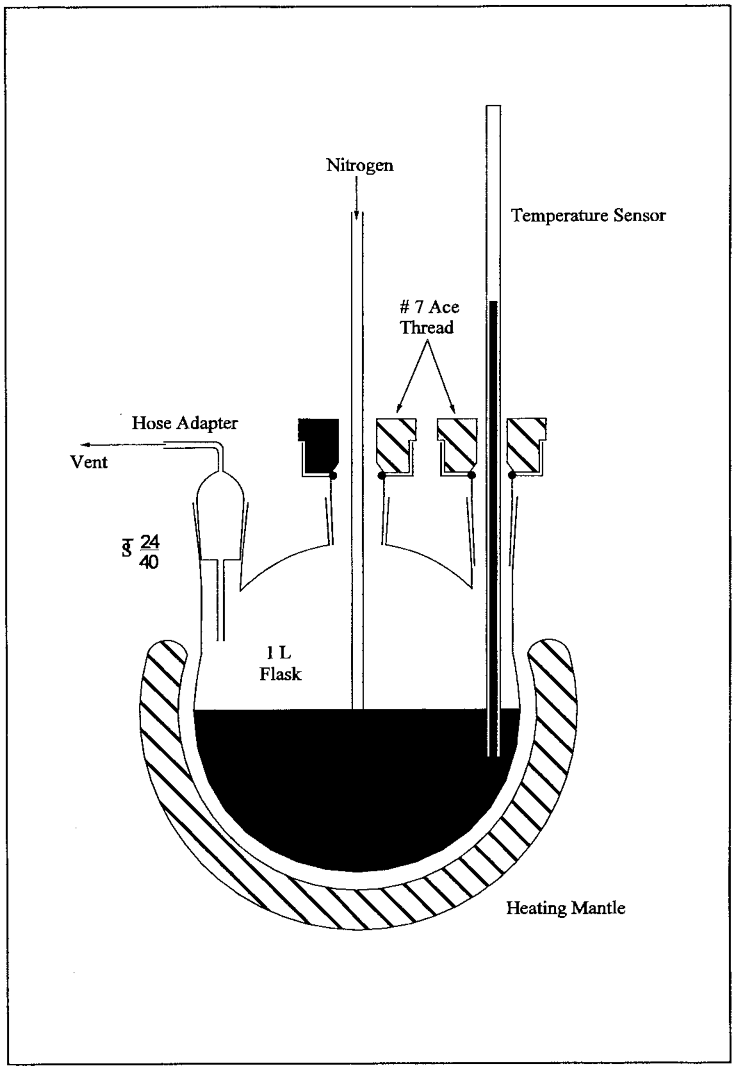


Figure 25D-4. Schematic of PEG Cleaning System.

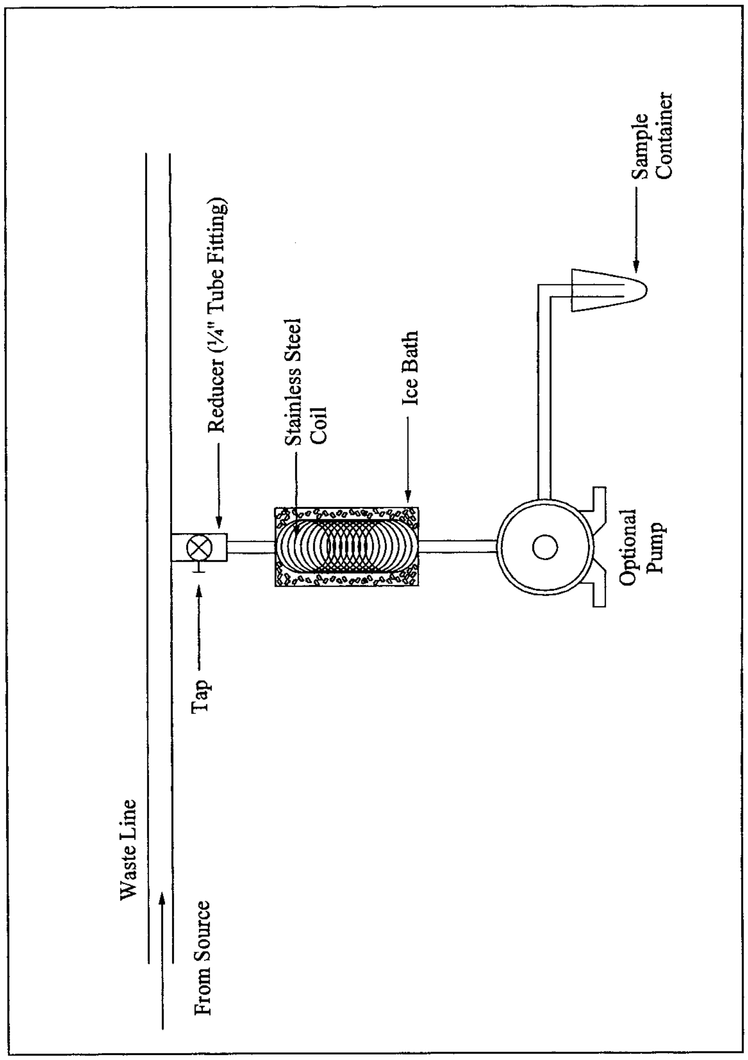


Figure 25D-5. Schematic of Sampling Apparatus.

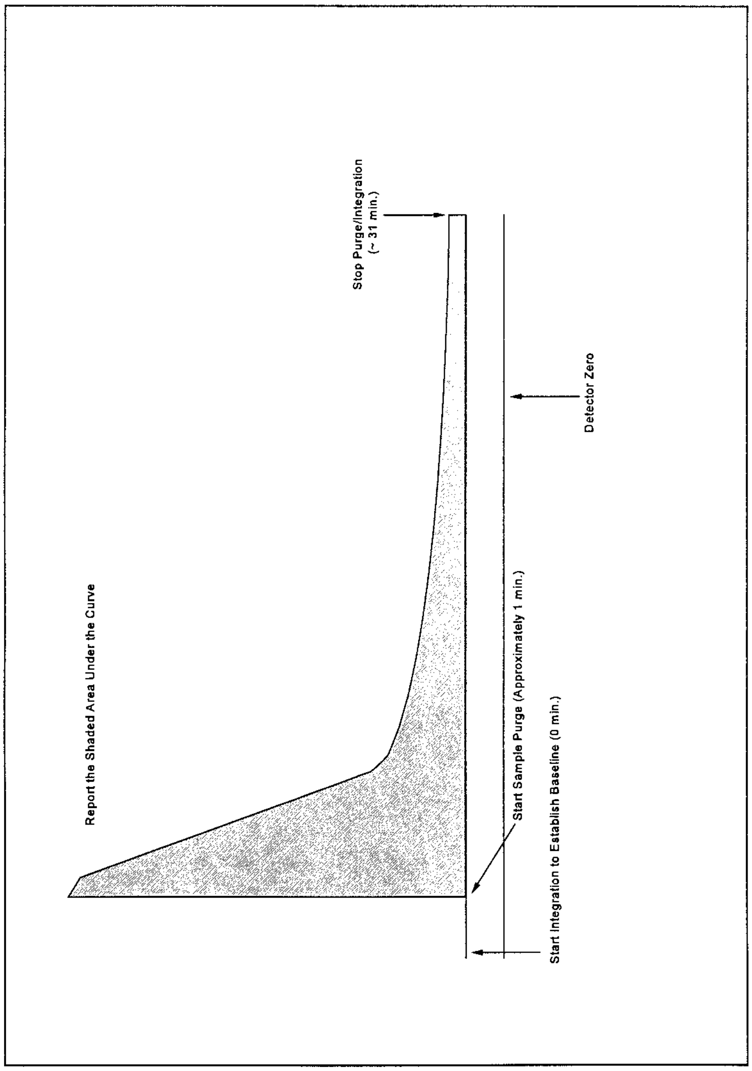


Figure 25D-6. Example Integration of Either Detector.

METHOD 25E—DETERMINATION OF VAPOR PHASE ORGANIC CONCENTRATION IN WASTE SAMPLES

NOTE: Performance of this method should not be attempted by persons unfamiliar with the operation of a flame ionization detector (FID) nor by those who are unfamiliar with source sampling because knowledge beyond the scope of this presentation is required. This method is not inclusive with respect to specifications (*e.g.*, reagents and standards) and calibration procedures. Some material is incorporated by reference from other methods. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 106, part 61, Appendix B, and Method 18, part 60, Appendix A.

1.0 Scope and Application

1.1 Applicability. This method is applicable for determining the vapor pressure of waste cited by an applicable regulation.

1.2 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 The headspace vapor of the sample is analyzed for carbon content by a headspace analyzer, which uses an FID.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 The analyst shall select the operating parameters best suited to the requirements for a particular analysis. The analyst shall produce confirming data through an adequate supplemental analytical technique and have the data available for review by the Administrator.

5.0 Safety [Reserved]

6.0 Equipment and Supplies

6.1 Sampling. The following equipment is required:

6.1.1 Sample Containers. Vials, glass, with butyl rubber septa, Perkin-Elmer Corporation Numbers 0105–0129 (glass vials), B001–0728 (gray butyl rubber septum, plug style), 0105–0131 (butyl rubber septa), or equivalent. The seal must be made from butyl rubber. Silicone rubber seals are not acceptable.

6.1.2 Vial Sealer. Perkin-Elmer Number 105–0106, or equivalent.

6.1.3 Gas-Tight Syringe. Perkin-Elmer Number 00230117, or equivalent.

6.1.4 The following equipment is required for sampling.

6.1.4.1 Tap.

6.1.4.2 Tubing. Teflon, 0.25-in. ID.

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1.4.3 Cooling Coil. Stainless steel (304), 0.25 in.-ID, equipped with a thermocouple at the coil outlet.

6.2 Analysis. The following equipment is required.

6.2.1 Balanced Pressure Headspace Sampler. Perkin-Elmer HS–6, HS–100, or equivalent, equipped with a glass bead column instead of a chromatographic column.

6.2.2 FID. An FID meeting the following specifications is required.

6.2.2.1 Linearity. A linear response (±5 percent) over the operating range as demonstrated by the procedures established in section 10.2.

6.2.2.2 Range. A full scale range of 1 to 10,000 parts per million (ppm) propane (C_3H_8). Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

6.2.3 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the output of the detector.

6.2.4 Temperature Sensor. Capable of reading temperatures in the range of 30 to 60 °C (86 to 140 °F) with an accuracy of ±0.1 °C (±0.2 °F).

7.0 Reagents and Standards

7.1 Analysis. The following items are required for analysis.

7.1.1 Hydrogen (H_2). Zero grade hydrogen, as required by the FID.

7.1.2 Carrier Gas. Zero grade nitrogen, containing less than 1 ppm carbon (C) and less than 1 ppm carbon dioxide.

7.1.3 Combustion Gas. Zero grade air or oxygen as required by the FID.

7.2 Calibration and Linearity Check.

7.2.1 Stock Cylinder Gas Standard. 100 percent propane. The manufacturer shall: (a) Certify the gas composition to be accurate to ±3 percent or better (see section 7.2.1.1); (b) recommend a maximum shelf life over which the gas concentration does not change by greater than ±5 percent from the certified value; and (c) affix the date of gas cylinder preparation, certified propane concentration, and recommended maximum shelf life to the cylinder before shipment to the buyer.

7.2.1.1 Cylinder Standards Certification. The manufacturer shall certify the concentration of the calibration gas in the cylinder by (a) directly analyzing the cylinder and (b) calibrating his analytical procedure on the day of cylinder analysis. To calibrate his analytical procedure, the manufacturer shall use, as a minimum, a three-point calibration curve.

7.2.1.2 Verification of Manufacturer's Calibration Standards. Before using, the manufacturer shall verify each calibration standard by (a) comparing it to gas mixtures prepared in accordance with the procedure described in section 7.1 of Method 106 of Part 61, Appendix B, or by (b) calibrating it against Standard Reference Materials (SRM's) prepared by the National Bureau of Standards, if such SRM's are available. The agreement between the initially determined concentration value and the verification concentration value must be within ±5 percent. The manufacturer must reverify all calibration standards on a time interval consistent with the shelf life of the cylinder standards sold.

8.0 Sampling Collection, Preservation, Storage, and Transport

8.1 Install a sampling tap to obtain a sample at a point which is most representative of the unexposed waste (where the waste has had minimum opportunity to volatilize to

the atmosphere). Assemble the sampling apparatus as shown in Figure 25E–1.

8.2 Begin sampling by purging the sample lines and cooling coil with at least four volumes of waste. Collect the purged material in a separate container and dispose of it properly.

8.3 After purging, stop the sample flow and transfer the Teflon sampling tube to a sample container. Sample at a flow rate such that the temperature of the waste is <10 °C (<50 °F). Fill the sample container halfway (±5 percent) and cap it within 5 seconds. Store immediately in a cooler and cover with ice.

8.4 Alternative sampling techniques may be used upon the approval of the Administrator.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
10.2, 10.3	FID calibration and response check	Ensure precision of analytical results.

10.0 Calibration and Standardization

NOTE: Maintain a record of performance of each item.

10.1 Use the procedures in sections 10.2 to calibrate the headspace analyzer and FID and check for linearity before the system is first placed in operation, after any shutdown longer than 6 months, and after any modification of the system.

10.2 Calibration and Linearity. Use the procedures in section 10 of Method 18 of Part 60, Appendix A, to prepare the standards and calibrate the flowmeters, using propane as the standard gas. Fill the calibration standard vials halfway (±5 percent) with deionized water. Purge and fill the airspace with calibration standard. Prepare a minimum of three concentrations of calibration standards in triplicate at concentrations that will bracket the applicable cutoff. For a cutoff of 5.2 kPa (0.75 psi), prepare nominal concentrations of 30,000, 50,000, and 70,000 ppm as propane. For a cutoff of 27.6 kPa (4.0 psi), prepare nominal concentrations of 200,000, 300,000, and 400,000 ppm as propane.

10.2.1 Use the procedures in section 11.3 to measure the FID response of each standard. Use a linear regression analysis to calculate the values for the slope (k) and the y-intercept (b). Use the procedures in sections 12.3 and 12.2 to test the calibration and the linearity.

10.3 Daily FID Calibration Check. Check the calibration at the beginning and at the end of the daily runs by using the following procedures. Prepare 2 calibration standards at the nominal cutoff concentration using the procedures in section 10.2. Place one at the beginning and one at the end of the daily run. Measure the FID response of the daily calibration standard and use the values for k and b from the most recent calibration to calculate the concentration of the daily standard. Use an equation similar to 25E–2 to calculate the percent difference between the daily standard and C_s. If the difference is within 5 percent, then the previous values for k and b can be used. Otherwise, use the procedures in section 10.2 to recalibrate the FID.

11.0 Analytical Procedures

11.1 Allow one hour for the headspace vials to equilibrate at the temperature specified in the regulation. Allow the FID to warm up until a stable baseline is achieved on the detector.

11.2 Check the calibration of the FID daily using the procedures in section 10.3.

11.3 Follow the manufacturer's recommended procedures for the normal operation of the headspace sampler and FID.

11.4 Use the procedures in sections 12.4 and 12.5 to calculate the vapor phase organic vapor pressure in the samples.

11.5 Monitor the output of the detector to make certain that the results are being properly recorded.

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A = Measurement of the area under the response curve, counts.

b = y-intercept of the linear regression line.

C_a = Measured vapor phase organic concentration of sample, ppm as propane.

C_{ma} = Average measured vapor phase organic concentration of standard, ppm as propane.

C_m = Measured vapor phase organic concentration of standard, ppm as propane.

C_s = Calculated standard concentration, ppm as propane.

k = Slope of the linear regression line.

P_{bar} = Atmospheric pressure at analysis conditions, mm Hg (in. Hg).

P* = Organic vapor pressure in the sample, kPa (psi).

PD = Percent difference between the average measured vapor phase organic concentration (C_m) and the calculated standard concentration (C_s).

RSD = Relative standard deviation.

$\beta = 1.333 \times 10^{-7}$ kPa/[(mm Hg)(ppm)], (4.91×10^{-7} psi/[(in. Hg)(ppm)])

12.2 Linearity. Use the following equation to calculate the measured standard concentration for each standard vial.

$$C_m = kA + b \qquad \text{Eq. 25E-1}$$

12.2.1 Calculate the average measured standard concentration (C_{ma}) for each set of triplicate standards and use the following equation to calculate PD between C_{ma} and C_s. The instrument linearity is acceptable if the PD is within five for each standard.

$$PD = \frac{C_s - C_{ma}}{C_s} \times 100 \qquad \text{Eq. 25E-2}$$

12.3. Relative Standard Deviation (RSD). Use the following equation to calculate the RSD for each triplicate set of standards.

$$RSD = \frac{100}{C_{ma}} \sqrt{\frac{\sum (C_m - C_{ma})^2}{2}} \qquad \text{Eq. 25E-3}$$

The calibration is acceptable if the RSD is within five for each standard concentration.

12.4 Concentration of organics in the headspace. Use the following equation to calculate the concentration of vapor phase organics in each sample.

$$C_a = kA + b \qquad \text{Eq. 25E-4}$$

12.5 Vapor Pressure of Organics in the Headspace Sample. Use the following equation to calculate the vapor pressure of organics in the sample.

$$P^* = \beta P_{bar} C_a \qquad \text{Eq. 25E-5}$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. ‘‘Determination of Solvent Vapor Concentrations by Total Combustion Analysis: a Comparison of Infared with Flame Ionization Detectors. Paper No. 75–33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. ‘‘Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74–190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9–13, 1974.) p. 25.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

Sunstone Solar Project 6
Draft Noxious Weed Control Plan

Prepared for

PINEGATE
RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 6, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

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Appendices

Appendix A: Oregon State Noxious Weed List

Appendix B: Morrow County Noxious Weed List

1.0 Introduction

Sunstone Solar 6, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 6 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Noxious Weed Control Plan has been prepared to comply with Oregon Administrative Rule 660-033-0130 (38)(h)(D), which states, in regard to photovoltaic solar power generation facilities, that:

> "C*onstruction or maintenance activities will not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. This provision may be satisfied by the submittal and county approval of a weed control plan prepared by an adequately qualified individual that includes a long-term maintenance agreement. The approved plan shall be attached to the decision as a condition of approval*."

Noxious weeds are non-native, aggressive plants with the potential to cause significant damage to native ecosystems and/or cause significant economic losses. Noxious weeds are opportunistic plant species that readily flourish in disturbed areas, are difficult to control, and thereby can compete with and/or prevent native plant species from re-establishing. Notably, the likelihood of introduction or explosion of noxious weeds is correlated with new disturbances in a region, such as large-scale construction projects. In addition, noxious weed species can adversely affect the structure, composition, and success of revegetation efforts associated with construction-related temporary disturbances.

The intent of this Plan is to provide clear methods to prevent the introduction and spread of designated noxious weeds from the construction and operation of the Facility, control existing populations of noxious weeds within construction areas, and monitor the success of efforts to prevent and control noxious weeds. The Certificate Holder and its contractors will be responsible for implementing the methods detailed in this Plan.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

Prior to construction, the Certificate Holder shall finalize this plan by completing the following:

- Conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform pre-construction weed treatment.
- Develop final noxious weed monitoring methods in consultation with ODOE and incorporate as an amendment to this plan upon ODOE approval.
- Update Table 2 in consultation with ODOE and the Morrow County Weed Department.
- Provide records demonstrating all personnel have been trained on noxious weed control.
- Provide evidence that existing noxious weed infestations have been identified and treated in a manner consistent with Morrow County recommendations.
- Consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern.

2.0 Regulatory Framework

2.1 State of Oregon

In Oregon, a noxious weed is defined under Oregon Revised Statutes (ORS) 569.175 as "a terrestrial, aquatic, or marine plant designated by the State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.". Noxious weeds have been declared by ORS 569.350 as a menace to public welfare, and control of these plants is the responsibility of private landowners and operators, as well as county, state, and federal governments.

The Oregon State Weed Board (OSWB) was created by the Oregon Department of Agriculture (ODA) under ORS 569.600. OSWB provides recommendations for noxious weed control at the state-level and is responsible for updating the State Noxious Weed List. The OSWB and the ODA classify noxious weeds in Oregon in accordance with the ODA Noxious Weed Policy and Classification System (ODA 2024). There are three designations under the State's system:

- **A Listed Weed:** A weed of known economic importance that occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent.
    - **Recommended Action:** Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed:** A weed of economic importance that is regionally abundant but may have limited distribution in some counties.

    - **Recommended Action:** Limited to intensive control at the state, county, or regional level as determined on a site-specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.

- **T-Designated Weed:** A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

2.2 Morrow County

The Morrow County Code Enforcement Ordinance establishes procedures for enforcing Morrow County Code through the authority granted to general law counties by ORS Chapter 203. Section 11 of the county Code Enforcement Ordinance, updated on July 5, 2021, establishes Morrow County as a weed control district, defines what is considered a noxious weed or weed of economic importance, identifies the responsibility of private landowners to control weeds, and outlines the authority of the weed control district and Morrow County Weed Program Manager/Inspector to administer and enforce weed control in the ordinance (Morrow County 2021).

Morrow County has its own weed classification system that differs from the state. Morrow County defines two classifications of weeds (Morrow County 2025):

- **Noxious Weeds - “A List”:** Any plant that is determined by the weed advisory board and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land, or property under provisions of Oregon State Statute and thus mandated for control.
- **Weeds of Economic Importance - “B List”:** Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

2.3 State and County Weed Lists

The ODA lists 46 Class A species and 88 Class B species for the state of Oregon, 19 of which are T-designated (ODA 2024; Appendix A). Morrow County specifically recognizes 36 species of noxious weeds (Appendix B; Morrow County 2025). Although not all the Morrow County listed noxious weeds noted in Appendix B occur in the vicinity of the Facility, the Certificate Holder and its contractors should be aware of the entire list while monitoring and controlling weeds. Noxious weeds known to occur in the vicinity of the site boundary are discussed in Section 3.0.

3.0 Noxious Weeds Identified at the Facility

In June, 2022 Tetra Tech completed rare plant and habitat categorization surveys within and adjacent to the original Sunstone Solar Project site boundary[2]. During those surveys, four listed noxious weed species were documented, including three ODA-listed noxious weed species and four Morrow County listed species noxious weed species. Table 1 lists the noxious weed species observed, their noxious weed designation (i.e., status), and the frequency of observations. Locations of these noxious weeds documented during surveys are included in Exhibit P, Attachment P-1 of the ASC[3]. Three of the four noxious weed species observed were state and/or County "B" listed weeds (Table 1; Morrow County 2025, ODA 2024). One species, rush skeletonweed (*Chondrilla juncea*), is an "A" List Weed in Morrow County and a state "T"-designated weed, meaning that ODA has targeted this species for prevention and control (Morrow County 2025; ODA 2024). Note that none of these noxious weed species observations are located within the Sunstone Solar Project 6/Facility site boundary, however, due to the likelihood that these species could be found at the Facility in the future, they are retained for awareness and noxious weed prevention purposes.

Cereal rye (*Secale cereale*) was abundant in the previously disturbed areas outside of active crop fields and was generally found in previously disturbed ground. Rush skeletonweed was found in isolated small populations or single individuals on the hillside between active cropland and a gravel county road. Puncturevine (*Tribulus terrestris*) and jointed goatgrass (*Aegilops cylindrica*) were found in the highly disturbed border in between active cropland and roads. The Certificate Holder will conduct an additional pre-construction noxious weed survey to identify the noxious weeds present at the Facility to inform management actions. The Certificate Holder may coordinate with landowners regarding noxious weed presence. Identified noxious weed infestations will be treated prior to construction.

Table 1. Noxious Weeds Observed during Surveys in 2022

Scientific Name	Common Name	Oregon State Status[1]	Morrow County Status[1]	Frequency
Aegilops cylindrica	Jointed goatgrass	B	B	Few small patches.
Chondrilla juncea	Rush skeletonweed	B*, T	A	Occasional single plants.
Secale cereale	Cereal rye	Not listed	B	Scattered large-sized patches.
Tribulus terrestris	Puncturevine	B*	B	Few small to large-sized patches.
1. Definitions for state and county noxious weed status are provided in Sections 2.1 and 2.2, respectively. Species marked with a (*) are targeted for biocontrol (ODA 2024).				

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[2] Site Certificate for the Sunstone Solar Project, November 18, 2024.

[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

In addition to noxious weeds, cheatgrass, an invasive annual grass, was identified in grassland habitats within the site boundary. While this species is not listed as a noxious weed by the state or county, it and other invasive annual grasses can adversely impact habitat and can increase fire risk. To address these issues and maintain compliance with the requirements of the Revegetation Plan required under Condition PRE-FW-01, the certificate holder will monitor the spread of these species as explained in Section 4.3 and 4.4.

4.0 Noxious Weed Management

This section of this Plan describes the steps the Certificate Holder will take to prevent and control the establishment and spread of noxious weed species during both construction and operation of the Facility. Noxious weed control methods for the Facility described in this Plan have been developed utilizing information from the ODA Noxious Weed Control Program and the Morrow County Weed Department.

The management of noxious weeds will be considered throughout all stages of construction and operation of the Facility and will include:

- **Prevention:** Implementing measures to prevent the spread of noxious weeds during construction, operation, and maintenance activities.
- **Treatment:** Treating noxious weed populations with their appropriate control methods, at appropriate time intervals.
- **Monitoring:** Assessing noxious weed changes within the Facility site boundary over time and ensuring that legacy as well as new weed populations are not increasing their distributions.

The Certificate Holder's objective is to prevent the introduction of new noxious weed populations and the spread of existing noxious weed populations. The methods described below will be implemented to minimize the spread of noxious weeds during construction activities. New noxious weeds detected during post-construction revegetation will be considered a result of construction activities and will be controlled accordingly.

4.1 Prevention

Prior to the start of construction, all personnel will be trained on the importance of noxious weed control. As part of start-up activities, and to help facilitate the avoidance of existing infestations and identification of new infestations, the Certificate Holder or their construction contractor will provide information and training to all construction personnel regarding noxious weed identification and prevention strategies. Operations and maintenance personnel will be similarly informed. The importance of preventing the spread of noxious weeds in areas not currently infested and controlling the proliferation of noxious weeds already present within or near the Facility will be emphasized.

The Certificate Holder will implement the following best management practices to minimize the spread of noxious weeds during construction activities, revegetation efforts, and operation and maintenance activities. The following practices center around ensuring that noxious weed seeds or reproductive plant fragments are not unintentionally dispersed within or outside of the Facility boundaries by personnel or their vehicles. These practices allow for responsible movement around sites with noxious weeds already present, and ensure that new populations or species are not accidentally introduced into the Facility boundaries.

- Flagging and treating areas of noxious weed infestations prior to construction to alert construction personnel;
- Limiting vehicle access to designated routes, whether existing roads or newly constructed roads, and the outer limits of construction disturbances per the final design for the Facility;
- Limiting vehicle traffic in noxious weed-infested areas;
- Cleaning construction vehicles each time they enter or exit the Facility at a wash station located inside the Facility at vehicle ingress/egress points;
- Cleaning vehicles and equipment associated with ground disturbance and movement of topsoil utilizing a mobile wash station after performing work in noxious weed-infested areas and prior to performing work in non-infested areas;
- Where feasible, not moving topsoil and other soils from noxious weed infested areas outside of the infested areas and returning them to their previous location during reclamation activities;
- Treating soils from infested areas with a pre-emergent herbicide prior to initiation of revegetation efforts;
- Providing information regarding target noxious weed species at the operations and maintenance buildings;
- Treating noxious weeds via biological, mechanical or chemical control (see Section 4.2);
- Preventing conditions favorable for noxious weed germination and spread by revegetating temporarily disturbed areas as soon as practicable;
- Monitoring areas of disturbance for noxious weeds after construction (see Section 4.3), during the normal course of revegetation maintenance of temporary workspaces, and implementing control measures as appropriate;
- Revegetating the site with appropriate, local native seed or native plants; when these are not available, non-invasive, and non-persistent non-native species may be used; and
- Ensuring that seed and straw mulch used for site rehabilitation and revegetation are certified free of noxious weed seed and propagules.

4.2 Treatment

Control of noxious weeds and other invasive weed species will be implemented through biological, mechanical, chemical, or biological control measures. The control method used will depend on the

weed species and size of infestation, time of year, proximity to intact native habitats, and resources available (Tu et al. 2003). Generally, mechanical control is best suited for small infestations of tap-rooted weeds that can be hand pulled or large occurrences in areas where mowing or soil disturbance is acceptable. Chemical control is used for most occurrences of perennial weeds with rhizomes or stolons and large occurrences of any weed in areas where mowing or soil disturbance are not recommended. Successful noxious weed control programs typically combine mechanical and chemical treatment strategies (USEPA 2008).

The Certificate Holder will be responsible for hiring a qualified contractor to implement the treatment of noxious weeds. The Certificate Holder will ensure that noxious weed management actions will be conducted by specialists with the following qualifications:

- Experience in native plant, non-native and invasive plants, and noxious weed identification;
- Experience in noxious weed mapping;
- If chemical control is used, specialists must possess a Commercial or Public Pesticide Applicator License from the ODA or possess an Immediately Supervised Pesticide Trainee License and be supervised by a licensed applicator;
- Training in noxious weed management or Integrated Pest Management with an emphasis in noxious weeds;
- Experience in coordination with agencies and private landowners; and
- No recent (within one year) violations on the contractor's record.

Existing noxious weed populations will be prevented from expanding in size and density and will not be spread to new sites. Existing populations of A listed noxious weeds will be eliminated. If it is determined that noxious weeds have invaded areas immediately adjacent to the Facility (e.g., areas visible just beyond the outer limits of construction disturbances associated with the Facility or along access roads) as a result of construction, the Certificate Holder will contact the landowner and seek approval to treat those noxious weed populations.

Long-term weed control methods will be described in a long-term monitoring plan as described in Section 4.3. The main factor in long-term weed control is successful revegetation with non-weedy species as described in the Draft Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). If feasible, long-term management of vegetation within the Facility solar array fence line may include prescriptive sheep and goat grazing by an authorized contractor, if approved by Morrow County, ODFW and ODOE. As noted above, short-term noxious weed control will be done through mechanical or chemical treatment. However, it will be important to ensure that the short-term treatment does not affect the establishment of the native perennial cover that will help provide the long-term control. Additionally, early detection and control of small noxious weed populations before they can expand into larger populations is extremely important for successful weed control efforts.

Noxious weed control will continue for the life of the Facility to meet the identified success criteria described in Section 4.3. Supplemental seeding of desirable species may be needed to meet and/or

maintain compliance with success criteria. Fertilizer application will be limited in areas treated for noxious weeds, as fertilizer can stimulate the growth of noxious weeds, and the timing of revegetation activities will need to be coordinated with noxious weed treatments.

4.2.1 Biological

Biological control involves the use of prescribed insects, fungi and livestock to control noxious weeds to achieve management objectives. Biological control methods are typically targeted to a specific species or plant to control its persistence. They are also used for maintenance in targeted areas for vegetation management control in height and density that includes mitigating fire risk and erosion. Biological control is environmentally friendly and should be the first consideration when applicable.

4.2.2 Mechanical Treatment

Mechanical treatment will be the preferred method of treatment for existing noxious weed populations where appropriate within the boundaries of the Facility. Mechanical control methods rely on removal of plants, seed heads, and/or cutting roots with a shovel or other hand tools or equipment that can be used to remove, mow, or disc noxious weed populations. Hand removal of plants is also included under this treatment method. Mechanical methods are useful for smaller, isolated populations of noxious weeds in areas of sensitive habitats. Additionally, hand removal of small infestations can minimize soil disturbance, allowing desirable species to remain and limiting conditions favorable for noxious weeds.

For some large noxious weed occurrences, mowing, tilling, discing, or other mechanical techniques may be used to reduce thatch prior to chemical application so that herbicide can more effectively make contact with the target species. However, some rhizomatous plants can spread by discing or tillage. In addition, rush skeletonweed, which was identified near the Facility (Section 3.0), can reproduce vegetatively from small segments of root, and discing or tilling can facilitate the spread of this species. As such, implementation of discing will be species-specific and avoided in areas where rush skeletonweed individuals have been found.

If tilling or discing is employed in areas that will be revegetated following construction, subsequent seeding will be conducted to re-establish desirable vegetative cover that will stabilize the soils and slow the potential re-invasion of noxious weeds. Discing, tilling, or other mechanical treatments that disturb the soil surface within native habitats will also be avoided in favor of herbicide application, which is an effective means of reducing the size of noxious weed populations as well as preventing the establishment of new infestations. Previously unbroken ground or fallow areas should not be tilled or rod-weeded to maintain native biocrusts and prevent exposing weed seeds.

4.2.3 Chemical Treatment

Chemical control can effectively remove noxious weeds through use of selective herbicide when mechanical control is not feasible. The specific herbicide used and the timing of application will be

chosen based on the specific noxious weed being treated, as appropriate herbicides differ between species and types of plants (i.e., dicots such as rush skeletonweed versus monocots such as jointed goatgrass). Example treatment methods, as well as the recommended timing of treatments for the four target noxious weeds identified within the Facility, are summarized in Table 2. The status of herbicide approval (e.g., confirming herbicides are approved for use by the U.S. Environmental Protection Agency [EPA] and ODA) will be checked annually.

Prior to construction and every fall season during facility operation, the Certificate Holder or its contractor will consult with the Morrow County Weed Department on timing, method, and application rates for each identified weed species of concern, to allow for adaptive weed management given changes in weed control effectiveness from noxious weed species tolerance to herbicide treatment over time. Results of the consultation shall be reported in the Certificate Holder's annual monitoring report. Any alternative control methods can be proposed by the Certificate Holder or its contractors after consulting with the Morrow County Weed Department and included in the Certificate Holder's annual monitoring report.

Herbicides will be applied on identified, treatable, noxious weed infestations. The Certificate Holder or their contractors will coordinate with the Morrow County Weed Department to determine which populations are treatable and will notify landowners of proposed herbicide use on their lands prior to application. If a noxious weed population is deemed to be untreatable (e.g., too widespread and established in an area to successfully control), the Certificate Holder will implement the applicable prevention measures discussed in Section 4.1, except for treatment with herbicides.

Table 2. Example Treatment for Target Noxious Weed Species

Scientific Name	Common Name	Treatment Method and Timing
Aegilops cylindrica	Jointed goatgrass	**Glyphosate** – Apply to actively growing plants emerged before bolt stage (i.e., stage of growth where growth is focused on seed development versus leaf development). • Rate: 0.38 to 0.75 lb ae/a[1] **Imazapic –** Apply pre-emergence in fall. Due to the residual effect of this herbicide, it will not be used in areas to be revegetated. • Rate: 0.063 to 0.188 lb/a[1] **Sulfometuron** – Apply in fall or in late winter before jointed goatgrass is 3 inches tall. • Rate: 1 to 1.5 oz ai/a (1.33 to 2 oz/a)[1]
Chondrilla juncea	Rush skeletonweed	**2,4-D or MCPA –** Apply to rosettes in the spring immediately before or during bolting. • Rate: 2 lb ae/a[1] **Aminopyralid (Milestone) –** Spring or fall when rosettes are present. • Rate: 1.75 oz ae/a (7 fluid oz/a Milestone)[1] **Clopyralid –** Apply to rosettes in fall or up to early bolting in spring. • Rate: 0.25 to 0.375 lb ae/a (0.66 to 1 pint/a)[1]

Scientific Name	Common Name	Treatment Method and Timing
		Picloram – Apply from late fall to early spring. For best results, apply just before or during bolting. • Rate: 1 lb ae/a[1]
Secale cereale	Cereal rye	Postemergence, non-selective herbicides such as glyphosate can control cereal rye. Glyphosate does not provide residual weed control, so any plants that emerge after treatment will not be controlled. Other herbicides that have found to provide control include Clethodim, Hexazinone, Rimsulfuron, Sethoxydim, and Sulfometuron.
Tribulus terrestris	Puncturevine	**2,4-D amine or 2,4-D LV ester–** Apply every 3 weeks during growing season or when new seedlings appear. • Rate: 1 to 2 lb ae in 10 to 20 gal water for spot treatments **Bentazon (Basagran) + imazamox (Raptor)–** Apply to small, actively growing puncture vine • Rate: 0.75 to 1 lb ai/A bentazon + 0.031 lb ai/a imazamox (4 oz/A Raptor) **Bromacil + diuron–** Apply before weeds emerge. • Rate: 8 lb ai/A (10 lb/a)[1] **Chlorsulfuron–** Apply late fall or late winter preemergence to growth. Needs moisture to activate. • Rate: 1 oz ai/a (1.5 oz/a)[1] **Fomesafen –** Apply pre- and postemergence, depending on crop. • Rate: 1 to 2 pints/A (0.25 to 0.5 lb ai/a)[1] **Imazapic –** Apply early postemergence when plants are cracking. • Rate: 0.125 to 0.188 lb ai/a[1] **Indaziflam –** Apply at least several weeks prior to expected germination of puncture vine. Apply to dry soils when rain is not expected for at least 48 hours. Can be successfully applied several months in advance of weed germination. • Rate: Grazed areas 0.046 to 0.065 lb ai/a (3.5 to 5 oz/a Rejuvra); areas not grazed or cut for hay 0.046 to 0.09 lb ai/A (3.5 to 7 oz/a Rejuvra). Use lower rates only where weed pressure is light and shorter period of residual activity is desired. **Norflurazon –** Apply in fall to spring, before puncture vine emerges. • Rate: Refer to label. Adjust rates depending on soil texture and organic matter **Paraquat –** Apply as a postemergence spray to puncture vine foliage • Rate: 0.38 to 0.49 lb ai/a[1] •

Sources: DiTomaso e al. 2013; LCNWCB 2022; Prather and Peachey 2022.

[1] a = acre; ae = acid equivalent; ai = active ingredient; lb= pound; oz = ounces

4.2.3.1 Herbicide Application and Handling

Herbicide application will occur within the appropriate season and during the appropriate timeframe to achieve desired results, as approved by ODOE and the county weed departments. Herbicide application will adhere to EPA and ODA standards. Only those herbicides that are approved by the EPA and ODA will be used. In general, application of herbicides will not occur when the following conditions exists:

- Wind velocity exceeds 15 miles per hour for granular application, or exceeds 10 miles per hour for liquid applications;
- Snow or ice covers the foliage of target species; or
- Adverse weather conditions are forecasted within the next few days.

Hand application methods (e.g., backpack spraying) may be used in roadless areas or in rough terrain. Vehicle-mounted sprayers (e.g., handgun, boom, and injector) will be used mainly in open areas that are readily accessible by vehicle. Calibration checks of equipment will be conducted prior to spraying activities, as well as periodically throughout use, to ensure that appropriate application rates are achieved.

Herbicides will be transported to the Facility daily with the following stipulations:

- Only the quantity needed for that day's work will be transported.
- Concentrate will be transported in approved containers only, and in a manner that will prevent spilling, stored separately from food, clothing, and safety equipment.
- Mixing will be done off-site and at a distance greater than 200 feet from open or flowing water, wetlands, or other sensitive species' habitat. No herbicides will be applied at these areas unless authorized by the appropriate regulatory agencies.
- All herbicide equipment and containers will be inspected daily for leaks.
- Herbicides use will be in accordance with all manufacture's label recommendations and warnings.

4.2.3.2 Herbicide Spills and Cleanups

All appropriate precautions will be taken to avoid herbicide spills. In the event of a spill, cleanup will be immediate. Contractors will keep spill kits in their vehicles and in an appropriate storage shed to allow for quick and effective response to spills. Items included in the spill kit will be:

- Protective clothing and gloves;
- Adsorptive clay, "kitty litter," or other commercial adsorbent;
- Plastic bags and a bucket;
- A shovel;
- A fiber brush and screw-in handle;
- A dustpan;

- Caution tape;
- Highway flares (use on existing hard-top roads only); and
- Detergent.

Response to an herbicide spill will vary with the size and location of the spill, but general procedures include:

- Stopping the leak;
- Containing the spilled material;
- Traffic control;
- Dressing the clean-up team in protective clothing;
- Cleaning up and removing the spilled herbicide, as well as the contaminated adsorptive material and soil; and
- Transporting the spilled herbicide and contaminated material to an authorized disposal site.

4.2.3.3 Herbicide Spill Reporting

All herbicide contractors will have readily available copies of the appropriate material safety data sheets for the herbicides used at their disposal and will keep copies of the material safety data sheets in the application vehicle. If an herbicide spill of any size occurs, the appropriate agency and spill coordinators will be notified promptly. In case of a spill into wetlands and waterbodies, the appropriate federal, state, and county agencies will be notified immediately. All herbicide spills equal to or greater than 200 pounds or 25 gallons of pesticide residue will be reported to the Oregon Emergency Response System in accordance with applicable laws and requirements (OAR 340-142-0050; ODEQ 2024). The Certificate Holder will report all herbicide spills to ODOE by phone or email within 24 hours with follow up reporting as appropriate.

4.3 Monitoring

Weed inspections will occur across the entire Facility through visual inspection of the site while driving and/or walking. Final monitoring methods will be determined in consultation with ODOE prior to construction and will be incorporated as an amendment to this plan upon ODOE approval. Monitoring will be conducted by a qualified botanist or weed specialist and will begin in the first growing season after seeding. Monitoring for noxious weeds and other undesirable weed species will occur at least five times per year including in the spring, June, July, and August for summer annuals and in the fall during the first two years following construction to capture the different life cycles of noxious weed species. This will allow real-time assessment of weed growth and inform proactive weed control measures to prevent large scale infestations. Frequent checks during early revegetation efforts will enable the Certificate Holder to respond to new weed infestations in a timely manner and ensure the success of the site’s revegetation. These inspections will be used to inform ongoing weed control efforts.

The initial monitoring survey will be scheduled slightly before herbicide application, as applicable, to identify any noxious weed species within the areas to be treated, with a focus on target noxious weed species observed prior to construction (Table 1), or other populations of target noxious weeds not previously observed.

Monitoring will assess the success of noxious weed treatments and will document any new noxious weed infestations observed. During the first two years following construction, the Certificate Holder will meet with ODOE and the Morrow County Weed Department at least once per season to provide updates on weed infestations and control measures at the Facility. These results will also be summarized in annual monitoring reports that describe the treatments performed, treatment success, make recommendations to improve treatment success (if necessary), and note any new target noxious weed species or emergence. Reports will be submitted to the Oregon Department of Energy (ODOE), Oregon Department of Fish and Wildlife (ODFW), and Morrow County annually.

Based on the success of control efforts after the second year of monitoring, the Certificate Holder will consult with ODOE and ODFW to determine if the monitoring cycle can be reduced for years three to five. After five years of monitoring, the Certificate Holder will design a long-term weed control plan in consultation with ODOE and the Morrow County Weed Department. The Certificate Holder will maintain ongoing communication with individual landowners, the Morrow County Weed Department, and ODOE regarding noxious weeds within the Facility. Landowners may also contact the Certificate Holder directly to report the presence of noxious weeds related to Facility activity. The Certificate Holder will control the noxious weeds on a case-by-case basis and prepare a summary of measures taken for that landowner. During the operational period of the Facility, the Certificate Holder will control noxious weeds as described in the long-term weed control plan. The Certificate Holder will report the investigator's findings and recommendations regarding weed control in the Facility's annual report required per OAR 345-026-0080.

The following contact information for the Morrow County Weed Program Manager will be used and updated as needed:

Corey Sweeney, Weed Program Manager
Morrow County Public Works
365 West Highway 74
Lexington, OR 97839
(541) 989-9502
mcweed@co.morrow.or.us

4.4 Success Criteria

Success criteria outlined below are designed to demonstrate compliance with OAR 660-033-0130(38)(D) to prevent the introduction and spread of noxious weed species. In each annual monitoring report, the Certificate Holder will include an assessment of whether the Facility is meeting or trending toward meeting the noxious weed control success criteria. Compliance with the Facility Site Certificate will be demonstrated through documentation of meeting these success criteria for the life of the Facility.

- Class A and Class B noxious weed presence within the solar array fence line will not exceed 15 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Class T noxious weed presence within the solar array fence line will not exceed 5 total populations (i.e., contiguous patches of individuals), and each respective population will not exceed 20 individuals or 20 square feet.
- Invasive Annual Grasses and other Undesirable Species will not exceed more then 50 percent cover within any 1 acre area or more than 30 percent cover within the solar array fence line.
- During revegetation of temporary disturbance areas outside of the solar array fence line presence and cover of noxious weeds is 75 percent or less than that of the reference site.

5.0 Roles and Responsibilities

The Certificate Holder is the overall responsible party for construction and operation of the Facility and implementation of the noxious weed management activities described in this Plan. However, the Certificate Holder may use contractors to complete tasks associated with noxious weed management and monitoring. Example responsible parties and their roles may include:

Monitoring Contractor

- Perform site visits to document noxious weed occurrences.
- Provide summary memo after each visit to Certificate Holder's operations manager outlining findings and treatment recommendations.
- Communicate directly with Weed Management Contractor and provide maps, and photos of noxious weed species locations to Weed Management Contractor.
- Communicate with Morrow County Weed Program Manager, and ODA about noxious weed survey findings and treatment plans.
- Prepare annual report for the Facility describing noxious weed monitoring findings and treatments.
- Organize and attend quarterly calls with the Certificate Holder and Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Certificate Holder Site Manager

- Communicate findings and recommendations from Monitoring Contractor to the Weed Management Contractor.
- Document the work performed by the Weed Management Contractor and provide documentation to Monitoring Contractor. Documentation should include type and quantity

of herbicides applied, dates applied, and any associated EPA/U.S. Department of Environmental Quality licensing/documentation of chemicals used.

