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TECHNICAL MEMORANDUM
CWMNW Arlington, OR

Annotated Outline of the Chemical Waste Management of the Northwest Landfill Radiological Dose and Risk Assessment for Bakken Oilfield Waste Disposals in Arlington, OR

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RAC RISK ASSESSMENT CORPORATION

In compliance with the Oregon Department of Energy's (ODOE) request for the risk assessment to follow the same general approach used for the Blue Ridge Landfill in Kentucky; RAC finds it imperative to incorporate the site-specific characteristics of the Arlington facility in performing the analysis. The Chemical Waste Management of the Northwest facility in Arlington, OR (CWMNW) is a Resource Conservation and Recovery Act (RCRA), Treatment, Storage and Disposal Facility (TSDF) permitted to treat, store and land dispose the universe of both hazardous and non-hazardous wastes whereas the Blue Ridge Landfill is permitted as a Subtitle D landfill primarily designed for the disposal of municipal solid waste. The CWMNW landfill is double lined with secondary and tertiary leak detection systems and the overall environmental setting is significantly different. Finally, there are some differences in the characteristics of the TENORM wastes that were disposed at each site. These site-specific factors will be accounted for in the dose and risk assessment for the CWMNW facility.

1. Introduction

The Dose and Risk Assessment report is intended to address the disposal and potential remediation options for an estimated 1,285 tons of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) waste received from the Bakken Oilfields. The waste was transported by Oilfield Waste Logistics (OWL) and disposed of in Landfill Unit L-14 of the Chemical Waste Management of the Northwest (CWMNW) Arlington, OR Facility between 2016 and 2019.

1.1 Scope and Background

This section is intended to explain the purpose and scope of the final dose and risk assessment report. The final report will include a comprehensive dose and risk assessment of the potential radiological doses and health risks associated with the Bakken Oilfield waste disposals at the CWMNW facility in Arlington, Oregon. The report will describe the waste in question and provide context for the dose and risk calculations included in the report, including disposal and remediation alternatives.

2. Arlington Landfill Environmental Setting

This section will provide details of the design and permitted use of the CWMNW Resource Conservation and Recovery Act (RCRA) Treatment, Storage, and Disposal Facility (TSDF). The final report will include a description of the natural and anthropogenic radiological background surrounding the site, results of the radiological survey performed for Landfill Unit L-14, the waste disposal procedures used in the management of the Bakken Oilfield wastes along with details of the location of these wastes within the disposal facility. The final report will also include a summary of the site geology and hydrogeology and the key environmental protection features which were used in siting the facility that create a model environmental setting for a RCRA TSDF.

2.2 Disposal Facility

2.1.1. Construction and Environmental Protection Features

2.1.2. Waste Handling Procedures

2.1.3. Leachate Management System

2.3 Site Geology and Hydrogeology

2.4 Background Radiation Levels

2.5 Environmental Sampling Data

3. Characterization of the Bakken Oilfield Waste

This section will describe the characteristics of the Bakken Oilfield waste that identify it as TENORM waste, including its origins and its radionuclide composition. This step of the assessment is known as the source term and is key to calculating doses and risks. The source term is defined by the quantity of radionuclides released, the temporal distribution of the release, and the physical characteristics of radionuclides released. This section will detail the different sources of data used to quantify the types, volumes, and radionuclide composition of the Bakken Oilfield wastes and will describe the method and details used to quantify the source term for the analysis. The remediation source term is a diluted version of the disposal source term to account for the mixing of the Bakken Oilfield wastes with other wastes.

3.1 Radiological Characterization of the Bakken Oilfield Waste

3.2 Radiological Source Term for Disposal Operations

3.3 Radiological Source Term for Remediation Alternatives

4. Exposure Scenarios Considered in the Dose and Risk Assessment

This section will explain the exposure scenarios evaluated for waste handlers, landfill workers, and the public for the different timeframes considered in the dose and risk assessment. For waste handlers during disposal of the Bakken Oilfield wastes, complete pathways of exposure include inhalation of radionuclides in air, inadvertent ingestion of soil, and external exposures. For members of the public during disposal operations, the only complete exposure pathway is the inhalation of radionuclides released to air. Exposure pathways for the excavate and remove alternative are the same as those for the disposal operations, except that a remediation supervisor is also considered. For the closure-in-place option, the complete pathway of exposure for landfill workers and the nearest current resident is inhalation of radon; for potential future onsite and offsite residents both inhalation of radon and drinking water ingestion from a well that is assumed to be located at the downgradient edge of the source, Landfill Unit L-14, are included. Methods used to define each receptor and all relevant exposure parameters for the assessment will be detailed here.

