Prepared for

Riverbend Landfill Co.
13469 SW Highway
McMinnville, Oregon 97128

FINAL ENGINEERED SITE CLOSURE AND POST-CLOSURE PLAN

RIVERBEND LANDFILL
MCMINNVILLE, OREGON

Prepared by

Geosyntec consultants
engineers | scientists | innovators

1111 Broadway, 6th Floor
Oakland, California 94607

Project Number: WG2423

9 November 2017

Prepared for:

WASTE MANAGEMENT

Riverbend Landfill Co.
13469 SW Highway
McMinnville, Oregon 97128

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McMinnville, Oregon

Fabrizio W. Settepani

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LIST OF ACRONYMS AND ABBREVIATIONS

ac	acre
a.m. or am	Ante Meridiem (Before Midday)
BMP	Best Management Practice
CCL	Compacted Clay Liner
CFR	Code of Federal Regulations
cm	centimeter
Co	company
CPCP	Closure and Post-Closure Plan
CQA	Construction Quality Assurance
cy	cubic yard
DEQ	(Oregon) Department of Environmental Quality
DM	District Manager
EA	Enforcement Agency
EP	Environmental Protection
EPA	Environmental Protection Agency
FCR	Federal Code of Regulations
FECP	Final Engineered Closure Plan
FECPPs	Final Engineered Closure and Post-Closure Plans
FEMA	Flood Emergency Management Agency
FESCPP	Final Engineered Site Closure and Post-Closure Plans
FEPP	Final Engineered Post-closure Plan
FIRM	Flood Insurance Rate Map
FML	Flexible Membrane Liner
FOS	Factor of Safety
FS	Factor of Safety
ft	foot or feet
g	Acceleration Due to Gravity (= 9.81 m/s^2)

gal	gallon(s)
GCCS	Gas Collection and Control System
GCL	Geosynthetic Clay Liner
Geosyntec	Geosyntec Consultants, Inc.
GTE	Gas to Energy
HDPE	High Density Polyethylene
HDR	HDR Engineering, Inc.
HELP	Hydrologic Evaluation of Landfill Performance
in.	inch(es)
L	liter
lb	pound
LCRS	Leachate Collection and Removal System
LDS	Leak Detection System
LFG	Landfill Gas
LLDPE	Linear Low Density Polyethylene
LSCS	Leachate Secondary Containment System
MCE	Maximum Credible Earthquake
msl	mean sea level
MSW	Municipal Solid Waste
M_w	Moment Magnitude
MW	Monitoring Well
NAVD	North American Vertical Datum
NGVD	National Geodetic Vertical Datum
No.	Number
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standard
OAR	Oregon Administrative Rule
OM	Operations Manager

O&M	Operations and Maintenance
ORS	Oregon Revised Statues
oz.	Ounce
P.E. or PE	Professional Engineer
PHGA	Peak Horizontal Ground Acceleration
p.m. or pm	Post Meridiem (After Midday)
PRC	Public Resources Code
psf	pounds per square foot
QA	Quality Assurance
QC	Quality Control
R	Range
RCRA	Resource Conservation and Recovery Act
RL	Riverbend Landfill
RLC	Riverbend Landfill Co.
s	second
SCADA	Supervisory Control and Data Acquisition
SCS	Soil Conservation Service or SCS Engineers, Inc.
Subtitle D	Part 258 of Title 40 of the Code of Federal Regulations
SWDP	Solid Waste Disposal Permit
SWMS	Storm Water Management System
SWPCP	Storm Water Pollution Control Plan
SY or sy	Square yard
T	Township
TOC	Table of Contents
tpd	tons per day
U.S. or US	United States
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency

Vista	Vista Consultants, LLC
VZM	Vadose Zone Monitoring
WM	Waste Management, Inc.
WMI	Waste Management, Inc.
yr	year