- Reviews annual reports to ensure all treatments performed by the Weed Management Contractor are documented.
- Maintain landowner communications, providing guidance to the Monitoring Contractor and Weed Management Contractor regarding landowner restrictions/requests for performing noxious weed monitoring/treatment on their properties.
- Attend quarterly calls with Monitoring Contractor and the Weed Management Contractor.
- Attend calls with ODOE, ODA, and Morrow County as needed.

Weed Management Contractor

- Review Monitoring Contractor memos describing noxious weed occurrences and recommendations and plan appropriate treatment to address those issues.
- Communicate treatment plan to the Certificate Holder.
- Maintain records of when, where, and what type of noxious weed treatments are being performed.
- Maintain all appropriate documentation of chemicals applied. Shares documentation during the quarterly calls with the Certificate Holder and Monitoring Contractor, and prior to Annual Report preparation.
- Attend quarterly calls with Monitoring Contractor and Certificate Holder.

Morrow County

- Review Monitoring Contractor memos describing weed occurrences and recommendations.
- Attend quarterly calls and provide recommendations.

6.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE. This Plan may also be amended periodically as the Certificate Holder continues to evaluate and modify, as needed, agricultural dual use activities at the Facility.

7.0 References

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Appendix A: Oregon State Noxious Weed List

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OREGON
DEPARTMENT OF
AGRICULTURE

Noxious Weed Policy and Classification System
2024

Noxious Weed Control Program

Address: 635 Capitol Street NE, Salem, Oregon 97301
Phone: (503) 986-4625 **Fax:** (503) 986-4786
www.oregon.gov/ODA/programs/Weeds/Pages/AboutWeeds.aspx

Mission Statement

To protect Oregon’s natural resources and agricultural economy from the invasion and proliferation of invasive noxious weeds.

Program Overview

The Oregon Department of Agriculture (ODA) Noxious Weed Control Program provides statewide leadership for coordination and management of state listed noxious weeds. The state program focuses on noxious weed control efforts by implementing early detection and rapid response projects for new invasive noxious weeds, implementing biological control, implementing statewide inventory and survey, assisting the public and cooperators through technology transfer and noxious weed education, maintaining noxious weed data and maps for priority listed noxious weeds, and assisting land managers and cooperators with integrated weed management projects. The Noxious Weed Control Program also supports the Oregon State Weed Board (OSWB) with administration of the OSWB Grant Program, developing statewide management objectives, developing weed risk assessments, and maintaining the state noxious weed list.

Troy Abercrombie
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(503) 986-4625

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Noxious Weed Control Policy and Classification System

Definition

“Noxious weed” means a terrestrial, aquatic or marine plant designated by the Oregon State Weed Board under ORS 569.615 as among those representing the greatest public menace and as a top priority for action by weed control programs.

Noxious weeds have become so thoroughly established and are spreading so rapidly on private, state, county, and federally owned lands, that they have been declared by ORS 569.350 to be a menace to public welfare. Steps leading to eradication, where possible, and intensive control are necessary. It is further recognized that the responsibility for eradication and intensive control rests not only on the private landowner and operator, but also on the county, state, and federal governments.

Weed Control Policy

Therefore, it shall be the policy of ODA to:

1. Assess non-native plants through risk assessment processes and make recommendations to the Oregon State Weed Board for potential listing.
2. Rate and classify weeds at the state level.
3. Prevent the establishment and spread of listed noxious weeds.
4. Encourage and implement the control or containment of infestations of listed noxious weed species and, if possible, eradicate them.
5. Develop and manage a biological weed control program.
6. Increase awareness of potential economic losses and other undesirable effects of existing and newly invading noxious weeds, and to act as a resource center for the dissemination of information.
7. Encourage and assist in the organization and operation of noxious weed control programs with government agencies and other weed management entities.
8. Develop partnerships with county weed control districts, universities, and other cooperators in the development of control methods.
9. Conduct statewide noxious weed surveys and weed control efficacy studies.

Weed Classification System

The purpose of this Classification System is to:

1. Act as the ODA's official guideline for prioritizing and implementing noxious weed control projects.
2. Assist the ODA in the distribution of available funds through the Oregon State Weed Board to assist county weed programs, cooperative weed management groups, private landowners, and other weed management entities.
3. Serve as a model for private and public sectors in developing noxious weed classification systems that aid in setting effective noxious weed control strategies.

Criteria for Determining Economic and Environmental Significance

Detrimental Effects

1. A plant species that causes or has the potential to cause severe negative impacts to Oregon's agricultural economy and natural resources.
2. A plant species that has the potential to or does endanger native flora and fauna by its encroachment into forest, range, aquatic and conservation areas.
3. A plant species that has the potential or does hamper the full utilization and enjoyment of recreational areas.
4. A plant species that is poisonous, injurious, or otherwise harmful to humans and/or animals.

Plant Reproduction

1. A plant that reproduces by seed capable of being dispersed over wide areas or that is long-lived, or produced in large numbers.
2. A plant species that reproduces and spreads by tubers, creeping roots, stolons, rhizomes, or other natural vegetative means.

Distribution

1. A weed of known economic importance which occurs in Oregon in small enough infestations to make eradication/containment possible; or not known to occur, but its presence in neighboring states makes future occurrence seem imminent.
2. A weed of economic or ecological importance and of limited distribution in Oregon.
3. A weed that has not infested the full extent of its potential habitat in Oregon.

Difficulty of Control

A plant species that is not easily controlled with current management practices such as chemical, cultural, biological, and physical methods.

Noxious Weed Control Classification Definitions

Noxious weeds, for the purpose of this system, shall be listed as either A or B, and may also be designated as T, which are priority targets for control, as directed by the Oregon State Weed Board.

- **A Listed Weed**:
  A weed of known economic importance which occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent (Table I).
  Recommended action: Focus on prevention of new infestations through vector control, certification programs, education, outreach and surveys. New and existing infestations are prioritized for eradication or intensive control when and where found. Regionally focused, species-specific Statewide Management Strategies for A-listed weeds may be developed as necessary.
- **B Listed Weed**:
  A weed of economic importance which is regionally abundant, but which may have limited distribution in some counties (Table II).
  Recommended action: Limited to intensive control at the state, county or regional level as determined on a site specific, case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the primary control method.
- **T-Designated Weed (T)**:
  A designated group of weed species selected from the B list as a focus for prevention and control by the Noxious Weed Control Program. T-designated noxious weeds are determined by the Oregon State Weed Board and management actions are prioritized and informed by species-specific T-List Statewide Management Strategies created and maintained by the ODA. Action against these weeds will receive priority in accordance with the recommendations of the Statewide Management Strategy.

Weed Biological Control

Oregon implements biological control, or “biocontrol” as part of its integrated pest management approach to managing noxious weeds. This is the practice of using host-specific natural enemies such as insects or pathogens to control noxious weeds. The Oregon Department of Agriculture Noxious Weed Program has adopted the International Code of Best Practices for biological control of weeds. Only safe, effective, and federally-approved natural enemies will be used for biocontrol.

Table I: A Listed Weeds

Common Name	Scientific Name
African rue	*Peganum harmala*
Camelthorn	*Alhagi pseudalhagi*
Cape-ivy	*Delairea odorata*
Coltsfoot	*Tussilago farfara*
Common frogbit	*Hydrocharis morsus-ranae*
Cordgrass	
Common	*Spartina anglica*
Dense-flowered	*Spartina densiflora*
Saltmeadow	*Spartina patens*
Smooth	*Spartina alterniflora*
Delta arrowhead	*Sagittaria platyphyla*
European water chestnut	*Trapa natans*
Flowering rush	*Butomus umbellatus*
Garden yellow loosestrife	*Lysimachia vulgaris*
Giant hogweed	*Heracleum mantegazzianum*
Goatgrass	
Barbed	*Aegilops triuncialis*
Ovate	*Aegilops ovata*
Goatsrue	*Galega officinalis*
Hawkweed	
King-devil	*Hieracium piloselloides*
Mouse-ear	*Hieracium pilosella*
Orange	*Hieracium aurantiacum*
Yellow	*Hieracium floribundum*
Hoary alyssum	*Berteroa incana*
Hydrilla	*Hydrilla verticillata*
Japanese dodder	*Cuscuta japonica*
Kudzu	*Pueraria lobata*
Matgrass	*Nardus stricta*
Oblong spurge	*Euphorbia oblongata*
Palmer amaranth	*Amaranthus palmeri*
Paterson’s curse	*Echium plantagineum*
Purple nutsedge	*Cyperus rotundus*
Ravennagrass	*Saccharum ravennae*
Squarrose knapweed	*Centaurea virgata*

(Continued) Table I: A Listed Weeds

Common Name	Scientific Name
Starthistle	
Iberian	*Centaurea iberica*
Purple	*Centaurea calcitrapa*
Thistle	
Plumeless	*Carduus acanthoides*
Smooth distaff	*Carthamus baeticus*
Taurian	*Onopordum tauricum*
Turkish	*Carduus cinereus*
Welted (curly plumeless)	*Carduus crispus*
Woolly distaff	*Carthamus lanatus*
Water soldiers	*Stratiotes aloides*
West Indian spongeplant	*Limnobium laevigatum*
White bryonia	*Bryonia alba*
Yellow floating heart	*Nymphoides peltata*
Yellowtuft	*Alyssum murale, A. corsicum*

Table II: B Listed Weeds

Common Name	Scientific Name
Armenian (Himalayan) blackberry	*Rubus armeniacus (R. procerus, R. discolor)*
Biddy-biddy	*Acaena novae-zelandiae*
Broom	
French*****	*Genista monspessulana*
Portuguese (T)	*Cytisus striatus*
Scotch*****	*Cytisus scoparius*
Spanish	*Spartium junceum*
Butterfly bush	*Buddleja davidii (B. variabilis)*
Common bugloss (T)	*Anchusa officinalis*
Common crupina **(T)**	*Crupina vulgaris*
Common reed	*Phragmities australis ssp. australis*
Common viper’s bugloss (T)	*Echium vulgare*
Cutleaf teasel	*Dipsacus laciniatus*
Dyer’s woad (T)	*Isatis tinctoria*
English hawthorn	*Crataegus monogyna*
Eurasian watermilfoil	*Myriophyllum spicatum*
False brome	*Brachypodium sylvaticum*
Field bindweed	*Convolvulus arvensis*
Garlic mustard (T)	*Alliaria petiolata*
Geranium	
Herb Robert	*Geranium robertianum*
Shiny leaf	*Geranium lucidum*
Giant reed (T)	*Arundo donax*
Gorse***** (T)	*Ulex europaeus*
Halogeton	*Halogeton glomeratus*
Houndstongue	*Cynoglossum officinale*

* Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Indigo bush	*Amorpha fruticosa*
Ivy	
Atlantic	*Hedera hibernica*
English	*Hedera helix*
Jointed goatgrass	*Aegilops cylindrica*
Jubata grass	*Cortaderia jubata*
Knapweed	
Diffuse*****	*Centaurea diffusa*
Meadow*****	*Centaurea pratensis*
Russian*****	*Acroptilon repens*
Spotted*****	*Centaurea stoebe (C. maculosa)*
Knotweed	
Bohemian*****	*Fallopia x bohemica*
Giant*****	*Fallopia sachalinensis (Polygonum)*
Himalayan	*Polygonum polystachyum*
Japanese*****	*Fallopia japonica (Polygonum)*
Kochia	*Kochia scoparia*
Lesser celandine	*Ranunculus ficaria*
Meadow hawkweed (T)	*Pilosella caespitosum (Hieracium)*
Mediterranean sage*	*Salvia aethiopis*
Medusahead rye	*Taeniatherum caput-medusae*
Old man’s beard	*Clematis vitalba*
Parrot feather	*Myriophyllum aquaticum*
Perennial peavine	*Lathyrus latifolius*
Perennial pepperweed (T)	*Lepidium latifolium*
Pheasant’s eye	*Adonis aestivalis*
Pine echium (T)	*Echium pininana*
Poison hemlock*****	*Conium maculatum*
Policeman’s helmet	*Impatiens glandulifera*
Primrose-willow	
Large-flower (T)	*Ludwigia grandiflora*
Water primrose (T)	*Ludwigia hexapetala*
Floating (T)	*Ludwigia peploides*

*Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Puncturevine*****	*Tribulus terrestris*
Purple loosestrife*****	*Lythrum salicaria*
Ribbongrass (T)	*Phalaris arundinacea var. Picta*
Rose	
Dog	*Rosa canina*
Sweetbriar	*Rosa rubiginosa*
Rush skeletonweed***** (T)	*Chondrilla juncea*
Saltcedar***** (T)	*Tamarix ramosissima*
Small broomrape	*Orabanche minor*
South American waterweed	*Egeria densa (Elodea)*
Spanish heath	*Erica lusitanica*
Spurge laurel	*Daphne laureola*
Spurge	
Leafy***** (T)	*Euphorbia esula*
Myrtle	*Euphorbia myrsinites*
St. Johnswort	*Hypericum perforatum*
Sulfur cinquefoil	*Potentilla recta*
Swainsonpea	*Sphaerophysa salsula*
Tansy ragwort***** (T)	*Senecio jacobaea (Jacobaea vulgaris)*
Thistle	
Bull	*Cirsium vulgare*
Canada*****	*Cirsium arvense*
Italian	*Carduus pycnocephalus*
Milk	*Silybum marianum*
Musk	*Carduus nutans*
Scotch	*Onopordum acanthium*
Slender-flowered	*Carduus tenuiflorus*
Toadflax	
Dalmatian*****	*Linaria dalmatica*
Yellow*****	*Linaria vulgaris*
Tree of heaven	*Ailanthus altissima*

*Biocontrol (See page 4)　(T) T-Designated Weed (See page 4)

(Continued) Table II: B Listed Weeds

Common Name	Scientific Name
Ventenata grass	*Ventenata dubia*
Whitetop	
Hairy	*Lepidium pubescens*
Lens-podded	*Lepidium chalepensis*
Whitetop (hoary cress)*****	*Lepidium draba*
Yellow archangel	*Lamiastrum galeobdolon*
Yellow flag iris	*Iris pseudacorus*
Yellow nutsedge	*Cyperus esculentus*
Yellow starthistle*	*Centaurea solstitialis*

*Biocontrol (See page 4)

(T) T-Designated Weed (See page 4)

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Appendix B: Morrow County Noxious Weed List

Morrow County Weed List:

NOXIOUS WEEDS

Noxious Weeds – “A” List” – Any plant that is determined by the weed advisory board, and so declared by the County Board of Commissioners to be injurious to public health, crops, livestock, land or property under provisions of Oregon State Statute and thus mandated for control.

Rush Skeletonweed

Yellow Starthistle

Tansy Ragwort

Yellow Toadflax

Dalmatian Toadflax

Mediterranean Sage

Leafy Spurge

Spikeweed

Musk Thistle

Scotch Thistle

Purple Loosestrife

Common Crupina

Whitetop (Hoary Cress)

Houndstongue

Flowering Rush

Yellow Flag Iris

Plumeless Thistle

WEEDS OF ECONOMIC IMPORTANCE

Weeds of Economic Importance – "B" List – Weeds of limited distribution in the county and subject to intensive control or eradication where feasible.

Poison Hemlock

Canada Thistle

Jointed Goatgrass

St. Johnswort

Perennial Sowthistle

Field Bindweed

Cereal Rye

Johnsongrass

Russian Knapweed

Diffuse Knapweed

Spotted Knapweed

Field Dodder

Water Hemlock

Medusahead Rye

Puncturevine

Kochia

Perennial Pepperweed

Myrtle Spurge

Ventenata

Morrow County Weed Advisory Board

The Morrow Soil and Water Conservation District Board also serves as the Weed Advisory Board

Sunstone Solar Project 6
Draft Revegetation and Reclamation Plan

Prepared for

Sunstone Solar 6, LLC

Prepared by

Tetra Tech, Inc.

October 2025

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1.0 Introduction

Sunstone Solar 6, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 6 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon (Figure 1). The proposed Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 200 MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Revegetation and Reclamation Plan (Plan) has been prepared to guide revegetation of areas temporarily disturbed during construction of the Facility, as well as revegetation within the solar array fence in compliance with Site Certificate Conditions PRE-FW-01 and PRE-SP-01. This Plan will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE), the Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Agriculture (ODA), and Morrow County Weed Department to reflect the final layout of the Facility.

Prior to construction, this Plan shall be finalized based on the following:

1. Certificate Holder shall finalize the Plan based on disturbance associated with the final design/layout by disturbance level and habitat type and category.
2. Certificate Holder shall develop and incorporate maps showing anticipated construction disturbance levels along with the total acreage and major activities associated with each level.
3. Certificate Holder shall update Table 1 prior to construction to reflect the disturbance acreage by habitat subtype for the final layout.
4. Certificate Holder shall develop and incorporate revegetation methods for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department.

Prior to construction, the following shall be completed:

1. Certificate Holder shall provide shapefiles showing anticipated construction disturbance levels at the site as a submittal to ODOE.
2. Certificate Holder shall provide the revegetation and seeding contractor’s qualifications and scope of work as a submittal to ODOE.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

3. Certificate Holder shall submit baseline soil compaction sample locations and baseline compaction results to ODOE.
4. Certificate Holder shall hold a kick-off meeting with their environmental contractor, construction contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
5. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the construction contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.

Prior to initiation of revegetation, the following shall be completed:

1. Certificate Holder shall hold a kick-off meeting with their environmental contractor, revegetation and seeding contractor, and ODOE at least 14 days prior to initiation of revegetation activities.
2. Certificate Holder shall prepare a crosswalk of the final version of this Plan for use by the revegetation and seeding contractor. A copy of the Plan crosswalk will be provided to all participating parties prior to the kick-off meeting date.
3. Certificate Holder shall complete post-construction soil compaction testing and submit results for review and approval to ODOE.

Throughout construction, revegetation, and operation activities, the Certificate Holder will take appropriate actions to prevent the spread of state and county listed noxious weeds. A stand-alone Draft Noxious Weed Control Plan has also been prepared (see Exhibit P, Attachment P-3[2]; updated for RFA 1, see Attachment 6), which contains information on state and Morrow County listed noxious weeds, noxious weeds observed during surveys, and treatment and monitoring of noxious weeds.

2.0 Site Description

The Facility includes a 1,247-acre site boundary within which all Facility components will be located. The Facility lies within the Columbia Plateau Ecoregion at elevations from 1,125 to 1,260 feet. The Facility is sited entirely on private land, which primarily consists of agriculture land used for growing dryland wheat. Native vegetation within the site boundary has been modified primarily through agricultural conversion, but also through the introduction of exotic grasses and other non-native vegetation.

Habitat mapping and categorization of the site boundary were conducted for the Facility in 2022. Habitat types within the site boundary include Agriculture, Pasture, and Mixed Environs (habitat subtype: Orchards, Vineyards, Wheat Fields, Other Row Crops) and Developed (habitat subtype: Urban and Mixed Environs). Details on habitat types, subtypes, and categories can be found in

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[2] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

Exhibit P of the Facility's ASC, especially Attachment P-1 which contains the biological survey reports. Details on potential disturbance to habitat from construction and operation of the Facility, as well as avoidance and minimization measures, can be found in the ASC Exhibits P and Q[3].

3.0 Description of Disturbance

Construction of the Facility will result in temporary and permanent disturbance (see Exhibits C[4] and P). Section 3.1.1 (below) details the acres of each habitat subtype that will be temporarily and permanently disturbed during construction and operation of the Facility. All areas within the solar array fence are considered a permanent disturbance and will be revegetated for the purposes of site stabilization to reduce erosion, dust pollution, and topsoil depletion, and to reduce potential for invasion by noxious and invasive plants. The entire solar array fence will occupy approximately 1,216 acres. As noted above, this area is considered permanently disturbed; however, vegetation within the solar array fence will be retained and/or revegetated and this area would be reclaimed upon retirement.

Temporary disturbance will occur in areas outside the solar array fence that will be disturbed during construction activities, but which will not be occupied by permanent facilities. Temporary disturbance will occur in association with the construction of aboveground and underground collector and transmission lines, new roads, and perimeter fence.

Prior to construction, a crosswalk of the final version of this Plan will be prepared for use by the construction contractor to facilitate Plan implementation and ensure ground disturbance is minimized to the extent practicable. A kick-off meeting with the Certificate Holder, their environmental contractor, construction contractor, and ODOE will be held at least 14 days prior to construction. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify that anticipated disturbance levels are followed to the extent possible and will document any variances and justifications for those variances for ODOE review.

3.1 Disturbance Levels

Revegetation needs will be determined by a combination of disturbance level and existing vegetative cover. Disturbance levels will primarily be determined by site conditions such as slope, gradient, and existing vegetation. Disturbance levels are defined as follows:

Level 1 - Mowing: Mowing is used to conserve vegetative resources within a facility while mitigating risk of fire and facilitating construction activities. Vegetation will be limited to a height of 12 inches and mowed to no less than 6 inches during construction. Mowing to no less than 6 inches protects perennial grass crowns and allows grasses to regenerate. Depending on facility objectives, vegetation can be allowed to reach a normal height or kept trimmed to a height between 6 inches and the plant's

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[3] Complete Application for Site Certificate, Exhibit Q, May 16, 2024.
[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

full height potential. Crushing of vegetation will be minimal and this disturbance level is designed to have a minimal impact on existing vegetation. This method is least likely to result in invasions of undesirable plant species.

Level 2 – Overland Drive and Crush: Disturbance caused by accessing a facility without significantly modifying the landscape. Vegetation is crushed to the ground, but no surface soil is removed so root structures are left intact. Even though vegetation may be damaged or destroyed, the surface soil and seed bank remain in place. Some crushed vegetation will likely sprout after disturbance ceases. These activities would result in minimal to moderate disturbance. This type of disturbance will result in a faster recovery time for vegetation compared to Levels 3 and 4. Soil seed banks remain largely in place, perennial vegetation can grow back, and minimal external efforts are necessary. This method is less likely to result in invasions of undesirable plant species compared to Levels 3 and 4.

Level 3 – Clear and Cut: Disturbance caused by accessing the facility including having to remove all vegetation in order to improve or provide suitable access for other equipment. All vegetation is removed, soils are compacted, and the root zone or soil A-horizon may be disturbed, but no sub-surface soil is removed. Clear and cut activities would result in moderate disturbance. This type of disturbance will result in moderate recovery times for vegetation. This method has a moderate risk for invasion of undesirable plant species. An example is imprinting to crush vegetation down into the soil or incidental grading and smoothing of surface soils.

Level 4 – Clear and Cut with Soil Removal: Disturbance is caused by removing all vegetation in the impact zone, soils are compacted, and surface soil and subsoil are displaced. These activities result in heavy disturbance. This type of disturbance results in an extensive recovery time for vegetation, and is most likely to lead to invasions of undesirable plant species, which can result in lengthy and expensive control efforts. Includes disc-and-roll construction, and other traditional construction methods where soils are disturbed and no vegetation is left intact. This category includes all work requiring the segregation and replacement of topsoils.

3.1.1 Facility Disturbance

To the maximum extent practicable, Level 1 and Level 2 disturbance will be used during Facility construction. Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable, although construction vehicles driving across the site may affect existing root systems by compacting soils. Grading within solar arrays will be limited to areas where the slope and gradient are outside of panel and racking tolerances (typically, but not exclusively, 10 percent maximum on North slopes and 15 percent maximum in other directions). Areas where the slope and gradient are within panel and racking tolerances will only be graded in road, inverter, and energy storage footprints where possible. Preservation of existing root systems will minimize soil erosion, providing both improved compliance with stormwater and dust management requirements, facilitate revegetation success, and preserve soil productivity for future agricultural use. Construction will be coordinated and sequenced to the extent practicable with landowners to maintain land in current production and

weed control until just prior to construction. This will avoid land being left unmanaged and minimize weed issues that can complicate revegetation.

Prior to construction, the Certificate Holder will provide maps and shapefiles showing anticipated construction disturbance levels at the Facility, along with total acreage and major activities associated with each level. This will serve to demonstrate the Certificate Holder's avoidance and minimization of ground disturbing activities to the extent practicable.

Table 1 presents the estimated maximum acreage of temporary and permanent disturbance to habitat subtypes associated with Facility construction and operation based on the permitted layout. Table 1 will be updated prior to construction to reflect the final disturbance acreage by habitat subtype for the final layout. Figures depicting the location of Facility infrastructure are included in Exhibit C, and a figure depicting habitat subtypes within the site boundary is available in Exhibit P.

Table 1. Maximum Temporary and Permanent Disturbance by Habitat Subtype

ODFW Habitat Category	Habitat Subtype	Permanent Disturbance (Acres)[1, 2]	Temporary Disturbance (Acres) [1]
6	Orchards, Vineyards, Wheat Fields, Other Row Crops	1,215	4.2
	Urban and Mixed Environs	0.6	-
	Grand Total[1]	**1,216**	**4.2**

Note: Totals in this table may not appear to sum correctly due to rounding. "-" means no disturbance.

1. Additional details associated with temporary and permanent disturbance are provided in Exhibit C of the ASC. Disturbances were calculated based on the layout permitted in the ASC and will be updated prior to construction based on an updated layout.
2. Acres of permanent disturbance includes the entire area within the solar array area fence including the footprints of all solar components and supporting facilities, as well as the areas outside of the footprint of permanent components and facilities (e.g., areas underneath and between rows of solar panels).

4.0 Reclamation and Revegetation Methods

This plan addresses revegetation methods for temporary disturbance to agricultural lands, as well as revegetation and vegetation management of lands within the solar array fence. Revegetation of temporarily disturbed developed habitat (i.e., Urban and Mixed Environs habitat subtype) will be determined on a case-by-case basis and is not covered further in this plan. Temporary disturbance to agricultural habitat (i.e., Orchards, Vineyards, Wheat Fields, Other Row Crops habitat subtype) will be restored as described in Section 4.5.1. The Certificate Holder will restore temporarily disturbed areas by re-establishing slope, surface stability, and drainage features, as needed, followed by soil preparation and seeding. Soil preparation and seeding techniques are described below.

Revegetation will begin as soon as feasible after completion of each construction phase. Seeding and planting will be done in a timely manner and in the appropriate season to facilitate germination and establishment of seeded species.

Prior to construction, final revegetation methods will be developed for each disturbance level in consultation with ODOE, ODA, ODFW, and the Morrow County Weed Department and will be incorporated as an amendment to this Plan upon ODOE approval.

4.1 Roles and Responsibilities

A construction contractor qualified to perform revegetation and seeding will be responsible for implementing measures in the National Pollutant Discharge Elimination System (NPDES) 1200-C permit, as well as revegetation activities discussed herein during and immediately after construction. A qualified botanist or revegetation specialist will be responsible for monitoring and reporting on revegetation success. Remedial revegetation actions, if needed during the operation phase, will be performed by a qualified contractor. The Certificate Holder will be responsible for ensuring that all contractors perform work in accordance with permit requirements and all agreed upon methods for revegetation.

The goal of this Plan is to increase the probability of revegetation success, reduce early weed establishment, reduce erosion and dust pollution, protect topsoil for future agricultural use in permanent disturbance areas, and ensure no loss of habitat quality for temporary disturbance to wildlife habitat. To ensure this goal is met, the Certificate Holder will ensure that the contractor selected for revegetation will be a qualified revegetation and seeding contractor with demonstrated experience in the Columbia Plateau. Options for contracting and managing this work include:

- Having the construction contractor subcontract revegetation work out to a qualified revegetation and seeding contractor. The contract will stipulate the Certificate Holder’s right to dictate the timing, methods, and management of seeding.
- Contracting directly with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.
- Having the environmental contractor contract with the qualified revegetation and seeding contractor, with the power to contractually enforce seed timing and methods.

The revegetation and seeding contractor’s qualifications and scope of work will be provided as a submittal to ODOE prior to construction. Additionally, a crosswalk of the final version of this Plan will be prepared for use by the revegetation and seeding contractor prior to initiation of revegetation to facilitate Plan implementation. A kick-off meeting with the Certificate Holder, their environmental contractor, revegetation and seeding contractor, and ODOE will be held at least 14 days prior to initiation of revegetation activities. A copy of the Plan crosswalk will be provided to ODOE staff prior to the kick-off meeting date. Staff from either the Certificate Holder or their environmental contractor will field-verify seeding methods and timing requirements are followed appropriately and will document any variances and the justifications for those variances. Monitoring and follow-up will be provided as described in Section 6.0 to ensure oversight and increase the probability of revegetation success.

4.2 Soil Reclamation

Soil scientists use a soil penetrometer to field measure subsurface compaction in soil. This tool measures resistance (pressure) to the advance of a cone-tipped rod with a T-handle, vertically through the soil column. The metric intends to measure soil compaction that can inhibit the ability of plants to penetrate the soil. An operator pushes the penetrometer rod with a cone base into the ground with consistent force. A pressure gauge records pressure in pounds per square inch (psi), equaling levels of resistance at differing soil layers. Resistance is measured at 3-inch intervals until the meter goes above 300 psi, which is a level of soil compaction most roots cannot penetrate. For this test compaction would be measured at 3, 6, 9, and 12 inches if the soils allow. Soil compaction testing must be completed in spring or late fall when soils are at field capacity (approximately 24 hours after a soaking rain). Baseline soil compaction measurements will be taken prior to construction. Baseline soil compaction sample locations and baseline compaction results will be submitted to ODOE prior to construction.

1. Baseline and post-construction soil compaction measurements and testing must be done in conditions favorable to soil testing (e.g. non-saturated or frozen soils).
2. Baseline soil compaction measurements will be documented and established by using the above protocol, or other protocol as approved by ODOE, to establish baseline soil conditions within temporary disturbance areas.
3. Recordation of the baseline soil plots must be represented on a map based on final Facility design.
4. Post-construction soil compaction testing following the above protocols must be completed in spring or late fall when soil conditions are favorable to soil testing (non-saturated or frozen soils). Compaction testing will occur after soil stockpiles are replaced and grading is complete but prior to initiation of revegetation activities.
5. If soil monitoring demonstrates that soils are compacted more than 300 psi, then remediation activities must be completed prior to initiation of revegetation activities. See Section 4.3 below, the Facility NPDES 1200-C permit, and applicable Site Certificate Conditions.

In addition, in areas where soil is removed during construction, the following measures will be taken where appropriate:

- During construction, excavated topsoil will be stockpiled separately from subsoil and replaced in proper order with topsoil on the surface to maintain soil productivity. Stockpiled soil will be put back in place prior to revegetation activities.
- Soils will be stabilized during construction using the appropriate best management practices as determined by the onsite stormwater pollution prevention plan implementor.
- Soil preparation will involve standard, commonly used methods (i.e. tracking, decompaction, and tilling), and will consider all relevant site-specific factors, including slope, size of area, and erosion potential. Soils will be de-compacted if necessary to create a

uniform seedbed using an agricultural disc, soil ripper, or similar equipment. Additional details regarding soil preparation are in Section 4.3.

- Topsoil and other soils from noxious weed infested areas will not be moved outside of the infested areas and will be returned to their previous location during reclamation activities to eliminate the transport of weed seeds, roots, or rhizomes.
- Soils from weed-infested areas will be treated with a non-persistent, pre-emergent herbicide prior to initiation of revegetation efforts, depending on site-specific conditions.
- Prior to final regrade and revegetation efforts, any weeds that have grown during periods of construction dormancy should be treated as described in the Noxious Weed Control Plan.
- The construction contractor will use appropriate erosion and sediment control practices (i.e., seeded or unseeded hydromulch, tackifier, weed-free erosion control blankets, weed-free or locally sourced straw mulch) to maintain topsoil during construction in both temporary and permanent disturbance areas.

4.3 Site Preparation

Existing vegetation root systems (e.g., crop stubble, fallow vegetation) will be left intact during construction to the maximum extent practicable. Areas where the slope and gradient are within the solar panel and racking tolerances will receive minimal grading, with grading in those areas limited to the roads, inverter, and energy storage footprints. In areas where soil is removed during construction, the Certificate Holder will demonstrate adequate soil stabilization to prevent erosion and dust pollution. The following measures will be taken where appropriate:

- Site preparation will take into account all relevant site-specific factors, including slope, size of area, and erosion potential.
- Areas of severe machine or vehicle tracking that would hinder seeding success and are unnecessary for soil stabilization will be regraded.
- In the spring, fall or winter of the year prior to when construction would occur, areas of high erosion risk (e.g., slopes, areas with low vegetative cover) should be seeded with a non-invasive, non-persistent cover crop such as triticale to stabilize soils.
- If soils are not suitable for revegetation, soil amendments may be required. Any imported topsoil, if required, will be demonstrated to be suitable for vegetative success.
- Where soil compaction testing demonstrates that soils are compacted greater than 300 psi, soils will be mechanically scarified (e.g., tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction, to maintain soil productivity, and reduce the potential for erosion on compacted soils. Dry soils should be de-compacted using an agricultural disc, soil ripper, or similar equipment.
- Prior to seeding and/or planting of revegetation areas, soils will be prepared into a firm, fine-textured seedbed that is relatively free of debris. Shallow tilling with a disc, followed by a harrow or drag if necessary, can typically achieve this. If replaced soil is too soft, then

seeds may be buried too deep to properly germinate; a roller or culti-packer should be used to pack down the soil.

- In non-cropland temporary disturbance areas, site complexity will be considered during soil preparation. For instance, it may be desirable to purposely create an uneven, patchy site that allows for depressions and other microsites that result in small variations in aspect and moisture holding to promote complexity.
- Seeded areas will be temporarily stabilized to facilitate establishment. This can be accomplished by application of seedless, certified weed-free hydromulch containing a tackifier or straw mulch crimping. Alternate methods may be proposed by the revegetation and seeding contractor but will require prior written approval by ODOE and must provide demonstrated success in sites with similar wind and soil conditions.
- The Certificate Holder or a designated construction contractor will use mulching and other appropriate practices, as required by the anticipated NPDES 1200-C permit, to control erosion and sediment during construction and revegetation work.

4.4 Revegetation of Permanent Disturbance Areas

During construction, the Certificate Holder will implement site stabilization measures, including seeding of all disturbed areas according to the Certificate Holder's anticipated NPDES 1200-C permit. Approximately 6 months prior to commercial operation of each phase of construction, the Certificate Holder will meet with ODFW, ODOE, and Morrow County Weed Department personnel to review the actual extent and conditions of disturbed areas and confirm the revegetation methods to be implemented.

As portions of the Facility are prepared for installation of Facility components (i.e., grading is complete), but prior to installation, all areas with less than 70 percent vegetative cover should be seeded with a non-invasive, non-persistent cover crop. The cover crop will be selected based on the time of year and site conditions; for example, winter wheat or sterile triticale can be seeded from fall to early spring, while peas should be seeded in spring. Tillage radish and sunflowers can be seeded in spring to break up compaction but are not suitable options for soil stability. A cover crop will stabilize soils and suppress noxious weed infestations to reduce erosion and facilitate revegetation of desired plant species.

Following the completion of each construction phase, permanent disturbance areas will be reseeded with a mix of native or non-invasive, non-native grasses and forbs as appropriate based on disturbance level and actual site conditions (see Section 4.4). All seeds will be obtained from a reputable supplier in compliance with the Oregon Seed Law (OAR 603-056). The final seed mix for permanent disturbance areas will include low growing grasses and pollinator-friendly forbs compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Table 3 in Section 4.7 includes an example of low-growing seed mix for permanent disturbance areas.

4.5 Revegetation of Temporary Disturbance Areas

4.5.1 Agricultural Lands

Temporarily disturbed agricultural lands will be reseeded with the appropriate crop or maintained as fallow in consultation with the landowner or farm operator. The Certificate Holder will consult with the landowner or farm operator to determine the seed mix, application methods, and rates for seed and fertilizer. Success of cropland revegetation will have been achieved when production of the revegetated area is comparable to that of adjacent, non-disturbed croplands of the same type.

Agricultural lands will be reseeded to match the timing of the crop rotation on adjacent cropland to facilitate easy harvest and re-establish the appropriate crop rotation. Agricultural lands that will be seeded in the year that construction is complete can be temporarily hydromulched or otherwise stabilized until seeding can occur in the fall; agricultural lands that will be fallow for a year (i.e., fallow rather than reseeded the year construction is complete) will be planted with a cover crop (dependent on timing of construction closeout) or have continued stabilization with hydromulch, straw mulch crimping, or other best management practices through the fallow year.

Soil compaction as a result of construction activity is a concern for restoring agricultural soils to their pre-construction productivity. Within temporary disturbance areas, the Certificate Holder will excavate and store topsoil separately from subsoil, so that topsoil is replaced and restored appropriately. During post-construction revegetation of temporary disturbance to agricultural lands, the Certificate Holder will loosen agricultural soil by mechanical scarification (tilling or ripping the soil) to an appropriate depth to reduce the potential effects of compaction. Soil amendment, by addition of organic matter (e.g., compost), may also be necessary to alleviate compaction.

Success determination will involve consultation with the landowner or farm operator, and the Certificate Holder will report to ODOE on the success of agricultural land revegetation efforts. Noxious weed control is necessary for successful revegetation of agricultural lands and will be implemented per the methods described in the Draft Noxious Weed Control Plan (Exhibit P, Attachment P-3; updated for RFA 1, see Attachment 6).

4.5.2 Wildlife Habitat

There is no temporary disturbance to wildlife habitat because no wildlife habitat will be disturbed by Facility construction. Revegetation of wildlife habitat is not discussed in this Plan.

4.6 Seeding Methods

The seeding method and timing of planting will be appropriate to the seed mixes (see Section 4.7), weather conditions (e.g., precipitation, wind speed, temperature, etc.), and site conditions (including area size, slope, and erosion potential) based upon consultation with ODOE, ODA, ODFW, the Morrow County Weed Department, and the seed supplier. Seeding from late September to March is typically recommended; however, the Certificate Holder will consult with ODOE, ODFW,

ODA, Morrow County Weed Department, and/or the seed supplier to determine the optimal timing for seed application based on climatic conditions of the particular year when construction and revegetation efforts are implemented.

Common seed application methods that may be used for revegetation are broadcast seeding, drill seeding, imprint seeding, and hydroseeding; each of these are discussed further below. Other seeding methods may be proposed for review and approval prior to revegetation efforts.

4.6.1 Broadcast Seeding

Broadcast seeding is the application of seed directly to the ground surface. This method may be chosen for areas with shallow and rocky soils, and the type of broadcast spreader would depend on the size of the area to be seeded and the terrain. Broadcast seeding may be completed before or after panel and fence installation.

In this method, the seed mix is typically broadcast at a rate of 20 to 24 pounds pure live seed per acre, or twice the recommended rate for drill seeding; this rate may be adjusted depending on the recommendation of the actual seed supplier and agencies. When feasible, due to the seasonality of when planting can occur, the entire area will be seeded after grading is complete but before placement of Facility components, providing more flexibility in seed application. In those instances where seeding occurs prior to installation of components, follow-up seeding will occur in areas temporarily disturbed by installation and any areas that are deficient in vegetation from the first round of seeding. Immediately following seed application, hydromulch or certified weed-free straw would be applied. Broadcast seeding will not be employed if winds exceed 5 miles per hour. If certified weed-free straw is unavailable, the Certificate Holder or a designated construction contractor will identify a local source of straw. The local source of the straw will be approved by the county weed master and ODFW prior to purchase. This straw will either be crimped into the ground or applied with a tackifier.

4.6.2 Drill Seeding

Drill seeding can be used for larger areas with deeper soils and moderate to gentle terrain to accommodate mechanical equipment. This method provides the advantage of planting the seed at a uniform depth and may provide better soil to seed contact. Drill seeding plants seeds using an agricultural or range seed drill at a rate of 12 to 14 pounds pure live seed per acre, per discussions with a seed supplier and ODFW. The rate may be adjusted depending on the recommendations of the actual seed supplier. Drill seeding will be difficult after Facility components have been installed so it will primarily be used if seeding occurs after grading is complete but before components are installed or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.3 *Imprint Seeding*

Imprint seeding is a no-till drill seeding method used to restore grasslands in areas with low annual precipitation. Seeds will be sown at 20 to 24 pounds pure live seed per acre or according to application rates recommended by the seed supplier. The seeder consists of a heavy metal drum roller with V-shaped, angled teeth and a seed agitator box. The teeth create V-shaped troughs with a depth of 4-7 inches to collect rainwater. The rolling drum presses the seed into the soil, insuring good seed-to-soil contact. The troughs collect rainwater for seed germination and seedling growth. Imprint seeders can be used on steep slopes and generally do not require seed bed preparation before seeding. Seeding can occur on soils with light to moderate vegetative cover, with vegetation acting as a mulch to prevent soil erosion until seedlings are established. Imprint seeders do not work well in areas with shrubs or heavy vegetation cover. Heavily compacted soils may need to be ripped or de-compacted before seeding. Imprint seeding will be difficult after solar components have been installed, so it will primarily be used if seeding occurs after grading is complete but before components are installed, or in areas that were temporarily disturbed during construction that do not have any permanent infrastructure (e.g., temporary access roads, laydown areas).

4.6.4 *Hydroseeding*

Hydroseeding is a method of hydraulically applying seeds, stabilizers, and soil amendments to the surface of the soil. Hydroseeding is most applicable for areas where drill or broadcast seeding machinery cannot access; this usually includes steeper sloped or narrow terrain but can be used in all terrains. Hydroseeding is feasible after panel installation but before the Facility is fenced. Soil bed preparation is also crucial for growth success and frequently includes tracking perpendicular to the slope to create micro conditions for seed. Flat grading and compaction are not recommended. Seeding rates increase by 30 to 50 percent of broadcast seeding rates (i.e., 30 pounds pure live seed per acre) per consultation with the seed supplier and ODFW. Prior to hydroseeding the tackifier and fertilizer, if included, will be reviewed and approved in consultation with ODOE. Fertilizer should not be used when hydroseeding wildlife habitat.

4.7 Seed Mixes

Two seed mixes are proposed for revegetation efforts: one for revegetation of temporary disturbance areas outside the solar array fence, and one for revegetation of permanent disturbance areas within the solar array fence. Tables 2 and 3 present example seed mixes that would be considered for revegetation. However, the number of seed mixes and composition of final seed mixes will be determined in consultation with ODOE and ODFW and will be based on pre-construction conditions and availability of seed at the time of procurement.

Grassland Seed Mix #1 would be appropriate for revegetation of temporarily disturbed areas outside the solar array fence, with the exception of areas that would be returned to agricultural production following construction (as noted in Section 4.5.1). The example seed mix is presented in Table 2 and contains a mixture of native grasses and native, pollinator-friendly forbs. This seed mix includes a mixture of deep-rooted grasses and flowering plants as these types of species can

capture and filter stormwater, build topsoil, and provide food sources and for native insects (Davis 2021). Forbs included in this seed mix were also chosen based on their bloom period. Including plants that flower throughout the growing season provides a continuous source of nectar and pollen and can attract a variety of pollinators (NRCS 2011).

Table 2. Example Grassland Seed Mix #1

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Bluebunch wheatgrass[1]	*Pseudoroegneria spicata*	35
	Sandberg's bluegrass[2]	*Poa secunda* ssp. *secunda*	15
	Bottlebrush squirreltail	*Elymus elymoides*	10
	Needle-and-thread grass[3]	*Hesperostipa comata*	10
Forbs	Low gumweed	*Grindelia nana*	5
	Hoary aster	*Dieteria* (*Machaeranthera*) *canescens*	5
	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Munro's globemallow[4]	*Sphaeralcea munroana*	5
	Western blue flax	*Linum lewisii*	5
	Yarrow	*Achillea millefolium*	5

1. An alternative to bluebunch wheatgrass is Snake River wheatgrass (*Elymus wawawaiensis*; also sold as "Secar" bluebunch wheatgrass).
2. An alternative to Sandberg's bluegrass is big bluegrass (*Poa secunda* subsp. *juncifolia*; also sold as *P. ampla*).
3. Alternatives to needle-and-thread grass include the non-native bunchgrasses crested wheatgrass (*Agropyron cristatum*) and sheep/hard fescue (*Festuca ovina/F. trachyphylla*).
4. An alternative to Munro's globemallow is blanketflower (*Gaillardia aristata*)

A second grassland seed mix, Grassland Seed Mix #2, is suggested for post-construction revegetation within the solar array fence, including areas that previously consisted of agricultural lands. The example seed mix presented in Table 3 contains a mixture of low-growing native and non-native grasses and native and non-native pollinator friendly forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). Similar to Grassland Seed Mix #1, this seed mix includes a mixture of deep-rooted grasses and flowering plants that flower throughout the growing season.

Table 3. Example Grassland Seed Mix #2

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Grasses	Sandberg's bluegrass	*Poa secunda* ssp. *secunda*	35
	Bottlebrush squirreltail, common squirreltail	*Elymus elymoides* ssp. *elymoides*	15
	Desert fescue[1]	*Vulpia microstachys*	10
	Thurber's needlegrass	*Eriocoma (Achnatherum) thurberianum*	10

Growth Habit	Common Name	*Scientific Name*	Percent of Mix
Forbs	Clover	*Trifolium macrocephalum, T. pratense, T. repens*	5
	Bigseed bisuitroot[2]	*Lomatium macrocarpum*	5
	Erigeron/fleabane	*Erigeron filifolius, E. linearis,* or *E. pumilus*	5
	Oregon sunshine	*Eriophyllum lanatum*	5
	Snow buckwheat	*Eriogonum niveum*	5
	Wollypod milkvetch	*Astragalus purshii*	5

1. Alternatives to desert fescue are sixweeks fescue (*Vulpia octoflora*) or sheep/hard fescue (*Festuca ovina*/*F. trachyphylla*).
2. An alternative to bigseed biscuitroot is longleaf phlox (*Phlox longifolia*).