4.1 During Disposal

- Waste handler. This individual is the person that physically drives the truck from the point of origin to the CWMNW Arlington Landfill. They operate the controls outside the truck that allow the waste to be physically deposited into the landfill. This individual is the maximally exposed individual during the disposals as they are outside their truck with no personal protective equipment (PPE) while the material is being deposited in the landfill. When the waste

arrives at the facility there is a landfill worker escort in a separate vehicle. The landfill worker escort remains inside their vehicle during the entire disposal process, and as a matter of routine, wears PPE due to the hazardous chemical nature of the wastes disposed. For these reasons, the dose to the landfill worker will be less than the dose to the waste handler and is not calculated explicitly. Dose to the waste handler during transport and dose to members of the public along the transport route are assumed to be negligible, and a stringent analysis of those exposure pathways is outside the scope of this assessment. Relevant pathways of exposure for the waste handler are:

  - Inhalation of particulates
  - Inadvertent ingestion of soil
  - External exposure

- Current offsite resident. These individuals currently occupy the closest homes to the CWMNW Arlington Landfill. They are located approximately 10,700 ft southwest from Landfill Unit L-14 where the Bakken Oilfield waste is located. The relevant pathway of exposure is:
  - Inhalation of particulates

4.2 Alternative 1: Closure-in-Place

- Landfill worker. These are individuals that work at the landfill near the Bakken Oilfield waste disposals on a regular basis for 30 years. Due to the hazardous chemical nature of the wastes disposed of in the Arlington Landfill, workers routinely wear PPE, but no credit is taken for this in the calculations. Access to the disposal areas of the landfill is restricted to essential personnel only. There is one complete pathway of exposure:
  - Inhalation of radon, assuming 30 years of exposure
- Current offsite resident. These individuals occupy the closest homes to the CWMNW Arlington Landfill and remain at this residence for 30 years. They are located approximately 10,700 ft southwest from Landfill Unit L-14 where the Bakken Oilfield waste is located. The relevant pathway of exposure is:
  - Inhalation of radon, assuming 30 years of exposure
- Future offsite resident. These are individuals that are assumed to live at the same location as the current offsite resident, but far into the future after the facility has closed. Complete pathways of exposure are:
  - Inhalation of radon, assuming 30 years of exposure
  - Ingestion of groundwater assuming it is potable, model is run to maximum concentration and dose
- Future onsite resident. These individuals are hypothetical future residents after the facility is closed that are assumed to live at the edge of the Bakken Oilfield waste disposals in Landfill Unit L-14. The onsite resident is assumed to draw their water from a well located at the downgradient edge of the disposals where the radionuclide concentration will be maximized. Complete pathways of exposure are:
  - Inhalation of radon, assuming 30 years of exposure

- Ingestion of groundwater assuming it is potable, model is run to maximum concentration and dose

4.3 Alternative 2: Excavate and Redispose Bakken Oilfield Waste

- Excavation worker. These are workers that are involved in the hypothetical excavation process. They are not landfill workers. Complete pathways of exposure are:
  - Inhalation of particulates
  - Inadvertent ingestion of soil
  - External exposure
- Supervisor. This individual monitors the hypothetical excavation process. They are only present for a subset of the removals. Complete pathways of exposure include:
  - Inhalation of particulates
  - Inadvertent ingestion of soil
  - External exposure
- Current offsite resident. These individuals currently occupy the closest homes to the CWMNW Arlington Landfill. They are located approximately 10,700 ft to the southwest from Landfill Unit L-14 where the Bakken Oilfield waste is located. Complete pathways of exposure include:
  - Inhalation of particulates

5. Dose and Risk Calculation Methodology

This section will provide the details of the methodology used for calculating the doses and risks from radiological exposures distinguishing between the air pathway and the groundwater pathway. Established methods will be used to calculate particulate releases to the air during disposal. A simple box model will be used to calculate exposure concentrations to the waste handler at the disposal site during disposal. The EPA AERMOD model will be used to calculate χ/Q values (i.e., dispersion factors). The χ/Q values are used with the atmospheric source term to calculate air concentrations at specific receptor locations such as the nearest current resident and future resident, both onsite and offsite. For radon, the NRC model (NUREG 3533) will be used to predict the flux at the surface above the disposed wastes, and χ/Q values from AERMOD will be used to calculate radon air concentrations at the receptor locations. Ingestion doses are based on standard soil ingestion rates per EPA Regional Screening Levels guidance.