1. INTRODUCTION

1.1 Background

The Riverbend Landfill (RL) is located at 13469 S.W. Highway 18, McMinnville, in Yamhill County, Oregon, and is owned and operated by the Riverbend Landfill Co. (RLC), an operating subsidiary of Waste Management, Inc. (WMI). The RL is a municipal solid waste (MSW) landfill that is regulated by the Oregon Department of Environmental Quality (DEQ) under the Code of Federal Regulations (CFR) Chapter 40, Section 258 (Criteria for Municipal Solid Waste Landfills), Oregon Revised Statutes (ORS) 459 (Solid Waste Management), and Oregon Administrative Rules (OAR) 340-94 (Solid Waste: Municipal Solid Waste Landfills). DEQ issued RLC (the permittee) solid waste disposal permit (SWDP) Number 345 for RL on 1 December 1999. This permit has been administratively extended by DEQ in compliance with OAR 340 093 0070(6)(b)(C) since its expiry date of 1 December 2009. Addendum No. 4 to SWDP #345 was issued on 12 December 2012 [DEQ, 2012]. A final grading plan modification (FGPM) proposal was submitted to DEQ for review and was subsequently approved in a letter dated 29 June 2017 [DEQ, 2017].

Vista Consultants, LLC (Vista) prepared the 2013 Closure and Post-Closure Plans (CPCPs) for RL [Vista, 2013]. The 2013 CPCPs were revised to reflect 2014 updates by HDR Engineering, Inc. (HDR) [HDR, 2014]. Both documents, reflecting Subtitle D (worst-case)[1] closure and post-closure scenarios, were reviewed and approved by the DEQ. In December 2014, Geosyntec Consultants, Inc. (Geosyntec) submitted the *Final Engineered Site Closure and Post-closure Plan* [Geosyntec, 2014] to the DEQ. In August 2017, HDR prepared a *Closure and Post-Closure Plan, Riverbend Landfill, McMinnville, Oregon* [HDR, 2017] to reflect Subtitle D's (worst-case) for the most-recent closure and post-closure scenarios. Geosyntec understands that these more recent documents were reviewed and approved by the DEQ.

This Final Engineered Site Closure and Post-Closure Plan (FESCPP or the Plan) has been prepared to comply with the requirements for final closure and post-closure activities and

[1] Subtitle D (worst-case) closure and post-closure plans are based on a hypothetical worst-case scenario for closure and post-closure costs and is intended to establish a conservative basis for estimating financial assurance funding requirements, and subsequently, a Final Engineered Closure Plan (FECP), as required by OAR 340-094-0100(2)(a), which shall include the elements of and replace the worst-case closure plan.

associated financial assurance criteria specified in ORS 459.272, OAR 340-94-100 through 145, and the Solid Waste Disposal Permit (SWDP) No. 345. The Plan relates to a closure permit, which must be obtained at least 5 years prior to anticipated final closure, or at a date specified in the permittee's closure permit pursuant to OAR 340-094-0100(2)(a). The Plan must reflect the intended closure design and will replace the most recent Subtitle D (worst-case) CPCP[2].

1.2 Main Objective

The main objective of the Plan is to describe final closure and post-closure activities that will be implemented at the RL to meet (or exceed) regulatory requirements and to ensure the long-term integrity of the facility following closure.

1.3 Organization of Report

The remainder of this report is organized as follows:

- Federal and state regulations, related to landfill closure and post-closure, are reviewed in Section 2;
- General site information about the RL is summarized in Section 3;
- Physical setting at the RL is described in Section 4;
- The Closure Plan for the RL is presented in Section 5;
- The Post-Closure Plan for the RL is presented in Section 6;
- Closure and post-closure financial assurance mechanism is discussed in Section 7;
- A list of references cited in the report is included in Section 8; and
- Limitations on the application of information presented in this report are described in Section 9.

Figures, tables and appendices, included at the end of this report, contain supplemental maps, plans, analyses, data and other information pertinent to the content of the RL Plan.

[2] The plan follows and is built on the assumptions made in HDR [2017].

2. REVIEW OF CLOSURE AND POST-CLOSURE REGULATIONS

The applicable federal regulations, which fall under Subtitle D of the Resource Conservation and Recovery Act (RCRA) and contained in Part 258, Title 40 of the Code of Federal Regulations (CFR), are referred to herein as "Subtitle D" regulations. The set of applicable state regulations is contained in Division 94 (Solid Waste: Municipal Solid Waste Landfills) of the Oregon Administrative Rules (OARs). In addition, the site permit (SWDP #345) issued by the DEQ provides site-specific requirements related to landfill construction, operations and closure. The specific regulatory requirements cited in this report are shown in *italics*.