4.8 Revegetation Methods by Disturbance Level

Revegetation methods for each disturbance level were developed to tailor revegetation to specific conditions (Table 4). Revegetation should follow soil reclamation, site preparation, and seeding methods described in Sections 4.2 through 4.7.

Table 4. Revegetation Methods by Disturbance Level

Disturbance Level	Soil Reclamation	Site Preparation	Seeding
1 – Mowing	Ensure vegetation remains intact.	Retain existing vegetation root systems to prevent erosion. Control weeds.	Seed if necessary to achieve success criteria
2 – Overland Drive and Crush	Measure soil compaction in areas of high vehicle traffic.	Retain existing vegetation root systems and/or mulch to prevent erosion. Decompact soil in areas of high vehicle traffic if necessary. Control weeds.	Seed if necessary to achieve success criteria
3 – Clear and Cut	Measure soil compaction.	Mulch to prevent erosion. Decompact soil if necessary. Control weeds.	Required
4 – Clear and Cut with Soil Removal	Measure soil compaction. Stockpile topsoil separately from subsoil and stabilize during construction.	Mulch to prevent erosion. Decompact soil. Regrade and replace subsoil then topsoil prior to seeding. Control weeds.	Required

5.0 Revegetation Documentation

Records will be kept of revegetation efforts in all temporary and permanent disturbance areas. Records will include:

- Date construction phase was completed;

- Acreage of each disturbance level;
- Description and photos of the affected area;
- Date revegetation was initiated;
- Description of the revegetation effort, including methods and timing;
- Supporting figures representing the location, acres affected, and pre-disturbance condition of the revegetation area; and
- Confirmation from the landowner that temporary disturbance in cropland have been satisfactorily restored.

The Certificate Holder will meet with ODOE at least 14 days prior to initiation of revegetation efforts. The Certificate Holder will update ODOE with these records monthly as revegetation work occurs and will provide ODOE with copies of these records along with submission of the monitoring report that is required by the Site Certificate.

6.0 Monitoring

6.1 Monitoring of Permanent Disturbance Areas

In accordance with the Certificate Holder's anticipated NPDES 1200-C permit all areas within the solar array fence must be revegetated to stabilize soils for the purposes of erosion and dust pollution control. Pursuant to OAR 345-022-0022, construction and operation of the Facility must not result in significant adverse impacts to soils, including but not limited to, erosion. Pursuant to MCZO 3.010.K.3.f.(3), construction or maintenance activities shall not result in the unabated introduction or spread of noxious weeds and other undesirable weed species. Therefore, monitoring is required to demonstrate compliance with the above site stabilization and weed control requirements. The Certificate Holder will monitor permanent disturbance areas to assess the following:

- Dominant species composition;
- Relative cover of desirable and undesirable forbs and grasses;
- Percent cover of bare soil;
- Degree of erosion;
- Presence noxious weeds; and
- Qualitative assessment of overall vigor of vegetation within revegetated areas.

Monitoring will be conducted by a qualified botanist or revegetation specialist and will begin within 60 days of the completion of initial site revegetation. Permanent disturbance areas will be monitored using a meander survey. During the meander survey, the surveyor will walk within the solar array fence and document the assessment items listed above using photos and spatial data collection. Areas of erosion and significant patches of bare soil will be mapped and photographed.

The surveyor will record dominant species, overall percent cover of forbs and grasses, and general notes about plant vigor.

Monitoring will be conducted at least once per season during the first year following construction. After the first complete year of monitoring, the Certificate Holder will consult with ODOE to determine if the monitoring cycle can be reduced based on revegetation progress. After five years of monitoring, the Certificate Holder will design a long-term monitoring plan in consultation with ODOE.

6.1.1 Success Criteria

Success criteria outlined below will demonstrate compliance with the soil protection standard (OAR 345-022-0022); NPDES 1200-C permit requirements; and the requirements of MCZO 3.010.K.3.f.(4):

- Establish uniform (i.e., evenly distributed, without large bare areas) perennial, non-invasive vegetation that provides 70 percent or more cover on all exposed areas.

Requirements of the soil protection standard and MCZO 3.010.K.3.f.(4) apply to the construction and operation of the Facility. Therefore, the Certificate Holder shall maintain compliance with revegetation success criteria for all areas within the solar array fence for the life of the Facility. In each monitoring report, the Certificate Holder will include an assessment of whether the area within the solar array fence is meeting or trending toward meeting the revegetation success criteria. Final determination of whether the Certificate Holder is in compliance with the revegetation obligations will be made by ODOE. Remedial actions and/or additional monitoring for areas may be required in areas that have been determined by ODOE not to have met the success criteria.

6.1.2 Reporting

Monitoring reports will be prepared and submitted to ODOE once per season during the first year following construction. After the first year of monitoring is complete, the reporting cycle will be modified to align with the new monitoring cycle determined in consultation with ODOE. The first monitoring report will include a detailed description and timeline of revegetation methods that were implemented including species, amounts, and locations of seed applications and dates revegetation work was performed.

Each monitoring report will include:

- GIS maps of revegetation areas and disturbance levels;
- Monitoring methods;
- Local climatic data (i.e., precipitation, temperature) for the monitoring month and year and percent deviation from the historical average;
- Results of monitoring efforts;

- The investigator's assessment of whether the revegetated areas are trending toward meeting the success criteria;
- Assessments of factors impacting the ability of revegetated area to trend towards meeting the success criteria; and
- Recommendations for adaptive management, if any.

6.2 Monitoring of Temporary Disturbance Areas

Per ODFW recommendations on other projects, temporary disturbance monitoring is not required for temporary disturbance areas less than 0.5 acres or when the area is not sufficiently large to accommodate a monitoring site. Because there are no non-agricultural habitat types with temporary disturbance areas greater than 0.5 acres, no monitoring or reference sites will be established for this Facility.

6.3 Adaptive Management

After each revegetation monitoring visit in either temporary or permanent disturbance areas, the Certificate Holder's qualified investigator will report to the Certificate Holder regarding the revegetation progress of each revegetation area. If applicable, the investigator will make recommendations to the Certificate Holder for reseeding, weed control, or other remedial measures for areas that are not showing progress toward achieving revegetation success. The investigator will provide a description of factors that may be contributing to the lack of revegetation success. The Certificate Holder will include the investigator's recommendations for adaptive management and the measures taken in the next monitoring report. ODOE may require reseeding or other remedial measures in cases where success criteria have not been met.

If a revegetation area is damaged by wildfire during the first 5 years following initial seeding, the Certificate Holder will amend this Plan, subject to ODOE approval, to restore the damaged area. The Certificate Holder will continue to monitor and report on revegetation progress during the remainder of the 5-year period. The Certificate Holder will report to ODOE and ODFW the area impacted by the fire (with a map or figure) within 72 hours of discovery.

6.4 Soil Reclamation Monitoring

Soil measurements conducted per Section 4.2 shall be evaluated to determine whether soils within disturbance areas have compaction readings of greater than 300 psi. If results show soils have compaction readings of greater than 300 psi, then remediation activities must be completed before revegetation can begin. Prior to initiation of revegetation, the Certificate Holder will provide the results of soil compaction testing to ODOE.

7.0 Plan Amendment

This Plan may be amended from time to time by agreement of the Certificate Holder and the Oregon Energy Facility Siting Council (EFSC). Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this plan. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

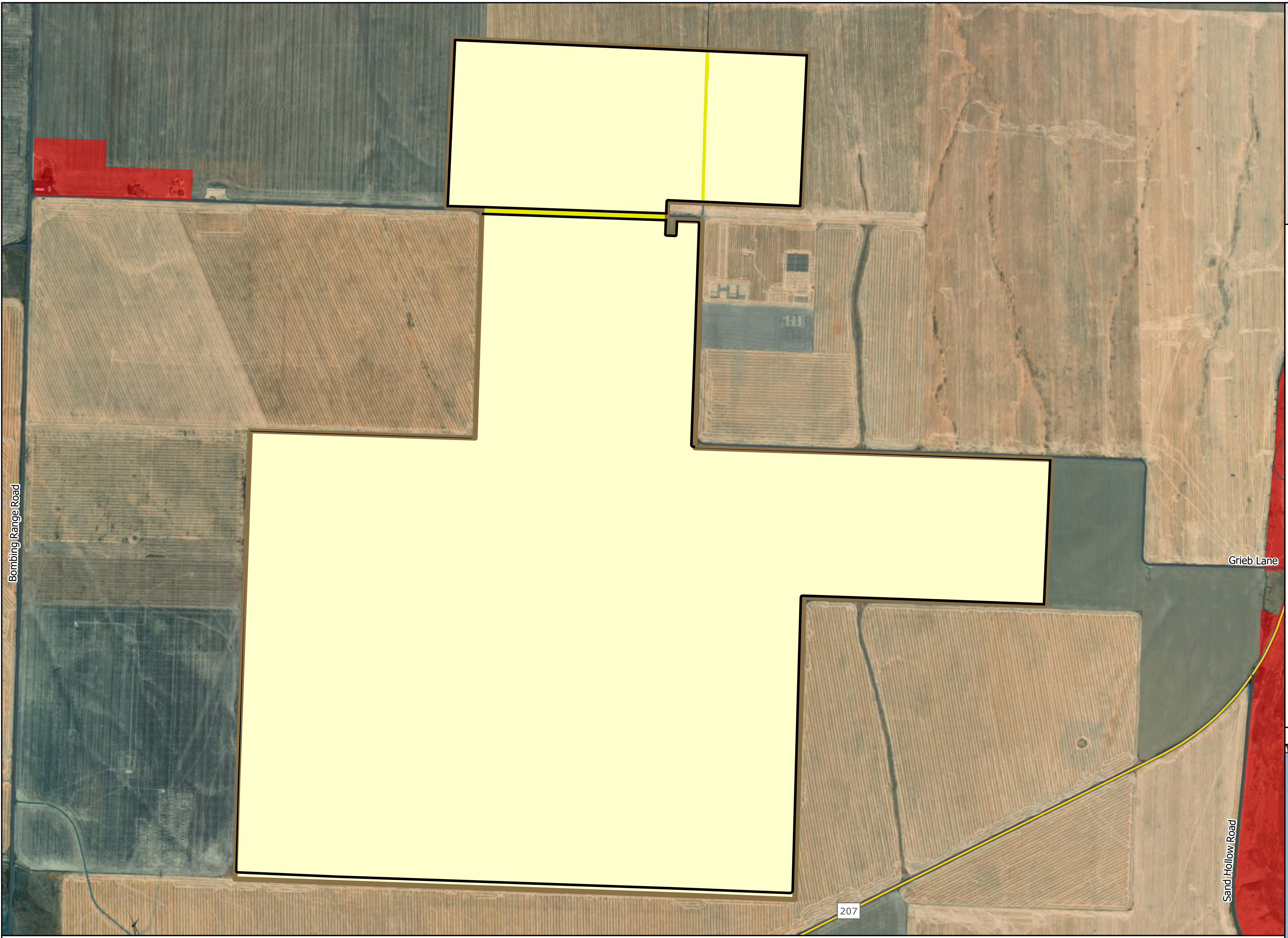
8.0 References

Davis, R. 2021. Global buzz for solar with pollinators and beekeeping. Fresh Energy, Center for Pollinators in Energy. Available at: https://fresh-energy.org/solar-beekeeping-goes-global

Mosley, J. 2018. Targeted Livestock Grazing to Suppress Cheatgrass. Department of Animal and Range Sciences, Montana State University. November. Available at: https://www.montana.edu/extension/sanders/Prescription%20for%20Cheatgrass%20November%2025%202018.pdf

NRCS (Natural Resources Conservation Service). 2011. Plants for Pollinators in the Inland Northwest. U.S.D.A Natural Resources Conservation Service, Spokane, Washington – Boise, Idaho.

Figure



Sunstone
Solar Project

Figure 1
Sunstone Solar Project 6

MORROW COUNTY, OR

▭ SS 6 Site Boundary
▭ Permitted Fenceline
🟥 Excluded from Development
— State Highway
— Local Roads
Habitat Subtypes by Category
Category 4
🟪 Intermittent or Ephemeral Stream
Category 6
🟨 Orchards, Vineyards, Wheat Fields, Other Row Crop
🟨 Urban and Mixed Environs

TETRA TECH
PINEGATE RENEWABLES

Reference Map

1:13,000
WGS 1984 UTM Zone 11N
0 0.25 0.5 Miles
NOT FOR CONSTRUCTION

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Sunstone Solar Project 6
Draft Wildlife Monitoring Plan

Prepared for

PINEGATE RENEWABLES
THE POWER OF TOMORROW™

Sunstone Solar 6, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

October 2025

Table of Contents

1.0 Introduction

Sunstone Solar 6, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct and operate the approved Sunstone Solar Project 6 (Facility), a photovoltaic solar energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal and average generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities and the anticipated phasing of construction are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Draft Wildlife Monitoring Plan (WMP) describes wildlife monitoring the Certificate Holder will conduct during operation of the Facility. This WMP has the following components:

1. Raptor nest surveys
2. Washington ground squirrel (WAGS; *Urocitellus washingtoni)* monitoring
3. Wildlife Reporting and Handling System (WRHS)
4. Data reporting

This WMP will be updated, as necessary, in coordination with the Oregon Department of Energy (ODOE) and the Oregon Department of Fish and Wildlife (ODFW) and will be updated as needed to reflect the final layout of the Facility.

2.0 Raptor Nest Surveys

The objectives of raptor nest surveys are: (1) to count raptor nests on the ground or above ground at the Facility; and (2) to determine whether there are noticeable changes in nesting activity in the local populations of raptor species, with particular focus on Swainson's hawks (*Buteo swainsoni*), the only state sensitive raptor species documented nesting during baseline surveys.

The Certificate Holder will conduct long-term ground-based monitoring of nests identified during the baseline raptor nest surveys, as well as any other nests identified subsequently. The ground-based surveys will be used to evaluate nest success by gathering data on nest occupancy. The Certificate Holder will employ qualified personnel to perform raptor nest surveys.

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

2.1 Initial Monitoring

The first monitoring season will be in the first full raptor nesting season after the commercial operating date. During the first monitoring season, the surveyor will conduct one ground survey for raptor nests in late May or early June and additional surveys as described in this section. The ground surveys will be conducted within the site boundary to determine nest occupancy.

All nests discovered during the anticipated pre-construction surveys and any nests discovered during post-construction surveys, whether active or inactive, will be given identification numbers. Global Positioning System (GPS) coordinates will be recorded for each nest. Locations of inactive nests will be recorded because they could become occupied during future years.

After the first monitoring season, the surveyor will analyze this one year of data compared to the baseline data. The Certificate Holder will provide a summary of the first-year results in the monitoring report described in Section 5.0.

2.2 Long-Term Monitoring

The surveyor will conduct raptor nest surveys at 5-year intervals for the life of the Facility.[2] The surveyor will conduct long-term raptor nest surveys following the methods described in Section 2.3 every 5 years after the first monitoring season in years divisible by 5. This may result in a greater than 5-year period between the initial monitoring season and the first long-term monitoring season (e.g., if the initial monitoring season is 2028, the first long-term monitoring season would be 2035 rather than 2033). During each long-term monitoring event biologists will visit all previously identified nest locations in addition to searching the survey area for new nest sites.

In conducting long-term surveys, the surveyor will follow the same survey protocols as the initial survey (Section 2.3), unless the Certificate Holder proposes alternative protocols that are approved by ODOE. In developing an alternative protocol, the Certificate Holder will consult with ODFW and ODOE and will take into consideration other raptor nest monitoring conducted in adjacent or overlapping areas.

The Certificate Holder will analyze the data to identify any trends in the number of raptor breeding attempts the Facility supports and the success of those attempts. The Certificate Holder will submit a report after each year of long-term raptor nest surveys.

2.3 Monitoring Protocol

Qualifications of surveyors: Surveys and nest monitoring will be conducted by professional, qualified biologists with a relevant academic background and sufficient field experience pertaining to avian biology and species identification.

Survey period: Occupancy surveys will be conducted between March 1 and May 31. The survey period may be extended in consultation with ODFW and ODOE.

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[2] As used in this plan, "life of the Facility" means continuously until the Facility is restored and the site certificate is terminated in accordance with OAR 345-027-0110.

Survey area: The survey area will be limited to leased parcels within the Site Boundary, where surveyor access is granted. Surveys will be performed from public roads and project roads, or from participating landowner parcels only, as site conditions safely permit (e.g. snow, mud).

Survey protocol: Biologists will conduct a ground-based search for raptor nest activity using binoculars and/or spotting scopes to search potential nest sites. Previously identified nests will be surveyed to determine the occupancy status of nests. New nests that are discovered will also be surveyed and visited in future monitoring years. A log will be kept to track nest occupancy status on all nests. ArcGIS Online or similar GIS program will be used to locate and track the nests.

Data collection: Data collected during the survey will include, at a minimum, the location, occupancy status, occupying species, activity observed, and condition of each nest.

Nest Location: Nest/Burrow Identification Number: Existing IDs will be used where possible in addition to corresponding GPS waypoint numbers.

Occupying Species: Using four-letter American Ornithologists' Union codes (e.g., SWHA = Swainson's hawk).

Raptor Activity:

- Adult Present: Proximity of the adult to the nest (e.g., on nest, nearby, or unknown).
- Eggs or Young: Number of eggs or young observed.
- Nest Substrate: Structure in which nest was located (e.g., broadleaf tree, cut bank, transmission

  pole, etc.).
- Nest Height: Height relative to the structure it is on (e.g., on top of transmission pole, 3/4 of height of tree).

Nest Condition: To assess nest condition the following criteria will be used:

- No Longer Present: For nests that are no longer present.
- Unknown: The nest cannot be found, was not surveyed, or the nest is present, but because of its

  location a determination cannot be made.
- Excellent: Defined cup or nest bowl with a well-maintained rim; adult or young present.
- Good: Nest bowl intact and rim defined; minor repair needed for nest to be used; margins of nest in loose configuration, minor slumping occurring.
- Fair: Nest bowl intact and nest not dilapidated; but needs significant repair in order to be used;

  material is slumping or sliding.

- Poor: Loose structure of nest bowl still present; nest walls and side falling out; nest is in need of

  major repair to be used.
- Remnant: Nest bowl not defined; scant material remaining and not usable unless fully rebuilt.

Determination of active nests: Nest occupancy status will be determined using the definitions below.

Active: Defined by the presence of one or more eggs, dependent young, or adults on the nest in the past 10 days during the breeding season, including the period when adults are displaying courtship behaviors and are building or adding to the nest in preparation for egg-laying.

Potentially Active: There is not observable activity during the visit, but active status cannot be confirmed.

Inactive: The inactive status will only be determined if the nest is observed for at least one hour each time over the course of two consecutive visits separated by at least one day.

3.0 Washington Ground Squirrel Monitoring

No WAGS were detected during baseline surveys, but any new colonies that are detected incidentally during other surveys, such as raptor nest monitoring, will be documented and the extent of those colonies delineated and included in future WAGS monitoring and reporting activities.

If any incidental WAGS are detected, the Certificate Holder will employ qualified personnel to monitor these locations every 5 years thereafter in years divisible by five for the life of the Facility (i.e., on the same monitoring schedule as the raptor nest surveys). The survey area will include the colonies (i.e., groups of active burrows) and a buffer of 785 feet in suitable habitat, if accessible. The surveyors will walk linear transects spaced 165 to 230 feet (50 to 70 meters) apart two times between February 15 and May 31. Surveys of each location will be spaced at least 2 weeks apart. Surveyors will record locations of activity centers and colony boundaries using a sub-meter accuracy GPS unit; approximate number of burrows; and representative photographs of burrows and scat. Surveyors will describe habitat characteristics at each location and note any noticeable land use or habitat changes that may have occurred since detection.

After each survey, the Certificate Holder will report the results to ODFW and ODOE and will include maps of the areas surveyed and detection locations. WAGS surveys will not be conducted if there are barriers to WAGS dispersal (i.e., active agriculture fields, highways, perennial waterbodies) or no suitable habitat.

4.0 Wildlife Reporting and Handling System

The Certificate Holder will document fatalities found during routine maintenance activities and any other incidentally detected fatalities. However, systematic post-construction fatality monitoring studies are not likely to produce significant findings or provide meaningful data on impacts based on the attributes of this Facility (especially relative to the costs that they incur to implement) as described below, and therefore no systematic post-construction fatality monitoring study is proposed for the Facility nor is one needed to meet the standards under Oregon Administrative Rule (OAR) 345-022-0060. In a December 2023 meeting with the Certificate Holder and ODOE, ODFW stated they are not requesting a post-construction fatality monitoring study for the Facility. If evidence of significant fatality events is detected by operations and maintenance (O&M) staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring and adaptive management.

Although mortality at the Facility due to collision with infrastructure is possible, as it is with most human development (e.g., buildings), the available literature on avian mortality at utility-scale photovoltaic solar energy sites suggests that mortality at these facilities is comparatively low (Walston et al. 2016, Loss et al. 2014, Kosciuch et al. 2020, Smith et al. 2021). In Oregon, results of a fatality study at a 56-MW photovoltaic facility near Prineville detected only three bird fatalities, only two of which were native birds (i.e., a horned lark [*Eremophila alpestris*] and a dark-eyed junco [*Junco hyemalis*]), during 1 year of standardized searches (ODOE 2020). These results suggest that large fatality events are unlikely at photovoltaic solar facilities in the region but that low numbers of fatalities of common ground-dwelling bird species could be detected at the Facility (ODOE 2020), and may be similar to background mortality levels. Post-construction fatality monitoring studies conducted at utility-scale photovoltaic solar facilities to date have reported lower fatality rates compared to other human development types, with fatalities in general primarily composed of resident ground-nesting birds.

In contrast to wind energy development, impacts to wildlife from photovoltaic solar development are primarily associated with habitat loss rather than direct mortality from collisions. The Facility is located almost entirely on wheat fields, and impacts to wildlife habitat will be minimal, restricted primarily to small tracts of disturbed grasslands. This habitat will be mitigated in accordance with ODFW's Habitat Mitigation Policy (OAR 635-415-0025), as described in the Facility's Exhibit P and Habitat Mitigation Plan (Attachment P-2 to Exhibit P; updated for RFA 1, see Attachment 6). The Certificate Holder will adhere to standard best management practices including following Avian Powerline Interaction Committee guidelines for minimizing avian collisions and electrocutions (APLIC 2006, 2012), primarily burying the medium voltage collector line system, and implementing down-shield lighting for permanent lighting at the substations and O&M buildings, and identifying a licensed local wildlife rehabilitator capable of responding to the Facility in the event of injured wildlife. Based on coordination with ODFW, the Certificate Holder will additionally install flight diverters on the overhead collector line that crosses Sand Hollow. The Certificate Holder will use wildlife-friendly fencing that does not include a top strand. Thus, the Facility has already minimized the risk of avian collision fatalities, based on known risk factors such as lighting (Gehring et al. 2009; Kerlinger et al. 2010; USFWS 2012, 2013).

Additionally, post-construction fatality monitoring is not necessary for the Certificate Holder to meet the standards under OAR 345-022-0060 (i.e., that the design, construction and operation of the facility, taking into account mitigation, are consistent with the general fish and wildlife habitat mitigation goals and standards of OAR 635-415-0025, ODFW's Fish and Wildlife Habitat Mitigation Policy) because the mitigation goals and standards relate to fish and wildlife habitat quality and quantity rather than fatalities of fish and wildlife individuals. OAR 635-415-0025 goals and standards for impacts to Category 2, 3, 4, and 5 habitat (i.e., the habitat categories addressed in the Facility's Habitat Mitigation Plan) include avoidance and, where impacts are unavoidable, mitigation to achieve the goal of no net loss of either habitat quantity or quality (Category 2, 3 and 4 habitat) and/or a net benefit in habitat quantity or quality (Category 2 and 5 habitat). Fatality monitoring, in itself, does not improve or maintain habitat quantity or quality, nor would the results of monitoring affect the habitat mitigation ratios or the size of the mitigation need described in the Facility's Habitat Mitigation Plan attached to Exhibit P and Attachment 6 for RFA 1. Therefore, a systematic post-construction fatality monitoring study is not necessary for the Energy Facility Siting Council (EFSC) to determine that the Facility is consistent with OAR 635-415-0025

Although standardized fatality searches will not be implemented, all incidentally detected fatalities will be reported in the WRHS. The WRHS is a program for O&M staff to report wildlife (including bird and bat) casualties found during operation of the Facility. O&M staff will be trained in the methods needed to carry out this program. This monitoring program includes the initial response, handling, and reporting of bird and bat carcasses discovered incidental to maintenance operations ("incidental finds"). Approximately 10 permanent O&M staff are anticipated to be on-site for Facility operations and be responsible for WRHS program implementation. If a battery energy storage system is installed, additional workers will be on-site, but they will likely be contract employees and will not be included in WRHS program implementation. As part of routine O&M activities, O&M staff will visit each inverter pad approximately every 6 months to visually inspect equipment. If evidence of significant fatality events is detected by O&M staff, the Certificate Holder will coordinate with ODOE and ODFW regarding the need for systematic post-construction fatality monitoring.

All carcasses discovered by O&M staff will be photographed and recorded. If O&M staff find a carcass at the Facility, they will notify qualified personnel who will identify the carcass. If the qualified personnel determines that a carcass is a state or federally threatened or endangered or otherwise protected species, agency reporting procedures and timelines specified in Section 5.0 shall be followed. Information recorded for each carcass and reported to ODFW and ODOE will include the location, date of discovery, species if known, as well as any evidence that might assist in determination of cause of death, such as evidence of electrocution, vehicular strike, wire strike, predation, or disease. Based on coordination with ODFW, feather spots[3] will be documented if

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[3] Feather spots are defined as at least 5 tail feathers, or 2 primary feathers, or a total of at least 10 feathers with no attached bone or tissue, within 5 meters of each other (CEC and CDFG 2007).

found as well, consistent with industry standards; however, feather spots will not necessarily be attributed to a Facility-caused fatality (personal communication with J. Thompson, ODFW, December 13, 2023). Fatalities documented by O&M staff will be reported to ODOE and ODFW annually, as described in Section 5.0.

Prior to construction, the Certificate Holder will develop and implement a protocol for handling injured birds. Any injured native birds found at the Facility may be carefully captured by trained qualified personnel and transported to a qualified rehabilitation specialist approved by ODOE. Alternatively, the Certificate Holder may contact a qualified rehabilitation specialist approved by ODOE to respond to injured wildlife. Blue Mountain Wildlife (https://bluemountainwildlife.org/, 541.278.0215), located in Pendleton, Oregon, has confirmed the ability to respond to injured native wildlife, especially migratory birds, at the Facility (Lynn Tompkins, personal communication, April 11, 2023). The Certificate Holder will pay costs, if any, charged for time and expenses related to care and rehabilitation of injured native birds found on the site, unless the cause of injury is clearly demonstrated to be unrelated to Facility operations.

5.0 Data Reporting

The Certificate Holder will report wildlife monitoring methods, data, and data analysis to ODOE for each calendar year in which wildlife monitoring occurs. Monitoring data include raptor nest survey data, WAGS monitoring data (if applicable), and WRHS data. The Certificate Holder may include the reporting of wildlife monitoring data and analysis in the annual report required under OAR 345-026-0080 or submit this information as a separate document at the same time the annual report is submitted. In addition, the Certificate Holder will provide to ODOE data or records generated in carrying out this WMP upon request by ODOE.

The Certificate Holder will notify the U.S. Fish and Wildlife Service and ODFW if any federal or state endangered or threatened species are killed or injured at the Facility within 24 hours of species identification.

6.0 Plan Amendment

This WMP may be amended from time to time by agreement of the Certificate Holder and EFSC. Such amendments may be made without amendment of the site certificate. EFSC authorizes ODOE to agree to amendments to this WMP. ODOE shall notify EFSC of all amendments, and EFSC retains the authority to approve, reject, or modify any amendment of this plan agreed to by ODOE.

7.0 References

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Inadvertent Discovery Plan

Sunstone Solar Project 6

Morrow County, Oregon

October 2025

Author:
Lara Rooke, MA, RPA

Prepared for

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TETRA TECH

1.0 INTRODUCTION

Pine Gate Renewables (PGR) proposes to construct and operate the approved Sunstone Solar Project 6 (Facility), a solar energy generation facility with related or supporting facilities including an energy storage system on private lands in Morrow County, Oregon. PGR seeks a Site Certificate through the Oregon Department of Energy (ODOE), Oregon Energy Facility Siting Council (EFSC or Council) for the Facility. The Facility will include an up to 200-megawatt (MW) solar project, battery energy storage system, and related or supporting facilities in Morrow County, Oregon. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1). The approved solar facility siting area (Facility site boundary) is located on privately owned agricultural land with areas of sage brush near the drainages and along Sand Hollow Canyon.

To meet the requirements for site certification, PGR must develop an Inadvertent Discovery Plan (IDP) for monitoring construction activities and responding to the discovery of archaeological resources or buried human remains.

2.0 CULTURAL RESOURCES IN THE PROJECT AREA

The entirety of the Facility site boundary and a 2-mile viewshed was surveyed for cultural resources, including pedestrian surveys along with subsurface shovel probing within the Facility site boundary. A single archaeological site was identified in the Facility site boundary. It has been recommended as not eligible for listing on the National Register of Historic Places (NRHP).

Prior to construction, PGR will develop a Monitoring Plan that incorporates this IDP and includes necessary staff, agency, and tribal contact information once determined. This plan should include monitoring protocols and staffing roles and incorporate input from the CTUIR.

3.0 PROCEDURES FOR THE DISCOVERY OF ARCHAEOLOGICAL RESOURCES

If any staff, contractors, or subcontractors, including archaeological and/or tribal monitors, believe that they have encountered cultural or archaeological remains of any kind, all work at and adjacent to the discovery shall immediately cease. The area of work stoppage will be adequate to provide for the security, protection, and integrity of the archaeological discovery. A cultural resource discovery may be pre-contact period or historic period in age and consist of (but not limited to):

- Areas of charcoal or charcoal-stained soil and stones;
- Stone tools or waste flakes (i.e., an arrowhead or stone chips);
- Bone, burned rock, or shell, whether or not seen in association with stone tools or chips;
- Clusters of tin cans, ceramics, flat glass, or bottles; and

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

- Concentrations of brick, railway tracks, or logging or agricultural equipment.

In the event unrecorded archaeological resources are identified during the construction or operation of the Sunstone Solar Project 6, work within 100 feet of the find shall be halted and directed away from the discovery until a Qualified Archaeologist[2] assesses the resource and its significance for inclusion on the NRHP. This assessment will include coordination with the CTUIR. (A wider avoidance area will be required for human remains; see below.) The archaeologist, in coordination with ODOE, the SHPO, Facility personnel, CTUIR, and the landowner, shall make the necessary plans for treatment of the finds and for the evaluation and mitigation of impacts if the finds are found to be eligible for listing on the NRHP.

A Qualified Archaeologist will determine if the resources are archaeological and greater than 50 years old. If the archaeologist believes that the discovery is a cultural resource, he or she in coordination with the PGR Construction Manager will establish a 100-foot avoidance buffer to protect the discovery site where construction activities will be suspended until treatment of the discovery can be determined. Vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery site or avoidance area. Any newly discovered archaeological resource will be considered eligible to the NRHP until determined otherwise. Work in the immediate area will not resume until treatment of the discovery has been completed.

If archaeological artifacts are observed during construction, the Qualified Archaeologist will ensure proper documentation and assessment of any discovered cultural resources. All precontact and historic cultural material discovered during project construction will be recorded by the archaeologist in SHPO’s online archaeological site form database. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/sediment descriptions will be prepared for subsurface exposure. Discovery locations will be documented on scaled site plans and site location maps.

If the Qualified Archaeologist in consultation with the SHPO and CTUIR determines that the discovery is an NRHP-eligible cultural resource, they will consult to determine appropriate treatment to be presented and agreed upon in a Memorandum of Agreement (MOA) or other appropriate documentation. Mitigation measures will be developed in consultation with PGR, ODOE, SHPO, CTUIR, and the landowner, and could include avoidance through redesign, conducting data recovery, and/or relocating materials. Treatment measures performed may include protecting in place or data recovery such as mapping, photography, limited probing, and sample collection, or other activity deemed appropriate through an MOA or other appropriate documentation.

If human remains are inadvertently discovered, ODOE, SHPO, the Legislative Commission on Indian Services (LCIS), and CTUIR will decide when construction may continue at the discovery location. Where cultural resources are encountered during construction, but additional project effects to the resources are not anticipated, Facility construction may continue while documentation and

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[2] *Qualified Archaeologist* - means a person with qualifications meeting the federal secretary of the interior's standards for a Professional Archaeologist . An individual who has: (A) A post-graduate degree in archaeology, anthropology, history, classics or other germane discipline with a specialization in archaeology, or a documented equivalency of such a degree; (B) Twelve weeks of supervised experience in basic archaeological field research, including both survey and excavation and four weeks of laboratory analysis or curating; and (C) Has designed and executed an archaeological study, as evidenced by a Master of Arts or Master of Science thesis, or report equivalent in scope and quality, dealing with archaeological field research.

assessment of the cultural resources proceed. If continued construction is likely to cause additional impacts to such resources, Facility activities within a radius of 100 feet of the discovery will cease until the Qualified Archaeologist has documented the site, evaluated its significance in consultation with CTUIR, and assessed potential effects to the site.

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the discovery of the cultural resource, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 100 foot buffer—work may continue outside of this buffer.
3) Notify PGR Project Manager and ODOE (see Attachment A).
4) Construction Manager will need to contact a Qualified Archaeologist to assess the find.
5) If archaeologist determines the find is an archaeological site or object, contact SHPO. If it is determined to *not* be archaeological, you may continue work.

4.0 PROCEDURES FOR THE DISCOVERY OF HUMAN REMAINS

If human remains and/or associated grave goods are inadvertently encountered during Project activities, the Oregon State legislature protocol[3] for inadvertent discovery of human remains will be followed (Oregon State Legislature 2025). All activity that may cause further disturbance to the remains shall cease and the area secured and protected from further disturbance. A 200-foot avoidance buffer will be utilized for human remains and associated grave goods until appropriate treatment is completed. The presence of skeletal remains will be immediately reported to the County Medical Examiner, Oregon State Police, SHPO, and LCIS. The remains will not be touched, moved, or further disturbed. The County Medical Examiner or LCIS State Physical Anthropologist will assume jurisdiction over the human skeletal remains and determine whether those remains are forensic or non-forensic. If the remains are non-forensic, then they will report that finding to SHPO and the State Physical Anthropologist with the LCIS, who will then take jurisdiction over the remains and will notify CTUIR.

Although excavation work in the immediate area of a human remains find will not resume until assessment has been completed, excavation work may continue in other parts of the Facility that have been surveyed for cultural resources. Due to the sensitive nature of such a find, human remains should never be left unattended. No work will resume in the area of a human remains discovery until written authorization has been received from the LCIS and SHPO.

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[3] https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

Discovery Procedures: What to do if you find something

1) **Immediately Discontinue All Ground Disturbing Activity. Do Not Touch Or Move The Objects, and Maintain Confidentiality of the Site. Do Not Take Photos.** Removing bone fragments, artifacts, and other items from any archaeological site, without proper authorization, is against the law. Violators could be charged in state or federal court resulting in a fine or imprisonment.
2) Do not draw any attention to the area with obvious flagging or markers. Maintain confidentiality concerning the inadvertent discovery, and do not discuss with anyone other than the contact people listed above. Secure and protect area of inadvertent discovery with 60-meter/200-foot buffer, then work may continue outside of this buffer with caution.
3) Cover remains from view and protect them from damage or exposure, restrict access, and leave in place until directed otherwise. Do not take photographs. Do not speak to the media.
4) Notify (refer to Attachment A for contact information):
   - PGR Project Manager
   - ODOE
   - Oregon State Police **DO NOT CALL 911**
   - SHPO
   - LCIS State Physical Anthropologist
   - CTUIR and other appropriate Native American Tribes determined by LCIS

5) If the site is determined not to be a crime scene by the Oregon State Police, do not move anything! The remains will continue to be secured in place along with any associated funerary objects, and protected from weather, water runoff, and shielded from view.
6) Do not resume any work in the buffered area until a plan is developed and carried out between ODOE, SHPO, LCIS, and appropriate Native American Tribes and you are directed that work may proceed.

5.0 CONFIDENTIALITY

The Facility and employees shall make their best efforts, in accordance with federal and state law, to ensure that its personnel and contractors keep the discovery confidential. The media, or any third-party member or members of the public are not to be contacted or have information regarding the discovery, and any public or media inquiry is to be reported to ODOE. Prior to any release, the responsible agencies and Tribes shall concur on the amount of information, if any, to be released to the public.

To protect fragile, vulnerable, or threatened sites, the National Historic Preservation Act, as amended (Section 304 [16 U.S.C. 470s-3]), and Oregon State law (Oregon Revised Statute 192.501(11)) establishes that the location of archaeological sites, both on land and underwater, shall be confidential.

6.0 REFERENCES

Oregon State Legislature

2025 Electronic document accessed July 2025, https://www.oregonlegislature.gov/cis/Pages/archaeology.aspx

ATTACHMENT A: CONTACTS

1. Pine Gate Renewables

Project Manager	To be determined prior to construction

2. Cultural Resource Contacts

Qualified Archaeologist	Lara Rooke, Tetra Tech (425) 217 7625 (Cell)
Oregon SHPO State Archaeologist	John Pouley (503) 480-9164
State Physical Anthropologist, LCIS	Dr. Elissa Bullion (971) 707-1372 or (503) 986-1067

3. Agency Contacts

ODOE	Christopher Clark (503) 871-7254
Oregon State Police	Craig Heuberger (503) 731-0079 or (503) 731-3030 (dispatch)
Morrow County Medical Examiner	(541) 676-5421

4. Tribal Contacts

CTUIR	Teara Farrow Ferman (Human Remains) (541) 429-7230 or (541) 377-2959 (cell) Ashley Morton (Archaeological Resources) (541) 429-7214

Sunstone Solar Project 6

Draft Construction Wildfire Mitigation Plan

Sunstone Solar Project 6
October 2025

Prepared for

Sunstone Solar 6, LLC

Prepared by

Tetra Tech, Inc.

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Table of Contents

List of Tables

Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 6, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
EMP	Emergency Management Plan
Facility	Sunstone Solar Project 6
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 6, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 6 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) is attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6), which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described in this plan, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final Construction WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.
[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During construction, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to construction of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115, if significantly different from Final Order on ASC and the Request for Amendment 1.

4.0 Inspection and Management

OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;

4.1 Vegetation Management

The Certificate Holder and contractor(s) will maintain vegetation within the Site Boundary and will also maintain a defensible space clearance along Facility features. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

The following best management practices to minimize fire risk from vehicle travel and fueling activities would be implemented at the site during construction:

- The movement of vehicles will be planned and managed to minimize fire risk.
- The contractor(s) will be responsible for identifying and marking paths for all off-road vehicle travel. All off-road vehicle travel will be required to stay on the identified paths. No off-road vehicle travel will be permitted while working alone. Travel off road or parking in vegetated areas will be restricted during fire season.
- Areas with grass that are as tall or taller than the exhaust system of a vehicle must be wetted before vehicles travel through it.
- Workers will be instructed to shut off the engine of any vehicle that gets stuck, and periodically inspect the area adjacent to the exhaust system for evidence of ignition of vegetation. Stuck vehicles will be pulled out rather than “rocked” free and the area will be inspected again after the vehicle has been moved.
- All combustion engines (including but not limited to off road vehicles, chainsaws, and generators) will be equipped with a spark arrester that meets U.S. Forest Service Standard 5100-1.
- The contractor(s) will designate a location for field fueling operations at the temporary construction yards. Any fueling of generators, pumps, etc. shall take place at this location only.
- Fuel containers, if used, shall remain in a vehicle or equipment trailer, parked at a designated location alongside a county right-of-way. No fuel containers shall be in the vehicles that exit the right-of-way except the five-gallon container that is required for the water truck pump.
- Smoking shall only be allowed in designated smoking areas at the Facility.

5.0 Preventative and Minimization Actions for Wildfire Risk

OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;

5.1 Preventative Actions

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads[3]. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. The areas immediately around the substations and battery energy storage system will be graveled, with no vegetation present. See Exhibit U[4] for additional discussion of Project fire prevention measures and coordination with local emergency responders.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during construction of the Facility, as applicable.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

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[3] Complete Application for Site Certificate, Exhibit D, May 16, 2024.

[4] Complete Application for Site Certificate, Exhibit U, May 16, 2024.

5.2.2 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fore spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high risk locations, designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.3 Emergency Management Plan

The EMP will be prepared prior to construction by the Certificate Holder and construction contractor and will contain policies and procedures for preparing for and responding to a range of potential emergencies, including fires. Implementation of the EMP will ensure risks to public health and safety and risks to emergency responders are minimized. Any potential fires inside the solar array will be controlled by trained staff who will be able to access the Facility around the clock. These measures will help keep external fires out or internal fires in. The EMP will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The plan will also specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, a construction kickoff meeting to discuss emergency planning, and invitations to observe any emergency drill conducted at the Facility.

In addition to the emergency responses to be stipulated in the EMP, personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

Another safety mitigation measure is to have available on site during construction is a water truck, water buffalo, or tank with minimum 500 gallon capacity.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

The Certificate Holder will track the industry groups and applicable design standards outlined in Table 2 to identify future technologies or best practices that could be implemented at the Facility.

Table 2: Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the substation enclosure.	Remodeling to the enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

Reference	Description	Method
1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/. 2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf. 3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.		

7.0 References

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IEEE. 2015. Guide for Safety in AC Substation Grounding. IEEE Std 80-2013 (Revision of IEEE Std 80-2000/ Incorporates IEEE Std 80-2013/Cor 1-2015), May, 1–226. https://doi.org/10.1109/IEEESTD.2015.7109078.

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NERC (North American Electric Reliability Corporation). 2009. Transmission Vegetation Management NERC Standard FAC-003-2 Technical Reference. NERC Standard FAC-003-2 Technical Reference Prepared by the North American Electric Reliability Corporation Vegetation Management Standard Drafting Team. Available online at: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-2.pdf

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NFPA. 2023. NFPA 70, National Electrical Code (NEC). 2023 Edition. Quincy, MA. Available online at: https://catalog.nfpa.org/NFPA-70-National-Electrical-Code-NEC-Softbound-P1194.aspx?icid=D731.

ODF and USFS (Oregon Department of Forestry and U.S. Department of Agriculture Forest Service). 2018. Oregon CWPP Planning Tool. Available online at: https://tools.oregonexplorer.info/oe_htmlviewer/index.html?viewer=wildfireplanning (Accessed October 2022).

Sunstone Solar Project 6
Draft Operational Wildfire Mitigation Plan

Sunstone Solar Project 6
October 2025

Prepared for

PINE GATE RENEWABLES | GETTING SOLAR DONE.

Sunstone Solar 6, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

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List of Tables

Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
Certificate Holder	Sunstone Solar 6, LLC, a subsidiary of Pine Gate Renewables, LLC
BMP	best management practice
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
EMP	Emergency Management Plan
Facility	Sunstone Solar Project 6
Li-ion	lithium-ion
MW	megawatt
O&M	operations and maintenance
OAR	Oregon Administrative Rules
Plan	Wildfire Mitigation Plan
RACE	Rescue, Alarm, Contain, Extinguish
RFA	Request for Amendment
SCADA	supervisory, control, and data acquisition
UL	Underwriters Laboratories

1.0 Introduction

Sunstone Solar 6, LLC, a subsidiary of Pine Gate Renewables, LLC (Certificate Holder), proposes to construct the approved Sunstone Solar Project 6 (Facility), a solar photovoltaic energy generation facility and related or supporting facilities in Morrow County, Oregon. The approved Facility will generate up to 200 megawatts (MW) of nominal electric generating capacity using solar panels wired in series and in parallel to form arrays, which in turn are connected to electrical infrastructure. Additionally, the Facility will also include a 1,200-MW-hour distributed battery energy storage system for the purpose of stabilizing the solar resource. The Certificate Holder proposes to permit a range of photovoltaic and related or associated technology within a site boundary that allows for micrositing flexibility in consideration of the perpetual evolution of technology and maximization of space efficiency, thereby allowing developmental flexibility to address varying market requirements. These facilities are all described in greater detail in Exhibit B of the Application for Site Certificate (ASC[1]) and Request for Amendment 1 (RFA 1).

This Wildfire Mitigation Plan (Plan) was attached to Exhibit V – Wildfire Prevention and Risk Mitigation[2] and updated for Request for Amendment (RFA) 1 (see Attachment 6) which was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(v), including providing evidence that the Facility complies with the approval standard in OAR 345-022-0115.

2.0 Wildfire Risk Minimization Procedures

> *OAR 345-022-0115(1)(b)(D) Identify procedures to minimize risks to public health and safety, the health and safety of responders, and damages to resources protected by Council standards in the event that a wildfire occurs at the facility site, regardless of ignition source;*

In addition to the measures described above, the risk of a wildfire affecting the public safety, first responders, or Oregon Energy Facility Siting Council–protected resources would be minimized by the procedures listed in Table 1.