Dose and risk associated with the groundwater pathway will be addressed using numerical models commonly employed in low-level radioactive waste performance assessments coupled with parameter values specific to conditions at the CWMNW site. The conceptual model, mathematical model, and parameter values will be detailed here. The groundwater conceptual model will account for transport from waste cell to the aquifer in the Selah formation. Because the aquifer in the Selah is not potable or used for irrigation, the groundwater assessment is only used as a bounding analysis. Based on recent studies that conclude leakage from the Selah aquifer to the lower Priest Rapids aquifer (a source

of potable water) is extremely limited, impacts to the Selah aquifer would bound any potential impacts to the Priest Rapids aquifer. Aquifer concentrations and ingestion doses will be calculated until peak dose occurs. The model will include the effects of 1) open cells during active operations, 2) engineered cap, and 3) long-term degradation of cap.

A qualitative assessment will be provided for the surface water pathway. This is because the Selah aquifer discharges to a closed basin in Alkali Flats and there is no viable transport pathway from Alkali Flats to surface water features including the Columbia River, consequently no surface water impacts are expected.

Dose and risk factors from DOE-STD-1196 and Federal Guidance Report 13 will be used.

5.1 Atmospheric Modeling Methods

5.2 Groundwater Modeling Methods

5.3 Surface Water Assessment

6. Dose and Risk Estimates During Disposal of the Bakken Oilfield Waste at the CWMNW Landfill

The calculated doses and risks for the exposure scenarios described in Section 4 will be presented and discussed.

6.1 Doses and Risks During Disposal

- Waste handlers
  - Inhalation of particulates
  - Inadvertent ingestion of soil
  - External exposure

- Current offsite residents
  - Inhalation of particulates

7. Dose and Risk Estimates for Remediation Alternatives

The calculated doses and risks for the exposure scenarios for the two remediation alternatives described in Section 4 will be presented and discussed.

7.1 Doses and Risks for Alternative 1: Closure-in-Place

- Landfill workers
  - Inhalation of radon, assuming 30 years of exposure
- Current offsite residents
  - Inhalation of radon, assuming 30 years of exposure

- Future offsite residents
  - Inhalation of radon, assuming 30 years of exposure
  - Ingestion of groundwater, model is run to maximum concentration and dose
- Future onsite residents
  - Inhalation of radon, assuming 30 years of exposure
  - Ingestion of groundwater, model is run to maximum concentration and dose

7.2 Doses and Risks for Alternative 2: Excavate and Redispose Bakken Oilfield Waste

- Excavation workers
  - Inhalation of particulates
  - Inadvertent ingestion of soil
  - External exposure
- Supervisor
  - Inhalation of particulates
  - Inadvertent ingestion of soil
  - External exposure
- Current offsite resident
  - Inhalation of particulates

8. Ecological Assessment

For the closure-in-place alternative an ecological assessment is provided to evaluate the radiological impacts to biota to ensure there are no deleterious effects. This assessment is in addition to the radiological assessment for human receptors evaluated in Section 7. The ecological assessment will be conducted using the ERICA (Environmental Risk from Ionizing Contaminants: Assessment and Management) tool which combines data on environmental transfer of radionuclides and dosimetry to obtain a measure of exposure that is then compared to exposure levels defined by regulators or levels at which deleterious effects are known to occur.

9. Radiation Dose and Risk in Perspective

The calculated doses and risks for different exposure scenarios and timeframes will be compared to a selection of radiation doses and risks from other sources, including natural and anthropogenic background near the site. Risks will be evaluated against the EPA's recommended acceptable risk level of 10^{-4} to 10^{-6}.

10. References

Appendices

A. RAC CV's
B. Details of Bakken Oilfield waste shipments
C. Bakken Oilfield waste analytical data
D. Aquifer characteristics
E. Supporting documentation (spreadsheets, calculation inputs, etc. – everything needed to replicate the calculations)

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