2.1 Closure and Post-closure Plans

2.1.1 Federal Requirements

2.1.1.1 Closure Plans

The Subtitle D regulations specify that a closure plan must be prepared for all MSW landfills. The minimum requirements for the closure plan are contained in §258.60(c):

> "*(c) The owner or operator must prepare a written closure plan that describes the steps necessary to close all MSWLF units at any point during its active life in accordance with the design requirements in §258.60 (a) or (b) as applicable. The closure plan, at a minimum, must include the following information:*
>
> *(1) A description of the final cover, designed in accordance with §258.60 (a) and the methods and procedures to be used to install the cover;*
>
> *(2) An estimate of the largest area of the MSWLF unit ever requiring a final cover as required under §258.60(a) at any time during the active life;*
>
> *(3) An estimate of the maximum inventory of wastes ever on-site over the active life of the landfill facility; and*
>
> *(4) A schedule for completing all activities necessary to satisfy the closure criteria in §258.60."*

2.1.1.2 Post-Closure Plans

The Subtitle D regulations specify that a post-closure care plan must be prepared for all MSW landfills. The minimum requirements for the post-closure plan are contained in §258.61(c) of Title 40 of the CFR (Subtitle D):

> *"(c) The owner or operator of all MSWLF units must prepare a written post-closure plan that includes, at a minimum, the following information:*
>
> *(1) A description of the monitoring and maintenance activities. . . for each MSWLF unit, and the frequency at which these activities will be performed;*
>
> *(2) Name, address, and telephone number of the person or office to contact about the facility during the post-closure period; and*
>
> *(3) A description of the planned uses of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the monitoring systems. . ."*

Further, §258.61(a) of Subtitle D requires that *"Post-closure care must be conducted for 30 years. . ."*

2.1.2 Oregon-Specific Requirements

The FESCPP for the RL is required by Part 340-094-100(1)(a) of the Oregon Administrative Rules (OARs).

According to this rule, *"At least five years prior to anticipated closure of a municipal solid waste landfill, the person holding the disposal site permit shall apply to renew the permit to cover the period of time remaining for site operations, closure of the site, and all or part of the time that active post-closure site maintenance is required by the Department. This last permit issued before final closure of the landfill is scheduled to occur shall be called a "closure permit."* According to these regulations, the "closure permit" to be issued before final closure of the landfill must include: (i) A Final Engineered Closure Plan (FECP), and (ii) A Final Engineered Post-Closure Plan (FEPP). Both of these documents are included herein.

According to Part 340-094-110 of the OARs, the FECP shall consist of at least the following elements:

- A description of the steps necessary to close all municipal solid waste landfill units at any point during their active life;
- A description of the final cover system that is designed to minimize infiltration and erosion;
- An estimate of the largest area of the landfill requiring a final cover;
- An estimate of the maximum inventory of wastes ever on site over the active life of the landfill;
- A schedule for completing all activities necessary to satisfy the applicable closure criteria in 40 CFR 258.60;
- Detailed design plans and specifications consistent with the applicable requirements of OARs 340-093-0140 and 340-94-0060(2), i.e., design plans and specifications for the closure improvements, including final cover system, gas control system, runoff/run-on control system, leachate treatment and disposal system;
- An updated final grading (topographic) plan for the site;
- An end use plan;
- A landscaping plan;
- An assessment of long-term settlement and its potential effects on the integrity of the closure;
- A description of the design, function, and operation of all environmental control systems;
- A description (plan) of how and when the facility will be closed (i.e., the procedures that will be used to ensure that facility operations are compatible with closure objectives and requirements);
- A detailed description of the environmental monitoring system;
- A schedule for implementing the closure plan;
- A detailed closure cost estimate; and

- Other information requested in the closure permit or otherwise required to comply with all applicable DEQ and federal regulations.

According to Part 340-094-115 of the OARs, the FEPP shall consist of at least the following elements:

- Procedures for maintaining the integrity and effectiveness of the final cover system;
- Procedures for maintaining and operating the leachate collection, treatment, and disposal systems;
- Procedures for maintaining and operating the environmental monitoring systems;
- Procedures for conducting environmental quality monitoring (e.g., groundwater, surface water, landfill gas, leachate, etc.);
- Procedures for maintaining and operating the landfill gas control system;
- Procedures for maintaining and operating the storm water runoff/run-on control systems;
- Procedures for providing overall, site-wide monitoring and security;
- Establishing appropriate uses of the property during the post-closure care period;
- A detailed schedule for post-closure monitoring, inspection, and maintenance and repairs;
- Description of operation and maintenance procedures for all environmental monitoring and control systems that will be in active use during the post¬-closure period;
- A detailed post-closure cost estimate; and
- Any other information required to comply with DEQ and federal regulations.