The Certificate Holder will contact local fire districts, as well as local emergency management agencies to request and incorporate any input into final WMP, as appropriate, about the location and types of temporary fire breaks needed in the event of a fire on or off site. The final WMP shall designate:

- Estimated response times for on-site staff and local emergency service providers, (to the extent emergency service information is available),
- Protocols for staff or emergency providers to erect or create fire breaks in the event of a fire, (to the extent emergency service information is available),
- Identify and provide maps of:

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[1] Complete Application for Site Certificate, Exhibit B, May 16, 2024.

[2] Complete Application for Site Certificate, Exhibit V, May 16, 2024.

  - Primary access points and facility components.
  - Important safety features or hazards such as shut-offs, battery components, and hazardous material storage areas.
  - Priority areas where fire breaks would be prioritized to protect fires spreading off site or impacting the facility site.

During operation, the Certificate Holder or its contractor will work directly with local emergency responders, if available, to compile and maintain a current list of adjacent landowners/property owners with contact information. The final Wildfire Mitigation Plan will identify the best notification procedures of adjacent landowners/property owners to provide to local and regional emergency services for emergency notifications, in the event of an ignition or fire at the facility.

Table 1: Procedures to Minimize Wildfire Risk

Topic	Procedures
Public health and safety	The public will be excluded from the solar array, substation, and battery energy storage system facilities by fencing. Ground-mounted inverters and junction boxes will be surrounded by bollards to minimize inadvertent vehicle/farm equipment collisions with electrical equipment.
First Responders	The Certificate Holder will offer annual training to local first responders. Training will cover the firefighting responses to electrical fires and how to safely respond to fires involving BESS components. Response to fires in the facility should focus on controlling spread to adjacent lands. Operational staff will be trained in the use of fire extinguishers for responding to incipient stage fires on site.
Resource Protection	Resources covered by Energy Facility Siting Council standards near the site boundary include agricultural land, shrub steppe habitat, and cultural resources. The existing county roads will form a fire break between fields that will discourage the spread of wildfire between fields into wildlife habitat or cultural resources.

3.0 Wildfire Risk Assessment Update

This Plan has been prepared to meet the approval standard under OAR 345-022-0115(1)(b), which requires:

> *OAR 345-022-0115(1)(b)(A) Identify areas within the site boundary that are subject to a heightened risk of wildfire, using current data from reputable sources, and discuss data and methods used in the analysis;*

Prior to operation of the facility provide a summary update of wildfire risk at the site as designated under OAR 345-022-0115.

4.0 Inspection and Management

> *OAR 345-022-0115(1)(b)(B) Describe the procedures, standards, and time frames that the applicant will use to inspect facility components and manage vegetation in the areas identified under subsection (a) of this section;*

4.1 Facility Inspections

Facility components will be inspected quarterly. The supervisory, control, and data acquisition (SCADA) system collects operating and performance data from the Facility as a whole and allows remote operation. The Certificate Holder will monitor the Facility components, such as the substation and solar arrays, 24 hours a day, 7 days a week including shutdown capabilities. These operational monitoring and maintenance measures are also discussed in Section 4.0.

The battery energy storage system may consist of either zinc-based batteries or lithium-ion (Li-ion) batteries and will be stored in completely contained, leak-proof modules. The modules will be stored on a concrete pad to capture any leaks that may occur. Operations and maintenance (O&M) employees will conduct inspections of the battery energy storage systems according to the manufacturer's recommendations, which are assumed to be monthly inspections.

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Section 2.7.1 of Exhibit B summarizes the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected.

Table 2 below provides draft operational inspections for electrical facility components from similar types of facilities. As part of finalizing the final operational WMP, the Certificate Holder may update this table as applicable to facility equipment, standards, and inspections.

Table 2: Draft Operational Inspections for Electrical Components

Inspection	Procedure	Standard	Time frame
Solar Inverter	Visual inspection of inverter and surrounding area.	SPCC Plan[1] Manufacturer's maintenance recommendations	Monthly SPCC Bi-annual Preventative Maintenance
Substation	Visual inspection of MPT, Avian Power Line Interaction Committee (APLIC) measures, and surrounding area.	Manufacturer's maintenance recommendations APLIC[2]	Monthly Yearly (APLIC)
BESS	Visual inspection of BESS, PCS, and surrounding areas	SPCC Plan Manufacturer's maintenance recommendations	Monthly

Inspection	Procedure	Standard	Time frame
Overhead electrical lines	Visual inspection of components, grounding, APLIC measures, vertical clearance distance between conductor and vegetation.	National Energy reliability Corporation (NERC)[3] APLIC	Bi-annual
1. The Operational Spill Prevention, Control, and Countermeasure Plan for the facility will require these components to be inspected monthly for spills. During these inspections, Operational Staff will also visually inspect the component and surrounding area. 2. The Certificate Holder will develop an inspection checklist and program of electrical equipment based on manufacturer's recommendations for individual components. 3. Vegetation maintenance standard FAC-003-0 .			

4.2 Vegetation Management

Vegetation within areas temporarily disturbed during construction of the Facility, as well as revegetation of areas within the solar array fence line area, will be revegetated as outlined in the Revegetation and Reclamation Plan (see Exhibit P, Attachment P-4[3]; updated for RFA 1, see Attachment 6). As noted in the Revegetation and Reclamation Plan, areas within the solar array fence line area will be revegetated with a mixture of low-growing grasses and forbs which would be compatible with desired vegetation conditions under the solar arrays (i.e., species whose mature height would not interfere with or shade the solar array). In addition, vegetation within the solar array fence line area will be managed as needed to reduce fuels for fire. This would include mowing vegetation under solar panels periodically, if required. The Certificate Holder will also maintain a 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

A physical vegetation survey assessment of the fenced area will be completed at least twice a year to monitor for vegetation clearances, maintain fire breaks, as applicable, and monitor for wildfire hazards. One of the vegetation survey assessments will occur in May or June, prior to the start of the dry season, a time when wildfire risk begins to become heightened. The survey will be conducted by the Site Operations Manager and will be used to assess the frequency of any upcoming vegetation maintenance required and identify areas that may need additional attention. The Site Operations Manager will visually assess and document vegetation height, abundance, and areas where vegetation should not be present such as crushed rock bed around collector substations. The vegetation survey assessment will determine that clearances and fire breaks (vegetative clearance areas and areas determined to remain clear to act as permanent fire breaks or areas where temporary fire breaks may be deployed in the event of a fire) are satisfactory, and if not, the mitigation procedures will be implemented (e.g., vegetation management) to ensure clearances and fire breaks are satisfactory The vegetation survey will document::

- Location of observations

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[3] Complete Application for Site Certificate, Exhibit P, May 16, 2024.

- Species
- Estimated growth rate
- Abundance
- Clearance / Setbacks
- Risk of fire hazard

Additional vegetation surveys may be required throughout the season based on seasonally heightened fire risk. Vegetation Maintenance procedures and BMPs will be followed during operation of the Facility to ensure that vegetation does not grow in a manner that blocks or reduces solar radiation reaching the solar panels and reduce the risk of starting a fire. Vegetation control will employ best management practices (BMPs) and techniques that are most appropriate for the local environment. BMPs may include physical vegetation control such as mowing. Noxious weeds within the site boundary will be controlled in accordance with the Noxious Weed Control Plan (see Exhibit P, Attachment P-4; updated for RFA 1, see Attachment 6). Efforts will be made to minimize the use of herbicides and only herbicides approved for use by the U.S. Environmental Protection Agency and Oregon Department of Agriculture will be used. Herbicides used for vegetation management of the site will be selected and used in a manner that fully complies with all applicable laws and regulations.

Vegetation within the fence line and below the solar arrays will be maintained to a height of 18 inches and provide a minimum of 24-inch clear distance to any exposed electrical cables. Exposed electrical wires should be running under the solar panels at the midpoint or higher than the center of the panel. The areas immediately around the substations and battery energy storage system will be graveled, with no vegetation present.

Ongoing vegetation management to ensure that vegetation does not grow in these graveled areas is outlined in Table 3.

Table 3. Vegetation Management Procedures by Facility Component

Vegetation Management	Procedure	Standard	Time Frame
Solar Inverter	Herbicide application on gravel pad around inverter to prevent vegetation growth.	Institute of Electrical and Electronics Engineers (IEEE) 80[1] National Electrical Code (NEC) 70[2]	Yearly, depending on vegetation condition.
Substation	Herbicide application on substation gravel pad. Highly compacted gravel foundations of substation are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.

Vegetation Management	Procedure	Standard	Time Frame
Battery energy storage system	Herbicide application on gravel pad surrounding the battery energy storage system. Highly compacted gravel foundations of the battery energy storage system are not suitable for vegetation.	IEEE 80[1] NEC 70[2]	Yearly, depending on vegetation condition.
Overhead electrical lines	Mow vegetation to achieve clearance requirements between conductor and ground.	North American Electric Reliability Corporation (NERC)[3]	Yearly, depending on vegetation condition.
1. IEEE (2015) 2. NFPA (2023) 3. NERC (2009)			

5.0 Preventative and Minimization Actions for Wildfire Risk

> *OAR 345-022-0115(1)(b)(C) Identify preventative actions and programs that the applicant will carry out to minimize the risk of facility components causing wildfire, including procedures that will be used to adjust operations during periods of heightened wildfire risk;*

5.1 Preventative Actions and Design Features

The Certificate Holder will minimize risk of operation of the facility causing wildfire by implementing a number of systems and procedures. During O&M activities, these will include requirements to conduct welding or metal cutting only in areas cleared of vegetation, and maintaining emergency firefighting equipment on-site. Employees will keep vehicles on roads and off dry grassland when feasible during the dry months of the year, unless such activities are required for emergency purposes, in which case fire precautions will be observed. Fire extinguishers and shovels will be kept in all vehicles. On-site employees will also receive training on fire prevention and response and have on-site fire extinguishers to respond to small fires. In the event of a large fire, emergency responders will be dispatched.

The Certificate Holder will minimize risk of Facility components causing wildfire through preventative actions. In the design of the Facility, the Certificate Holder will implement the design considerations and best practices outlined in Table 4 to minimize electrical fire risk from facility components.

Table 4. Design Considerations for Fire Safety by Facility Component

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Electrical connections by qualified electricians	X	X	X	X
Inspections for mechanical integrity prior to energizations	X	X	X	X

Consideration	Inverter	Substation	Battery Energy Storage System	Overhead Lines
Lighting protection	X	X	X	X
Corrosion protection	X	X	X	X
Strain relief of connecting cabling	X	X	X	X
Protection against moisture	X	X	X	X
Grounding systems	X	X	X	X
Safety setback from structures	X[1]	X[1]	X[1]	X[2]
Technology specific design standards	X[3]	X[4]	X[5]	X[3]
1. Graveled inside structure's perimeter fence with additional 3-foot gravel setback outside of structure's perimeter fence 2. Vertical and horizontal clearances from structures depends on voltage of conductor. 3. NFPA 70 (.NFPA 2023). 4. IEEE 979 (IEEE 2012). 5. NFPA 1, Chapter 52 (NFPA 2021).				

During Facility operations, the areas within the site boundary that are subject to a heightened risk of wildfire include the solar array areas. The solar array areas will have low-growing vegetation maintained below the solar arrays during the operational period of the Facility. Measures for reducing the risk of fire ignition and reducing the risk of equipment damage were a wildfire to occur are discussed further in Section 3.0, including the Facility's vegetation management program (see Section 3.2), and through the emergency response procedures that will be described in the Emergency Management Plan (EMP). The EMP will be developed for the Facility and is outlined below in Section 4.2.5. The collector substation area, transformer pads, and the permanent, fenced parking and storage area will have reduced risk for fire due to the fact that these areas will have a gravel base with no vegetation within a 10-foot perimeter to reduce fire risk.

The Facility components will meet National Electrical Code and Institute of Electrical and Electronics Engineers standards and will not pose a significant fire risk. The solar array will have shielded electrical cabling, as required by applicable code, to prevent electrical fires. In addition, the collector system and substation will have redundant surge arrestors to deactivate the Facility during unusual operational events that could start fires. The collector substation will have also sufficient spacing between equipment to prevent the spread of fire.

Unless already paved, access roads will be graveled. Facility roads will be sufficiently sized for emergency vehicle access in accordance with 2019 Oregon Fire Code requirements, including Section 503 and Appendix D - Fire Apparatus Access Roads. Specifically, roads will primarily be 10 feet wide in the solar array area with roads up to 20 feet wide near the substation, with an internal turning radius of 28 feet and less than 10 percent grade, or a similar profile depending on siting, to provide access to emergency vehicles. A 5-foot noncombustible, defensible space clearance along the fenced perimeter of the site boundary will be maintained. The areas immediately around the substations and battery energy storage system will be graveled, with no vegetation present. See Exhibit U for additional discussion of Project fire prevention measures and coordination with local emergency responders. Vegetation free areas such as gravel pads or base and facility perimeter and interior roads act as a permanent fire break which could minimize the spread of fires on site or impacts from an external wildfire.

Smoke/fire detectors will be placed around the site that will be tied to the SCADA system and will contact local firefighting services. This communication system allows each solar string, battery energy storage system, and substation to be monitored by a SCADA system, accessed through both the SCADA control room in the substations or remotely. This system monitors these components for variables such as meteorological conditions, critical operating parameters, and power output. The solar array is controlled and monitored via the SCADA system and can be controlled remotely. SCADA software is tuned specifically to the needs of each project by the solar module manufacturer or a third-party SCADA vendor. This system will be monitored 24/7 by a remote operations center.

The Certificate Holder proposes to construct either a direct current–coupled distributed battery energy storage system (located throughout the solar array fence line area at the inverter and transformer sites) or alternating current–coupled battery energy storage system (concentrated in a single location within the solar array fence). The system as a whole will use a series of self-contained containers located within the solar array fence line area. The containers may have their own additional fencing, to be determined prior to construction. Each container will be placed on a concrete foundation. Regardless of the battery technology selected, the containers are estimated to require up to 0.2 to 0.4 acre each with a total of 2,491 containers. Each container is rated for outdoor environments and holds the batteries and a battery management system.

The Facility will use either Li-ion batteries or zinc batteries to store up to 200 MW alternating current of power over a 6-hour discharge duration (1,200 megawatt-hours alternating current) (ASC Exhibit C, Figure C-2[4]).

The zinc-based batteries under consideration for this Facility are non-flammable and tolerate wide temperature ranges. As a result, the manufacturer affirms that they are not anticipated to present a fire hazard and do not require on-site fire suppression systems. Additionally, zinc batteries will have fans and a heating unit for climate control.

The following paragraphs summarize the information pertinent to fire prevention and control for a Li-ion battery energy storage system, if selected. The chemicals used in Li-ion batteries are generally nontoxic but do present a flammability hazard. Li-ion systems would also include a fire prevention system and cooling units placed either on top of the containers or along the side. Li-ion batteries are susceptible to overheating and typically require cooling systems dedicated to each battery energy storage system enclosure, especially at the utility scale (Jeevarajan et al. 2022). The gas released by an overheating Li-ion cell is mainly carbon dioxide but may also include carbon monoxide, methane, ethylene, and propylene (Jeevarajan et al. 2022).

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[4] Complete Application for Site Certificate, Exhibit C, May 16, 2024.

The Certificate Holder will implement the following fire prevention and control methods to minimize fire and safety risks for the Li-ion batteries proposed for the battery energy storage system:

- The batteries will be stored in completely contained, leak-proof modules.
- Ample working space will be provided around the battery energy storage system for maintenance and safety purposes.
- Off-site, 24-hour monitoring of the battery energy storage system will be implemented and will include shutdown capabilities.
- Transportation of Li-ion batteries is subject to 49 Code of Federal Regulations (CFR) 173.185 – Department of Transportation Pipeline and Hazardous Material Administration. This regulation contains requirements for prevention of a dangerous evolution of heat; prevention of short circuits; prevention of damage to the terminals; and prevention of batteries coming into contact with other batteries or conductive materials. Adherence to the requirements and regulations, personnel training, safe interim storage, and segregation from other potential waste streams will minimize any public hazard related to transport, use, or disposal of batteries.
- Design of the battery energy storage system will be in accordance with applicable Underwriters Laboratories (UL; specifically, 1642, 1741, 1973, 9540A), National Electric Code, and National Fire Protection Association (specifically 855) standards, which require rigorous industry testing and certification related to fire safety and/or other regulatory requirements applicable to battery storage at the time of construction.
- Additionally, the Certificate Holder will employ the following design practices, as applicable to the available technology and design at time of construction:
  - Use of Li-ion phosphate battery chemistry that does not release oxygen when it decomposes due to temperature;
  - Employment of an advanced and proven battery management system;
  - Qualification testing of battery systems in accordance with UL 9540A (UL Solutions 2025);
  - Employment of Fike fire control panels with 24-hour battery backup at every battery container;
  - Installation of fire sensors, smoke and hydrogen detectors, alarms, emergency ventilation systems, cooling systems, and aerosol fire suppression/extinguishing systems in every battery container;
  - Installation of doors that are equipped with a contact that will shut down the battery container if opened;
  - Installation of fire extinguishing and thermal insulation sheets between each individual battery cell;

  - Implementation of locks and fencing to prevent entry of unauthorized personnel;
  - Installation of remote power disconnect switches; and
  - Clear and visible signs to identify remote power disconnect switches.

5.2 Preventative Programs

The Certificate Holder will implement the following programs to minimize fire risk during operations of the Facility.

5.2.1 Occupational Safety and Health Act–Compliant Fire Prevention Plan

To assure safe and healthful working conditions under the Occupational Safety and Health Act of 1970, all workers, contracting employees, and other personnel performing official duties at the Facility will conduct work under a Fire Prevention Plan that meets applicable portions of 29 CFR 1910.39, 29 CFR 1910.155, and 29 CFR 1910, subpart L. The plan will ensure that:

- Workers are trained in fire prevention, good housekeeping, and use of a fire extinguisher.
- Necessary equipment is available to fight incipient stage fires. Fire beyond incipient stage shall be managed using local fire response organizations.
- Provide necessary safety equipment for handling and storing combustible and flammable material.
- Ensure equipment is maintained to prevent and control sources of ignition.
- Do not allow smoking or open flames in an area where combustible materials are located.
- Implement a Hot Work Procedure program.

5.2.2 Electrical Safety Program

All operational workers will be trained in electrical safety and the specific hazards of the Facility. This training will address:

- Minimum experience requirements to work on different types of electrical components;
- Electrical equipment testing and troubleshooting;
- Switching system;
- Provisions for entering high voltage areas (e.g., substation);
- Minimum approach distances; and
- Required personal protective equipment.

5.2.3 Lock Out/Tag Out Program

During maintenance activities, electrical equipment will be de-energized and physically locked or tagged in the de-energized positions to inadvertent events that could result in arc flash.

5.2.4 Fire Weather Monitoring and Hot Work

Burn probability, expected flame length, and overall risk may increase during periods of the fire season. Personnel on site will monitor Fire Weather Watches and Red Flag Warnings. A fire weather watch indicates the potential for weather conducive to large fire spread in the next 12 to 72 hours. A Red Flag Warning is issued when current weather conditions are conducive to large fire growth in the next 24 hours. Personnel monitoring these conditions shall halt work in high-risk locations, as designated in this plan, and employ additional mitigation measures designated in this plan. Mitigation measures during a Red Flag Warning include, but are not limited to, communicating to on-site staff of the Red Flag Warning, communicating with local fire protection agency personnel of on-going conditions, driving or parking on roads to avoid sparking a fire in grass or brush, and halting construction activities that may increase fire risk such as hot work. All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces, and fire suppression equipment will be immediately available during hot work activities. Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.

5.2.5 Emergency Management Plan

Emergency Management will cover response procedures that consider the dry nature of the region and address risks on a seasonal basis. The final WMP will specify communication channels the Certificate Holder intends to pursue with local fire protection agency personnel, for example, annual meetings to discuss emergency planning, protocols for how to respond to electrical fires and safely respond to a fire involving BESS components, and invitations to observe any emergency drill conducted at the Facility.

At the beginning of Facility operations, a copy of the site plan indicating the arrangement of the Facility structures, access points, and fire breaks will be provided to the local fire district.

Personnel will be trained on the RACE (Rescue, Alarm, Contain, Extinguish) procedure to implement in the event of a fire start. The RACE procedure includes:

- **Rescue** anyone in danger (if safe to do so);
- **Alarm** – call the control room, who will then determine if 911 should be alerted;
- **Contain** the fire (if safe to do so); and
- **Extinguish** the incipient fire stage (if safe to do so).

Vehicles on-site will carry fire suppression equipment during the fire season. This equipment shall include, at a minimum:

- Fire Extinguisher: Dry chemical, 2.5 or 2.8 pound, 1A-10B: C U/L rating, properly mounted or secured;
- Shovel;
- Collapsible Pail or Backpack Pump: 5-gallon capacity; and
- Drip Can.

During times of heightened wildfire risk, a water truck, water buffalo, or tank with minimum 500 gallon capacity will be stationed at the site during operations and maintenance activities.

Personnel will receive training on use of suppression equipment. All personnel shall also be equipped with communication equipment capable of reaching the control room from all locations within the amended site boundary.

6.0 Plan Updates and Modifications

> *OAR 345-022-0115(1)(b)(E) Describe methods the applicant will use to ensure that updates of the plan incorporate best practices and emerging technologies to minimize and mitigate wildfire risk.*

This Plan will be updated by the Certificate Holder every 5 years. Updates to this Plan will account for changes in local fire protection agency personnel and changes in best practices for minimizing and mitigating fire risk. It is recommended to consult with Morrow County, the local fire department, and the Morrow County Emergency Manager.

After each 5-year review, a copy of the updated plans will be provided to the Oregon Department of Energy with the annual compliance report required under OAR 345-026-008(2).

Every 5 years, the Certificate Holder will review wildfire risk and update this Plan for the site boundary. Evaluation of wildfire risk will be consistent with the requirements of OAR 345-022-0115(1) using current data from reputable sources.

The Certificate Holder may consider revisions to this Plan at its sole discretion to incorporate future best practices or emerging technology depending on whether the new technology is cost effective and suitable for the site conditions. The Certificate Holder will track the industry groups and applicable design standards outlined in Table 5 to identify future technologies or best practices that could be implemented at the Facility.

Table 5. Resources for Future Best Practices

Reference	Description	Method
American Clean Power (ACP)	Industry group that establishes best practices for renewable energy projects	The Certificate Holder is a member of ACP and participates in best practice development[1].
North American Electric Reliability Corporation (NERC)	National Energy Reliability Corporation develops electrical standards for large energy facilities.	The Certificate Holder will follow NERC Standard FAC-003-0 for its vegetation management program of transmission lines[2], or updates to this standard as approved by NERC.
Oregon Specialty Building Codes (OSBC)	Building codes applicable to inhabitable spaces, including the substation enclosure.	Remodeling to the enclosure structure that requires permits will follow any updates to the OSBC at that time.
APLIC	Avian protection methods for electrical facility reduce fires related to bird/mammal nests on electrical equipment	The Certificate Holder is a member of APLIC[3]. An operational wildlife monitoring program will inspect for wildlife nesting on facilities that could cause fire, and take actions following applicable laws (e.g., Migratory Bird Treaty Act).

1. Link to ACP Standards & Practices: https://cleanpower.org/resources/types/standards-and-practices/.
2. NERC FAC-003-0: https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-0.pdf.
3. Link to APLIC member organization: https://www.aplic.org/member_websites.php.

7.0 References

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ODF and USFS (Oregon Department of Forestry and U.S. Department of Agriculture Forest Service). 2018. Oregon CWPP Planning Tool. Available online at: https://tools.oregonexplorer.info/oe_htmlviewer/index.html?viewer=wildfireplanning (Accessed October 2022).

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Attachment 4. Retirement Cost Estimates

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Sunstone Solar Project 1

Estimate Summary
TETRA TECH, INC.
Job Code: Sunstone solar
Description: Decommissioning Estimate

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1	1.00	Lump Sum	SUNSTONE SOLAR RETIREMENT - SUNSTONE SOLAR 1	0.00	Detail	U.S. Dollar	24,197,939.27	24,197,939.27
1.1	1.00	Lump Sum	Equipment & Facilities Mob / Demob	0.10	Detail	U.S. Dollar	218,136.80	218,136.80
1.1.1	1.00	Lump Sum	Equipment Mob	0.00	Detail	U.S. Dollar	81,200.00	81,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UERNTRLG	Rental Equip Transp-Large		8.00	Each	U.S. Dollar	10,000.00	80,000.00
UERNTRSM	Rental Equip Transp-Small		8.00	Each	U.S. Dollar	150.00	1,200.00

1.1.2	1.00	Lump Sum	Site Facilities	0.00	Detail	U.S. Dollar	2,200.00	2,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UOCONMOB	Connex Box Mob		2.00	Each	U.S. Dollar	300.00	600.00
UOTRLTRN	Trailer Trnsp/Setup/Trdwn		2.00	Each	U.S. Dollar	800.00	1,600.00

1.1.3	5.00	Day	Crew Mob & Site Setup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

1.1.4	5.00	Day	Crew Demob & Site Cleanup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

1.2	4.00	Month	Project Site Support	0.05	Detail	U.S. Dollar	71,469.70	285,878.80
1.2.1	4.00	Month	Site Facilities	0.00	Detail	U.S. Dollar	1,755.00	7,020.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
URCONNEX	Connex Box		8.00	Month	U.S. Dollar	150.00	1,200.00
UROFFTRL	Office Trailer -12x60		4.00	Month	U.S. Dollar	500.00	2,000.00
UO1STAID	1st Aid Supplies		4.00	Month	U.S. Dollar	300.00	1,200.00
UOOFFSUP	Office Supplies($/prs/mo)		4.00	Month	U.S. Dollar	55.00	220.00
URPRTAJH	Port-a-John Unit(s) (4)		8.00	Month	U.S. Dollar	300.00	2,400.00

1.2.2	4.00	Month	Field Management	0.05	Detail	U.S. Dollar	69,714.70	278,858.80

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L90FXX02	Field - Proj Superintendent	880.00	1.00	Each (hourly)	U.S. Dollar	114.95	101,156.00
RPUTRK05	F-250 4X4 3/4 TON PICKUP	2,640.00	3.00	Each (hourly)	U.S. Dollar	11.07	29,211.60
L90FEL00	Field - Engr. Tech	880.00	1.00	Each (hourly)	U.S. Dollar	64.24	56,531.20
L90FXX03	Field - SHSO	880.00	1.00	Each (hourly)	U.S. Dollar	104.50	91,960.00

1.3	1.00	Each	Substation Retirement	0.03	Detail	U.S. Dollar	214,103.31	214,103.31
1.3.1	1.00	Day	Fence Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

1.3.2	1.00	Each	Transformer Removal	0.17	Detail	U.S. Dollar	102,309.50	102,309.50
1.3.2.1	1.00	Each	Oil Removal & Disposal	1.00	Detail	U.S. Dollar	66,314.40	66,314.40

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.3.2.1.1	1.00	Each	Oil Removal	1.00	Detail	U.S. Dollar	939.40	939.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40

1.3.2.1.2	16,000.00	Gallon	Oil Disposal	0.00	Detail	U.S. Dollar	4.00	64,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		64,000.00	Each	U.S. Dollar	1.00	64,000.00

1.3.2.1.3	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	1,375.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,375.00	Each	U.S. Dollar	1.00	1,375.00

1.3.2.2	1.00	Each	Dismantle & Loadout Transformer	0.20	Detail	U.S. Dollar	35,995.10	35,995.10
1.3.2.2.1	1.00	Each	Dismantle, Cut & Size	0.20	Detail	U.S. Dollar	29,995.10	29,995.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	200.00	4.00	Each (hourly)	U.S. Dollar	46.97	9,394.00
L010101	OPERATOR	100.00	2.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*REXCAV06A	Excav 100K w/ Bucket & Grapple	50.00	1.00	Each (hourly)	U.S. Dollar	124.54	6,226.75
*REXCAV06E	Excav 100K w/ Shear	50.00	1.00	Each (hourly)	U.S. Dollar	185.50	9,274.75

1.3.2.2.2	4.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	6,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		6,000.00	Each	U.S. Dollar	1.00	6,000.00

1.3.3	1.00	Each	Remove Control Building	2.00	Detail	U.S. Dollar	2,612.51	2,612.51
1.3.3.1	1.00	Each	Demo	2.00	Detail	U.S. Dollar	1,112.51	1,112.51

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	5.00	1.00	Each (hourly)	U.S. Dollar	46.97	234.85
L010101	OPERATOR	5.00	1.00	Each (hourly)	U.S. Dollar	51.00	254.98
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5.00	1.00	Each (hourly)	U.S. Dollar	124.54	622.68

1.3.3.2	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

1.3.4	1.00	Day	UG Utility & Ground Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

1.3.5	1,000.00	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	28,045.10
1.3.5.1	1,000.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	280.00	Detail	U.S. Dollar	15.52	15,516.50

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	35.71	1.00	Each (hourly)	U.S. Dollar	46.97	1,677.50
L010101	OPERATOR	71.43	2.00	Each (hourly)	U.S. Dollar	51.00	3,642.57
*REXCAV06C	Excav 100K w/ Hammer	35.71	1.00	Each (hourly)	U.S. Dollar	160.97	5,748.75

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

*REXCAV06A	Excav 100K w/ Bucket & Grapple	35.71	1.00	Each (hourly)	U.S. Dollar	124.54	4,447.68

1.3.5.2	1,000.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	12,528.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	100.00	1.00	Each (hourly)	U.S. Dollar	74.29	7,429.00
L080940	TEAMSTER	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60

1.3.6	1.00	Each	Misc. Material Disposal	0.00	Detail	U.S. Dollar	2,900.00	2,900.00
1.3.6.1	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

1.3.6.2	20.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,400.00	Each	U.S. Dollar	1.00	1,400.00

1.3.7	1.00	Each	Restore Yard	0.09	Detail	U.S. Dollar	75,612.19	75,612.19
1.3.7.1	7.30	Acre	Remove Aggregate / Backfill / Regrade	1.60	Detail	U.S. Dollar	2,062.47	15,056.05

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	91.25	2.00	Each (hourly)	U.S. Dollar	46.97	4,286.01
L010101	OPERATOR	91.25	2.00	Each (hourly)	U.S. Dollar	51.00	4,653.39
REXCAV06B	Gradall - Excavator	45.63	1.00	Each (hourly)	U.S. Dollar	75.73	3,455.12
*RDOZER08	CAT D6 LGP Dozer	45.63	1.00	Each (hourly)	U.S. Dollar	58.34	2,661.53

1.3.7.2	2,000.00	Cubic Yard	Vegetative Cover	300.00	Detail	U.S. Dollar	27.36	54,716.13
1.3.7.2.1	2,000.00	Cubic Yard	Topsoil, Delivered	0.00	Detail	U.S. Dollar	20.00	40,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
IMSOIL	Topsoil		2,000.00	Cubic Yard	U.S. Dollar	20.00	40,000.00

1.3.7.2.2	2,000.00	Cubic Yard	Placement	300.00	Detail	U.S. Dollar	7.36	14,716.13

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	133.33	2.00	Each (hourly)	U.S. Dollar	51.00	6,799.47
RDOZER08	CAT D6N XL	133.33	2.00	Each (hourly)	U.S. Dollar	59.38	7,916.67

1.3.7.3	7.30	Acre	Re-Seed With Native Vegetation	0.00	Detail	U.S. Dollar	800.00	5,840.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		7.30	Acre	U.S. Dollar	800.00	5,840.00

1.4	1.00	Lump Sum	Transmission Line Retirement	0.02	Detail	U.S. Dollar	298,438.33	298,438.33
1.4.1	31.00	Each	Structure Removal	1.00	Detail	U.S. Dollar	4,785.16	148,339.96
1.4.1.1	31.00	Each	Cut / Lower Structure	2.00	Detail	U.S. Dollar	1,916.53	59,412.43

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	620.00	4.00	Each (hourly)	U.S. Dollar	46.97	29,121.40
L010101	OPERATOR	155.00	1.00	Each (hourly)	U.S. Dollar	51.00	7,904.38
*RXMISC14	MAN LIFT GAS 125ft	155.00	1.00	Each (hourly)	U.S. Dollar	53.52	8,295.60
*RXMISC23	GROVE RT 200 TON	155.00	1.00	Each (hourly)	U.S. Dollar	90.91	14,091.05

1.4.1.2	31.00	Each	Cut / Size Structure & Loadout	2.00	Detail	U.S. Dollar	2,118.63	65,677.53

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	930.00	6.00	Each (hourly)	U.S. Dollar	46.97	43,682.10

Cost Item CBS Position Code	Quantity UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

L010101	OPERATOR	155.00	1.00 Each (hourly)	U.S. Dollar	51.00	7,904.38
*RXMISC23	GROVE RT 200 TON	155.00	1.00 Each (hourly)	U.S. Dollar	90.91	14,091.05

1.4.1.3	15.50 Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	23,250.00

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		23,250.00 Each	U.S. Dollar	1.00	23,250.00

Notes: ***

Assume 9 ton per steel structure and cable span

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1.4.2	31.00 Each	Remove Foundations To Subgrade	0.98	Detail	U.S. Dollar	4,841.88	150,098.37
1.4.2.1	31.00 Each	Excavate / Remove Foundation - Various Depth	1.00	Detail	U.S. Dollar	4,814.32	149,243.92

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	620.00	2.00 Each (hourly)	U.S. Dollar	46.97	29,121.40
L010101	OPERATOR	620.00	2.00 Each (hourly)	U.S. Dollar	51.00	31,617.52
*REXCAV06C	Excav 100K w/ Hammer	310.00	1.00 Each (hourly)	U.S. Dollar	160.97	49,899.15
*REXCAV06A	Excav 100K w/ Bucket & Grapple	310.00	1.00 Each (hourly)	U.S. Dollar	124.54	38,605.85

1.4.2.2	51.15 Cubic Yard	Concrete Transport Offsite	75.00	Detail	U.S. Dollar	16.70	854.45

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	6.82	1.00 Each (hourly)	U.S. Dollar	74.29	506.66
L080940	TEAMSTER	6.82	1.00 Each (hourly)	U.S. Dollar	51.00	347.79

1.5	1.00 Lump Sum	Collector Line Retirement	0.07	Detail	U.S. Dollar	46,946.45	46,946.45
1.5.1	5,850.00 Linear Feet	Conductor Removal	585.00	Detail	U.S. Dollar	5.50	32,154.10
1.5.1.1	1.00 Lump Sum	Cut / Lower Cable, Size & Loadout	0.10	Detail	U.S. Dollar	31,404.10	31,404.10

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	400.00	4.00 Each (hourly)	U.S. Dollar	46.97	18,788.00
L010101	OPERATOR	100.00	1.00 Each (hourly)	U.S. Dollar	51.00	5,099.60
*RXMISC14	MAN LIFT GAS 125ft	100.00	1.00 Each (hourly)	U.S. Dollar	53.52	5,352.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	100.00	1.00 Each (hourly)	U.S. Dollar	21.65	2,164.50

1.5.1.2	0.50 Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	750.00

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		750.00 Each	U.S. Dollar	1.00	750.00

1.5.2	26.00 Each	Utility Pole Removal	5.00	Detail	U.S. Dollar	568.94	14,792.35
1.5.2.1	26.00 Each	Cut / Lower Pole	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00 Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00 Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00 Each (hourly)	U.S. Dollar	46.84	1,217.84

1.5.2.2	26.00 Each	Size & Loadout	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00 Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00 Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00 Each (hourly)	U.S. Dollar	46.84	1,217.84

1.5.2.3	2.00 Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	3,000.00

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		3,000.00 Each	U.S. Dollar	1.00	3,000.00

Cost Item CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.5.2.4	26.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,820.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,820.00	Each	U.S. Dollar	1.00	1,820.00

Notes: ***

Assumption: 101 poles x 2000' per pole

****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.6	1.00	Each	O&M Building Removal	0.21	Detail	U.S. Dollar	27,418.75	27,418.75
1.6.1	40.00	Ton	Structure Demo	10.00	Detail	U.S. Dollar	505.96	20,238.48

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*REXCAV06A	Excav 100K w/ Bucket & Grapple	40.00	1.00	Each (hourly)	U.S. Dollar	124.54	4,981.40
*REXCAV06E	Excav 100K w/ Shear	40.00	1.00	Each (hourly)	U.S. Dollar	185.50	7,419.80
L010101	OPERATOR	80.00	2.00	Each (hourly)	U.S. Dollar	51.00	4,079.68
L060100	GENERAL LABORER	80.00	2.00	Each (hourly)	U.S. Dollar	46.97	3,757.60

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.6.2	50.00	Cubic Yard	Remove Foundations To Subgrade	71.43	Detail	U.S. Dollar	35.61	1,780.27
1.6.2.1	50.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	250.00	Detail	U.S. Dollar	17.38	868.92

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	2.00	1.00	Each (hourly)	U.S. Dollar	46.97	93.94
L010101	OPERATOR	4.00	2.00	Each (hourly)	U.S. Dollar	51.00	203.98
*REXCAV06C	Excav 100K w/ Hammer	2.00	1.00	Each (hourly)	U.S. Dollar	160.97	321.93
*REXCAV06A	Excav 100K w/ Bucket & Grapple	2.00	1.00	Each (hourly)	U.S. Dollar	124.54	249.07

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.6.2.2	50.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	18.23	911.35

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	5.00	1.00	Each (hourly)	U.S. Dollar	74.29	371.45
L080940	TEAMSTER	5.00	1.00	Each (hourly)	U.S. Dollar	51.00	254.98
L010101	OPERATOR	2.50	0.50	Each (hourly)	U.S. Dollar	51.00	127.49
RFELWH09	CAT 966F LOADER, 4.25CY	2.50	0.50	Each (hourly)	U.S. Dollar	62.97	157.43

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.6.3	40.00	Ton	Material T&D	0.00	Detail	U.S. Dollar	135.00	5,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		2,600.00	Each	U.S. Dollar	1.00	2,600.00
USDISPOSAL	Disposal Fee's		2,800.00	Each	U.S. Dollar	1.00	2,800.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.7	1,200.00	MW	DC Storage Retirement	2.47	Detail	U.S. Dollar	3,148.02	3,777,627.74
1.7.1	1,200.00	MW	Battery Removal & Disposal	5.00	Detail	U.S. Dollar	2,044.07	2,452,881.60
1.7.1.1	240.00	Day	Remove Batteries, Load For Transport	1.00	Detail	U.S. Dollar	3,251.10	780,264.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	14,400.00	6.00	Each (hourly)	U.S. Dollar	46.97	676,368.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	4,800.00	2.00	Each (hourly)	U.S. Dollar	21.65	103,896.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.7.1.2	396.00	Each	Transport Batteries	0.00	Detail	U.S. Dollar	1,605.60	635,817.60
1.7.1.2.1	396.00	Each	Roll Off Liners	0.00	Detail	U.S. Dollar	105.60	41,817.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODCLINER	Rolloff Liner		396.00	Each	U.S. Dollar	105.60	41,817.60

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.7.1.2.2	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	594,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost

				Cost Item				
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

USTRUCKING	Trucking Sub		594,000.00	Each	U.S. Dollar	1.00	594,000.00

1.7.1.3	5,184.00	Ton	Disposal Fee's	0.00	Detail	U.S. Dollar	200.00	1,036,800.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,036,800.00	Each	U.S. Dollar	1.00	1,036,800.00

1.7.2	1,200.00	MW	Structure & Components Removal	4.90	Detail	U.S. Dollar	1,103.96	1,324,746.14
1.7.2.1	120.00	Day	Refrigerant Recovery	1.00	Detail	U.S. Dollar	1,207.80	144,936.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	2,400.00	2.00	Each (hourly)	U.S. Dollar	60.39	144,936.00

1.7.2.2	3,936.00	Ton	Structure Demo	43.33	Detail	U.S. Dollar	116.76	459,569.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*REXCAV06A	Excav 100K w/ Bucket & Grapple	908.31	1.00	Each (hourly)	U.S. Dollar	124.54	113,116.10
*REXCAV06E	Excav 100K w/ Shear	908.31	1.00	Each (hourly)	U.S. Dollar	185.50	168,486.54
L010101	OPERATOR	1,816.62	2.00	Each (hourly)	U.S. Dollar	51.00	92,640.12
L060100	GENERAL LABORER	1,816.62	2.00	Each (hourly)	U.S. Dollar	46.97	85,326.42

1.7.2.3	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	544,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		544,500.00	Each	U.S. Dollar	1.00	544,500.00

1.7.2.4	105,000.00	Gallon	Glycol Recovery & Disposal	0.00	Detail	U.S. Dollar	1.00	105,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLIQUID	Liquids T&D		105,000.00	Each	U.S. Dollar	1.00	105,000.00

1.7.2.5	2,522.40	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	70,740.96
1.7.2.5.1	2,522.40	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	39,138.82

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	90.09	1.00	Each (hourly)	U.S. Dollar	46.97	4,231.33
L010101	OPERATOR	180.17	2.00	Each (hourly)	U.S. Dollar	51.00	9,188.02
*REXCAV06C	Excav 100K w/ Hammer	90.09	1.00	Each (hourly)	U.S. Dollar	160.97	14,500.65
*REXCAV06A	Excav 100K w/ Bucket & Grapple	90.09	1.00	Each (hourly)	U.S. Dollar	124.54	11,218.82

1.7.2.5.2	2,522.40	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	31,602.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	252.24	1.00	Each (hourly)	U.S. Dollar	74.29	18,738.91
L080940	TEAMSTER	252.24	1.00	Each (hourly)	U.S. Dollar	51.00	12,863.23

1.8	1.00	Lump Sum	Solar Array Retirement	0.01	Detail	U.S. Dollar	7,950,255.65	7,950,255.65
1.8.1	83,952.00	Linear Feet	Fence Removal	5,124.80	Detail	U.S. Dollar	1.31	110,061.34
1.8.1.1	83,952.00	Linear Feet	Fence Removal	5,124.80	Detail	U.S. Dollar	1.04	87,561.34

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	491.45	3.00	Each (hourly)	U.S. Dollar	51.00	25,061.76
L060100	GENERAL LABORER	982.89	6.00	Each (hourly)	U.S. Dollar	46.97	46,166.39
RBACKH09	Deere 710J BACKHOE, 1.62CY	491.45	3.00	Each (hourly)	U.S. Dollar	33.24	16,333.19

1.8.1.2	15.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	22,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		22,500.00	Each	U.S. Dollar	1.00	22,500.00

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.8.2	656,256.00	Each	Solar Panel Removal & Disposal	10,000.00	Detail	U.S. Dollar	7.17	4,708,588.14
1.8.2.1	656,256.00	Each	Solar Panel Removal	10,000.00	Detail	U.S. Dollar	3.07	2,017,928.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	6,562.56	10.00	Each (hourly)	U.S. Dollar	21.65	142,046.61
L010101	OPERATOR	6,562.56	10.00	Each (hourly)	U.S. Dollar	51.00	334,664.31
L060100	GENERAL LABORER	32,812.80	50.00	Each (hourly)	U.S. Dollar	46.97	1,541,217.22

Notes: **

Assumed production: 20 panels per laborer per hour,
Includes packaging and preparing for shipment offsite.
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.8.2.2	875.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,312,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,312,500.00	Each	U.S. Dollar	1.00	1,312,500.00

Notes: **************************************

Assumption: 45,000 lbs per load
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.8.2.3	19,688.00	Ton	Recycling Cost	0.00	Detail	U.S. Dollar	70.00	1,378,160.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,378,160.00	Each	U.S. Dollar	1.00	1,378,160.00

Notes: **

Assumption: 60 lbs each
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.8.3	1.00	Lump Sum	Solar Rack (Trackers) & Post Removal	0.01	Detail	U.S. Dollar	3,131,606.18	3,131,606.18
1.8.3.1	10,938.00	Each	Solar Rack (Trackers) & Post Removal	160.00	Detail	U.S. Dollar	252.98	2,767,106.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10,938.00	16.00	Each (hourly)	U.S. Dollar	51.00	557,794.25
L060100	GENERAL LABORER	10,938.00	16.00	Each (hourly)	U.S. Dollar	46.97	513,757.86
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5,469.00	8.00	Each (hourly)	U.S. Dollar	124.54	681,081.92
*REXCAV06E	Excav 100K w/ Shear	5,469.00	8.00	Each (hourly)	U.S. Dollar	185.50	1,014,472.16

Notes: ***

Assumed production: .5 hour per rack per crew. Crew to include
1 excavator w/shear, 1 excavator w/grapple, 2 operators and 2
laborers. Includes post removal and sizing of steel for sale as scrap,
and loadout to haul trucks.
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.8.3.2	243.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	364,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		364,500.00	Each	U.S. Dollar	1.00	364,500.00

Notes: **************************************

Assumption: 45,000 lbs per load
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.9	54.00	Each	Inverter / Transformer Removal	1.00	Detail	U.S. Dollar	3,143.21	169,733.07
1.9.1	54.00	Each	Disconnect Electrical	2.00	Detail	U.S. Dollar	592.13	31,974.75

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	270.00	1.00	Each (hourly)	U.S. Dollar	60.39	16,305.30
L060100	GENERAL LABORER	270.00	1.00	Each (hourly)	U.S. Dollar	46.97	12,681.90
RPUTRK05	F-250 4X4 3/4 TON PICKUP	270.00	1.00	Each (hourly)	U.S. Dollar	11.07	2,987.55

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.9.2	54.00	Each	Loadout Inverter & Transformer	2.00	Detail	U.S. Dollar	1,051.08	56,758.32

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

L060100	GENERAL LABORER	540.00	2.00	Each (hourly)	U.S. Dollar	46.97	25,363.80
L010101	OPERATOR	270.00	1.00	Each (hourly)	U.S. Dollar	51.00	13,768.92
RHYDCR06	GROVE RT880 73 TON	270.00	1.00	Each (hourly)	U.S. Dollar	65.28	17,625.60

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.9.3	54.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	81,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		81,000.00	Each	U.S. Dollar	1.00	81,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.10	105,665.00	Cubic Yard	Remove Inverter / Transformer / BESS Foundations	73.68	Detail	U.S. Dollar	28.05	2,963,385.49
1.10.1	105,665.00	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	1,639,550.97

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	3,773.75	1.00	Each (hourly)	U.S. Dollar	46.97	177,253.04
L010101	OPERATOR	7,547.50	2.00	Each (hourly)	U.S. Dollar	51.00	384,892.31
*REXCAV06C	Excav 100K w/ Hammer	3,773.75	1.00	Each (hourly)	U.S. Dollar	160.97	607,441.67
*REXCAV06A	Excav 100K w/ Bucket & Grapple	3,773.75	1.00	Each (hourly)	U.S. Dollar	124.54	469,963.96

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.10.2	105,665.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	1,323,834.52

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	10,566.50	1.00	Each (hourly)	U.S. Dollar	74.29	784,985.29
L080940	TEAMSTER	10,566.50	1.00	Each (hourly)	U.S. Dollar	51.00	538,849.23

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.11	1.00	Lump Sum	Site Restoration - Partial Site Seeding	0.02	Detail	U.S. Dollar	607,907.45	607,907.45
1.11.1	39,960.00	Linear Feet	Site Roads - Removal & Restoration	5,000.00	Detail	U.S. Dollar	1.63	65,240.05

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	319.68	4.00	Each (hourly)	U.S. Dollar	58.34	18,648.53
L010101	OPERATOR	559.44	7.00	Each (hourly)	U.S. Dollar	51.00	28,529.20
RDUTRK06	CAT D350D, 18CY-24CY	159.84	2.00	Each (hourly)	U.S. Dollar	74.29	11,874.51
*RFELWH08C	CAT 980 LOADER	79.92	1.00	Each (hourly)	U.S. Dollar	77.43	6,187.81

Notes: *************************************

Assume topsoil for restoration available onsite.

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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.11.2	8.00	Each	Remove CONEX Storage & Gravel Pads	6.00	Detail	U.S. Dollar	750.46	6,003.65
1.11.2.1	8.00	Each	Remove & Load CONEX	12.00	Detail	U.S. Dollar	81.53	652.24

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	6.67	1.00	Each (hourly)	U.S. Dollar	51.00	339.97
RHYDCR05	GROVE RT600E 40 TON	6.67	1.00	Each (hourly)	U.S. Dollar	46.84	312.27

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.11.2.2	8.00	Each	Remove CONEX Gravel Pads	12.00	Detail	U.S. Dollar	168.93	1,351.41

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	6.67	1.00	Each (hourly)	U.S. Dollar	51.00	339.97
RDUTRK06	CAT D350D, 18CY-24CY	6.67	1.00	Each (hourly)	U.S. Dollar	74.29	495.27
*RFELWH08C	CAT 980 LOADER	6.67	1.00	Each (hourly)	U.S. Dollar	77.43	516.17

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.11.2.3	8.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	500.00	4,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		4,000.00	Each	U.S. Dollar	1.00	4,000.00

Notes: ***

Assumption: CONEX containers will be accepted locally
for re-use, and will only require local transport

****

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.11.3	500.00	Acre	Spot Grade Disturbed Areas	16.00	Detail	U.S. Dollar	273.33	136,663.75

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	1,250.00	4.00	Each (hourly)	U.S. Dollar	58.34	72,918.75
L010101	OPERATOR	1,250.00	4.00	Each (hourly)	U.S. Dollar	51.00	63,745.00

Notes: **

Assume that 35% of the area distrubed by construction
will be regraded.
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.11.4	500.00	Acre	Re-Seed With Native Vegetation - Roads & Areas Disturbed By Construction	0.00	Detail	U.S. Dollar	800.00	400,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		500.00	Acre	U.S. Dollar	800.00	400,000.00

Notes: **

Assume that 35% of the area distrubed by construction
will be re-seeded.
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.12	1.00	Lump Sum	Contractor Markups	0.00	Detail	U.S. Dollar	3,438,465.05	3,438,465.05
1.12.1	1.00	Lump Sum	Home Office, Project Management (5% Of Cost)	0.00	Detail	U.S. Dollar	829,991.60	829,991.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USMARKUP5	5% Markup		16,599,832.00	Each	U.S. Dollar	0.05	829,991.60

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.12.2	1.00	Lump Sum	Contractor OH & Fee (15% Of Cost)	0.00	Detail	U.S. Dollar	2,608,473.45	2,608,473.45

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USMARKUP	15% Markup		17,389,823.00	Each	U.S. Dollar	0.15	2,608,473.45

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.13	1.00	Lump Sum	ODOE Applied Contingencies	0.00	Detail	U.S. Dollar	4,199,642.37	4,199,642.37
1.13.1	1.00	Lump Sum	1% Performance Bond	0.00	Detail	U.S. Dollar	199,982.97	199,982.97

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE1	ODOE 1% Markup		19,998,297.00	Each	U.S. Dollar	0.01	199,982.97

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.13.2	1.00	Lump Sum	10% Administrative and Project Management	0.00	Detail	U.S. Dollar	1,999,829.70	1,999,829.70

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		19,998,297.00	Each	U.S. Dollar	0.10	1,999,829.70

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
1.13.3	1.00	Lump Sum	10% Future Development Contingency	0.00	Detail	U.S. Dollar	1,999,829.70	1,999,829.70

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		19,998,297.00	Each	U.S. Dollar	0.10	1,999,829.70

Report Total:	24,197,939.27

Category	Total
Labor	5,924,349.16
Rented Equipment	4,510,050.09
Supplies	43,237.60
Materials	40,000.00
Subcontract	9,373,460.05
Travel-Risk-Adj	105,000.00
ODCs	4,201,842.37

Sunstone Solar Project 2

Estimate Summary
TETRA TECH, INC.
Job Code: Sunstone solar
Description: Decommissioning Estimate

CBS Position Code	Quantity	UM	Cost Item Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2	1.00	Each	SUNSTONE SOLAR RETIREMENT - SUNSTONE SOLAR 2	0.00	Detail	U.S. Dollar	23,446,360.38	23,446,360.38
2.1	1.00	Lump Sum	Equipment & Facilities Mob / Demob	0.10	Detail	U.S. Dollar	218,136.80	218,136.80
2.1.1	1.00	Lump Sum	Equipment Mob	0.00	Detail	U.S. Dollar	81,200.00	81,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UERNTRLG	Rental Equip Transp-Large		8.00	Each	U.S. Dollar	10,000.00	80,000.00
UERNTRSM	Rental Equip Transp-Small		8.00	Each	U.S. Dollar	150.00	1,200.00

2.1.2	1.00	Lump Sum	Site Facilities	0.00	Detail	U.S. Dollar	2,200.00	2,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UOCONMOB	Connex Box Mob		2.00	Each	U.S. Dollar	300.00	600.00
UOTRLTRN	Trailer Trnsp/Setup/Trdwn		2.00	Each	U.S. Dollar	800.00	1,600.00

2.1.3	5.00	Day	Crew Mob & Site Setup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

2.1.4	5.00	Day	Crew Demob & Site Cleanup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

2.2	4.00	Month	Project Site Support	0.05	Detail	U.S. Dollar	71,469.70	285,878.80
2.2.1	4.00	Month	Site Facilities	0.00	Detail	U.S. Dollar	1,755.00	7,020.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
URCONNEX	Connex Box		8.00	Month	U.S. Dollar	150.00	1,200.00
UROFFTRL	Office Trailer -12x60		4.00	Month	U.S. Dollar	500.00	2,000.00
UO1STAID	1st Aid Supplies		4.00	Month	U.S. Dollar	300.00	1,200.00
UOOFFSUP	Office Supplies($/prs/mo)		4.00	Month	U.S. Dollar	55.00	220.00
URPRTAJH	Port-a-John Unit(s) (4)		8.00	Month	U.S. Dollar	300.00	2,400.00

2.2.2	4.00	Month	Field Management	0.05	Detail	U.S. Dollar	69,714.70	278,858.80

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L90FXX02	Field - Proj Superintendent	880.00	1.00	Each (hourly)	U.S. Dollar	114.95	101,156.00
RPUTRK05	F-250 4X4 3/4 TON PICKUP	2,640.00	3.00	Each (hourly)	U.S. Dollar	11.07	29,211.60
L90FEL00	Field - Engr. Tech	880.00	1.00	Each (hourly)	U.S. Dollar	64.24	56,531.20
L90FXX03	Field - SHSO	880.00	1.00	Each (hourly)	U.S. Dollar	104.50	91,960.00

2.3	1.00	Each	Substation Retirement	0.04	Detail	U.S. Dollar	170,429.15	170,429.15
2.3.1	1.00	Day	Fence Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

2.3.2	1.00	Each	Transformer Removal	0.17	Detail	U.S. Dollar	102,309.50	102,309.50
2.3.2.1	1.00	Each	Oil Removal & Disposal	1.00	Detail	U.S. Dollar	66,314.40	66,314.40

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.3.2.1.1	1.00	Each	Oil Removal	1.00	Detail	U.S. Dollar	939.40	939.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40

2.3.2.1.2	16,000.00	Gallon	Oil Disposal	0.00	Detail	U.S. Dollar	4.00	64,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		64,000.00	Each	U.S. Dollar	1.00	64,000.00

2.3.2.1.3	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	1,375.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,375.00	Each	U.S. Dollar	1.00	1,375.00

2.3.2.2	1.00	Each	Dismantle & Loadout Transformer	0.20	Detail	U.S. Dollar	35,995.10	35,995.10
2.3.2.2.1	1.00	Each	Dismantle, Cut & Size	0.20	Detail	U.S. Dollar	29,995.10	29,995.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	200.00	4.00	Each (hourly)	U.S. Dollar	46.97	9,394.00
L010101	OPERATOR	100.00	2.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*REXCAV06A	Excav 100K w/ Bucket & Grapple	50.00	1.00	Each (hourly)	U.S. Dollar	124.54	6,226.75
*REXCAV06E	Excav 100K w/ Shear	50.00	1.00	Each (hourly)	U.S. Dollar	185.50	9,274.75

2.3.2.2.2	4.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	6,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		6,000.00	Each	U.S. Dollar	1.00	6,000.00

2.3.3	1.00	Each	Remove Control Building	2.00	Detail	U.S. Dollar	2,612.51	2,612.51
2.3.3.1	1.00	Each	Demo	2.00	Detail	U.S. Dollar	1,112.51	1,112.51

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	5.00	1.00	Each (hourly)	U.S. Dollar	46.97	234.85
L010101	OPERATOR	5.00	1.00	Each (hourly)	U.S. Dollar	51.00	254.98
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5.00	1.00	Each (hourly)	U.S. Dollar	124.54	622.68

2.3.3.2	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

2.3.4	1.00	Day	UG Utility & Ground Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

2.3.5	1,000.00	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	28,045.10
2.3.5.1	1,000.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	280.00	Detail	U.S. Dollar	15.52	15,516.50

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	35.71	1.00	Each (hourly)	U.S. Dollar	46.97	1,677.50
L010101	OPERATOR	71.43	2.00	Each (hourly)	U.S. Dollar	51.00	3,642.57
*REXCAV06C	Excav 100K w/ Hammer	35.71	1.00	Each (hourly)	U.S. Dollar	160.97	5,748.75

Cost Item								
CBS Position Code	**Quantity**	**UM**	**Description**	**UM/Day**	**Cost Source**	**Currency**	**Unit Cost**	**Total Cost**

*REXCAV06A	Excav 100K w/ Bucket & Grapple	35.71	1.00	Each (hourly)	U.S. Dollar	124.54	4,447.68

2.3.5.2	1,000.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	12,528.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	100.00	1.00	Each (hourly)	U.S. Dollar	74.29	7,429.00
L080940	TEAMSTER	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60

2.3.6	1.00	Each	Misc. Material Disposal	0.00	Detail	U.S. Dollar	2,900.00	2,900.00
2.3.6.1	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

2.3.6.2	20.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,400.00	Each	U.S. Dollar	1.00	1,400.00

2.3.7	1.00	Each	Restore Yard	0.23	Detail	U.S. Dollar	31,938.02	31,938.02
2.3.7.1	1.60	Acre	Remove Aggregate / Backfill / Regrade	1.60	Detail	U.S. Dollar	2,062.47	3,299.96

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40
L010101	OPERATOR	20.00	2.00	Each (hourly)	U.S. Dollar	51.00	1,019.92
REXCAV06B	Gradall - Excavator	10.00	1.00	Each (hourly)	U.S. Dollar	75.73	757.29
*RDOZER08	CAT D6 LGP Dozer	10.00	1.00	Each (hourly)	U.S. Dollar	58.34	583.35

2.3.7.2	1,000.00	Cubic Yard	Vegetative Cover	300.00	Detail	U.S. Dollar	27.36	27,358.07
2.3.7.2.1	1,000.00	Cubic Yard	Topsoil, Delivered	0.00	Detail	U.S. Dollar	20.00	20,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
IMSOIL	Topsoil		1,000.00	Cubic Yard	U.S. Dollar	20.00	20,000.00

2.3.7.2.2	1,000.00	Cubic Yard	Placement	300.00	Detail	U.S. Dollar	7.36	7,358.07

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	66.67	2.00	Each (hourly)	U.S. Dollar	51.00	3,399.73
RDOZER08	CAT D6N XL	66.67	2.00	Each (hourly)	U.S. Dollar	59.38	3,958.33

2.3.7.3	1.60	Acre	Re-Seed With Native Vegetation	0.00	Detail	U.S. Dollar	800.00	1,280.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		1.60	Acre	U.S. Dollar	800.00	1,280.00

2.4	1.00	Lump Sum	Collector Line Retirement	0.07	Detail	U.S. Dollar	46,946.45	46,946.45
2.4.1	5,850.00	Linear Feet	Conductor Removal	585.00	Detail	U.S. Dollar	5.50	32,154.10
2.4.1.1	1.00	Lump Sum	Cut / Lower Cable, Size & Loadout	0.10	Detail	U.S. Dollar	31,404.10	31,404.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	400.00	4.00	Each (hourly)	U.S. Dollar	46.97	18,788.00
L010101	OPERATOR	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*RXMISC14	MAN LIFT GAS 125ft	100.00	1.00	Each (hourly)	U.S. Dollar	53.52	5,352.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	100.00	1.00	Each (hourly)	U.S. Dollar	21.65	2,164.50

2.4.1.2	0.50	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	750.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		750.00	Each	U.S. Dollar	1.00	750.00

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.4.2	26.00	Each	Utility Pole Removal	5.00	Detail	U.S. Dollar	568.94	14,792.35
2.4.2.1	26.00	Each	Cut / Lower Pole	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00	Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00	Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00	Each (hourly)	U.S. Dollar	46.84	1,217.84

2.4.2.2	26.00	Each	Size & Loadout	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00	Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00	Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00	Each (hourly)	U.S. Dollar	46.84	1,217.84

2.4.2.3	2.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	3,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		3,000.00	Each	U.S. Dollar	1.00	3,000.00

2.4.2.4	26.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,820.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,820.00	Each	U.S. Dollar	1.00	1,820.00

Notes: **

Assumption: 101 poles x 2000' per pole

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2.5	1.00	Each	O&M Building Removal	0.21	Detail	U.S. Dollar	27,418.75	27,418.75
2.5.1	40.00	Ton	Structure Demo	10.00	Detail	U.S. Dollar	505.96	20,238.48

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*REXCAV06A	Excav 100K w/ Bucket & Grapple	40.00	1.00	Each (hourly)	U.S. Dollar	124.54	4,981.40
*REXCAV06E	Excav 100K w/ Shear	40.00	1.00	Each (hourly)	U.S. Dollar	185.50	7,419.80
L010101	OPERATOR	80.00	2.00	Each (hourly)	U.S. Dollar	51.00	4,079.68
L060100	GENERAL LABORER	80.00	2.00	Each (hourly)	U.S. Dollar	46.97	3,757.60

2.5.2	50.00	Cubic Yard	Remove Foundations To Subgrade	71.43	Detail	U.S. Dollar	35.61	1,780.27
2.5.2.1	50.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	250.00	Detail	U.S. Dollar	17.38	868.92

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	2.00	1.00	Each (hourly)	U.S. Dollar	46.97	93.94
L010101	OPERATOR	4.00	2.00	Each (hourly)	U.S. Dollar	51.00	203.98
*REXCAV06C	Excav 100K w/ Hammer	2.00	1.00	Each (hourly)	U.S. Dollar	160.97	321.93
*REXCAV06A	Excav 100K w/ Bucket & Grapple	2.00	1.00	Each (hourly)	U.S. Dollar	124.54	249.07

2.5.2.2	50.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	18.23	911.35

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	5.00	1.00	Each (hourly)	U.S. Dollar	74.29	371.45
L080940	TEAMSTER	5.00	1.00	Each (hourly)	U.S. Dollar	51.00	254.98
L010101	OPERATOR	2.50	0.50	Each (hourly)	U.S. Dollar	51.00	127.49
RFELWH09	CAT 966F LOADER, 4.25CY	2.50	0.50	Each (hourly)	U.S. Dollar	62.97	157.43

2.5.3	40.00	Ton	Material T&D	0.00	Detail	U.S. Dollar	135.00	5,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		2,600.00	Each	U.S. Dollar	1.00	2,600.00
USDISPOSAL	Disposal Fee's		2,800.00	Each	U.S. Dollar	1.00	2,800.00

			Cost Item					
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.6	1,200.00	MW	DC Storage Retirement	2.47	Detail	U.S. Dollar	3,148.02	3,777,627.74
2.6.1	1,200.00	MW	Battery Removal & Disposal	5.00	Detail	U.S. Dollar	2,044.07	2,452,881.60
2.6.1.1	240.00	Day	Remove Batteries, Load For Transport	1.00	Detail	U.S. Dollar	3,251.10	780,264.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	14,400.00	6.00	Each (hourly)	U.S. Dollar	46.97	676,368.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	4,800.00	2.00	Each (hourly)	U.S. Dollar	21.65	103,896.00

2.6.1.2	396.00	Each	Transport Batteries	0.00	Detail	U.S. Dollar	1,605.60	635,817.60
2.6.1.2.1	396.00	Each	Roll Off Liners	0.00	Detail	U.S. Dollar	105.60	41,817.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODCLINER	Rolloff Liner		396.00	Each	U.S. Dollar	105.60	41,817.60

2.6.1.2.2	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	594,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		594,000.00	Each	U.S. Dollar	1.00	594,000.00

2.6.1.3	5,184.00	Ton	Disposal Fee's	0.00	Detail	U.S. Dollar	200.00	1,036,800.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,036,800.00	Each	U.S. Dollar	1.00	1,036,800.00

2.6.2	1,200.00	MW	Structure & Components Removal	4.90	Detail	U.S. Dollar	1,103.96	1,324,746.14
2.6.2.1	120.00	Day	Refrigerant Recovery	1.00	Detail	U.S. Dollar	1,207.80	144,936.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	2,400.00	2.00	Each (hourly)	U.S. Dollar	60.39	144,936.00

2.6.2.2	3,936.00	Ton	Structure Demo	43.33	Detail	U.S. Dollar	116.76	459,569.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*REXCAV06A	Excav 100K w/ Bucket & Grapple	908.31	1.00	Each (hourly)	U.S. Dollar	124.54	113,116.10
*REXCAV06E	Excav 100K w/ Shear	908.31	1.00	Each (hourly)	U.S. Dollar	185.50	168,486.54
L010101	OPERATOR	1,816.62	2.00	Each (hourly)	U.S. Dollar	51.00	92,640.12
L060100	GENERAL LABORER	1,816.62	2.00	Each (hourly)	U.S. Dollar	46.97	85,326.42

2.6.2.3	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	544,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		544,500.00	Each	U.S. Dollar	1.00	544,500.00

2.6.2.4	105,000.00	Gallon	Glycol Recovery & Disposal	0.00	Detail	U.S. Dollar	1.00	105,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLIQUID	Liquids T&D		105,000.00	Each	U.S. Dollar	1.00	105,000.00

2.6.2.5	2,522.40	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	70,740.96
2.6.2.5.1	2,522.40	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	39,138.82

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	90.09	1.00	Each (hourly)	U.S. Dollar	46.97	4,231.33
L010101	OPERATOR	180.17	2.00	Each (hourly)	U.S. Dollar	51.00	9,188.02
*REXCAV06C	Excav 100K w/ Hammer	90.09	1.00	Each (hourly)	U.S. Dollar	160.97	14,500.65
*REXCAV06A	Excav 100K w/ Bucket & Grapple	90.09	1.00	Each (hourly)	U.S. Dollar	124.54	11,218.82

2.6.2.5.2	2,522.40	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	31,602.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	252.24	1.00	Each (hourly)	U.S. Dollar	74.29	18,738.91
L080940	TEAMSTER	252.24	1.00	Each (hourly)	U.S. Dollar	51.00	12,863.23

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.7	1.00	Lump Sum	Solar Array Retirement	0.01	Detail	U.S. Dollar	7,855,381.03	7,855,381.03
2.7.1	11,616.00	Linear Feet	Fence Removal	5,809.92	Detail	U.S. Dollar	1.31	15,186.72
2.7.1.1	11,616.00	Linear Feet	Fence Removal	5,809.92	Detail	U.S. Dollar	0.92	10,686.72

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	59.98	3.00	Each (hourly)	U.S. Dollar	51.00	3,058.75
L060100	GENERAL LABORER	119.96	6.00	Each (hourly)	U.S. Dollar	46.97	5,634.53
RBACKH09	Deere 710J BACKHOE, 1.62CY	59.98	3.00	Each (hourly)	U.S. Dollar	33.24	1,993.44

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.7.1.2	3.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	4,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		4,500.00	Each	U.S. Dollar	1.00	4,500.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.7.2	656,256.00	Each	Solar Panel Removal & Disposal	10,000.00	Detail	U.S. Dollar	7.17	4,708,588.14
2.7.2.1	656,256.00	Each	Solar Panel Removal	10,000.00	Detail	U.S. Dollar	3.07	2,017,928.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	6,562.56	10.00	Each (hourly)	U.S. Dollar	21.65	142,046.61
L010101	OPERATOR	6,562.56	10.00	Each (hourly)	U.S. Dollar	51.00	334,664.31
L060100	GENERAL LABORER	32,812.80	50.00	Each (hourly)	U.S. Dollar	46.97	1,541,217.22

Notes: ***

Assumed production: 20 panels per laborer per hour,
Includes packaging and preparing for shipment offsite.
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.7.2.2	875.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,312,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,312,500.00	Each	U.S. Dollar	1.00	1,312,500.00

Notes: ***************************************

Assumption: 45,000 lbs per load
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.7.2.3	19,688.00	Ton	Recycling Cost	0.00	Detail	U.S. Dollar	70.00	1,378,160.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,378,160.00	Each	U.S. Dollar	1.00	1,378,160.00

Notes: ***

Assumption: 60 lbs each
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.7.3	1.00	Lump Sum	Solar Rack (Trackers) & Post Removal	0.01	Detail	U.S. Dollar	3,131,606.18	3,131,606.18
2.7.3.1	10,938.00	Each	Solar Rack (Trackers) & Post Removal	160.00	Detail	U.S. Dollar	252.98	2,767,106.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10,938.00	16.00	Each (hourly)	U.S. Dollar	51.00	557,794.25
L060100	GENERAL LABORER	10,938.00	16.00	Each (hourly)	U.S. Dollar	46.97	513,757.86
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5,469.00	8.00	Each (hourly)	U.S. Dollar	124.54	681,081.92
*REXCAV06E	Excav 100K w/ Shear	5,469.00	8.00	Each (hourly)	U.S. Dollar	185.50	1,014,472.16

Notes: **

Assumed production: .5 hour per rack per crew. Crew to include 1 excavator w/shear, 1 excavator w/grapple, 2 operators and 2 laborers. Includes post removal and sizing of steel for sale as scrap, and loadout to haul trucks.
****

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.7.3.2	243.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	364,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		364,500.00	Each	U.S. Dollar	1.00	364,500.00

Notes: **

Assumption: 45,000 lbs per load

****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.8	54.00	Each	Inverter / Transformer Removal	1.00	Detail	U.S. Dollar	3,143.21	169,733.07
2.8.1	54.00	Each	Disconnect Electrical	2.00	Detail	U.S. Dollar	592.13	31,974.75

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	270.00	1.00	Each (hourly)	U.S. Dollar	60.39	16,305.30
L060100	GENERAL LABORER	270.00	1.00	Each (hourly)	U.S. Dollar	46.97	12,681.90
RPUTRK05	F-250 4X4 3/4 TON PICKUP	270.00	1.00	Each (hourly)	U.S. Dollar	11.07	2,987.55

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.8.2	54.00	Each	Loadout Inverter & Transformer	2.00	Detail	U.S. Dollar	1,051.08	56,758.32

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	540.00	2.00	Each (hourly)	U.S. Dollar	46.97	25,363.80
L010101	OPERATOR	270.00	1.00	Each (hourly)	U.S. Dollar	51.00	13,768.92
RHYDCR06	GROVE RT880 73 TON	270.00	1.00	Each (hourly)	U.S. Dollar	65.28	17,625.60

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.8.3	54.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	81,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		81,000.00	Each	U.S. Dollar	1.00	81,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.9	105,665.00	Cubic Yard	Remove Inverter / Transformer / BESS Foundations	73.68	Detail	U.S. Dollar	28.05	2,963,385.49
2.9.1	105,665.00	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	1,639,550.97

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	3,773.75	1.00	Each (hourly)	U.S. Dollar	46.97	177,253.04
L010101	OPERATOR	7,547.50	2.00	Each (hourly)	U.S. Dollar	51.00	384,892.31
*REXCAV06C	Excav 100K w/ Hammer	3,773.75	1.00	Each (hourly)	U.S. Dollar	160.97	607,441.67
*REXCAV06A	Excav 100K w/ Bucket & Grapple	3,773.75	1.00	Each (hourly)	U.S. Dollar	124.54	469,963.96

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.9.2	105,665.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	1,323,834.52

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	10,566.50	1.00	Each (hourly)	U.S. Dollar	74.29	784,985.29
L080940	TEAMSTER	10,566.50	1.00	Each (hourly)	U.S. Dollar	51.00	538,849.23

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.10	1.00	Lump Sum	Site Restoration - Partial Site Seeding	0.03	Detail	U.S. Dollar	532,398.07	532,398.07
2.10.1	39,072.00	Linear Feet	Site Roads - Removal & Restoration	5,000.00	Detail	U.S. Dollar	1.63	63,790.28

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	312.58	4.00	Each (hourly)	U.S. Dollar	58.34	18,234.12
L010101	OPERATOR	547.01	7.00	Each (hourly)	U.S. Dollar	51.00	27,895.22
RDUTRK06	CAT D350D, 18CY-24CY	156.29	2.00	Each (hourly)	U.S. Dollar	74.29	11,610.64
*RFELWH08C	CAT 980 LOADER	78.14	1.00	Each (hourly)	U.S. Dollar	77.43	6,050.30

Notes: **************************************

Assume topsoil for restoration available onsite.

****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.10.2	8.00	Each	Remove CONEX Storage & Gravel Pads	6.00	Detail	U.S. Dollar	750.46	6,003.65
2.10.2.1	8.00	Each	Remove & Load CONEX	12.00	Detail	U.S. Dollar	81.53	652.24

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost

L010101	OPERATOR	6.67	1.00 Each (hourly)	U.S. Dollar	51.00	339.97
RHYDCR05	GROVE RT600E 40 TON	6.67	1.00 Each (hourly)	U.S. Dollar	46.84	312.27

CBS Position Code	Quantity UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.10.2.2	8.00 Each	Remove CONEX Gravel Pads	12.00	Detail	U.S. Dollar	168.93	1,351.41

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	6.67	1.00 Each (hourly)	U.S. Dollar	51.00	339.97
RDUTRK06	CAT D350D, 18CY-24CY	6.67	1.00 Each (hourly)	U.S. Dollar	74.29	495.27
*RFELWH08C	CAT 980 LOADER	6.67	1.00 Each (hourly)	U.S. Dollar	77.43	516.17

CBS Position Code	Quantity UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.10.2.3	8.00 Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	500.00	4,000.00

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		4,000.00 Each	U.S. Dollar	1.00	4,000.00

Notes: **
Assumption: CONEX containers will be accepted locally
for re-use, and will only require local transport
****

CBS Position Code	Quantity UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.10.3	431.00 Acre	Spot Grade Disturbed Areas	16.00	Detail	U.S. Dollar	273.33	117,804.15

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	1,077.50	4.00 Each (hourly)	U.S. Dollar	58.34	62,855.96
L010101	OPERATOR	1,077.50	4.00 Each (hourly)	U.S. Dollar	51.00	54,948.19

Notes: ***
Assume that 35% of the area distrubed by construction
will be regraded.
****

CBS Position Code	Quantity UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.10.4	431.00 Acre	Re-Seed With Native Vegetation - Roads & Areas Disturbed By Construction	0.00	Detail	U.S. Dollar	800.00	344,800.00

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		431.00 Acre	U.S. Dollar	800.00	344,800.00

Notes: ***
Assume that 35% of the area distrubed by construction
will be re-seeded.
****

CBS Position Code	Quantity UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.11	1.00 Lump Sum	Contractor Markups	0.00	Detail	U.S. Dollar	3,329,822.05	3,329,822.05
2.11.1	1.00 Lump Sum	Home Office, Project Management (5% Of Cost)	0.00	Detail	U.S. Dollar	802,366.75	802,366.75

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
USMARKUP5	5% Markup		16,047,335.00 Each	U.S. Dollar	0.05	802,366.75

CBS Position Code	Quantity UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.11.2	1.00 Lump Sum	Contractor OH & Fee (15% Of Cost)	0.00	Detail	U.S. Dollar	2,527,455.30	2,527,455.30

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
USMARKUP	15% Markup		16,849,702.00 Each	U.S. Dollar	0.15	2,527,455.30

CBS Position Code	Quantity UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.12	1.00 Lump Sum	ODOE Applied Contingencies	0.00	Detail	U.S. Dollar	4,069,202.97	4,069,202.97
2.12.1	1.00 Lump Sum	1% Performance Bond	0.00	Detail	U.S. Dollar	193,771.57	193,771.57

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
UODOE1	ODOE 1% Markup		19,377,157.00 Each	U.S. Dollar	0.01	193,771.57

CBS Position Code	Quantity UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.12.2	1.00 Lump Sum	10% Administrative and Project Management	0.00	Detail	U.S. Dollar	1,937,715.70	1,937,715.70

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		19,377,157.00 Each	U.S. Dollar	0.10	1,937,715.70

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
2.12.3	1.00	Lump Sum	10% Future Development Contingency	0.00	Detail	U.S. Dollar	1,937,715.70	1,937,715.70

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		19,377,157.00	Each	U.S. Dollar	0.10	1,937,715.70

Report Total:	23,446,360.38

Category	Total
Labor	5,692,304.71
Rented Equipment	4,350,608.04
Supplies	43,237.60
Materials	20,000.00
Subcontract	9,163,807.05
Travel-Risk-Adj	105,000.00
ODCs	4,071,402.97

Sunstone Solar Project 3

Estimate Summary

TETRA TECH, INC.
Job Code: Sunstone solar
Description: Decommissioning Estimate

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3	1.00	Each	SUNSTONE SOLAR RETIREMENT - SUNSTONE SOLAR 3	0.00	Detail	U.S. Dollar	23,391,436.10	23,391,436.10
3.1	1.00	Lump Sum	Equipment & Facilities Mob / Demob	0.10	Detail	U.S. Dollar	218,136.80	218,136.80
3.1.1	1.00	Lump Sum	Equipment Mob	0.00	Detail	U.S. Dollar	81,200.00	81,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UERNTRLG	Rental Equip Transp-Large		8.00	Each	U.S. Dollar	10,000.00	80,000.00
UERNTRSM	Rental Equip Transp-Small		8.00	Each	U.S. Dollar	150.00	1,200.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.1.2	1.00	Lump Sum	Site Facilities	0.00	Detail	U.S. Dollar	2,200.00	2,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UOCONMOB	Connex Box Mob		2.00	Each	U.S. Dollar	300.00	600.00
UOTRLTRN	Trailer Trnsp/Setup/Trdwn		2.00	Each	U.S. Dollar	800.00	1,600.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.1.3	5.00	Day	Crew Mob & Site Setup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.1.4	5.00	Day	Crew Demob & Site Cleanup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.2	4.00	Month	Project Site Support	0.05	Detail	U.S. Dollar	71,469.70	285,878.80
3.2.1	4.00	Month	Site Facilities	0.00	Detail	U.S. Dollar	1,755.00	7,020.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
URCONNEX	Connex Box		8.00	Month	U.S. Dollar	150.00	1,200.00
UROFFTRL	Office Trailer -12x60		4.00	Month	U.S. Dollar	500.00	2,000.00
UO1STAID	1st Aid Supplies		4.00	Month	U.S. Dollar	300.00	1,200.00
UOOFFSUP	Office Supplies($/prs/mo)		4.00	Month	U.S. Dollar	55.00	220.00
URPRTAJH	Port-a-John Unit(s) (4)		8.00	Month	U.S. Dollar	300.00	2,400.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.2.2	4.00	Month	Field Management	0.05	Detail	U.S. Dollar	69,714.70	278,858.80

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L90FXX02	Field - Proj Superintendent	880.00	1.00	Each (hourly)	U.S. Dollar	114.95	101,156.00
RPUTRK05	F-250 4X4 3/4 TON PICKUP	2,640.00	3.00	Each (hourly)	U.S. Dollar	11.07	29,211.60
L90FEL00	Field - Engr. Tech	880.00	1.00	Each (hourly)	U.S. Dollar	64.24	56,531.20
L90FXX03	Field - SHSO	880.00	1.00	Each (hourly)	U.S. Dollar	104.50	91,960.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.3	1.00	Each	Substation Retirement	0.04	Detail	U.S. Dollar	170,429.15	170,429.15
3.3.1	1.00	Day	Fence Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.3.2	1.00	Each	Transformer Removal	0.17	Detail	U.S. Dollar	102,309.50	102,309.50
3.3.2.1	1.00	Each	Oil Removal & Disposal	1.00	Detail	U.S. Dollar	66,314.40	66,314.40

			Cost Item					
CBS Position Code	**Quantity**	**UM**	**Description**	**UM/Day**	**Cost Source**	**Currency**	**Unit Cost**	**Total Cost**
3.3.2.1.1	1.00	Each	Oil Removal	1.00	Detail	U.S. Dollar	939.40	939.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40

3.3.2.1.2	16,000.00	Gallon	Oil Disposal	0.00	Detail	U.S. Dollar	4.00	64,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		64,000.00	Each	U.S. Dollar	1.00	64,000.00

3.3.2.1.3	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	1,375.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,375.00	Each	U.S. Dollar	1.00	1,375.00

3.3.2.2	1.00	Each	Dismantle & Loadout Transformer	0.20	Detail	U.S. Dollar	35,995.10	35,995.10
3.3.2.2.1	1.00	Each	Dismantle, Cut & Size	0.20	Detail	U.S. Dollar	29,995.10	29,995.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	200.00	4.00	Each (hourly)	U.S. Dollar	46.97	9,394.00
L010101	OPERATOR	100.00	2.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*REXCAV06A	Excav 100K w/ Bucket & Grapple	50.00	1.00	Each (hourly)	U.S. Dollar	124.54	6,226.75
*REXCAV06E	Excav 100K w/ Shear	50.00	1.00	Each (hourly)	U.S. Dollar	185.50	9,274.75

3.3.2.2.2	4.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	6,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		6,000.00	Each	U.S. Dollar	1.00	6,000.00

3.3.3	1.00	Each	Remove Control Building	2.00	Detail	U.S. Dollar	2,612.51	2,612.51
3.3.3.1	1.00	Each	Demo	2.00	Detail	U.S. Dollar	1,112.51	1,112.51

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	5.00	1.00	Each (hourly)	U.S. Dollar	46.97	234.85
L010101	OPERATOR	5.00	1.00	Each (hourly)	U.S. Dollar	51.00	254.98
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5.00	1.00	Each (hourly)	U.S. Dollar	124.54	622.68

3.3.3.2	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

3.3.4	1.00	Day	UG Utility & Ground Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

3.3.5	1,000.00	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	28,045.10
3.3.5.1	1,000.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	280.00	Detail	U.S. Dollar	15.52	15,516.50

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	35.71	1.00	Each (hourly)	U.S. Dollar	46.97	1,677.50
L010101	OPERATOR	71.43	2.00	Each (hourly)	U.S. Dollar	51.00	3,642.57
*REXCAV06C	Excav 100K w/ Hammer	35.71	1.00	Each (hourly)	U.S. Dollar	160.97	5,748.75

Cost Item								
CBS Position Code	**Quantity**	**UM**	**Description**	**UM/Day**	**Cost Source**	**Currency**	**Unit Cost**	**Total Cost**
*REXCAV06A			Excav 100K w/ Bucket & Grapple	35.71	1.00 Each (hourly)	U.S. Dollar	124.54	4,447.68
3.3.5.2	1,000.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	12,528.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	100.00	1.00	Each (hourly)	U.S. Dollar	74.29	7,429.00
L080940	TEAMSTER	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60

3.3.6	1.00	Each	Misc. Material Disposal	0.00	Detail	U.S. Dollar	2,900.00	2,900.00
3.3.6.1	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

3.3.6.2	20.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,400.00	Each	U.S. Dollar	1.00	1,400.00

3.3.7	1.00	Each	Restore Yard	0.23	Detail	U.S. Dollar	31,938.02	31,938.02
3.3.7.1	1.60	Acre	Remove Aggregate / Backfill / Regrade	1.60	Detail	U.S. Dollar	2,062.47	3,299.96

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40
L010101	OPERATOR	20.00	2.00	Each (hourly)	U.S. Dollar	51.00	1,019.92
REXCAV06B	Gradall - Excavator	10.00	1.00	Each (hourly)	U.S. Dollar	75.73	757.29
*RDOZER08	CAT D6 LGP Dozer	10.00	1.00	Each (hourly)	U.S. Dollar	58.34	583.35

3.3.7.2	1,000.00	Cubic Yard	Vegetative Cover	300.00	Detail	U.S. Dollar	27.36	27,358.07
3.3.7.2.1	1,000.00	Cubic Yard	Topsoil, Delivered	0.00	Detail	U.S. Dollar	20.00	20,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
IMSOIL	Topsoil		1,000.00	Cubic Yard	U.S. Dollar	20.00	20,000.00

3.3.7.2.2	1,000.00	Cubic Yard	Placement	300.00	Detail	U.S. Dollar	7.36	7,358.07

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	66.67	2.00	Each (hourly)	U.S. Dollar	51.00	3,399.73
RDOZER08	CAT D6N XL	66.67	2.00	Each (hourly)	U.S. Dollar	59.38	3,958.33

3.3.7.3	1.60	Acre	Re-Seed With Native Vegetation	0.00	Detail	U.S. Dollar	800.00	1,280.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		1.60	Acre	U.S. Dollar	800.00	1,280.00

3.4	1.00	Lump Sum	Collector Line Retirement	0.07	Detail	U.S. Dollar	46,946.45	46,946.45
3.4.1	5,850.00	Linear Feet	Conductor Removal	585.00	Detail	U.S. Dollar	5.50	32,154.10
3.4.1.1	1.00	Lump Sum	Cut / Lower Cable, Size & Loadout	0.10	Detail	U.S. Dollar	31,404.10	31,404.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	400.00	4.00	Each (hourly)	U.S. Dollar	46.97	18,788.00
L010101	OPERATOR	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*RXMISC14	MAN LIFT GAS 125ft	100.00	1.00	Each (hourly)	U.S. Dollar	53.52	5,352.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	100.00	1.00	Each (hourly)	U.S. Dollar	21.65	2,164.50

3.4.1.2	0.50	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	750.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		750.00	Each	U.S. Dollar	1.00	750.00

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.4.2	26.00	Each	Utility Pole Removal	5.00	Detail	U.S. Dollar	568.94	14,792.35
3.4.2.1	26.00	Each	Cut / Lower Pole	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00	Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00	Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00	Each (hourly)	U.S. Dollar	46.84	1,217.84

3.4.2.2	26.00	Each	Size & Loadout	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00	Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00	Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00	Each (hourly)	U.S. Dollar	46.84	1,217.84

3.4.2.3	2.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	3,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		3,000.00	Each	U.S. Dollar	1.00	3,000.00

3.4.2.4	26.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,820.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,820.00	Each	U.S. Dollar	1.00	1,820.00

Notes: **

Assumption: 101 poles x 2000' per pole

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3.5	1.00	Each	O&M Building Removal	0.21	Detail	U.S. Dollar	27,418.75	27,418.75
3.5.1	40.00	Ton	Structure Demo	10.00	Detail	U.S. Dollar	505.96	20,238.48

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*REXCAV06A	Excav 100K w/ Bucket & Grapple	40.00	1.00	Each (hourly)	U.S. Dollar	124.54	4,981.40
*REXCAV06E	Excav 100K w/ Shear	40.00	1.00	Each (hourly)	U.S. Dollar	185.50	7,419.80
L010101	OPERATOR	80.00	2.00	Each (hourly)	U.S. Dollar	51.00	4,079.68
L060100	GENERAL LABORER	80.00	2.00	Each (hourly)	U.S. Dollar	46.97	3,757.60

3.5.2	50.00	Cubic Yard	Remove Foundations To Subgrade	71.43	Detail	U.S. Dollar	35.61	1,780.27
3.5.2.1	50.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	250.00	Detail	U.S. Dollar	17.38	868.92

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	2.00	1.00	Each (hourly)	U.S. Dollar	46.97	93.94
L010101	OPERATOR	4.00	2.00	Each (hourly)	U.S. Dollar	51.00	203.98
*REXCAV06C	Excav 100K w/ Hammer	2.00	1.00	Each (hourly)	U.S. Dollar	160.97	321.93
*REXCAV06A	Excav 100K w/ Bucket & Grapple	2.00	1.00	Each (hourly)	U.S. Dollar	124.54	249.07

3.5.2.2	50.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	18.23	911.35

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	5.00	1.00	Each (hourly)	U.S. Dollar	74.29	371.45
L080940	TEAMSTER	5.00	1.00	Each (hourly)	U.S. Dollar	51.00	254.98
L010101	OPERATOR	2.50	0.50	Each (hourly)	U.S. Dollar	51.00	127.49
RFELWH09	CAT 966F LOADER, 4.25CY	2.50	0.50	Each (hourly)	U.S. Dollar	62.97	157.43

3.5.3	40.00	Ton	Material T&D	0.00	Detail	U.S. Dollar	135.00	5,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		2,600.00	Each	U.S. Dollar	1.00	2,600.00
USDISPOSAL	Disposal Fee's		2,800.00	Each	U.S. Dollar	1.00	2,800.00

				Cost Item				
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.6	1,200.00	MW	DC Storage Retirement	2.47	Detail	U.S. Dollar	3,148.02	3,777,627.74
3.6.1	1,200.00	MW	Battery Removal & Disposal	5.00	Detail	U.S. Dollar	2,044.07	2,452,881.60
3.6.1.1	240.00	Day	Remove Batteries, Load For Transport	1.00	Detail	U.S. Dollar	3,251.10	780,264.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	14,400.00	6.00	Each (hourly)	U.S. Dollar	46.97	676,368.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	4,800.00	2.00	Each (hourly)	U.S. Dollar	21.65	103,896.00

3.6.1.2	396.00	Each	Transport Batteries	0.00	Detail	U.S. Dollar	1,605.60	635,817.60
3.6.1.2.1	396.00	Each	Roll Off Liners	0.00	Detail	U.S. Dollar	105.60	41,817.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODCLINER	Rolloff Liner		396.00	Each	U.S. Dollar	105.60	41,817.60

3.6.1.2.2	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	594,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		594,000.00	Each	U.S. Dollar	1.00	594,000.00

3.6.1.3	5,184.00	Ton	Disposal Fee's	0.00	Detail	U.S. Dollar	200.00	1,036,800.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,036,800.00	Each	U.S. Dollar	1.00	1,036,800.00

3.6.2	1,200.00	MW	Structure & Components Removal	4.90	Detail	U.S. Dollar	1,103.96	1,324,746.14
3.6.2.1	120.00	Day	Refrigerant Recovery	1.00	Detail	U.S. Dollar	1,207.80	144,936.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	2,400.00	2.00	Each (hourly)	U.S. Dollar	60.39	144,936.00

3.6.2.2	3,936.00	Ton	Structure Demo	43.33	Detail	U.S. Dollar	116.76	459,569.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*REXCAV06A	Excav 100K w/ Bucket & Grapple	908.31	1.00	Each (hourly)	U.S. Dollar	124.54	113,116.10
*REXCAV06E	Excav 100K w/ Shear	908.31	1.00	Each (hourly)	U.S. Dollar	185.50	168,486.54
L010101	OPERATOR	1,816.62	2.00	Each (hourly)	U.S. Dollar	51.00	92,640.12
L060100	GENERAL LABORER	1,816.62	2.00	Each (hourly)	U.S. Dollar	46.97	85,326.42