2.2 Financial Assurance Requirements

2.2.1 Federal Requirements

2.2.1.1 Closure

Federal closure requirements are contained in Part 258.71 of Title 40 of the CFR:

"(a) The owner or operator must have a detailed written estimate, in current dollars, of the cost of hiring a third party to close the largest area of all MSWLF units ever requiring a final cover as required under §258.60 at any time during the active life in accordance with the closure plan. The owner or operator must notify the State Director that the estimate has been placed in the operating record.

(1) The cost estimate must equal the cost of closing the largest area of all MSWLF units ever requiring a final cover at any time during the active life when the extent and manner of its operation would make closure the most expensive, as indicated by its closure plan (see §258.60(c)(2) of this part).

(2) During the active life of the MSWLF unit, the owner or operator must annually adjust the post-closure cost estimate for inflation.

(3) The owner or operator must increase the closure care cost estimate and the amount of financial assurance provided under paragraph (b) of this section if changes to the closure plan or MSWLF unit conditions increase the maximum cost of closure at any time during the remaining active life.

(4) The owner or operator may reduce the closure cost estimate and the amount of financial assurance provided under paragraph (b) of this section if the cost estimate exceeds the maximum cost of closure care remaining at any time during the remaining active life of the MSWLF unit. The owner or operator must notify the State Director that the justification for the reduction of the closure cost estimate and the amount of financial assurance has been placed in the operating record."

2.2.1.2 Post-Closure Care

Federal financial assurance requirements for post-closure care are specified in Part 258.72 of Title 40 of the CFR as follows:

"(a) The owner or operator must have a detailed written estimate, in current dollars, of the cost of hiring a third party to conduct post-closure care for the MSWLF unit in compliance with the post-closure plan developed under §258.61 of this part. The post-closure cost estimate used to demonstrate financial assurance in paragraph (b) of this section must account for the total costs of conducting post-

closure care, including annual and periodic costs as described in the post-closure plan over the entire post-closure care period. The owner or operator must notify the State Director that the estimate has been placed in the operating record.

(1) The cost estimate for post-closure care must be based on the most expensive costs of post-closure care during the post-closure care period.

(2) During the active life of the MSWLF unit and during the post-closure care period, the owner or operator must annually adjust the post-closure cost estimate for inflation.

(3) The owner or operator must increase the post-closure care cost estimate and the amount of financial assurance provided under paragraph (b) of this section if changes in the post-closure plan or MSWLF unit conditions increase the maximum costs of post-closure care.

(4) The owner or operator may reduce the post-closure cost estimate and the amount of financial assurance provided under paragraph (b) of this section if the cost estimate exceeds the maximum costs of post-closure care remaining over the post-closure care period. The owner or operator must notify the State Director that the justification for the reduction of the post-closure cost estimate and the amount of financial assurance has been placed in the operating record."

2.2.2 Oregon-Specific Requirements

Oregon adopts the federal requirements described above, and has additional Financial Assurance Criteria in OAR 340-94-140:

"(1) Financial Assurance Required. The owner or operator of a municipal solid waste landfill shall maintain a financial assurance plan with detailed written cost estimates of the amount of financial assurance that is necessary and shall provide evidence of financial assurance for the costs of:

(a) Closure of the municipal solid waste landfill;

(b) Post-closure maintenance of the municipal solid waste landfill; and

(c) Any corrective action required by the Department to be taken at the municipal solid waste landfill, pursuant to OAR 340-094-0080(3)…

(4) Financial assurance plans. The financial assurance plan is a vehicle for determining the amount of financial assurance necessary and demonstrating that financial assurance is being provided. A financial assurance plan shall include but not be limited to the following, as applicable:

(a) Cost Estimates. A detailed written estimate of the third-party costs in current dollars according to the provisions of 40 CFR, §258.75. A landfill owner or operator meeting the criteria in 40 CFR §258.75 (a) through (c) may estimate the current dollar cost using a discount rate no greater than the Department's current reference rate. The Department shall determine the reference rate annually during the month of June. It shall be in effect for the fiscal year beginning on the first day of July immediately following the determination date and ending on June 30 of the following calendar year. (The reference rate shall be based on the current yield of composite long-term U.S. Treasury Bonds as published in the Federal Reserve's H.15 (519) Selected Interest Rates for the first full week of the month in which the reference rate is determined, less the annualized Gross Domestic Product implicit price deflator as published in the most recent U.S. Bureau of Economic Analysis Survey of Current Business). The written estimate shall be prepared by a Registered Professional Engineer and shall include costs of:

(A) Closing the municipal solid waste landfill;

(B) Providing post-closure care, including installing, operating and maintaining any environmental control system required on the landfill site;

(C) Performing required corrective action activities; and

(D) Complying with any other requirement the Department may impose as a condition of issuing a closure permit, closing the site, maintaining a closed facility, or implementing corrective action.

(b) The source of the cost estimates;

(c) A detailed description of the form of the financial assurance and a copy of the financial assurance mechanism;

(d) A method and schedule for providing for or accumulating any required amount of funds which may be necessary to meet the financial assurance requirement;

(5) Amount of Financial Assurance Required. The amount of financial assurance required shall be established as follows:

(a) Closure. Detailed cost estimates for closure shall be based on the "worst-case" closure plan or the Final Engineered Site Closure Plan, as applicable. Cost estimates for the Final Engineered Site Closure Plan shall take into consideration at least the following:

(A) Amount and type of solid waste deposited in the site;

(B) Amount and type of buffer from adjacent land and from drinking water sources;

(C) Amount, type, availability and cost of required cover;

(D) Seeding, grading, erosion control and surface water diversion required;

(E) Planned future use of the disposal site property;

(F) The portion of the site property closed before final closure of the entire site; and

(G) Any other conditions imposed on the permit relating to closure of the site.

(b) Post-closure care. Detailed cost estimates for post-closure care shall be based on the "Subtitle D" post-closure plan or the Final Engineered Post-Closure Plan, as applicable. Cost estimates for the Final Engineered Post-Closure Plan shall also take into consideration at least the following:

(A) Type, duration of use, initial cost and maintenance cost of any active system necessary for controlling or stopping discharges; and

(B) Any other conditions imposed on the permit relating to post-closure care of the site.

(c) Corrective action. Estimated total costs of required corrective action activities for the entire corrective action period, as described in a corrective action report pursuant to requirements of OAR 340-094-0080(3) and 40 CFR, §258. 73;

(d) If a permittee is responsible for providing financial assurance for closure, post-closure care and/or corrective action activities at more than one municipal solid waste landfill, the amount of financial assurance required is equal to the sum of all cost estimates for each activity at each facility.

2.2.3 2017 Cost Estimate Update

As noted above, DEQ permits cost estimates to be computed based on the prior year costs adjusted using a quotient derived from Implicit Price Deflator (IPD) values. IPD values are published by the U.S. Department of Commerce, Bureau of Economic Analysis on a quarterly basis. The IPD values relevant to this report are presented in Appendix I, and are as follows:

- IPD for July 2017 (i.e., 2nd quarter 2017) = 113.049 [HDR, 2017];
- IPD for October 2017 (i.e., 4th quarter 2017) = 113.869; and
- The resulting quotient = 113.869 / 113.049 = 1.0072535 for this cost estimate.

Unless otherwise noted, the estimated 2017 closure and post-closure costs presented in Sections 5 and 6, and contained in the tables in Appendix I, are based on adjusting the July 2017 values in [HDR, 2017] by this quotient.

To develop post-closure costs for leachate management and treatment, Geosyntec used the leachate quantities presented in HDR [2017]. RLC hauls leachate off-site for treatment and disposal. It is assumed that this will continue under final engineered closure and post-closure conditions. The volume of leachate that will be generated will decrease

over time following closure and the installation of a geomembrane-based cover system over the entire landfill.

3. GENERAL SITE INFORMATION

3.1 Facility Introduction

The RL is a municipal solid waste (MSW) landfill located in McMinnville, Oregon, that has been in operation since 1982. The landfill is owned and operated by RLC, a subsidiary of WMI, and is permitted by the DEQ to receive municipal solid waste (MSW) and approved special waste [SCS, 2010].