3.6.2.3	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	544,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		544,500.00	Each	U.S. Dollar	1.00	544,500.00

3.6.2.4	105,000.00	Gallon	Glycol Recovery & Disposal	0.00	Detail	U.S. Dollar	1.00	105,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLIQUID	Liquids T&D		105,000.00	Each	U.S. Dollar	1.00	105,000.00

3.6.2.5	2,522.40	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	70,740.96
3.6.2.5.1	2,522.40	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	39,138.82

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	90.09	1.00	Each (hourly)	U.S. Dollar	46.97	4,231.33
L010101	OPERATOR	180.17	2.00	Each (hourly)	U.S. Dollar	51.00	9,188.02
*REXCAV06C	Excav 100K w/ Hammer	90.09	1.00	Each (hourly)	U.S. Dollar	160.97	14,500.65
*REXCAV06A	Excav 100K w/ Bucket & Grapple	90.09	1.00	Each (hourly)	U.S. Dollar	124.54	11,218.82

3.6.2.5.2	2,522.40	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	31,602.14

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	252.24	1.00	Each (hourly)	U.S. Dollar	74.29	18,738.91
L080940	TEAMSTER	252.24	1.00	Each (hourly)	U.S. Dollar	51.00	12,863.23

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.7	1.00	Lump Sum	Solar Array Retirement	0.01	Detail	U.S. Dollar	7,854,071.11	7,854,071.11
3.7.1	10,560.00	Linear Feet	Fence Removal	5,189.45	Detail	U.S. Dollar	1.31	13,876.80
3.7.1.1	10,560.00	Linear Feet	Fence Removal	5,189.45	Detail	U.S. Dollar	1.03	10,876.80

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	61.05	3.00	Each (hourly)	U.S. Dollar	51.00	3,113.15
L060100	GENERAL LABORER	122.09	6.00	Each (hourly)	U.S. Dollar	46.97	5,734.75
RBACKH09	Deere 710J BACKHOE, 1.62CY	61.05	3.00	Each (hourly)	U.S. Dollar	33.24	2,028.90

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.7.1.2	2.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	3,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		3,000.00	Each	U.S. Dollar	1.00	3,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.7.2	656,256.00	Each	Solar Panel Removal & Disposal	10,000.00	Detail	U.S. Dollar	7.17	4,708,588.14
3.7.2.1	656,256.00	Each	Solar Panel Removal	10,000.00	Detail	U.S. Dollar	3.07	2,017,928.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	6,562.56	10.00	Each (hourly)	U.S. Dollar	21.65	142,046.61
L010101	OPERATOR	6,562.56	10.00	Each (hourly)	U.S. Dollar	51.00	334,664.31
L060100	GENERAL LABORER	32,812.80	50.00	Each (hourly)	U.S. Dollar	46.97	1,541,217.22

Notes: **
Assumed production: 20 panels per laborer per hour,
Includes packaging and preparing for shipment offsite.
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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.7.2.2	875.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,312,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,312,500.00	Each	U.S. Dollar	1.00	1,312,500.00

Notes: **************************************
Assumption: 45,000 lbs per load
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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.7.2.3	19,688.00	Ton	Recycling Cost	0.00	Detail	U.S. Dollar	70.00	1,378,160.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,378,160.00	Each	U.S. Dollar	1.00	1,378,160.00

Notes: **
Assumption: 60 lbs each
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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.7.3	1.00	Lump Sum	Solar Rack (Trackers) & Post Removal	0.01	Detail	U.S. Dollar	3,131,606.18	3,131,606.18
3.7.3.1	10,938.00	Each	Solar Rack (Trackers) & Post Removal	160.00	Detail	U.S. Dollar	252.98	2,767,106.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10,938.00	16.00	Each (hourly)	U.S. Dollar	51.00	557,794.25
L060100	GENERAL LABORER	10,938.00	16.00	Each (hourly)	U.S. Dollar	46.97	513,757.86
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5,469.00	8.00	Each (hourly)	U.S. Dollar	124.54	681,081.92
*REXCAV06E	Excav 100K w/ Shear	5,469.00	8.00	Each (hourly)	U.S. Dollar	185.50	1,014,472.16

Notes: ***
Assumed production: .5 hour per rack per crew. Crew to include
1 excavator w/shear, 1 excavator w/grapple, 2 operators and 2
laborers. Includes post removal and sizing of steel for sale as scrap,
and loadout to haul trucks.
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CBS Position Code	Quantity	UM	Cost Item Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.7.3.2	243.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	364,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		364,500.00	Each	U.S. Dollar	1.00	364,500.00

Notes: **************************************

Assumption: 45,000 lbs per load

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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.8	54.00	Each	Inverter / Transformer Removal	1.00	Detail	U.S. Dollar	3,143.21	169,733.07
3.8.1	54.00	Each	Disconnect Electrical	2.00	Detail	U.S. Dollar	592.13	31,974.75

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	270.00	1.00	Each (hourly)	U.S. Dollar	60.39	16,305.30
L060100	GENERAL LABORER	270.00	1.00	Each (hourly)	U.S. Dollar	46.97	12,681.90
RPUTRK05	F-250 4X4 3/4 TON PICKUP	270.00	1.00	Each (hourly)	U.S. Dollar	11.07	2,987.55

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.8.2	54.00	Each	Loadout Inverter & Transformer	2.00	Detail	U.S. Dollar	1,051.08	56,758.32

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	540.00	2.00	Each (hourly)	U.S. Dollar	46.97	25,363.80
L010101	OPERATOR	270.00	1.00	Each (hourly)	U.S. Dollar	51.00	13,768.92
RHYDCR06	GROVE RT880 73 TON	270.00	1.00	Each (hourly)	U.S. Dollar	65.28	17,625.60

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.8.3	54.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	81,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		81,000.00	Each	U.S. Dollar	1.00	81,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.9	105,665.00	Cubic Yard	Remove Inverter / Transformer / BESS Foundations	73.68	Detail	U.S. Dollar	28.05	2,963,385.49
3.9.1	105,665.00	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	1,639,550.97

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	3,773.75	1.00	Each (hourly)	U.S. Dollar	46.97	177,253.04
L010101	OPERATOR	7,547.50	2.00	Each (hourly)	U.S. Dollar	51.00	384,892.31
*REXCAV06C	Excav 100K w/ Hammer	3,773.75	1.00	Each (hourly)	U.S. Dollar	160.97	607,441.67
*REXCAV06A	Excav 100K w/ Bucket & Grapple	3,773.75	1.00	Each (hourly)	U.S. Dollar	124.54	469,963.96

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.9.2	105,665.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	1,323,834.52

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	10,566.50	1.00	Each (hourly)	U.S. Dollar	74.29	784,985.29
L080940	TEAMSTER	10,566.50	1.00	Each (hourly)	U.S. Dollar	51.00	538,849.23

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.10	1.00	Lump Sum	Site Restoration - Partial Site Seeding	0.03	Detail	U.S. Dollar	496,116.24	496,116.24
3.10.1	38,544.00	Linear Feet	Site Roads - Removal & Restoration	5,000.00	Detail	U.S. Dollar	1.63	62,928.24

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	308.35	4.00	Each (hourly)	U.S. Dollar	58.34	17,987.71
L010101	OPERATOR	539.62	7.00	Each (hourly)	U.S. Dollar	51.00	27,518.26
RDUTRK06	CAT D350D, 18CY-24CY	154.18	2.00	Each (hourly)	U.S. Dollar	74.29	11,453.74
*RFELWH08C	CAT 980 LOADER	77.09	1.00	Each (hourly)	U.S. Dollar	77.43	5,968.54

Notes: *************************************

Assume topsoil for restoration available onsite.

****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.10.2	8.00	Each	Remove CONEX Storage & Gravel Pads	6.00	Detail	U.S. Dollar	750.46	6,003.65
3.10.2.1	8.00	Each	Remove & Load CONEX	12.00	Detail	U.S. Dollar	81.53	652.24

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

L010101	OPERATOR	6.67	1.00	Each (hourly)	U.S. Dollar	51.00	339.97
RHYDCR05	GROVE RT600E 40 TON	6.67	1.00	Each (hourly)	U.S. Dollar	46.84	312.27

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.10.2.2	8.00	Each	Remove CONEX Gravel Pads	12.00	Detail	U.S. Dollar	168.93	1,351.41

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	6.67	1.00	Each (hourly)	U.S. Dollar	51.00	339.97
RDUTRK06	CAT D350D, 18CY-24CY	6.67	1.00	Each (hourly)	U.S. Dollar	74.29	495.27
*RFELWH08C	CAT 980 LOADER	6.67	1.00	Each (hourly)	U.S. Dollar	77.43	516.17

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.10.2.3	8.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	500.00	4,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		4,000.00	Each	U.S. Dollar	1.00	4,000.00

Notes: ***

Assumption: CONEX containers will be accepted locally
for re-use, and will only require local transport
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.10.3	398.00	Acre	Spot Grade Disturbed Areas	16.00	Detail	U.S. Dollar	273.33	108,784.35

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	995.00	4.00	Each (hourly)	U.S. Dollar	58.34	58,043.33
L010101	OPERATOR	995.00	4.00	Each (hourly)	U.S. Dollar	51.00	50,741.02

Notes: ***

Assume that 35% of the area distrubed by construction
will be regraded.
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.10.4	398.00	Acre	Re-Seed With Native Vegetation - Roads & Areas Disturbed By Construction	0.00	Detail	U.S. Dollar	800.00	318,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		398.00	Acre	U.S. Dollar	800.00	318,400.00

Notes: ***

Assume that 35% of the area distrubed by construction
will be re-seeded.
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.11	1.00	Lump Sum	Contractor Markups	0.00	Detail	U.S. Dollar	3,322,021.85	3,322,021.85
3.11.1	1.00	Lump Sum	Home Office, Project Management (5% Of Cost)	0.00	Detail	U.S. Dollar	800,487.20	800,487.20

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USMARKUP5	5% Markup		16,009,744.00	Each	U.S. Dollar	0.05	800,487.20

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.11.2	1.00	Lump Sum	Contractor OH & Fee (15% Of Cost)	0.00	Detail	U.S. Dollar	2,521,534.65	2,521,534.65

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USMARKUP	15% Markup		16,810,231.00	Each	U.S. Dollar	0.15	2,521,534.65

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.12	1.00	Lump Sum	ODOE Applied Contingencies	0.00	Detail	U.S. Dollar	4,059,670.65	4,059,670.65
3.12.1	1.00	Lump Sum	1% Performance Bond	0.00	Detail	U.S. Dollar	193,317.65	193,317.65

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE1	ODOE 1% Markup		19,331,765.00	Each	U.S. Dollar	0.01	193,317.65

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.12.2	1.00	Lump Sum	10% Administrative and Project Management	0.00	Detail	U.S. Dollar	1,933,176.50	1,933,176.50

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		19,331,765.00	Each	U.S. Dollar	0.10	1,933,176.50

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
3.12.3	1.00	Lump Sum	10% Future Development Contingency	0.00	Detail	U.S. Dollar	1,933,176.50	1,933,176.50

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		19,331,765.00	Each	U.S. Dollar	0.10	1,933,176.50

Report Total:	23,391,436.10

Category	Total
Labor	5,687,875.21
Rented Equipment	4,345,345.79
Supplies	43,237.60
Materials	20,000.00
Subcontract	9,128,106.85
Travel-Risk-Adj	105,000.00
ODCs	4,061,870.65

Sunstone Solar Project 4

Estimate Summary
TETRA TECH, INC.
Job Code: Sunstone solar
Description: Decommissioning Estimate

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4	1.00	Each	SUNSTONE SOLAR RETIREMENT - SUNSTONE SOLAR 4	0.00	Detail	U.S. Dollar	23,420,740.28	23,420,740.28
4.1	1.00	Lump Sum	Equipment & Facilities Mob / Demob	0.10	Detail	U.S. Dollar	218,136.80	218,136.80
4.1.1	1.00	Lump Sum	Equipment Mob	0.00	Detail	U.S. Dollar	81,200.00	81,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UERNTRLG	Rental Equip Transp-Large		8.00	Each	U.S. Dollar	10,000.00	80,000.00
UERNTRSM	Rental Equip Transp-Small		8.00	Each	U.S. Dollar	150.00	1,200.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.1.2	1.00	Lump Sum	Site Facilities	0.00	Detail	U.S. Dollar	2,200.00	2,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UOCONMOB	Connex Box Mob		2.00	Each	U.S. Dollar	300.00	600.00
UOTRLTRN	Trailer Trnsp/Setup/Trdwn		2.00	Each	U.S. Dollar	800.00	1,600.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.1.3	5.00	Day	Crew Mob & Site Setup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.1.4	5.00	Day	Crew Demob & Site Cleanup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.2	4.00	Month	Project Site Support	0.05	Detail	U.S. Dollar	71,469.70	285,878.80
4.2.1	4.00	Month	Site Facilities	0.00	Detail	U.S. Dollar	1,755.00	7,020.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
URCONNEX	Connex Box		8.00	Month	U.S. Dollar	150.00	1,200.00
UROFFTRL	Office Trailer -12x60		4.00	Month	U.S. Dollar	500.00	2,000.00
UO1STAID	1st Aid Supplies		4.00	Month	U.S. Dollar	300.00	1,200.00
UOOFFSUP	Office Supplies($/prs/mo)		4.00	Month	U.S. Dollar	55.00	220.00
URPRTAJH	Port-a-John Unit(s) (4)		8.00	Month	U.S. Dollar	300.00	2,400.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.2.2	4.00	Month	Field Management	0.05	Detail	U.S. Dollar	69,714.70	278,858.80

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L90FXX02	Field - Proj Superintendent	880.00	1.00	Each (hourly)	U.S. Dollar	114.95	101,156.00
RPUTRK05	F-250 4X4 3/4 TON PICKUP	2,640.00	3.00	Each (hourly)	U.S. Dollar	11.07	29,211.60
L90FEL00	Field - Engr. Tech	880.00	1.00	Each (hourly)	U.S. Dollar	64.24	56,531.20
L90FXX03	Field - SHSO	880.00	1.00	Each (hourly)	U.S. Dollar	104.50	91,960.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3	1.00	Each	Substation Retirement	0.04	Detail	U.S. Dollar	170,429.15	170,429.15
4.3.1	1.00	Day	Fence Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3.2	1.00	Each	Transformer Removal	0.17	Detail	U.S. Dollar	102,309.50	102,309.50
4.3.2.1	1.00	Each	Oil Removal & Disposal	1.00	Detail	U.S. Dollar	66,314.40	66,314.40

			Cost Item					
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3.2.1.1	1.00	Each	Oil Removal	1.00	Detail	U.S. Dollar	939.40	939.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3.2.1.2	16,000.00	Gallon	Oil Disposal	0.00	Detail	U.S. Dollar	4.00	64,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		64,000.00	Each	U.S. Dollar	1.00	64,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3.2.1.3	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	1,375.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,375.00	Each	U.S. Dollar	1.00	1,375.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3.2.2	1.00	Each	Dismantle & Loadout Transformer	0.20	Detail	U.S. Dollar	35,995.10	35,995.10
4.3.2.2.1	1.00	Each	Dismantle, Cut & Size	0.20	Detail	U.S. Dollar	29,995.10	29,995.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	200.00	4.00	Each (hourly)	U.S. Dollar	46.97	9,394.00
L010101	OPERATOR	100.00	2.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*REXCAV06A	Excav 100K w/ Bucket & Grapple	50.00	1.00	Each (hourly)	U.S. Dollar	124.54	6,226.75
*REXCAV06E	Excav 100K w/ Shear	50.00	1.00	Each (hourly)	U.S. Dollar	185.50	9,274.75

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3.2.2.2	4.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	6,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		6,000.00	Each	U.S. Dollar	1.00	6,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3.3	1.00	Each	Remove Control Building	2.00	Detail	U.S. Dollar	2,612.51	2,612.51
4.3.3.1	1.00	Each	Demo	2.00	Detail	U.S. Dollar	1,112.51	1,112.51

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	5.00	1.00	Each (hourly)	U.S. Dollar	46.97	234.85
L010101	OPERATOR	5.00	1.00	Each (hourly)	U.S. Dollar	51.00	254.98
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5.00	1.00	Each (hourly)	U.S. Dollar	124.54	622.68

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3.3.2	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3.4	1.00	Day	UG Utility & Ground Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.3.5	1,000.00	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	28,045.10
4.3.5.1	1,000.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	280.00	Detail	U.S. Dollar	15.52	15,516.50

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	35.71	1.00	Each (hourly)	U.S. Dollar	46.97	1,677.50
L010101	OPERATOR	71.43	2.00	Each (hourly)	U.S. Dollar	51.00	3,642.57
*REXCAV06C	Excav 100K w/ Hammer	35.71	1.00	Each (hourly)	U.S. Dollar	160.97	5,748.75

			Cost Item					
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

*REXCAV06A	Excav 100K w/ Bucket & Grapple	35.71	1.00	Each (hourly)	U.S. Dollar	124.54	4,447.68

4.3.5.2	1,000.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	12,528.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	100.00	1.00	Each (hourly)	U.S. Dollar	74.29	7,429.00
L080940	TEAMSTER	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60

4.3.6	1.00	Each	Misc. Material Disposal	0.00	Detail	U.S. Dollar	2,900.00	2,900.00
4.3.6.1	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

4.3.6.2	20.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,400.00	Each	U.S. Dollar	1.00	1,400.00

4.3.7	1.00	Each	Restore Yard	0.23	Detail	U.S. Dollar	31,938.02	31,938.02
4.3.7.1	1.60	Acre	Remove Aggregate / Backfill / Regrade	1.60	Detail	U.S. Dollar	2,062.47	3,299.96

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40
L010101	OPERATOR	20.00	2.00	Each (hourly)	U.S. Dollar	51.00	1,019.92
REXCAV06B	Gradall - Excavator	10.00	1.00	Each (hourly)	U.S. Dollar	75.73	757.29
*RDOZER08	CAT D6 LGP Dozer	10.00	1.00	Each (hourly)	U.S. Dollar	58.34	583.35

4.3.7.2	1,000.00	Cubic Yard	Vegetative Cover	300.00	Detail	U.S. Dollar	27.36	27,358.07
4.3.7.2.1	1,000.00	Cubic Yard	Topsoil, Delivered	0.00	Detail	U.S. Dollar	20.00	20,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
IMSOIL	Topsoil		1,000.00	Cubic Yard	U.S. Dollar	20.00	20,000.00

4.3.7.2.2	1,000.00	Cubic Yard	Placement	300.00	Detail	U.S. Dollar	7.36	7,358.07

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	66.67	2.00	Each (hourly)	U.S. Dollar	51.00	3,399.73
RDOZER08	CAT D6N XL	66.67	2.00	Each (hourly)	U.S. Dollar	59.38	3,958.33

4.3.7.3	1.60	Acre	Re-Seed With Native Vegetation	0.00	Detail	U.S. Dollar	800.00	1,280.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		1.60	Acre	U.S. Dollar	800.00	1,280.00

4.4	1.00	Lump Sum	Collector Line Retirement	0.07	Detail	U.S. Dollar	46,946.45	46,946.45
4.4.1	5,850.00	Linear Feet	Conductor Removal	585.00	Detail	U.S. Dollar	5.50	32,154.10
4.4.1.1	1.00	Lump Sum	Cut / Lower Cable, Size & Loadout	0.10	Detail	U.S. Dollar	31,404.10	31,404.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	400.00	4.00	Each (hourly)	U.S. Dollar	46.97	18,788.00
L010101	OPERATOR	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*RXMISC14	MAN LIFT GAS 125ft	100.00	1.00	Each (hourly)	U.S. Dollar	53.52	5,352.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	100.00	1.00	Each (hourly)	U.S. Dollar	21.65	2,164.50

4.4.1.2	0.50	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	750.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		750.00	Each	U.S. Dollar	1.00	750.00

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.4.2	26.00	Each	Utility Pole Removal	5.00	Detail	U.S. Dollar	568.94	14,792.35
4.4.2.1	26.00	Each	Cut / Lower Pole	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00	Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00	Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00	Each (hourly)	U.S. Dollar	46.84	1,217.84

4.4.2.2	26.00	Each	Size & Loadout	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00	Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00	Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00	Each (hourly)	U.S. Dollar	46.84	1,217.84

4.4.2.3	2.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	3,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		3,000.00	Each	U.S. Dollar	1.00	3,000.00

4.4.2.4	26.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,820.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,820.00	Each	U.S. Dollar	1.00	1,820.00

Notes: **

Assumption: 101 poles x 2000' per pole

****

4.5	1,200.00	MW	DC Storage Retirement	2.47	Detail	U.S. Dollar	3,148.02	3,777,627.74
4.5.1	1,200.00	MW	Battery Removal & Disposal	5.00	Detail	U.S. Dollar	2,044.07	2,452,881.60
4.5.1.1	240.00	Day	Remove Batteries, Load For Transport	1.00	Detail	U.S. Dollar	3,251.10	780,264.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	14,400.00	6.00	Each (hourly)	U.S. Dollar	46.97	676,368.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	4,800.00	2.00	Each (hourly)	U.S. Dollar	21.65	103,896.00

4.5.1.2	396.00	Each	Transport Batteries	0.00	Detail	U.S. Dollar	1,605.60	635,817.60
4.5.1.2.1	396.00	Each	Roll Off Liners	0.00	Detail	U.S. Dollar	105.60	41,817.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODCLINER	Rolloff Liner		396.00	Each	U.S. Dollar	105.60	41,817.60

4.5.1.2.2	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	594,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		594,000.00	Each	U.S. Dollar	1.00	594,000.00

4.5.1.3	5,184.00	Ton	Disposal Fee's	0.00	Detail	U.S. Dollar	200.00	1,036,800.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,036,800.00	Each	U.S. Dollar	1.00	1,036,800.00

4.5.2	1,200.00	MW	Structure & Components Removal	4.90	Detail	U.S. Dollar	1,103.96	1,324,746.14
4.5.2.1	120.00	Day	Refrigerant Recovery	1.00	Detail	U.S. Dollar	1,207.80	144,936.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	2,400.00	2.00	Each (hourly)	U.S. Dollar	60.39	144,936.00

4.5.2.2	3,936.00	Ton	Structure Demo	43.33	Detail	U.S. Dollar	116.76	459,569.18

Cost Item CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*REXCAV06A	Excav 100K w/ Bucket & Grapple	908.31	1.00	Each (hourly)	U.S. Dollar	124.54	113,116.10
*REXCAV06E	Excav 100K w/ Shear	908.31	1.00	Each (hourly)	U.S. Dollar	185.50	168,486.54
L010101	OPERATOR	1,816.62	2.00	Each (hourly)	U.S. Dollar	51.00	92,640.12
L060100	GENERAL LABORER	1,816.62	2.00	Each (hourly)	U.S. Dollar	46.97	85,326.42

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.5.2.3	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	544,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		544,500.00	Each	U.S. Dollar	1.00	544,500.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.5.2.4	105,000.00	Gallon	Glycol Recovery & Disposal	0.00	Detail	U.S. Dollar	1.00	105,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLIQUID	Liquids T&D		105,000.00	Each	U.S. Dollar	1.00	105,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.5.2.5	2,522.40	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	70,740.96
4.5.2.5.1	2,522.40	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	39,138.82

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	90.09	1.00	Each (hourly)	U.S. Dollar	46.97	4,231.33
L010101	OPERATOR	180.17	2.00	Each (hourly)	U.S. Dollar	51.00	9,188.02
*REXCAV06C	Excav 100K w/ Hammer	90.09	1.00	Each (hourly)	U.S. Dollar	160.97	14,500.65
*REXCAV06A	Excav 100K w/ Bucket & Grapple	90.09	1.00	Each (hourly)	U.S. Dollar	124.54	11,218.82

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.5.2.5.2	2,522.40	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	31,602.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	252.24	1.00	Each (hourly)	U.S. Dollar	74.29	18,738.91
L080940	TEAMSTER	252.24	1.00	Each (hourly)	U.S. Dollar	51.00	12,863.23

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.6	1.00	Lump Sum	Solar Array Retirement	0.01	Detail	U.S. Dollar	7,858,807.75	7,858,807.75
4.6.1	14,256.00	Linear Feet	Fence Removal	5,399.12	Detail	U.S. Dollar	1.31	18,613.44
4.6.1.1	14,256.00	Linear Feet	Fence Removal	5,399.12	Detail	U.S. Dollar	0.99	14,113.44

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	79.21	3.00	Each (hourly)	U.S. Dollar	51.00	4,039.54
L060100	GENERAL LABORER	158.43	6.00	Each (hourly)	U.S. Dollar	46.97	7,441.26
RBACKH09	Deere 710J BACKHOE, 1.62CY	79.21	3.00	Each (hourly)	U.S. Dollar	33.24	2,632.64

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.6.1.2	3.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	4,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		4,500.00	Each	U.S. Dollar	1.00	4,500.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.6.2	656,256.00	Each	Solar Panel Removal & Disposal	10,000.00	Detail	U.S. Dollar	7.17	4,708,588.14
4.6.2.1	656,256.00	Each	Solar Panel Removal	10,000.00	Detail	U.S. Dollar	3.07	2,017,928.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	6,562.56	10.00	Each (hourly)	U.S. Dollar	21.65	142,046.61
L010101	OPERATOR	6,562.56	10.00	Each (hourly)	U.S. Dollar	51.00	334,664.31
L060100	GENERAL LABORER	32,812.80	50.00	Each (hourly)	U.S. Dollar	46.97	1,541,217.22

Notes: **
Assumed production: 20 panels per laborer per hour,
Includes packaging and preparing for shipment offsite.
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.6.2.2	875.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,312,500.00

CBS Position Code	Quantity	UM	Cost Item Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,312,500.00	Each	U.S. Dollar	1.00	1,312,500.00

Notes: **************************************

Assumption: 45,000 lbs per load

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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.6.2.3	19,688.00	Ton	Recycling Cost	0.00	Detail	U.S. Dollar	70.00	1,378,160.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,378,160.00	Each	U.S. Dollar	1.00	1,378,160.00

Notes: **

Assumption: 60 lbs each

****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.6.3	1.00	Lump Sum	Solar Rack (Trackers) & Post Removal	0.01	Detail	U.S. Dollar	3,131,606.18	3,131,606.18
4.6.3.1	10,938.00	Each	Solar Rack (Trackers) & Post Removal	160.00	Detail	U.S. Dollar	252.98	2,767,106.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10,938.00	16.00	Each (hourly)	U.S. Dollar	51.00	557,794.25
L060100	GENERAL LABORER	10,938.00	16.00	Each (hourly)	U.S. Dollar	46.97	513,757.86
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5,469.00	8.00	Each (hourly)	U.S. Dollar	124.54	681,081.92
*REXCAV06E	Excav 100K w/ Shear	5,469.00	8.00	Each (hourly)	U.S. Dollar	185.50	1,014,472.16

Notes: ***

Assumed production: .5 hour per rack per crew. Crew to include 1 excavator w/shear, 1 excavator w/grapple, 2 operators and 2 laborers. Includes post removal and sizing of steel for sale as scrap, and loadout to haul trucks.

****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.6.3.2	243.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	364,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		364,500.00	Each	U.S. Dollar	1.00	364,500.00

Notes: **************************************

Assumption: 45,000 lbs per load

****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.7	54.00	Each	Inverter / Transformer Removal	1.00	Detail	U.S. Dollar	3,143.21	169,733.07
4.7.1	54.00	Each	Disconnect Electrical	2.00	Detail	U.S. Dollar	592.13	31,974.75

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	270.00	1.00	Each (hourly)	U.S. Dollar	60.39	16,305.30
L060100	GENERAL LABORER	270.00	1.00	Each (hourly)	U.S. Dollar	46.97	12,681.90
RPUTRK05	F-250 4X4 3/4 TON PICKUP	270.00	1.00	Each (hourly)	U.S. Dollar	11.07	2,987.55

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.7.2	54.00	Each	Loadout Inverter & Transformer	2.00	Detail	U.S. Dollar	1,051.08	56,758.32

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	540.00	2.00	Each (hourly)	U.S. Dollar	46.97	25,363.80
L010101	OPERATOR	270.00	1.00	Each (hourly)	U.S. Dollar	51.00	13,768.92
RHYDCR06	GROVE RT880 73 TON	270.00	1.00	Each (hourly)	U.S. Dollar	65.28	17,625.60

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.7.3	54.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	81,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		81,000.00	Each	U.S. Dollar	1.00	81,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.8	105,665.00	Cubic Yard	Remove Inverter / Transformer / BESS Foundations	73.68	Detail	U.S. Dollar	28.05	2,963,385.49
4.8.1	105,665.00	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	1,639,550.97

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost

				Cost Item				
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

L060100	GENERAL LABORER	3,773.75	1.00 Each (hourly)	U.S. Dollar	46.97	177,253.04
L010101	OPERATOR	7,547.50	2.00 Each (hourly)	U.S. Dollar	51.00	384,892.31
*REXCAV06C	Excav 100K w/ Hammer	3,773.75	1.00 Each (hourly)	U.S. Dollar	160.97	607,441.67
*REXCAV06A	Excav 100K w/ Bucket & Grapple	3,773.75	1.00 Each (hourly)	U.S. Dollar	124.54	469,963.96

4.8.2	105,665.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	1,323,834.52

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	10,566.50	1.00 Each (hourly)	U.S. Dollar	74.29	784,985.29
L080940	TEAMSTER	10,566.50	1.00 Each (hourly)	U.S. Dollar	51.00	538,849.23

4.9	1.00	Lump Sum	Site Restoration - Partial Site Seeding	0.03	Detail	U.S. Dollar	538,854.88	538,854.88

4.9.1	41,712.00	Linear Feet	Site Roads - Removal & Restoration	5,000.00	Detail	U.S. Dollar	1.63	68,100.43

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	333.70	4.00 Each (hourly)	U.S. Dollar	58.34	19,466.16
L010101	OPERATOR	583.97	7.00 Each (hourly)	U.S. Dollar	51.00	29,780.03
RDUTRK06	CAT D350D, 18CY-24CY	166.85	2.00 Each (hourly)	U.S. Dollar	74.29	12,395.14
*RFELWH08C	CAT 980 LOADER	83.42	1.00 Each (hourly)	U.S. Dollar	77.43	6,459.10

Notes: *************************************

Assume topsoil for restoration available onsite.

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4.9.2	8.00	Each	Remove CONEX Storage & Gravel Pads	6.00	Detail	U.S. Dollar	750.46	6,003.65

4.9.2.1	8.00	Each	Remove & Load CONEX	12.00	Detail	U.S. Dollar	81.53	652.24

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	6.67	1.00 Each (hourly)	U.S. Dollar	51.00	339.97
RHYDCR05	GROVE RT600E 40 TON	6.67	1.00 Each (hourly)	U.S. Dollar	46.84	312.27

4.9.2.2	8.00	Each	Remove CONEX Gravel Pads	12.00	Detail	U.S. Dollar	168.93	1,351.41

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	6.67	1.00 Each (hourly)	U.S. Dollar	51.00	339.97
RDUTRK06	CAT D350D, 18CY-24CY	6.67	1.00 Each (hourly)	U.S. Dollar	74.29	495.27
*RFELWH08C	CAT 980 LOADER	6.67	1.00 Each (hourly)	U.S. Dollar	77.43	516.17

4.9.2.3	8.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	500.00	4,000.00

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		4,000.00 Each	U.S. Dollar	1.00	4,000.00

Notes: **

Assumption: CONEX containers will be accepted locally
for re-use, and will only require local transport

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4.9.3	433.00	Acre	Spot Grade Disturbed Areas	16.00	Detail	U.S. Dollar	273.33	118,350.81

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	1,082.50	4.00 Each (hourly)	U.S. Dollar	58.34	63,147.64
L010101	OPERATOR	1,082.50	4.00 Each (hourly)	U.S. Dollar	51.00	55,203.17

Notes: **

Assume that 35% of the area distrubed by construction
will be regraded.

****

4.9.4	433.00	Acre	Re-Seed With Native Vegetation - Roads & Areas Disturbed By Construction	0.00	Detail	U.S. Dollar	800.00	346,400.00

Resource Code	Description	Hours	Quantity UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		433.00 Acre	U.S. Dollar	800.00	346,400.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

Notes: ***
Assume that 35% of the area distrubed by construction
will be re-seeded.
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.10	1.00	Lump Sum	Contractor Markups	0.00	Detail	U.S. Dollar	3,326,183.50	3,326,183.50
4.10.1	1.00	Lump Sum	Home Office, Project Management (5% Of Cost)	0.00	Detail	U.S. Dollar	801,490.00	801,490.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USMARKUP5	5% Markup		16,029,800.00	Each	U.S. Dollar	0.05	801,490.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.10.2	1.00	Lump Sum	Contractor OH & Fee (15% Of Cost)	0.00	Detail	U.S. Dollar	2,524,693.50	2,524,693.50

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USMARKUP	15% Markup		16,831,290.00	Each	U.S. Dollar	0.15	2,524,693.50

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.11	1.00	Lump Sum	ODOE Applied Contingencies	0.00	Detail	U.S. Dollar	4,064,756.64	4,064,756.64
4.11.1	1.00	Lump Sum	1% Performance Bond	0.00	Detail	U.S. Dollar	193,559.84	193,559.84

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE1	ODOE 1% Markup		19,355,984.00	Each	U.S. Dollar	0.01	193,559.84

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.11.2	1.00	Lump Sum	10% Administrative and Project Management	0.00	Detail	U.S. Dollar	1,935,598.40	1,935,598.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		19,355,984.00	Each	U.S. Dollar	0.10	1,935,598.40

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
4.11.3	1.00	Lump Sum	10% Future Development Contingency	0.00	Detail	U.S. Dollar	1,935,598.40	1,935,598.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		19,355,984.00	Each	U.S. Dollar	0.10	1,935,598.40

Report Total:	23,420,740.28

Category	Total
Labor	5,688,714.35
Rented Equipment	4,340,463.18
Supplies	43,237.60
Materials	20,000.00
Subcontract	9,156,368.50
Travel-Risk-Adj	105,000.00
ODCs	4,066,956.64

Sunstone Solar Project 5

Estimate Summary

TETRA TECH, INC.

Job Code: Sunstone solar

Description: Decommissioning Estimate

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5	1.00	Each	SUNSTONE SOLAR RETIREMENT - SUNSTONE SOLAR 5	0.00	Detail	U.S. Dollar	24,974,952.51	24,974,952.51
5.1	1.00	Lump Sum	Equipment & Facilities Mob / Demob	0.10	Detail	U.S. Dollar	218,136.80	218,136.80
5.1.1	1.00	Lump Sum	Equipment Mob	0.00	Detail	U.S. Dollar	81,200.00	81,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UERNTRLG	Rental Equip Transp-Large		8.00	Each	U.S. Dollar	10,000.00	80,000.00
UERNTRSM	Rental Equip Transp-Small		8.00	Each	U.S. Dollar	150.00	1,200.00

5.1.2	1.00	Lump Sum	Site Facilities	0.00	Detail	U.S. Dollar	2,200.00	2,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UOCONMOB	Connex Box Mob		2.00	Each	U.S. Dollar	300.00	600.00
UOTRLTRN	Trailer Trnsp/Setup/Trdwn		2.00	Each	U.S. Dollar	800.00	1,600.00

5.1.3	5.00	Day	Crew Mob & Site Setup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

5.1.4	5.00	Day	Crew Demob & Site Cleanup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

5.2	4.00	Month	Project Site Support	0.05	Detail	U.S. Dollar	71,469.70	285,878.80
5.2.1	4.00	Month	Site Facilities	0.00	Detail	U.S. Dollar	1,755.00	7,020.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
URCONNEX	Connex Box		8.00	Month	U.S. Dollar	150.00	1,200.00
UROFFTRL	Office Trailer -12x60		4.00	Month	U.S. Dollar	500.00	2,000.00
UO1STAID	1st Aid Supplies		4.00	Month	U.S. Dollar	300.00	1,200.00
UOOFFSUP	Office Supplies($/prs/mo)		4.00	Month	U.S. Dollar	55.00	220.00
URPRTAJH	Port-a-John Unit(s) (4)		8.00	Month	U.S. Dollar	300.00	2,400.00

5.2.2	4.00	Month	Field Management	0.05	Detail	U.S. Dollar	69,714.70	278,858.80

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L90FXX02	Field - Proj Superintendent	880.00	1.00	Each (hourly)	U.S. Dollar	114.95	101,156.00
RPUTRK05	F-250 4X4 3/4 TON PICKUP	2,640.00	3.00	Each (hourly)	U.S. Dollar	11.07	29,211.60
L90FEL00	Field - Engr. Tech	880.00	1.00	Each (hourly)	U.S. Dollar	64.24	56,531.20
L90FXX03	Field - SHSO	880.00	1.00	Each (hourly)	U.S. Dollar	104.50	91,960.00

5.3	1.00	Each	Substation Retirement	0.04	Detail	U.S. Dollar	170,429.15	170,429.15
5.3.1	1.00	Day	Fence Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

5.3.2	1.00	Each	Transformer Removal	0.17	Detail	U.S. Dollar	102,309.50	102,309.50
5.3.2.1	1.00	Each	Oil Removal & Disposal	1.00	Detail	U.S. Dollar	66,314.40	66,314.40

Cost Item CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.3.2.1.1	1.00	Each	Oil Removal	1.00	Detail	U.S. Dollar	939.40	939.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40

5.3.2.1.2	16,000.00	Gallon	Oil Disposal	0.00	Detail	U.S. Dollar	4.00	64,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		64,000.00	Each	U.S. Dollar	1.00	64,000.00

5.3.2.1.3	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	1,375.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,375.00	Each	U.S. Dollar	1.00	1,375.00

5.3.2.2	1.00	Each	Dismantle & Loadout Transformer	0.20	Detail	U.S. Dollar	35,995.10	35,995.10

5.3.2.2.1	1.00	Each	Dismantle, Cut & Size	0.20	Detail	U.S. Dollar	29,995.10	29,995.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	200.00	4.00	Each (hourly)	U.S. Dollar	46.97	9,394.00
L010101	OPERATOR	100.00	2.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*REXCAV06A	Excav 100K w/ Bucket & Grapple	50.00	1.00	Each (hourly)	U.S. Dollar	124.54	6,226.75
*REXCAV06E	Excav 100K w/ Shear	50.00	1.00	Each (hourly)	U.S. Dollar	185.50	9,274.75

5.3.2.2.2	4.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	6,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		6,000.00	Each	U.S. Dollar	1.00	6,000.00

5.3.3	1.00	Each	Remove Control Building	2.00	Detail	U.S. Dollar	2,612.51	2,612.51

5.3.3.1	1.00	Each	Demo	2.00	Detail	U.S. Dollar	1,112.51	1,112.51

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	5.00	1.00	Each (hourly)	U.S. Dollar	46.97	234.85
L010101	OPERATOR	5.00	1.00	Each (hourly)	U.S. Dollar	51.00	254.98
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5.00	1.00	Each (hourly)	U.S. Dollar	124.54	622.68

5.3.3.2	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

5.3.4	1.00	Day	UG Utility & Ground Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

5.3.5	1,000.00	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	28,045.10

5.3.5.1	1,000.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	280.00	Detail	U.S. Dollar	15.52	15,516.50

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	35.71	1.00	Each (hourly)	U.S. Dollar	46.97	1,677.50
L010101	OPERATOR	71.43	2.00	Each (hourly)	U.S. Dollar	51.00	3,642.57
*REXCAV06C	Excav 100K w/ Hammer	35.71	1.00	Each (hourly)	U.S. Dollar	160.97	5,748.75

				Cost Item				
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

*REXCAV06A	Excav 100K w/ Bucket & Grapple	35.71	1.00	Each (hourly)	U.S. Dollar	124.54	4,447.68

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.3.5.2	1,000.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	12,528.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	100.00	1.00	Each (hourly)	U.S. Dollar	74.29	7,429.00
L080940	TEAMSTER	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.3.6	1.00	Each	Misc. Material Disposal	0.00	Detail	U.S. Dollar	2,900.00	2,900.00
5.3.6.1	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.3.6.2	20.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,400.00	Each	U.S. Dollar	1.00	1,400.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.3.7	1.00	Each	Restore Yard	0.23	Detail	U.S. Dollar	31,938.02	31,938.02
5.3.7.1	1.60	Acre	Remove Aggregate / Backfill / Regrade	1.60	Detail	U.S. Dollar	2,062.47	3,299.96

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40
L010101	OPERATOR	20.00	2.00	Each (hourly)	U.S. Dollar	51.00	1,019.92
REXCAV06B	Gradall - Excavator	10.00	1.00	Each (hourly)	U.S. Dollar	75.73	757.29
*RDOZER08	CAT D6 LGP Dozer	10.00	1.00	Each (hourly)	U.S. Dollar	58.34	583.35

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.3.7.2	1,000.00	Cubic Yard	Vegetative Cover	300.00	Detail	U.S. Dollar	27.36	27,358.07
5.3.7.2.1	1,000.00	Cubic Yard	Topsoil, Delivered	0.00	Detail	U.S. Dollar	20.00	20,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
IMSOIL	Topsoil		1,000.00	Cubic Yard	U.S. Dollar	20.00	20,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.3.7.2.2	1,000.00	Cubic Yard	Placement	300.00	Detail	U.S. Dollar	7.36	7,358.07

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	66.67	2.00	Each (hourly)	U.S. Dollar	51.00	3,399.73
RDOZER08	CAT D6N XL	66.67	2.00	Each (hourly)	U.S. Dollar	59.38	3,958.33

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.3.7.3	1.60	Acre	Re-Seed With Native Vegetation	0.00	Detail	U.S. Dollar	800.00	1,280.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		1.60	Acre	U.S. Dollar	800.00	1,280.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.4	1.00	Each	Switchyard Retirement	0.07	Detail	U.S. Dollar	76,611.39	76,611.39
5.4.1	1.00	Day	Fence Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.4.2	1.00	Day	UG Utility & Ground Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.4.3	1.00	Each	Dismantle & Loadout Racks & Switching	0.50	Detail	U.S. Dollar	13,498.04	13,498.04
5.4.3.1	1.00	Each	Dismantle, Cut & Size	0.50	Detail	U.S. Dollar	11,998.04	11,998.04

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	80.00	4.00	Each (hourly)	U.S. Dollar	46.97	3,757.60
L010101	OPERATOR	40.00	2.00	Each (hourly)	U.S. Dollar	51.00	2,039.84
*REXCAV06A	Excav 100K w/ Bucket & Grapple	20.00	1.00	Each (hourly)	U.S. Dollar	124.54	2,490.70
*REXCAV06E	Excav 100K w/ Shear	20.00	1.00	Each (hourly)	U.S. Dollar	185.50	3,709.90

5.4.3.2	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

5.4.4	284.00	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	7,964.81
5.4.4.1	284.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	280.00	Detail	U.S. Dollar	15.52	4,406.69

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	10.14	1.00	Each (hourly)	U.S. Dollar	46.97	476.41
L010101	OPERATOR	20.29	2.00	Each (hourly)	U.S. Dollar	51.00	1,034.49
*REXCAV06C	Excav 100K w/ Hammer	10.14	1.00	Each (hourly)	U.S. Dollar	160.97	1,632.65
*REXCAV06A	Excav 100K w/ Bucket & Grapple	10.14	1.00	Each (hourly)	U.S. Dollar	124.54	1,263.14

5.4.4.2	284.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	3,558.12

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	28.40	1.00	Each (hourly)	U.S. Dollar	74.29	2,109.84
L080940	TEAMSTER	28.40	1.00	Each (hourly)	U.S. Dollar	51.00	1,448.29

5.4.5	1.00	Each	Misc. Material Disposal	0.00	Detail	U.S. Dollar	2,900.00	2,900.00
5.4.5.1	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

5.4.5.2	20.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,400.00	Each	U.S. Dollar	1.00	1,400.00

5.4.6	1.00	Each	Restore Yard	0.15	Detail	U.S. Dollar	49,624.52	49,624.52
5.4.6.1	3.00	Acre	Remove Aggregate / Backfill / Regrade	1.60	Detail	U.S. Dollar	2,062.47	6,187.42

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	37.50	2.00	Each (hourly)	U.S. Dollar	46.97	1,761.38
L010101	OPERATOR	37.50	2.00	Each (hourly)	U.S. Dollar	51.00	1,912.35
REXCAV06B	Gradall - Excavator	18.75	1.00	Each (hourly)	U.S. Dollar	75.73	1,419.91
*RDOZER08	CAT D6 LGP Dozer	18.75	1.00	Each (hourly)	U.S. Dollar	58.34	1,093.78

5.4.6.2	1,500.00	Cubic Yard	Vegetative Cover	300.00	Detail	U.S. Dollar	27.36	41,037.10
5.4.6.2.1	1,500.00	Cubic Yard	Topsoil, Delivered	0.00	Detail	U.S. Dollar	20.00	30,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
IMSOIL	Topsoil		1,500.00	Cubic Yard	U.S. Dollar	20.00	30,000.00

5.4.6.2.2	1,500.00	Cubic Yard	Placement	300.00	Detail	U.S. Dollar	7.36	11,037.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost

Cost Item CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

L010101	OPERATOR	100.00	2.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
RDOZER08	CAT D6N XL	100.00	2.00	Each (hourly)	U.S. Dollar	59.38	5,937.50

5.4.6.3	3.00	Acre	Re-Seed With Native Vegetation	0.00	Detail	U.S. Dollar	800.00	2,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		3.00	Acre	U.S. Dollar	800.00	2,400.00

5.5	1.00	Lump Sum	Collector Line Retirement	0.07	Detail	U.S. Dollar	46,946.45	46,946.45
5.5.1	5,850.00	Linear Feet	Conductor Removal	585.00	Detail	U.S. Dollar	5.50	32,154.10
5.5.1.1	1.00	Lump Sum	Cut / Lower Cable, Size & Loadout	0.10	Detail	U.S. Dollar	31,404.10	31,404.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	400.00	4.00	Each (hourly)	U.S. Dollar	46.97	18,788.00
L010101	OPERATOR	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*RXMISC14	MAN LIFT GAS 125ft	100.00	1.00	Each (hourly)	U.S. Dollar	53.52	5,352.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	100.00	1.00	Each (hourly)	U.S. Dollar	21.65	2,164.50

5.5.1.2	0.50	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	750.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		750.00	Each	U.S. Dollar	1.00	750.00

5.5.2	26.00	Each	Utility Pole Removal	5.00	Detail	U.S. Dollar	568.94	14,792.35
5.5.2.1	26.00	Each	Cut / Lower Pole	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00	Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00	Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00	Each (hourly)	U.S. Dollar	46.84	1,217.84

5.5.2.2	26.00	Each	Size & Loadout	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00	Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00	Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00	Each (hourly)	U.S. Dollar	46.84	1,217.84

5.5.2.3	2.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	3,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		3,000.00	Each	U.S. Dollar	1.00	3,000.00

5.5.2.4	26.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,820.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,820.00	Each	U.S. Dollar	1.00	1,820.00

Notes: ***

Assumption: 101 poles x 2000' per pole

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5.6	1.00	Each	O&M Building Removal	0.21	Detail	U.S. Dollar	27,418.75	27,418.75
5.6.1	40.00	Ton	Structure Demo	10.00	Detail	U.S. Dollar	505.96	20,238.48

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*REXCAV06A	Excav 100K w/ Bucket & Grapple	40.00	1.00	Each (hourly)	U.S. Dollar	124.54	4,981.40
*REXCAV06E	Excav 100K w/ Shear	40.00	1.00	Each (hourly)	U.S. Dollar	185.50	7,419.80
L010101	OPERATOR	80.00	2.00	Each (hourly)	U.S. Dollar	51.00	4,079.68
L060100	GENERAL LABORER	80.00	2.00	Each (hourly)	U.S. Dollar	46.97	3,757.60

5.6.2	50.00	Cubic Yard	Remove Foundations To Subgrade	71.43	Detail	U.S. Dollar	35.61	1,780.27

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.6.2.1	50.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	250.00	Detail	U.S. Dollar	17.38	868.92

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	2.00	1.00	Each (hourly)	U.S. Dollar	46.97	93.94
L010101	OPERATOR	4.00	2.00	Each (hourly)	U.S. Dollar	51.00	203.98
*REXCAV06C	Excav 100K w/ Hammer	2.00	1.00	Each (hourly)	U.S. Dollar	160.97	321.93
*REXCAV06A	Excav 100K w/ Bucket & Grapple	2.00	1.00	Each (hourly)	U.S. Dollar	124.54	249.07

5.6.2.2	50.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	18.23	911.35

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	5.00	1.00	Each (hourly)	U.S. Dollar	74.29	371.45
L080940	TEAMSTER	5.00	1.00	Each (hourly)	U.S. Dollar	51.00	254.98
L010101	OPERATOR	2.50	0.50	Each (hourly)	U.S. Dollar	51.00	127.49
RFELWH09	CAT 966F LOADER, 4.25CY	2.50	0.50	Each (hourly)	U.S. Dollar	62.97	157.43

5.6.3	40.00	Ton	Material T&D	0.00	Detail	U.S. Dollar	135.00	5,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		2,600.00	Each	U.S. Dollar	1.00	2,600.00
USDISPOSAL	Disposal Fee's		2,800.00	Each	U.S. Dollar	1.00	2,800.00

5.7	1,200.00	MW	DC Storage Retirement	2.47	Detail	U.S. Dollar	3,148.02	3,777,627.74
5.7.1	1,200.00	MW	Battery Removal & Disposal	5.00	Detail	U.S. Dollar	2,044.07	2,452,881.60
5.7.1.1	240.00	Day	Remove Batteries, Load For Transport	1.00	Detail	U.S. Dollar	3,251.10	780,264.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	14,400.00	6.00	Each (hourly)	U.S. Dollar	46.97	676,368.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	4,800.00	2.00	Each (hourly)	U.S. Dollar	21.65	103,896.00

5.7.1.2	396.00	Each	Transport Batteries	0.00	Detail	U.S. Dollar	1,605.60	635,817.60
5.7.1.2.1	396.00	Each	Roll Off Liners	0.00	Detail	U.S. Dollar	105.60	41,817.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODCLINER	Rolloff Liner		396.00	Each	U.S. Dollar	105.60	41,817.60

5.7.1.2.2	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	594,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		594,000.00	Each	U.S. Dollar	1.00	594,000.00

5.7.1.3	5,184.00	Ton	Disposal Fee's	0.00	Detail	U.S. Dollar	200.00	1,036,800.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,036,800.00	Each	U.S. Dollar	1.00	1,036,800.00

5.7.2	1,200.00	MW	Structure & Components Removal	4.90	Detail	U.S. Dollar	1,103.96	1,324,746.14
5.7.2.1	120.00	Day	Refrigerant Recovery	1.00	Detail	U.S. Dollar	1,207.80	144,936.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	2,400.00	2.00	Each (hourly)	U.S. Dollar	60.39	144,936.00

5.7.2.2	3,936.00	Ton	Structure Demo	43.33	Detail	U.S. Dollar	116.76	459,569.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*REXCAV06A	Excav 100K w/ Bucket & Grapple	908.31	1.00	Each (hourly)	U.S. Dollar	124.54	113,116.10
*REXCAV06E	Excav 100K w/ Shear	908.31	1.00	Each (hourly)	U.S. Dollar	185.50	168,486.54
L010101	OPERATOR	1,816.62	2.00	Each (hourly)	U.S. Dollar	51.00	92,640.12

Cost Item CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

L060100	GENERAL LABORER	1,816.62	2.00	Each (hourly)	U.S. Dollar	46.97	85,326.42

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.7.2.3	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	544,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		544,500.00	Each	U.S. Dollar	1.00	544,500.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.7.2.4	105,000.00	Gallon	Glycol Recovery & Disposal	0.00	Detail	U.S. Dollar	1.00	105,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLIQUID	Liquids T&D		105,000.00	Each	U.S. Dollar	1.00	105,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.7.2.5	2,522.40	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	70,740.96
5.7.2.5.1	2,522.40	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	39,138.82

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	90.09	1.00	Each (hourly)	U.S. Dollar	46.97	4,231.33
L010101	OPERATOR	180.17	2.00	Each (hourly)	U.S. Dollar	51.00	9,188.02
*REXCAV06C	Excav 100K w/ Hammer	90.09	1.00	Each (hourly)	U.S. Dollar	160.97	14,500.65
*REXCAV06A	Excav 100K w/ Bucket & Grapple	90.09	1.00	Each (hourly)	U.S. Dollar	124.54	11,218.82

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.7.2.5.2	2,522.40	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	31,602.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	252.24	1.00	Each (hourly)	U.S. Dollar	74.29	18,738.91
L080940	TEAMSTER	252.24	1.00	Each (hourly)	U.S. Dollar	51.00	12,863.23

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.8	1.00	Lump Sum	Solar Array Retirement	0.01	Detail	U.S. Dollar	8,034,997.03	8,034,997.03
5.8.1	148,368.00	Linear Feet	Fence Removal	5,139.55	Detail	U.S. Dollar	1.31	194,802.72
5.8.1.1	148,368.00	Linear Feet	Fence Removal	5,139.55	Detail	U.S. Dollar	1.04	154,302.72

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	866.04	3.00	Each (hourly)	U.S. Dollar	51.00	44,164.43
L060100	GENERAL LABORER	1,732.07	6.00	Each (hourly)	U.S. Dollar	46.97	81,355.54
RBACKH09	Deere 710J BACKHOE, 1.62CY	866.04	3.00	Each (hourly)	U.S. Dollar	33.24	28,782.75

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.8.1.2	27.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	40,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		40,500.00	Each	U.S. Dollar	1.00	40,500.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.8.2	656,256.00	Each	Solar Panel Removal & Disposal	10,000.00	Detail	U.S. Dollar	7.17	4,708,588.14
5.8.2.1	656,256.00	Each	Solar Panel Removal	10,000.00	Detail	U.S. Dollar	3.07	2,017,928.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	6,562.56	10.00	Each (hourly)	U.S. Dollar	21.65	142,046.61
L010101	OPERATOR	6,562.56	10.00	Each (hourly)	U.S. Dollar	51.00	334,664.31
L060100	GENERAL LABORER	32,812.80	50.00	Each (hourly)	U.S. Dollar	46.97	1,541,217.22

Notes: **

Assumed production: 20 panels per laborer per hour,
Includes packaging and preparing for shipment offsite.
****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.8.2.2	875.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,312,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,312,500.00	Each	U.S. Dollar	1.00	1,312,500.00

Notes: **************************************

Assumption: 45,000 lbs per load
****

CBS Position Code	Quantity	UM	Cost Item Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.8.2.3	19,688.00	Ton	Recycling Cost	0.00	Detail	U.S. Dollar	70.00	1,378,160.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,378,160.00	Each	U.S. Dollar	1.00	1,378,160.00

Notes: **

Assumption: 60 lbs each

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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.8.3	1.00	Lump Sum	Solar Rack (Trackers) & Post Removal	0.01	Detail	U.S. Dollar	3,131,606.18	3,131,606.18
5.8.3.1	10,938.00	Each	Solar Rack (Trackers) & Post Removal	160.00	Detail	U.S. Dollar	252.98	2,767,106.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10,938.00	16.00	Each (hourly)	U.S. Dollar	51.00	557,794.25
L060100	GENERAL LABORER	10,938.00	16.00	Each (hourly)	U.S. Dollar	46.97	513,757.86
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5,469.00	8.00	Each (hourly)	U.S. Dollar	124.54	681,081.92
*REXCAV06E	Excav 100K w/ Shear	5,469.00	8.00	Each (hourly)	U.S. Dollar	185.50	1,014,472.16

Notes: ***

Assumed production: .5 hour per rack per crew. Crew to include 1 excavator w/shear, 1 excavator w/grapple, 2 operators and 2 laborers. Includes post removal and sizing of steel for sale as scrap, and loadout to haul trucks.

****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.8.3.2	243.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	364,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		364,500.00	Each	U.S. Dollar	1.00	364,500.00

Notes: **************************************

Assumption: 45,000 lbs per load

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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.9	54.00	Each	Inverter / Transformer Removal	1.00	Detail	U.S. Dollar	3,143.21	169,733.07
5.9.1	54.00	Each	Disconnect Electrical	2.00	Detail	U.S. Dollar	592.13	31,974.75

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	270.00	1.00	Each (hourly)	U.S. Dollar	60.39	16,305.30
L060100	GENERAL LABORER	270.00	1.00	Each (hourly)	U.S. Dollar	46.97	12,681.90
RPUTRK05	F-250 4X4 3/4 TON PICKUP	270.00	1.00	Each (hourly)	U.S. Dollar	11.07	2,987.55

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.9.2	54.00	Each	Loadout Inverter & Transformer	2.00	Detail	U.S. Dollar	1,051.08	56,758.32

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	540.00	2.00	Each (hourly)	U.S. Dollar	46.97	25,363.80
L010101	OPERATOR	270.00	1.00	Each (hourly)	U.S. Dollar	51.00	13,768.92
RHYDCR06	GROVE RT880 73 TON	270.00	1.00	Each (hourly)	U.S. Dollar	65.28	17,625.60

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.9.3	54.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	81,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		81,000.00	Each	U.S. Dollar	1.00	81,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.10	105,665.00	Cubic Yard	Remove Inverter / Transformer / BESS Foundations	73.68	Detail	U.S. Dollar	28.05	2,963,385.49
5.10.1	105,665.00	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	1,639,550.97

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	3,773.75	1.00	Each (hourly)	U.S. Dollar	46.97	177,253.04
L010101	OPERATOR	7,547.50	2.00	Each (hourly)	U.S. Dollar	51.00	384,892.31
*REXCAV06C	Excav 100K w/ Hammer	3,773.75	1.00	Each (hourly)	U.S. Dollar	160.97	607,441.67
*REXCAV06A	Excav 100K w/ Bucket & Grapple	3,773.75	1.00	Each (hourly)	U.S. Dollar	124.54	469,963.96

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
5.10.2	105,665.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	1,323,834.52

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	10,566.50	1.00	Each (hourly)	U.S. Dollar	74.29	784,985.29
L080940	TEAMSTER	10,566.50	1.00	Each (hourly)	U.S. Dollar	51.00	538,849.23

5.11	1.00	Lump Sum	Site Restoration - Partial Site Seeding	0.01	Detail	U.S. Dollar	1,322,381.12	1,322,381.12

5.11.1	91,872.00	Linear Feet	Site Roads - Removal & Restoration	5,000.00	Detail	U.S. Dollar	1.63	149,993.35

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	734.98	4.00	Each (hourly)	U.S. Dollar	58.34	42,874.82
L010101	OPERATOR	1,286.21	7.00	Each (hourly)	U.S. Dollar	51.00	65,591.46
RDUTRK06	CAT D350D, 18CY-24CY	367.49	2.00	Each (hourly)	U.S. Dollar	74.29	27,300.68
*RFELWH08C	CAT 980 LOADER	183.74	1.00	Each (hourly)	U.S. Dollar	77.43	14,226.38

Notes: *************************************

Assume topsoil for restoration available onsite.

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5.11.2	9.00	Each	Remove CONEX Storage & Gravel Pads	6.00	Detail	U.S. Dollar	750.46	6,754.10

5.11.2.1	9.00	Each	Remove & Load CONEX	12.00	Detail	U.S. Dollar	81.53	733.77

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	7.50	1.00	Each (hourly)	U.S. Dollar	51.00	382.47
RHYDCR05	GROVE RT600E 40 TON	7.50	1.00	Each (hourly)	U.S. Dollar	46.84	351.30

5.11.2.2	9.00	Each	Remove CONEX Gravel Pads	12.00	Detail	U.S. Dollar	168.93	1,520.33

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	7.50	1.00	Each (hourly)	U.S. Dollar	51.00	382.47
RDUTRK06	CAT D350D, 18CY-24CY	7.50	1.00	Each (hourly)	U.S. Dollar	74.29	557.18
*RFELWH08C	CAT 980 LOADER	7.50	1.00	Each (hourly)	U.S. Dollar	77.43	580.69

5.11.2.3	9.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	500.00	4,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		4,500.00	Each	U.S. Dollar	1.00	4,500.00

Notes: **

Assumption: CONEX containers will be accepted locally
for re-use, and will only require local transport

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5.11.3	1,086.00	Acre	Spot Grade Disturbed Areas	16.00	Detail	U.S. Dollar	273.33	296,833.67

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	2,715.00	4.00	Each (hourly)	U.S. Dollar	58.34	158,379.53
L010101	OPERATOR	2,715.00	4.00	Each (hourly)	U.S. Dollar	51.00	138,454.14

Notes: ***

Assume that 35% of the area distrubed by construction
will be regraded.

****

5.11.4	1,086.00	Acre	Re-Seed With Native Vegetation - Roads & Areas Disturbed By Construction	0.00	Detail	U.S. Dollar	800.00	868,800.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		1,086.00	Acre	U.S. Dollar	800.00	868,800.00

Notes: ***

Assume that 35% of the area distrubed by construction
will be re-seeded.

****

5.12	1.00	Lump Sum	Contractor Markups	0.00	Detail	U.S. Dollar	3,546,910.75	3,546,910.75

			Cost Item					
CBS Position Code	**Quantity**	**UM**	**Description**	**UM/Day**	**Cost Source**	**Currency**	**Unit Cost**	**Total Cost**
5.12.1	1.00	Lump Sum	Home Office, Project Management (5% Of Cost)	0.00	Detail	U.S. Dollar	854,677.30	854,677.30

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USMARKUP5	5% Markup		17,093,546.00	Each	U.S. Dollar	0.05	854,677.30

5.12.2	1.00	Lump Sum	Contractor OH & Fee (15% Of Cost)	0.00	Detail	U.S. Dollar	2,692,233.45	2,692,233.45

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USMARKUP	15% Markup		17,948,223.00	Each	U.S. Dollar	0.15	2,692,233.45

5.13	1.00	Lump Sum	ODOE Applied Contingencies	0.00	Detail	U.S. Dollar	4,334,495.97	4,334,495.97
5.13.1	1.00	Lump Sum	1% Performance Bond	0.00	Detail	U.S. Dollar	206,404.57	206,404.57

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE1	ODOE 1% Markup		20,640,457.00	Each	U.S. Dollar	0.01	206,404.57

5.13.2	1.00	Lump Sum	10% Administrative and Project Management	0.00	Detail	U.S. Dollar	2,064,045.70	2,064,045.70

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		20,640,457.00	Each	U.S. Dollar	0.10	2,064,045.70

5.13.3	1.00	Lump Sum	10% Future Development Contingency	0.00	Detail	U.S. Dollar	2,064,045.70	2,064,045.70

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		20,640,457.00	Each	U.S. Dollar	0.10	2,064,045.70

Report Total:	24,974,952.51

Category	Total
Labor	5,949,907.87
Rented Equipment	4,541,915.32
Supplies	43,237.60
Materials	50,000.00
Subcontract	9,948,195.75
Travel-Risk-Adj	105,000.00
ODCs	4,336,695.97

Sunstone Solar Project 6

Estimate Summary

TETRA TECH, INC.

Job Code: Sunstone solar

Description: Decommissioning Estimate

			Cost Item					
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6	1.00	Each	SUNSTONE SOLAR RETIREMENT - SUNSTONE SOLAR 6	0.00	Detail	U.S. Dollar	23,440,771.91	23,440,771.91
6.1	1.00	Lump Sum	Equipment & Facilities Mob / Demob	0.10	Detail	U.S. Dollar	218,136.80	218,136.80
6.1.1	1.00	Lump Sum	Equipment Mob	0.00	Detail	U.S. Dollar	81,200.00	81,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UERNTRLG	Rental Equip Transp-Large		8.00	Each	U.S. Dollar	10,000.00	80,000.00
UERNTRSM	Rental Equip Transp-Small		8.00	Each	U.S. Dollar	150.00	1,200.00

6.1.2	1.00	Lump Sum	Site Facilities	0.00	Detail	U.S. Dollar	2,200.00	2,200.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UOCONMOB	Connex Box Mob		2.00	Each	U.S. Dollar	300.00	600.00
UOTRLTRN	Trailer Trnsp/Setup/Trdwn		2.00	Each	U.S. Dollar	800.00	1,600.00

6.1.3	5.00	Day	Crew Mob & Site Setup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

6.1.4	5.00	Day	Crew Demob & Site Cleanup	1.00	Detail	U.S. Dollar	13,473.68	67,368.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	1,000.00	20.00	Each (hourly)	U.S. Dollar	46.97	46,970.00
L010101	OPERATOR	400.00	8.00	Each (hourly)	U.S. Dollar	51.00	20,398.40

6.2	4.00	Month	Project Site Support	0.05	Detail	U.S. Dollar	71,469.70	285,878.80
6.2.1	4.00	Month	Site Facilities	0.00	Detail	U.S. Dollar	1,755.00	7,020.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
URCONNEX	Connex Box		8.00	Month	U.S. Dollar	150.00	1,200.00
UROFFTRL	Office Trailer -12x60		4.00	Month	U.S. Dollar	500.00	2,000.00
UO1STAID	1st Aid Supplies		4.00	Month	U.S. Dollar	300.00	1,200.00
UOOFFSUP	Office Supplies($/prs/mo)		4.00	Month	U.S. Dollar	55.00	220.00
URPRTAJH	Port-a-John Unit(s) (4)		8.00	Month	U.S. Dollar	300.00	2,400.00

6.2.2	4.00	Month	Field Management	0.05	Detail	U.S. Dollar	69,714.70	278,858.80

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L90FXX02	Field - Proj Superintendent	880.00	1.00	Each (hourly)	U.S. Dollar	114.95	101,156.00
RPUTRK05	F-250 4X4 3/4 TON PICKUP	2,640.00	3.00	Each (hourly)	U.S. Dollar	11.07	29,211.60
L90FEL00	Field - Engr. Tech	880.00	1.00	Each (hourly)	U.S. Dollar	64.24	56,531.20
L90FXX03	Field - SHSO	880.00	1.00	Each (hourly)	U.S. Dollar	104.50	91,960.00

6.3	1.00	Each	Substation Retirement	0.04	Detail	U.S. Dollar	170,429.15	170,429.15
6.3.1	1.00	Day	Fence Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

6.3.2	1.00	Each	Transformer Removal	0.17	Detail	U.S. Dollar	102,309.50	102,309.50
6.3.2.1	1.00	Each	Oil Removal & Disposal	1.00	Detail	U.S. Dollar	66,314.40	66,314.40

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.3.2.1.1	1.00	Each	Oil Removal	1.00	Detail	U.S. Dollar	939.40	939.40

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40

6.3.2.1.2	16,000.00	Gallon	Oil Disposal	0.00	Detail	U.S. Dollar	4.00	64,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		64,000.00	Each	U.S. Dollar	1.00	64,000.00

6.3.2.1.3	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	1,375.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,375.00	Each	U.S. Dollar	1.00	1,375.00

6.3.2.2	1.00	Each	Dismantle & Loadout Transformer	0.20	Detail	U.S. Dollar	35,995.10	35,995.10
6.3.2.2.1	1.00	Each	Dismantle, Cut & Size	0.20	Detail	U.S. Dollar	29,995.10	29,995.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	200.00	4.00	Each (hourly)	U.S. Dollar	46.97	9,394.00
L010101	OPERATOR	100.00	2.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*REXCAV06A	Excav 100K w/ Bucket & Grapple	50.00	1.00	Each (hourly)	U.S. Dollar	124.54	6,226.75
*REXCAV06E	Excav 100K w/ Shear	50.00	1.00	Each (hourly)	U.S. Dollar	185.50	9,274.75

6.3.2.2.2	4.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	6,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		6,000.00	Each	U.S. Dollar	1.00	6,000.00

6.3.3	1.00	Each	Remove Control Building	2.00	Detail	U.S. Dollar	2,612.51	2,612.51
6.3.3.1	1.00	Each	Demo	2.00	Detail	U.S. Dollar	1,112.51	1,112.51

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	5.00	1.00	Each (hourly)	U.S. Dollar	46.97	234.85
L010101	OPERATOR	5.00	1.00	Each (hourly)	U.S. Dollar	51.00	254.98
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5.00	1.00	Each (hourly)	U.S. Dollar	124.54	622.68

6.3.3.2	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

6.3.4	1.00	Day	UG Utility & Ground Removal	1.00	Detail	U.S. Dollar	1,312.01	1,312.01

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10.00	1.00	Each (hourly)	U.S. Dollar	51.00	509.96
L060100	GENERAL LABORER	10.00	1.00	Each (hourly)	U.S. Dollar	46.97	469.70
RBACKH09	Deere 710J BACKHOE, 1.62CY	10.00	1.00	Each (hourly)	U.S. Dollar	33.24	332.35

6.3.5	1,000.00	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	28,045.10
6.3.5.1	1,000.00	Cubic Yard	Excavate / Remove Foundation - Various Depth	280.00	Detail	U.S. Dollar	15.52	15,516.50

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	35.71	1.00	Each (hourly)	U.S. Dollar	46.97	1,677.50
L010101	OPERATOR	71.43	2.00	Each (hourly)	U.S. Dollar	51.00	3,642.57
*REXCAV06C	Excav 100K w/ Hammer	35.71	1.00	Each (hourly)	U.S. Dollar	160.97	5,748.75

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

*REXCAV06A	Excav 100K w/ Bucket & Grapple	35.71	1.00	Each (hourly)	U.S. Dollar	124.54	4,447.68

6.3.5.2	1,000.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	12,528.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	100.00	1.00	Each (hourly)	U.S. Dollar	74.29	7,429.00
L080940	TEAMSTER	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60

6.3.6	1.00	Each	Misc. Material Disposal	0.00	Detail	U.S. Dollar	2,900.00	2,900.00
6.3.6.1	1.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,500.00	Each	U.S. Dollar	1.00	1,500.00

6.3.6.2	20.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,400.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,400.00	Each	U.S. Dollar	1.00	1,400.00

6.3.7	1.00	Each	Restore Yard	0.23	Detail	U.S. Dollar	31,938.02	31,938.02
6.3.7.1	1.60	Acre	Remove Aggregate / Backfill / Regrade	1.60	Detail	U.S. Dollar	2,062.47	3,299.96

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	20.00	2.00	Each (hourly)	U.S. Dollar	46.97	939.40
L010101	OPERATOR	20.00	2.00	Each (hourly)	U.S. Dollar	51.00	1,019.92
REXCAV06B	Gradall - Excavator	10.00	1.00	Each (hourly)	U.S. Dollar	75.73	757.29
*RDOZER08	CAT D6 LGP Dozer	10.00	1.00	Each (hourly)	U.S. Dollar	58.34	583.35

6.3.7.2	1,000.00	Cubic Yard	Vegetative Cover	300.00	Detail	U.S. Dollar	27.36	27,358.07
6.3.7.2.1	1,000.00	Cubic Yard	Topsoil, Delivered	0.00	Detail	U.S. Dollar	20.00	20,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
IMSOIL	Topsoil		1,000.00	Cubic Yard	U.S. Dollar	20.00	20,000.00

6.3.7.2.2	1,000.00	Cubic Yard	Placement	300.00	Detail	U.S. Dollar	7.36	7,358.07

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	66.67	2.00	Each (hourly)	U.S. Dollar	51.00	3,399.73
RDOZER08	CAT D6N XL	66.67	2.00	Each (hourly)	U.S. Dollar	59.38	3,958.33

6.3.7.3	1.60	Acre	Re-Seed With Native Vegetation	0.00	Detail	U.S. Dollar	800.00	1,280.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		1.60	Acre	U.S. Dollar	800.00	1,280.00

6.4	1.00	Lump Sum	Collector Line Retirement	0.07	Detail	U.S. Dollar	46,946.45	46,946.45
6.4.1	5,850.00	Linear Feet	Conductor Removal	585.00	Detail	U.S. Dollar	5.50	32,154.10
6.4.1.1	1.00	Lump Sum	Cut / Lower Cable, Size & Loadout	0.10	Detail	U.S. Dollar	31,404.10	31,404.10

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	400.00	4.00	Each (hourly)	U.S. Dollar	46.97	18,788.00
L010101	OPERATOR	100.00	1.00	Each (hourly)	U.S. Dollar	51.00	5,099.60
*RXMISC14	MAN LIFT GAS 125ft	100.00	1.00	Each (hourly)	U.S. Dollar	53.52	5,352.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	100.00	1.00	Each (hourly)	U.S. Dollar	21.65	2,164.50

6.4.1.2	0.50	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	750.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		750.00	Each	U.S. Dollar	1.00	750.00

Cost Item								
CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.4.2	26.00	Each	Utility Pole Removal	5.00	Detail	U.S. Dollar	568.94	14,792.35
6.4.2.1	26.00	Each	Cut / Lower Pole	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00	Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00	Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00	Each (hourly)	U.S. Dollar	46.84	1,217.84

6.4.2.2	26.00	Each	Size & Loadout	10.00	Detail	U.S. Dollar	191.78	4,986.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	52.00	2.00	Each (hourly)	U.S. Dollar	46.97	2,442.44
L010101	OPERATOR	26.00	1.00	Each (hourly)	U.S. Dollar	51.00	1,325.90
RHYDCR05	GROVE RT600E 40 TON	26.00	1.00	Each (hourly)	U.S. Dollar	46.84	1,217.84

6.4.2.3	2.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	3,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		3,000.00	Each	U.S. Dollar	1.00	3,000.00

6.4.2.4	26.00	Ton	Disposal Cost	0.00	Detail	U.S. Dollar	70.00	1,820.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,820.00	Each	U.S. Dollar	1.00	1,820.00

Notes: **

Assumption: 101 poles x 2000' per pole

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6.5	1,200.00	MW	DC Storage Retirement	2.47	Detail	U.S. Dollar	3,148.02	3,777,627.74
6.5.1	1,200.00	MW	Battery Removal & Disposal	5.00	Detail	U.S. Dollar	2,044.07	2,452,881.60
6.5.1.1	240.00	Day	Remove Batteries, Load For Transport	1.00	Detail	U.S. Dollar	3,251.10	780,264.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	14,400.00	6.00	Each (hourly)	U.S. Dollar	46.97	676,368.00
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	4,800.00	2.00	Each (hourly)	U.S. Dollar	21.65	103,896.00

6.5.1.2	396.00	Each	Transport Batteries	0.00	Detail	U.S. Dollar	1,605.60	635,817.60
6.5.1.2.1	396.00	Each	Roll Off Liners	0.00	Detail	U.S. Dollar	105.60	41,817.60

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODCLINER	Rolloff Liner		396.00	Each	U.S. Dollar	105.60	41,817.60

6.5.1.2.2	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	594,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		594,000.00	Each	U.S. Dollar	1.00	594,000.00

6.5.1.3	5,184.00	Ton	Disposal Fee's	0.00	Detail	U.S. Dollar	200.00	1,036,800.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,036,800.00	Each	U.S. Dollar	1.00	1,036,800.00

6.5.2	1,200.00	MW	Structure & Components Removal	4.90	Detail	U.S. Dollar	1,103.96	1,324,746.14
6.5.2.1	120.00	Day	Refrigerant Recovery	1.00	Detail	U.S. Dollar	1,207.80	144,936.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	2,400.00	2.00	Each (hourly)	U.S. Dollar	60.39	144,936.00

6.5.2.2	3,936.00	Ton	Structure Demo	43.33	Detail	U.S. Dollar	116.76	459,569.18

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*REXCAV06A	Excav 100K w/ Bucket & Grapple	908.31	1.00	Each (hourly)	U.S. Dollar	124.54	113,116.10
*REXCAV06E	Excav 100K w/ Shear	908.31	1.00	Each (hourly)	U.S. Dollar	185.50	168,486.54
L010101	OPERATOR	1,816.62	2.00	Each (hourly)	U.S. Dollar	51.00	92,640.12
L060100	GENERAL LABORER	1,816.62	2.00	Each (hourly)	U.S. Dollar	46.97	85,326.42

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.5.2.3	396.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,375.00	544,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		544,500.00	Each	U.S. Dollar	1.00	544,500.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.5.2.4	105,000.00	Gallon	Glycol Recovery & Disposal	0.00	Detail	U.S. Dollar	1.00	105,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLIQUID	Liquids T&D		105,000.00	Each	U.S. Dollar	1.00	105,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.5.2.5	2,522.40	Cubic Yard	Remove Foundations To Subgrade	73.68	Detail	U.S. Dollar	28.05	70,740.96
6.5.2.5.1	2,522.40	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	39,138.82

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	90.09	1.00	Each (hourly)	U.S. Dollar	46.97	4,231.33
L010101	OPERATOR	180.17	2.00	Each (hourly)	U.S. Dollar	51.00	9,188.02
*REXCAV06C	Excav 100K w/ Hammer	90.09	1.00	Each (hourly)	U.S. Dollar	160.97	14,500.65
*REXCAV06A	Excav 100K w/ Bucket & Grapple	90.09	1.00	Each (hourly)	U.S. Dollar	124.54	11,218.82

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.5.2.5.2	2,522.40	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	31,602.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	252.24	1.00	Each (hourly)	U.S. Dollar	74.29	18,738.91
L080940	TEAMSTER	252.24	1.00	Each (hourly)	U.S. Dollar	51.00	12,863.23

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.6	1.00	Lump Sum	Solar Array Retirement	0.01	Detail	U.S. Dollar	7,888,763.11	7,888,763.11
6.6.1	36,960.00	Linear Feet	Fence Removal	5,189.45	Detail	U.S. Dollar	1.31	48,568.80
6.6.1.1	36,960.00	Linear Feet	Fence Removal	5,189.45	Detail	U.S. Dollar	1.03	38,068.80

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	213.66	3.00	Each (hourly)	U.S. Dollar	51.00	10,896.03
L060100	GENERAL LABORER	427.33	6.00	Each (hourly)	U.S. Dollar	46.97	20,071.63
RBACKH09	Deere 710J BACKHOE, 1.62CY	213.66	3.00	Each (hourly)	U.S. Dollar	33.24	7,101.14

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.6.1.2	7.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	10,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		10,500.00	Each	U.S. Dollar	1.00	10,500.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.6.2	656,256.00	Each	Solar Panel Removal & Disposal	10,000.00	Detail	U.S. Dollar	7.17	4,708,588.14
6.6.2.1	656,256.00	Each	Solar Panel Removal	10,000.00	Detail	U.S. Dollar	3.07	2,017,928.14

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RLIFTS05	JCB 508C, 8,000lbs FRKLFT	6,562.56	10.00	Each (hourly)	U.S. Dollar	21.65	142,046.61
L010101	OPERATOR	6,562.56	10.00	Each (hourly)	U.S. Dollar	51.00	334,664.31
L060100	GENERAL LABORER	32,812.80	50.00	Each (hourly)	U.S. Dollar	46.97	1,541,217.22

Notes: **

Assumed production: 20 panels per laborer per hour,
Includes packaging and preparing for shipment offsite.
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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.6.2.2	875.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	1,312,500.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		1,312,500.00	Each	U.S. Dollar	1.00	1,312,500.00

Notes: **************************************
Assumption: 45,000 lbs per load
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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.6.2.3	19,688.00	Ton	Recycling Cost	0.00	Detail	U.S. Dollar	70.00	1,378,160.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USDISPOSAL	Disposal Fee's		1,378,160.00	Each	U.S. Dollar	1.00	1,378,160.00

Notes: **
Assumption: 60 lbs each
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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.6.3	1.00	Lump Sum	Solar Rack (Trackers) & Post Removal	0.01	Detail	U.S. Dollar	3,131,606.18	3,131,606.18
6.6.3.1	10,938.00	Each	Solar Rack (Trackers) & Post Removal	160.00	Detail	U.S. Dollar	252.98	2,767,106.18

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	10,938.00	16.00	Each (hourly)	U.S. Dollar	51.00	557,794.25
L060100	GENERAL LABORER	10,938.00	16.00	Each (hourly)	U.S. Dollar	46.97	513,757.86
*REXCAV06A	Excav 100K w/ Bucket & Grapple	5,469.00	8.00	Each (hourly)	U.S. Dollar	124.54	681,081.92
*REXCAV06E	Excav 100K w/ Shear	5,469.00	8.00	Each (hourly)	U.S. Dollar	185.50	1,014,472.16

Notes: ***
Assumed production: .5 hour per rack per crew. Crew to include 1 excavator w/shear, 1 excavator w/grapple, 2 operators and 2 laborers. Includes post removal and sizing of steel for sale as scrap, and loadout to haul trucks.
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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.6.3.2	243.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	364,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		364,500.00	Each	U.S. Dollar	1.00	364,500.00

Notes: **************************************
Assumption: 45,000 lbs per load
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CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.7	54.00	Each	Inverter / Transformer Removal	1.00	Detail	U.S. Dollar	3,143.21	169,733.07
6.7.1	54.00	Each	Disconnect Electrical	2.00	Detail	U.S. Dollar	592.13	31,974.75

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010110	Craft - MEP	270.00	1.00	Each (hourly)	U.S. Dollar	60.39	16,305.30
L060100	GENERAL LABORER	270.00	1.00	Each (hourly)	U.S. Dollar	46.97	12,681.90
RPUTRK05	F-250 4X4 3/4 TON PICKUP	270.00	1.00	Each (hourly)	U.S. Dollar	11.07	2,987.55

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.7.2	54.00	Each	Loadout Inverter & Transformer	2.00	Detail	U.S. Dollar	1,051.08	56,758.32

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L060100	GENERAL LABORER	540.00	2.00	Each (hourly)	U.S. Dollar	46.97	25,363.80
L010101	OPERATOR	270.00	1.00	Each (hourly)	U.S. Dollar	51.00	13,768.92
RHYDCR06	GROVE RT880 73 TON	270.00	1.00	Each (hourly)	U.S. Dollar	65.28	17,625.60

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.7.3	54.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	1,500.00	81,000.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		81,000.00	Each	U.S. Dollar	1.00	81,000.00

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.8	105,665.00	Cubic Yard	Remove Inverter / Transformer / BESS Foundations	73.68	Detail	U.S. Dollar	28.05	2,963,385.49
6.8.1	105,665.00	Cubic Yard	Excavate / Remove Foundation	280.00	Detail	U.S. Dollar	15.52	1,639,550.97

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost

Cost Item

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost

L060100	GENERAL LABORER	3,773.75	1.00	Each (hourly)	U.S. Dollar	46.97	177,253.04
L010101	OPERATOR	7,547.50	2.00	Each (hourly)	U.S. Dollar	51.00	384,892.31
*REXCAV06C	Excav 100K w/ Hammer	3,773.75	1.00	Each (hourly)	U.S. Dollar	160.97	607,441.67
*REXCAV06A	Excav 100K w/ Bucket & Grapple	3,773.75	1.00	Each (hourly)	U.S. Dollar	124.54	469,963.96

6.8.2	105,665.00	Cubic Yard	Concrete Transport Offsite	100.00	Detail	U.S. Dollar	12.53	1,323,834.52

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
RDUTRK06	CAT D350D, 18CY-24CY	10,566.50	1.00	Each (hourly)	U.S. Dollar	74.29	784,985.29
L080940	TEAMSTER	10,566.50	1.00	Each (hourly)	U.S. Dollar	51.00	538,849.23

6.9	1.00	Lump Sum	Site Restoration - Partial Site Seeding	0.03	Detail	U.S. Dollar	522,609.71	522,609.71

6.9.1	35,904.00	Linear Feet	Site Roads - Removal & Restoration	5,000.00	Detail	U.S. Dollar	1.63	58,618.09

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	287.23	4.00	Each (hourly)	U.S. Dollar	58.34	16,755.68
L010101	OPERATOR	502.66	7.00	Each (hourly)	U.S. Dollar	51.00	25,633.45
RDUTRK06	CAT D350D, 18CY-24CY	143.62	2.00	Each (hourly)	U.S. Dollar	74.29	10,669.23
*RFELWH08C	CAT 980 LOADER	71.81	1.00	Each (hourly)	U.S. Dollar	77.43	5,559.73

Notes: **************************************

Assume topsoil for restoration available onsite.

****

6.9.2	9.00	Each	Remove CONEX Storage & Gravel Pads	6.00	Detail	U.S. Dollar	750.46	6,754.10

6.9.2.1	9.00	Each	Remove & Load CONEX	12.00	Detail	U.S. Dollar	81.53	733.77

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	7.50	1.00	Each (hourly)	U.S. Dollar	51.00	382.47
RHYDCR05	GROVE RT600E 40 TON	7.50	1.00	Each (hourly)	U.S. Dollar	46.84	351.30

6.9.2.2	9.00	Each	Remove CONEX Gravel Pads	12.00	Detail	U.S. Dollar	168.93	1,520.33

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
L010101	OPERATOR	7.50	1.00	Each (hourly)	U.S. Dollar	51.00	382.47
RDUTRK06	CAT D350D, 18CY-24CY	7.50	1.00	Each (hourly)	U.S. Dollar	74.29	557.18
*RFELWH08C	CAT 980 LOADER	7.50	1.00	Each (hourly)	U.S. Dollar	77.43	580.69

6.9.2.3	9.00	Each	Trucking - Per Load	0.00	Detail	U.S. Dollar	500.00	4,500.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USTRUCKING	Trucking Sub		4,500.00	Each	U.S. Dollar	1.00	4,500.00

Notes: **

Assumption: CONEX containers will be accepted locally
for re-use, and will only require local transport

****

6.9.3	426.00	Acre	Spot Grade Disturbed Areas	16.00	Detail	U.S. Dollar	273.33	116,437.52

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
*RDOZER08	CAT D6 LGP Dozer	1,065.00	4.00	Each (hourly)	U.S. Dollar	58.34	62,126.78
L010101	OPERATOR	1,065.00	4.00	Each (hourly)	U.S. Dollar	51.00	54,310.74

Notes: ***

Assume that 35% of the area distrubed by construction
will be regraded.

****

6.9.4	426.00	Acre	Re-Seed With Native Vegetation - Roads & Areas Disturbed By Construction	0.00	Detail	U.S. Dollar	800.00	340,800.00

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USLANDSCAPE	Landscape Sub		426.00	Acre	U.S. Dollar	800.00	340,800.00

			Cost Item					
CBS Position Code	**Quantity**	**UM**	**Description**	**UM/Day**	**Cost Source**	**Currency**	**Unit Cost**	**Total Cost**

Notes: **

Assume that 35% of the area distrubed by construction will be re-seeded.

****

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.10	1.00	Lump Sum	Contractor Markups	0.00	Detail	U.S. Dollar	3,329,028.40	3,329,028.40
6.10.1	1.00	Lump Sum	Home Office, Project Management (5% Of Cost)	0.00	Detail	U.S. Dollar	802,175.50	802,175.50

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USMARKUP5	5% Markup		16,043,510.00	Each	U.S. Dollar	0.05	802,175.50

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.10.2	1.00	Lump Sum	Contractor OH & Fee (15% Of Cost)	0.00	Detail	U.S. Dollar	2,526,852.90	2,526,852.90

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
USMARKUP	15% Markup		16,845,686.00	Each	U.S. Dollar	0.15	2,526,852.90

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.11	1.00	Lump Sum	ODOE Applied Contingencies	0.00	Detail	U.S. Dollar	4,068,233.19	4,068,233.19
6.11.1	1.00	Lump Sum	1% Performance Bond	0.00	Detail	U.S. Dollar	193,725.39	193,725.39

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE1	ODOE 1% Markup		19,372,539.00	Each	U.S. Dollar	0.01	193,725.39

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.11.2	1.00	Lump Sum	10% Administrative and Project Management	0.00	Detail	U.S. Dollar	1,937,253.90	1,937,253.90

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		19,372,539.00	Each	U.S. Dollar	0.10	1,937,253.90

CBS Position Code	Quantity	UM	Description	UM/Day	Cost Source	Currency	Unit Cost	Total Cost
6.11.3	1.00	Lump Sum	10% Future Development Contingency	0.00	Detail	U.S. Dollar	1,937,253.90	1,937,253.90

Resource Code	Description	Hours	Quantity	UM	Currency	Unit Cost	Total Cost
UODOE2	ODOE 10% Markup		19,372,539.00	Each	U.S. Dollar	0.10	1,937,253.90

Report Total: 23,440,771.91

Category	Total
Labor	5,703,247.19
Rented Equipment	4,338,740.53
Supplies	43,237.60
Materials	20,000.00
Subcontract	9,160,113.40
Travel-Risk-Adj	105,000.00
ODCs	4,070,433.19

Attachment 5. Opinion of Legal Counsel

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PINE GATE RENEWABLES, LLC

July 18, 2025

Oregon Department of Energy
550 Capitol St. NE, 1st Floor
Salem, Oregon 97301

Subject: **In the Matter of the Application for an Amendment to the Site Certificate for the Sunstone Solar Project**

Dear Sir or Madam:

I am an attorney for Pine Gate Renewables, LLC, a North Carolina limited liability company, and its wholly owned subsidiaries and affiliates, Sunstone Solar 1, LLC; Sunstone Solar 2, LLC; Sunstone Solar 3, LLC; Sunstone Solar 4, LLC; Sunstone Solar 5, LLC; and Sunstone Solar 6, LLC (together the "Applicants"). I have examined originals or certified copies of the books and records of the Applicants and such other documents, limited liability company records, certificates of public officials, and instruments regarding the Applicants as I have deemed necessary and appropriate for the purposes of this opinion letter.

In rendering the opinion expressed below, I have assumed (i) the authenticity of all the documents submitted to me as originals and (ii) the conformity to original documents of all documents submitted to me as copies. As to factual matters, I have relied to the extent deemed proper upon statements and certifications of officers and managers of the Applicants.

Based on the foregoing, to the best of my knowledge, I am of the opinion that, subject to the Applicants' meeting of all applicable federal, state and local laws (including all rules and regulations promulgated thereunder), the Applicants have the legal authority to construct and operate the up to six, 200 MW nameplate capacity solar generation and battery storage facilities and associated facilities located in Morrow County, Oregon (the "Projects") without violating their articles of organization, covenants, or similar agreements. Each of the Applicants will maintain its own separate decommissioning bond for the Projects.

The foregoing opinion is limited solely to whether the Applicants have the authority under their operating agreements to construct, own, and operate the Project. I express no opinion as to the applicability of any federal, state, or local laws (including all Oregon laws and any rules and regulations promulgated thereunder) to such construction and operation or as to the effects of the foregoing laws on such construction and operation.