In March 2012, RLC applied to DEQ for a permit that would allow construction of a mechanically stabilized earthen (MSE) berm. Construction of the berm provided approximately 1.0 Million cubic yards (cy) of additional disposal capacity though it did not increase the landfill's overall permitted height. The berm construction, approved by DEQ on 30 May 2013,[3] increased the area of the landfill to a total footprint of approximately 87.4 acres.

In 2017, RLC applied to DEQ for a permit to allow additional waste filling within the permitted footprint of the landfill and generally covering previously-closed portions of Modules 1, 2, and 3. The Final Grading Plan Modification (FGPM) project included: (i) Using the existing final cover system of the landfill over previously closed areas as an overliner system over which new waste fill would be placed, (ii) Retrofitting areas of the final cover system that included a linear low density polyethylene (LLDPE) geomembrane by removing the LLDPE geomembrane and installing a high density polyethylene (HDPE) geomembrane, and (iii) Constructing a new overliner system over areas of Modules 2 and 3 that had not been closed, consisting of HDPE geomembrane. Construction of the FGPM provides approximately 0.5 Million cubic yards of additional disposal capacity within the landfill footprint.

3.2 Site Location

The landfill is located off Highway 18, approximately 3 miles southwest of McMinnville, Oregon (Figure 1). The site address is 13469 SW Highway 18, McMinnville, Oregon

[3] Letter from Oregon DEQ to WM, Approval of Mechanically Stabilized Earthen Berm, Riverbend Landfill, Solid Waste Permit No. 345, Yamhill County, 30 May 2013.

97128. The phone number is 503-472-8788. The site is in Sections 1 and 12, Township T5S, Range R5W, W.M., of Yamhill County.

To the south the landfill is bordered by the floodplain of the South Yamhill River, farmlands and forest to the north and west, and an unnamed tributary of the South Yamhill River on the east. Vehicular traffic enters the landfill property at the northwest side of the property from State Route 18.

3.3 Current Land Use

The floodplain of the South Yamhill River borders the landfill on the south. Agricultural lands and buildings surround the site on the north, west and east. A recreational vehicle (RV) park was located to the southwest of the landfill but is now closed.

3.4 Landfill Development

The landfill was developed by constructing a series of waste disposal cells designated as Modules 1 through 9 (Figure 2). The construction of each new Module involved excavation of soils underlying the site. The plan area permitted for waste disposal is approximately 87.4 acres. The FGPM project did not expand the permitted footprint of the waste disposal area.

The landfill is protected from flooding of the South Yamhill River by a flood control berm located along the south and east portions of the north boundaries of the landfill. The flood control berm was constructed to a nominal elevation of 145 feet, which exceeds the design 100-year flood elevation [SCS, 2010].

Information summarized below is based on information provided in RLC [2017].

3.4.1 Modules 1, 2 and 3

Modules 1, 2, and 3 were constructed sequentially from 1982 to 1993. These Modules were developed successively from west to east. A final cover system and a landfill gas collection system were constructed over the southern side of these Modules during 1994 and 1995. The northern side of Modules 1, 2, and 3 were covered with overliner systems as part of developing the Modules to the north. The overliners drain to the northern modules. Figures 3 and 4 show the configurations of the liner, final cover, and the

overliner systems. The new FGPM area overlies areas covering portions of Modules 1, 2, and 3 and some adjacent Module areas.

3.4.2 Module 4

Module 4 was built in 1994 east of the south part of Module 3. It contains a double composite liner system, a primary leachate collection and recovery system (LCRS) and a leachate secondary collection system (LSCS). A ridge is aligned from the north to south along the approximate centerline of Module 4. The LCRS and LSCS consist of two parallel trench systems aligned from the north to south on each side of the central ridge.

The two LCRS and LSCS trenches in Module 4 drain into two sumps located on the south side of the Module. The east sump drains by gravity to the west sump. In addition, the LCRS in Modules 1, 2, 3, and a portion of Module 5 drain to the Module 4 LCRS sump. The west sump has pumps to remove the liquids. The liquids are conveyed to a force main that conveys the leachate to the leachate pond, which represents the storage portion of the landfill leachate management system.

Figures 3 and 4 show the configurations of the liner and final cover systems.