[SEPARATE SIGNATURE PAGE TO FOLLOW]

Sincerely,

Pine Gate Renewables, LLC
a North Carolina limited liability company

Signed by:
By: Dante Alessandri
1A5372D1BA1F482...
Name: Dante Alessandri
Title: Authorized Signatory

Attachment 6. Property Owner List

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Request for Amendment 1 to the Site Certificate for the Sunstone Solar Project

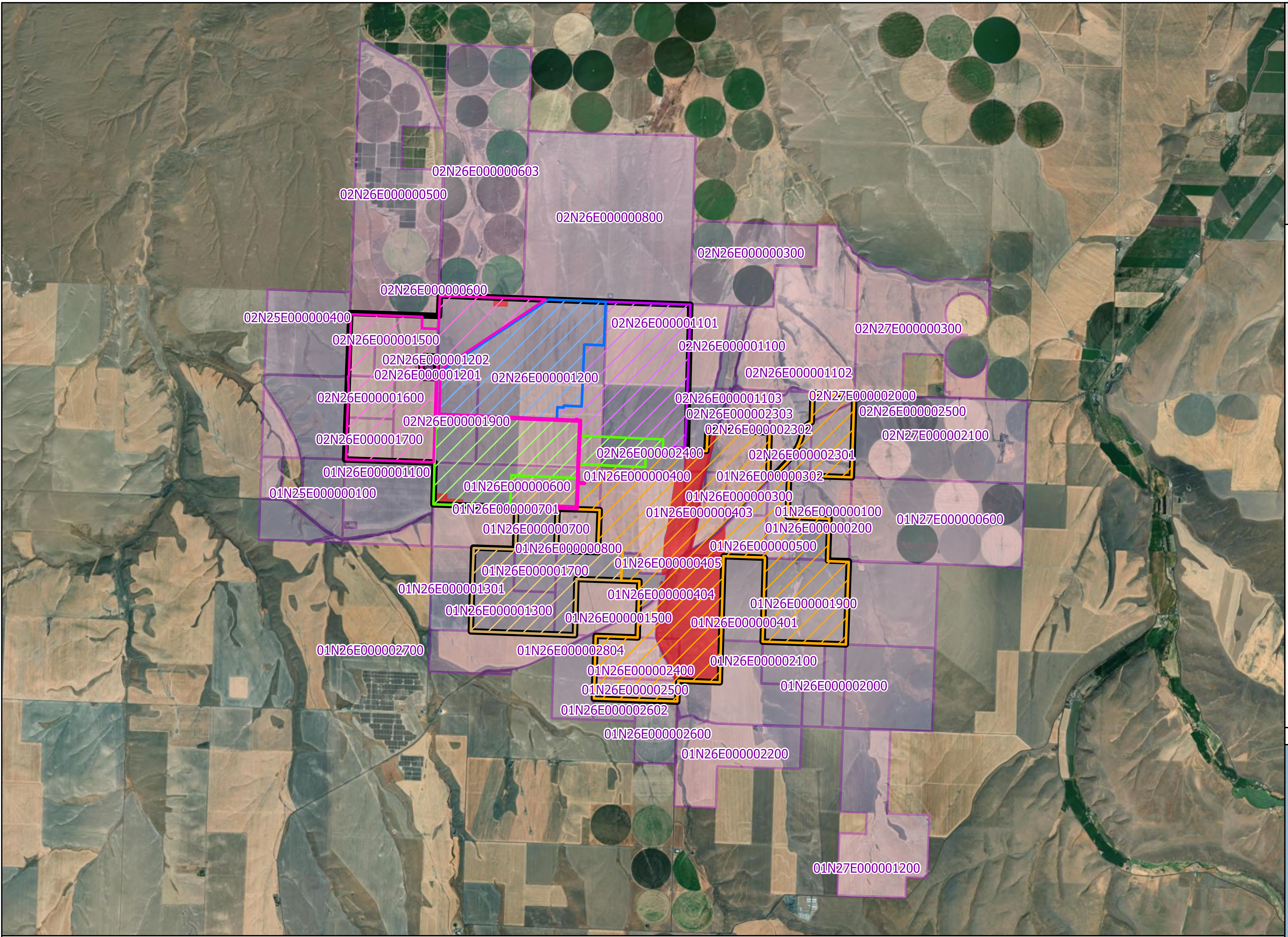
Property Owner List and Tax Lot Map - Morrow County Assessor Data (Obtained July 8, 2025)

Map Tax Lot	Owner	Mail Address	Mail City	State	Zip Code	Full Mailing Address
01N25E000000100	KILKENNY LAND COMPANY, LLC	1124 SW MYRTLE DR	PORTLAND	OR	97201	1124 SW MYRTLE DR, PORTLAND, OR 97201
01N26E000000100	N & C LAND, LLC	71062 PERKINS RD	ECHO	OR	97826	71062 PERKINS RD, ECHO, OR 97826
01N26E000000200	ASHBECK, TONY R & ASHBECK, GERALD T	71384A HIGHWAY 207	ECHO	OR	97826	71384A HIGHWAY 207, ECHO, OR 97826
01N26E000000300	WILLIAM J DOHERTY RANCH, LLC	70644 DOHERTY RD	LEXINGTON	OR	97839	70644 DOHERTY RD, LEXINGTON, OR 97839
01N26E000000301	CUTSFORTH, KRAIG ALLEN	12502 112TH AVE E	PUYALLUP	WA	98374	12502 112TH AVE E, PUYALLUP, WA 98374
01N26E000000302	SAINT PATRICK CATHOLIC CHURCH OF HEPPNER	PO BOX 633	HEPPNER	OR	97836	PO BOX 633, HEPPNER, OR 97836
01N26E000000400	WILLIAM J DOHERTY RANCH, LLC	70644 DOHERTY RD	LEXINGTON	OR	97839	70644 DOHERTY RD, LEXINGTON, OR 97839
01N26E000000401	SANDERSON, TERESA ANN 50% ETAL	78262 HWY 97	WASCO	OR	97065	78262 HWY 97, WASCO, OR 97065
01N26E000000402	COLUMBIA BASIN ELECTRIC CO-OP	PO BOX 398	HEPPNER	OR	97836	PO BOX 398, HEPPNER, OR 97836
01N26E000000403	WILLIAM J DOHERTY RANCH, LLC	70644 DOHERTY RD	LEXINGTON	OR	97839	70644 DOHERTY RD, LEXINGTON, OR 97839
01N26E000000404	STATE OF OREGON, STATE HIGHWAY COMMISSION	335 CAPITOL STREET, NE, MS #11	SALEM	OR	97301	335 CAPITOL STREET, NE, MS #11, SALEM, OR 97301
01N26E000000405	DOHERTY, BRIAN W & DOHERTY, PEGGY A	70516 HIGHWAY 207	LEXINGTON	OR	97839	70516 HIGHWAY 207, LEXINGTON, OR 97839
01N26E000000500	ASHBECK, TONY R & ASHBECK, GERALD T	71384A HIGHWAY 207	ECHO	OR	97826	71384A HIGHWAY 207, ECHO, OR 97826
01N26E000000600	GRIEB FARMS, INC	72540 ALPINE LN	LEXINGTON	OR	97839	72540 ALPINE LN, LEXINGTON, OR 97839
01N26E000000700	WILLIAM J DOHERTY RANCH, LLC	70644 DOHERTY RD	LEXINGTON	OR	97839	70644 DOHERTY RD, LEXINGTON, OR 97839
01N26E000000701	NORTH LEX POWER AND LAND, LLC	72967 STRAWBERRY LN	LEXINGTON	OR	97839	72967 STRAWBERRY LN, LEXINGTON, OR 97839
01N26E000000800	NORTH LEX POWER AND LAND, LLC	72967 STRAWBERRY LN	LEXINGTON	OR	97839	72967 STRAWBERRY LN, LEXINGTON, OR 97839
01N26E000001100	NORTH LEX POWER AND LAND, LLC	72967 STRAWBERRY LN	LEXINGTON	OR	97839	72967 STRAWBERRY LN, LEXINGTON, OR 97839
01N26E000001300	WILLIAM J DOHERTY RANCH, LLC	70644 DOHERTY RD	LEXINGTON	OR	97839	70644 DOHERTY RD, LEXINGTON, OR 97839
01N26E000001301	NORTH LEX POWER AND LAND, LLC	72967 STRAWBERRY LN	LEXINGTON	OR	97839	72967 STRAWBERRY LN, LEXINGTON, OR 97839
01N26E000001500	NORTH LEX POWER AND LAND, LLC	72967 STRAWBERRY LN	LEXINGTON	OR	97839	72967 STRAWBERRY LN, LEXINGTON, OR 97839
01N26E000001700	WILLIAM J DOHERTY RANCH, LLC	70644 DOHERTY RD	LEXINGTON	OR	97839	70644 DOHERTY RD, LEXINGTON, OR 97839
01N26E000001900	ASHBECK, TONY R & ASHBECK, GERALD T	71384A HIGHWAY 207	ECHO	OR	97826	71384A HIGHWAY 207, ECHO, OR 97826
01N26E000002000	SANDHOLLOW RANCH LLC	PO BOX 1587	HERMISTON	OR	97838	PO BOX 1587, HERMISTON, OR 97838
01N26E000002100	SANDHOLLOW RANCH LLC	PO BOX 1587	HERMISTON	OR	97838	PO BOX 1587, HERMISTON, OR 97838
01N26E000002200	SANDHOLLOW RANCH LLC	PO BOX 1587	HERMISTON	OR	97838	PO BOX 1587, HERMISTON, OR 97838
01N26E000002400	WILLIAM J DOHERTY RANCH, LLC	70644 DOHERTY RD	LEXINGTON	OR	97839	70644 DOHERTY RD, LEXINGTON, OR 97839
01N26E000002500	MONAGLE, JOHN B & PATRICIA ANNE ETAL	517 NW 7TH	PENDLETON	OR	97801	517 NW 7TH, PENDLETON, OR 97801
01N26E000002600	TURNER-LINDSAY FARMS, LLC	75655 BASELINE RD	HEPPNER	OR	97836	75655 BASELINE RD, HEPPNER, OR 97836
01N26E000002602	HEIDEMAN, LOREN A & DELLA K, TRUSTEES	22948 FAIRVIEW LN	IONE	OR	97843	22948 FAIRVIEW LN, IONE, OR 97843
01N26E000002700	NORTH LEX POWER AND LAND, LLC	72967 STRAWBERRY LN	LEXINGTON	OR	97839	72967 STRAWBERRY LN, LEXINGTON, OR 97839
01N26E000002804	KARYL SMITH, INC	8825 N ORCHARD PR RD	SPOKANE	WA	99217	8825 N ORCHARD PR RD, SPOKANE, WA 99217
01N27E000000600	N & C LAND, LLC	71062 PERKINS RD	ECHO	OR	97826	71062 PERKINS RD, ECHO, OR 97826
01N27E000001200	SANDHOLLOW RANCH LLC	PO BOX 1587	HERMISTON	OR	97838	PO BOX 1587, HERMISTON, OR 97838
02N25E000000400	KILKENNY LAND COMPANY, LLC	1124 SW MYRTLE DR	PORTLAND	OR	97201	1124 SW MYRTLE DR, PORTLAND, OR 97201
02N26E000000300	SANDHOLLOW LAND, LLC	PO BOX 307	LEXINGTON	OR	97839	PO BOX 307, LEXINGTON, OR 97839
02N26E000000500	BAKER PRODUCE SOUTH, INC	PO BOX 4063	PASCO	WA	99302	PO BOX 4063, PASCO, WA 99302
02N26E000000600	BAKER PRODUCE SOUTH, INC	PO BOX 4063	PASCO	WA	99302	PO BOX 4063, PASCO, WA 99302
02N26E000000603	BAKER PRODUCE SOUTH, INC	PO BOX 4063	PASCO	WA	99302	PO BOX 4063, PASCO, WA 99302
02N26E000000800	IVAR & LINA LLC	958 W CODY AVE	HERMISTON	OR	97838	958 W CODY AVE, HERMISTON, OR 97838
02N26E000001100	CHRISTENSEN, ASHLEY	74681 ALPINE LN	LEXINGTON	OR	97839	74681 ALPINE LN, LEXINGTON, OR 97839
02N26E000001101	MATHENY PROPERTY LLC	74596 ALPINE LN	LEXINGTON	OR	97839	74596 ALPINE LN, LEXINGTON, OR 97839
02N26E000001102	IVAR & LINA LLC	958 W CODY AVE	HERMISTON	OR	97838	958 W CODY AVE, HERMISTON, OR 97838
02N26E000001103	MATHENY, STEFAN & MATHENY, CHELSEA	71151 DOHERTY RD	LEXINGTON	OR	97839	71151 DOHERTY RD, LEXINGTON, OR 97839
02N26E000001200	GRIEB FARMS, INC	72540 ALPINE LN	LEXINGTON	OR	97839	72540 ALPINE LN, LEXINGTON, OR 97839
02N26E000001201	GAS TRANSMISSION NORTHWEST LLC	700 LOUISIANA ST SUITE 1300	HOUSTON	TX	77002	700 LOUISIANA ST SUITE 1300, HOUSTON, TX 77002
02N26E000001202	GAS TRANSMISSION NORTHWEST, LLC	700 LOUISIANA ST SUITE 1300	HOUSTON	TX	77002	700 LOUISIANA ST SUITE 1300, HOUSTON, TX 77002
02N26E000001500	GRIEB, KEN & CARRI	72540 ALPINE LN	LEXINGTON	OR	97839	72540 ALPINE LN, LEXINGTON, OR 97839
02N26E000001600	GRIEB, KEN & CARRI	72540 ALPINE LN	LEXINGTON	OR	97839	72540 ALPINE LN, LEXINGTON, OR 97839
02N26E000001700	GRIEB, KEN & CARRI	72540 ALPINE LN	LEXINGTON	OR	97839	72540 ALPINE LN, LEXINGTON, OR 97839
02N26E000001900	GRIEB, KEN & CARRI	72540 ALPINE LN	LEXINGTON	OR	97839	72540 ALPINE LN, LEXINGTON, OR 97839
02N26E000002300	SAINT PATRICK CATHOLIC CHURCH OF HEPPNER	PO BOX 633	HEPPNER	OR	97836	PO BOX 633, HEPPNER, OR 97836
02N26E000002301	ASHBECK, TONY R & ASHBECK, GERALD T	71384A HIGHWAY 207	ECHO	OR	97826	71384A HIGHWAY 207, ECHO, OR 97826
02N26E000002302	SANDHOLLOW LAND, LLC	PO BOX 307	LEXINGTON	OR	97839	PO BOX 307, LEXINGTON, OR 97839
02N26E000002303	UNIVERSITY OF PORTLAND	5000 WILLAMETTE BLVD	PORTLAND	OR	97200	5000 WILLAMETTE BLVD, PORTLAND, OR 97200
02N26E000002400	WILLIAM J DOHERTY RANCH, LLC	70644 DOHERTY RD	LEXINGTON	OR	97839	70644 DOHERTY RD, LEXINGTON, OR 97839
02N26E000002500	ASHBECK, TONY R & ASHBECK, GERALD T	71384A HIGHWAY 207	ECHO	OR	97826	71384A HIGHWAY 207, ECHO, OR 97826
02N26E000002600	ASHBECK, TONY R & ASHBECK, GERALD T	71384A HIGHWAY 207	ECHO	OR	97826	71384A HIGHWAY 207, ECHO, OR 97826
02N27E000000300	IVAR & LINA LLC	958 W CODY AVE	HERMISTON	OR	97838	958 W CODY AVE, HERMISTON, OR 97838
02N27E000002000	STATE OF OREGON	417 TRANSPORTATION BLDG	SALEM	OR	97310	417 TRANSPORTATION BLDG, SALEM, OR 97310
02N27E000002100	N & C LAND, LLC	71062 PERKINS RD	ECHO	OR	97826	71062 PERKINS RD, ECHO, OR 97826

Sunstone Solar Project

Figure 1 Taxlots

MORROW COUNTY, OR



- ▬ ASC Approved Site Boundary
- 🟥 Excluded from Development
- ▭ Taxlot Boundary*

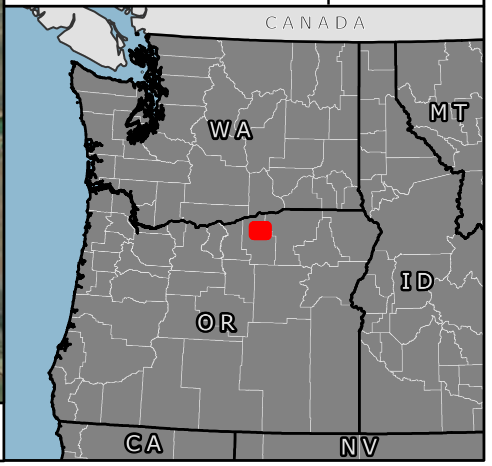
Proposed Boundaries

- ▨ SS 1 Site Boundary
- ▨ SS 2 Site Boundary
- ▨ SS 3 Site Boundary
- ▨ SS 4 Site Boundary
- ▨ SS 5 Site Boundary
- ▨ SS 6 Site Boundary

*Data received from Morrow County on 7/8/2025

TETRA TECH

Reference Map



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0 0.5 1 2 3 4 Miles

NOT FOR CONSTRUCTION

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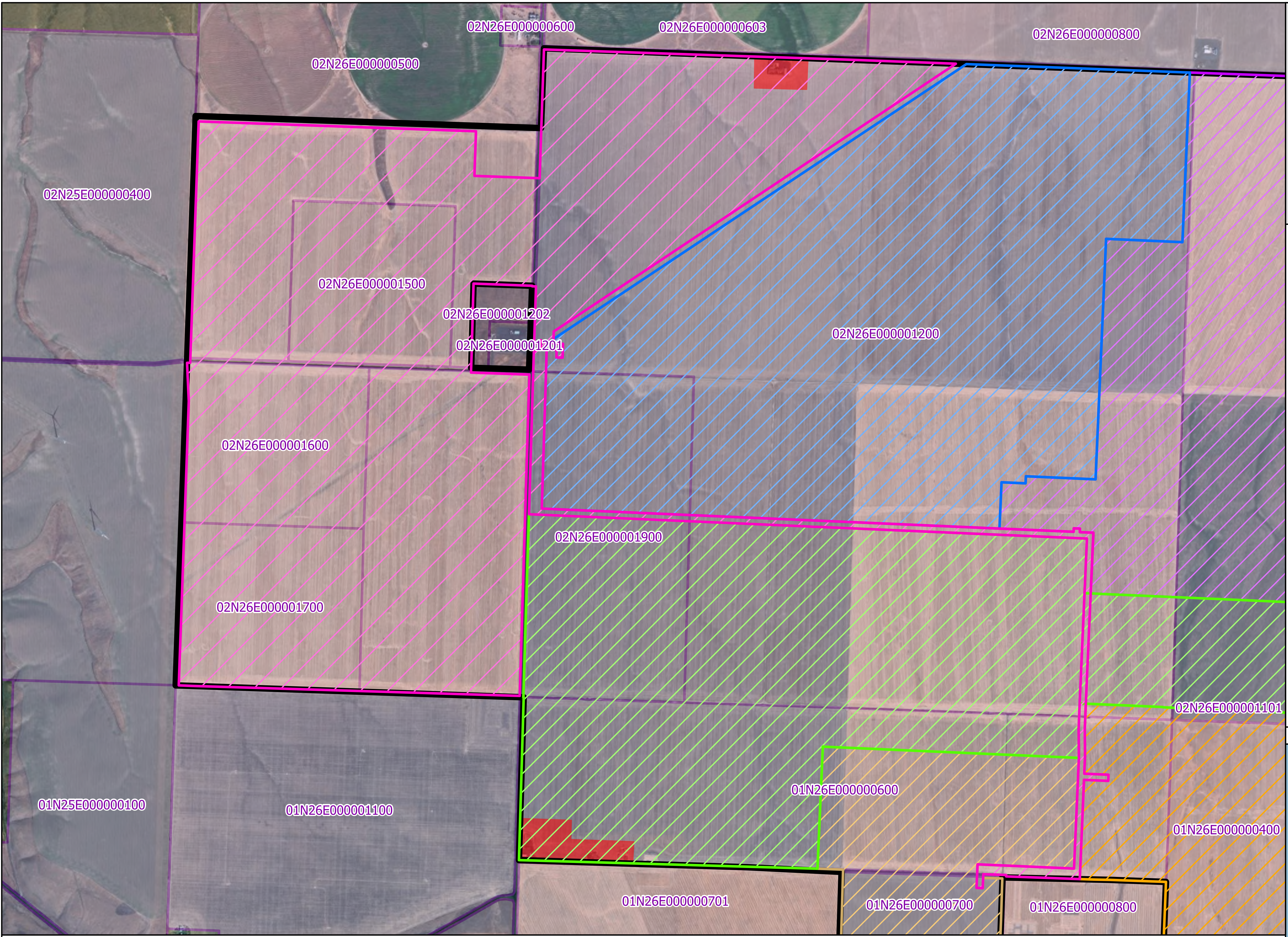
Sunstone Solar Project

Figure 1.1 Taxlots

MORROW COUNTY, OR



▬ ASC Approved Site Boundary

🟥 Excluded from Development

▨ Taxlot Boundary*

Proposed Boundaries

▨ SS 1 Site Boundary

▨ SS 2 Site Boundary

▨ SS 3 Site Boundary

▨ SS 4 Site Boundary

▨ SS 5 Site Boundary

▨ SS 6 Site Boundary

*Data received from Morrow County on 7/8/2025

TETRA TECH

Reference Map

1:18,000

WGS 1984 UTM Zone 11N

0 500 1,000 2,000 3,000 4,000 Feet

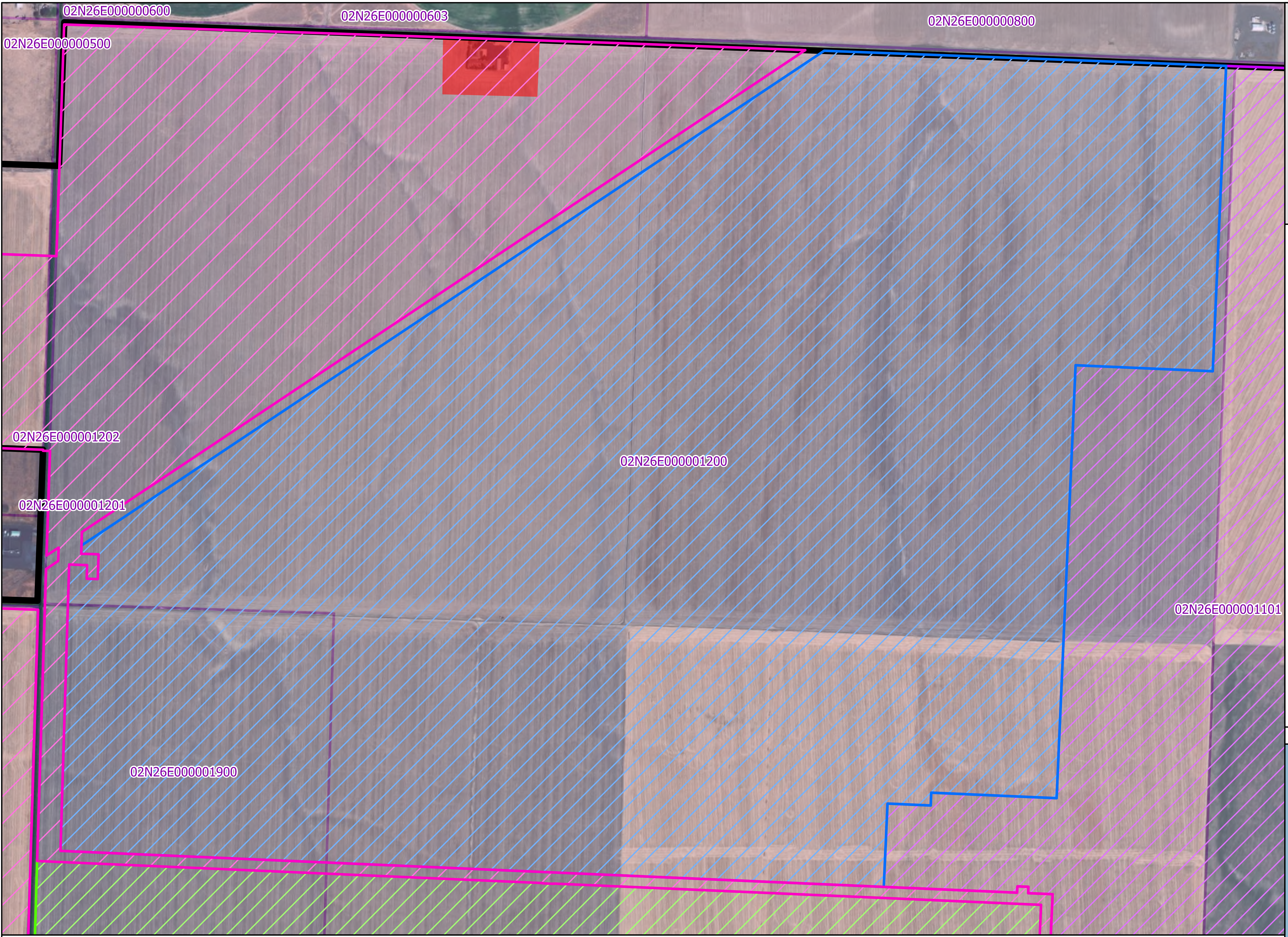
NOT FOR CONSTRUCTION

\\tt.local\GIS\US\CES\Projects\PDX\PineGateRenewables\Sunstone\Maps\RFA_20250530\PGR_Sunstone_RFA_20251028.aprx

Sunstone Solar Project

Figure 1.2 Taxlots

MORROW COUNTY, OR



▬ ASC Approved Site Boundary

🟥 Excluded from Development

☐ Taxlot Boundary*

Proposed Boundaries

▨ SS 1 Site Boundary

▨ SS 2 Site Boundary

▨ SS 3 Site Boundary

▨ SS 4 Site Boundary

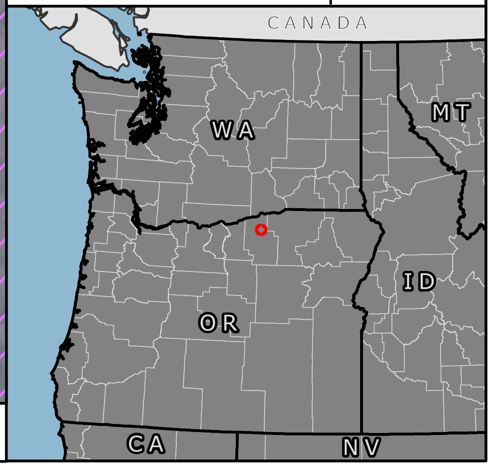
▨ SS 5 Site Boundary

▨ SS 6 Site Boundary

*Data received from Morrow County on 7/8/2025

TETRA TECH

Reference Map



1:10,000

WGS 1984 UTM Zone 11N

0 500 1,000 2,000 3,000 4,000 Feet

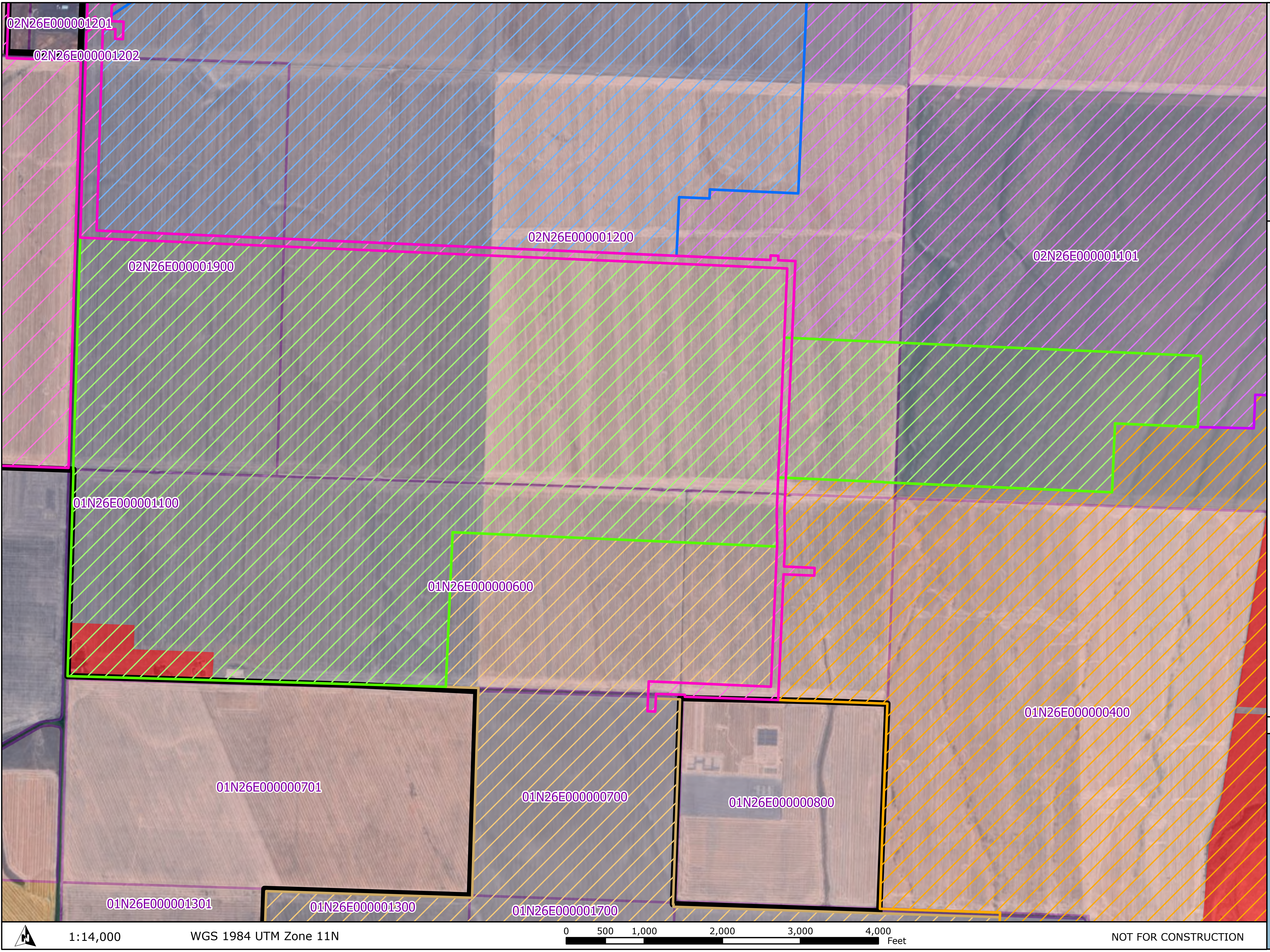
NOT FOR CONSTRUCTION

\\tt.local\GIS\US\CES\Projects\PDX\PineGateRenewables\Sunstone\Maps\RFA_20250530\PGR_Sunstone_RFA_20251028.aprx

Sunstone Solar Project

Figure 1.3 Taxlots

MORROW COUNTY, OR



- ▬ ASC Approved Site Boundary
- 🟥 Excluded from Development
- ▭ Taxlot Boundary*

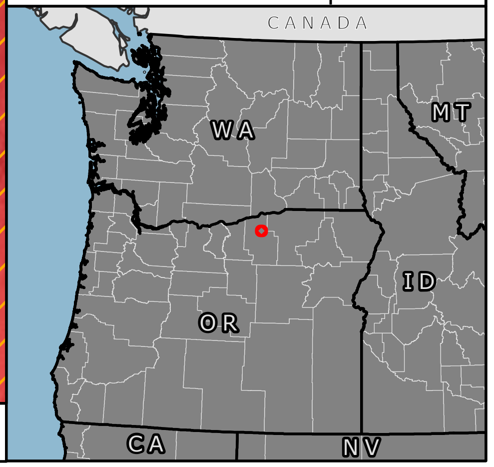
Proposed Boundaries

- ▨ SS 1 Site Boundary
- ▨ SS 2 Site Boundary
- ▨ SS 3 Site Boundary
- ▨ SS 4 Site Boundary
- ▨ SS 5 Site Boundary
- ▨ SS 6 Site Boundary

*Data received from Morrow County on 7/8/2025

TETRA TECH

Reference Map

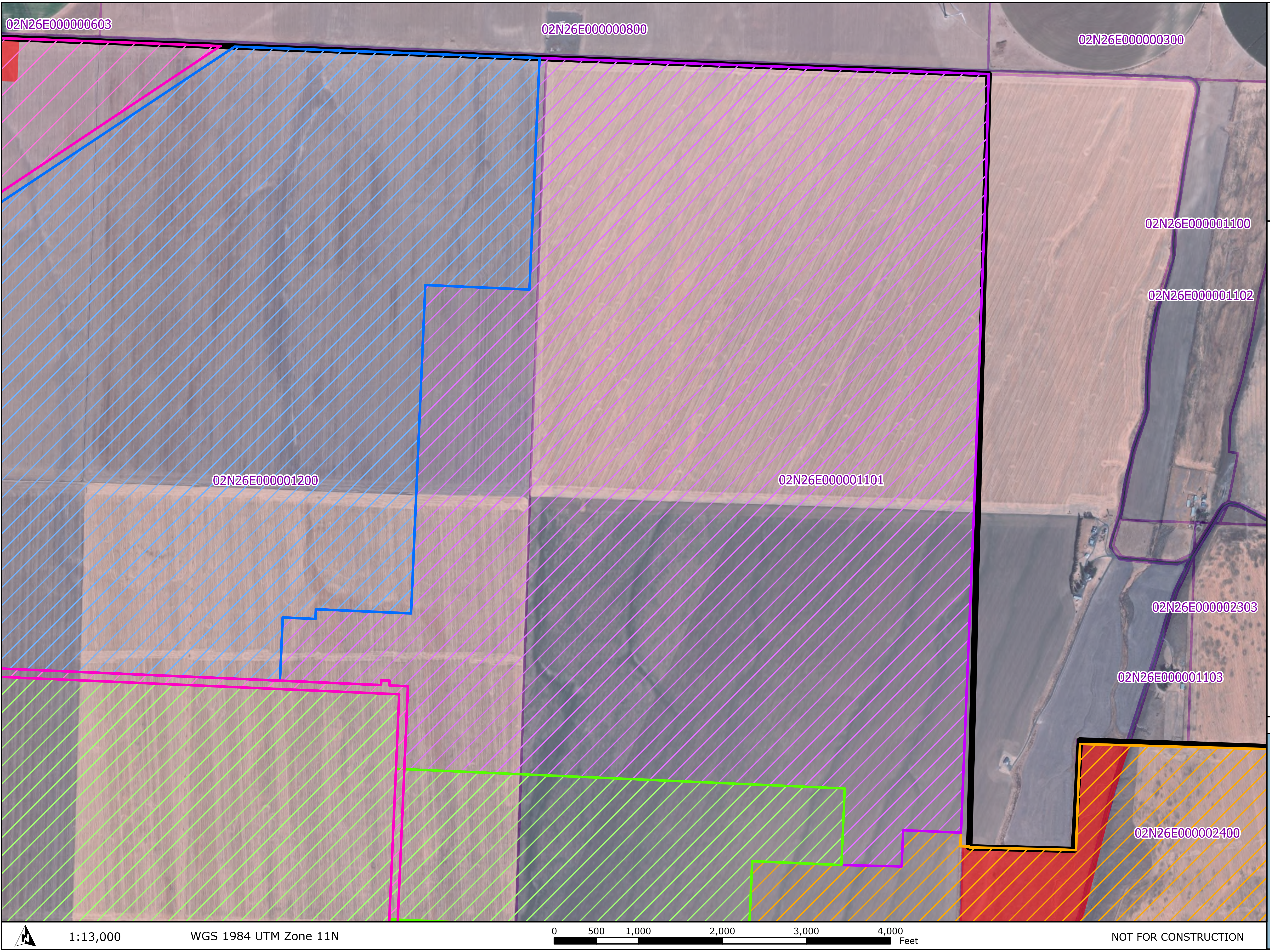


\\tt.local\GIS\US\CES\Projects\PDX\PineGateRenewables\Sunstone\Maps\RFA_20250530\PGR_Sunstone_RFA_20251028.aprx

Sunstone Solar Project

Figure 1.4 Taxlots

MORROW COUNTY, OR



1:13,000

WGS 1984 UTM Zone 11N

NOT FOR CONSTRUCTION

▬ ASC Approved Site Boundary

🟥 Excluded from Development

▭ Taxlot Boundary*

Proposed Boundaries

▨ SS 1 Site Boundary

▨ SS 2 Site Boundary

▨ SS 3 Site Boundary

▨ SS 4 Site Boundary

▨ SS 5 Site Boundary

▨ SS 6 Site Boundary

*Data received from Morrow County on 7/8/2025

TETRA TECH

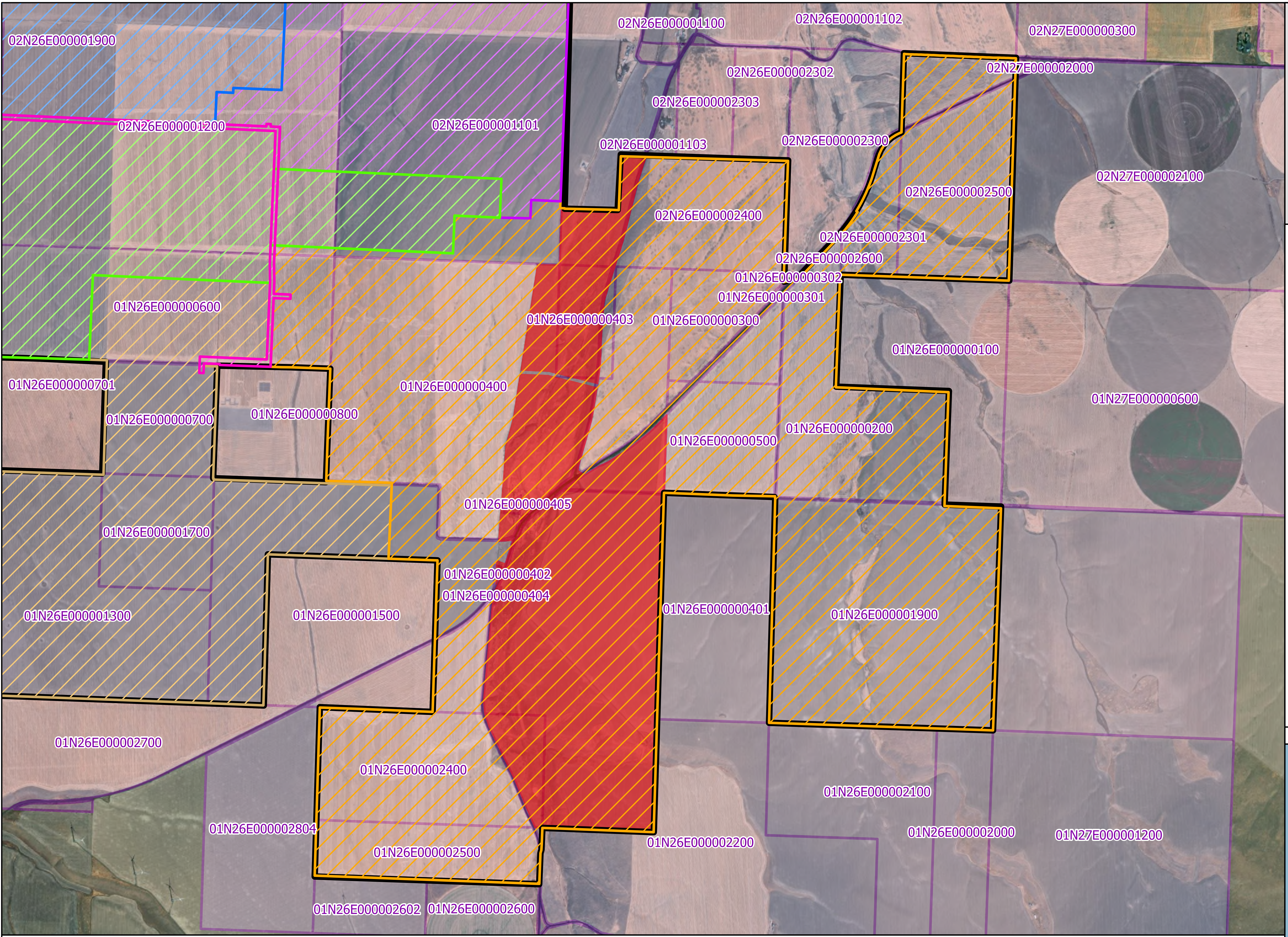
Reference Map

\\tt.local\GIS\US\CES\Projects\PDX\PineGateRenewables\Sunstone\Maps\RFA_20250530\PGR_Sunstone_RFA_20251028.aprx

Sunstone Solar Project

Figure 1.5 Taxlots

MORROW COUNTY, OR



- ▭ ASC Approved Site Boundary
- 🟥 Excluded from Development
- ▭ Taxlot Boundary*

Proposed Boundaries

- ▨ SS 1 Site Boundary
- ▨ SS 2 Site Boundary
- ▨ SS 3 Site Boundary
- ▨ SS 4 Site Boundary
- ▨ SS 5 Site Boundary
- ▨ SS 6 Site Boundary

*Data received from Morrow County on 7/8/2025

TETRA TECH

Reference Map

1:26,000

WGS 1984 UTM Zone 11N

0 500 1,000 2,000 3,000 4,000
Feet

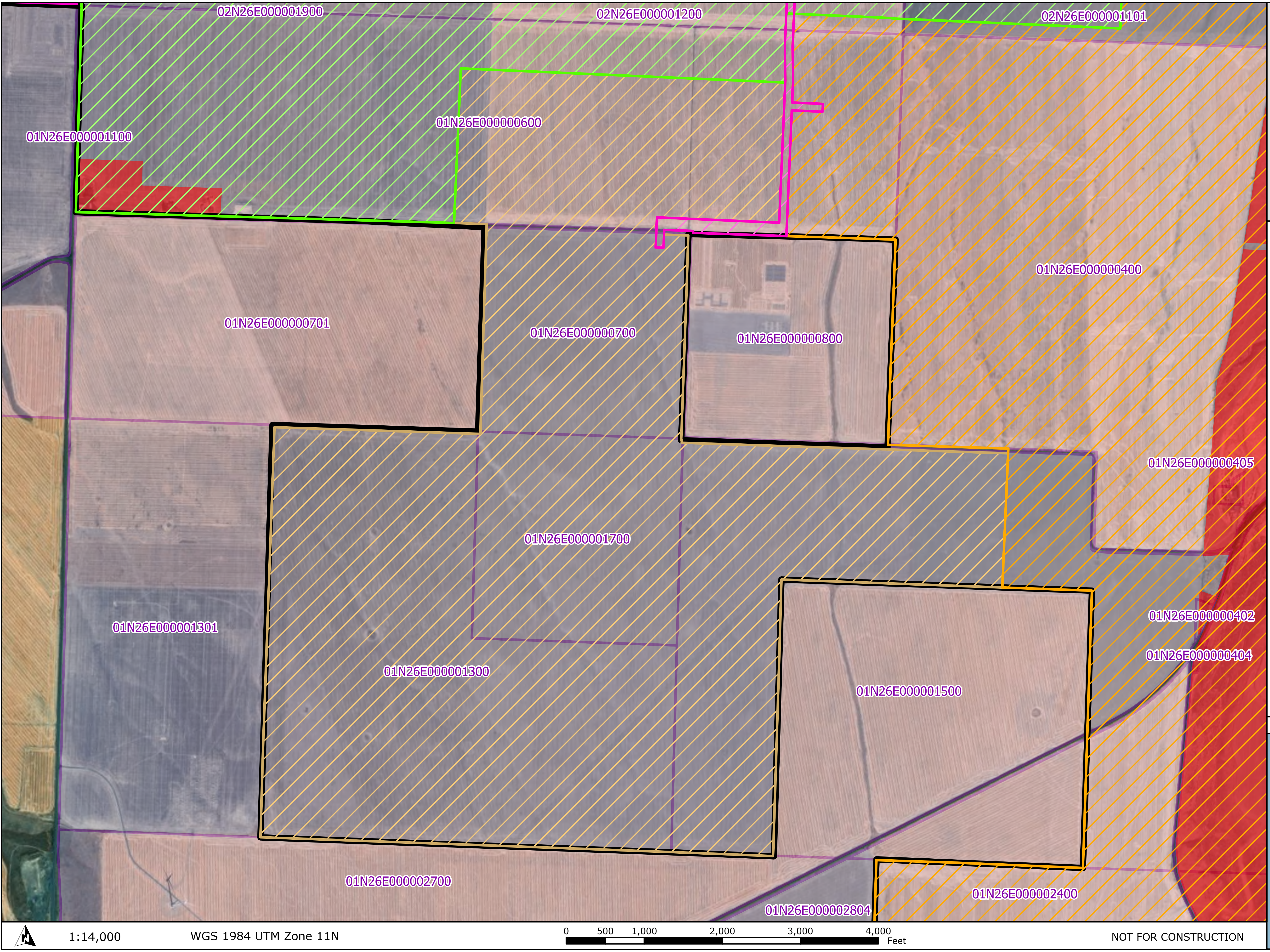
NOT FOR CONSTRUCTION

\\tt.local\GIS\US\CES\Projects\PDX\PineGateRenewables\Sunstone\Maps\RFA_20250530\PGR_Sunstone_RFA_20251028.aprx

Sunstone Solar Project

Figure 1.6
Taxlots

MORROW COUNTY, OR



▬ ASC Approved Site Boundary

🟥 Excluded from Development

▭ Taxlot Boundary*

Proposed Boundaries

▨ SS 1 Site Boundary

▨ SS 2 Site Boundary

▨ SS 3 Site Boundary

▨ SS 4 Site Boundary

▨ SS 5 Site Boundary

▨ SS 6 Site Boundary

*Data received from Morrow County on 7/8/2025

TETRA TECH

Reference Map

\\tt.local\GIS\US\CES\Projects\PDX\PineGateRenewables\Sunstone\Maps\RFA_20250530\PGR_Sunstone_RFA_20251028.aprx