3.4.3 Module 5

Module 5 was built in 1995 north of Module 4 and east of the northern part of Module 3. Module 5 is contiguous with Module 4. A ridge is aligned from north to south along the approximate centerline of Module 5, which is a continuation of the Module 4 ridge. The LCRS and LSCS in Module 5 consist of two parallel trench systems aligned on either side of the central ridge. The LCRS and LSCS of Module 5 drain by gravity into the LCRS and LSCS of Module 4. Figure 3 shows the configurations of the liner systems.

3.4.4 Modules 6 and 7

Modules 6 and 7 were constructed in 1997 and 1998 respectively. Module 6 adjoins the northeastern edges of Modules 4 and 5, and Module 7 adjoins the east edge of Module 6. Both Modules have composite liners that incorporate a LCRS and a LSCS. A geosynthetic clay liner (GCL) was used in lieu of low permeability soil in the primary composite liner on the side slopes. Figures 3 and 4 show the configurations of the liner and final cover systems.

Module 7 drains to Module 6, which in turn has a sump on the south side of the landfill. This sump is equipped with pumps that transfer liquids from the LCRS and LSCS to a force main that conveys the leachate to the existing leachate pond, which represents the storage portion of the landfill leachate management system.

3.4.5 Module 8

Module 8 was constructed in four stages designated 8A, 8B, 8C and 8D along with associated overliners for the areas that are adjacent to Modules 1, 2, and 3. Module 8 (A, B, C and D) was constructed between 2002 and 2009, from east to west. Each Module stage includes a composite liner. Figure 3 shows the configurations of the liner systems.

3.4.6 Module 9

Module 9 was developed by constructing a mechanically stabilized earthen (MSE) berm along the west side of Modules 1 and 8D. The MSE berm reaches a maximum height of approximately 40 feet along the western portion of Module 8D and decreases in height to ramps located at the northwestern and southwestern ends of the landfill. The outside slope of the MSE berm is vegetated and the inside slope consists of engineered fill. The width at the top of the MSE berm accommodates a landfill perimeter drainage ditch, two-way road traffic (highway vehicles only), and the anchor trench for the composite liner and the future final cover system. The outside slope of the MSE berm is 1H:3V (horizontal to vertical) whereas the inside slope is generally 1H:1V, or flatter.

The southern half of the area drains to a sump located in the southwest corner of the Module. The northern half of the area drains to Module 8D. The liner systems are connected to provide waste and liquid containment.

The liner system for Module 9 is the same as the liner system for Module 8D. On the southeastern side of Module 9, the final cover system for Modules 1 and 2 also functions as a liner system and leachate collection system for the disposed waste. The water that percolates through the new waste placed in the FGPM area will drain to the Module 9 sump and to a new sump located near the eastern side of the FGPM area.[4]

[4] The new sump has been designated 3A P and 3A S by RLC.

To monitor the performance of the MSE berm, an instrumentation program was developed and implemented by RLC. Instrumentation consists of:

- Slope Inclinometers (SI) used to measure the magnitude and rate of shear strain to provide information regarding slope movement;
- Vibrating Wire Piezometers (PZ) used to measure the pore pressure at a specific depth in the soil stratum; and
- Extensometers (EX) used to monitor vertical displacement (settlement or heave) in the foundation soil and MSE berm.

Leachate from the Module 9 sump is pumped to the landfill leachate pond.

3.5 Monitoring and Control Systems

3.5.1 Monitoring Programs

A description of the monitoring programs at the RL, including (i) groundwater monitoring, (ii) storm water monitoring, and (iii) surface water monitoring programs performed as part of the environmental monitoring plan requirements, is included in Appendix A which also includes a figure showing locations of the three monitoring networks.

3.5.2 Soil Vadose Zone Monitoring

Although the leachate irrigation operation was discontinued in 2012 in the poplar tree reuse area, the soil vadose zone is monitored as requested by the Oregon DEQ.

3.5.3 Storm Water Management System

To accommodate the MSE berm design, the permanent storm water management system (SWMS) for the landfill was designed for the 100-year, 24-hour storm event instead of

the 25-year, 24-hour storm required by the Subtitle D regulations. The SWMS elements on the landfill include collection ditches, downdrains[5], and culverts[6].

The landfill ditches, downdrains, and culverts discharge to two storm water ponds. One pond is located near the northwest corner of the MSE berm and south of the entrance facilities; the second pond is located south of Modules 1, 2, and 3. A new pond located north of Module 8 is expected to be constructed to provide additional surface water management capacity. At locations where drainage patterns do not allow for discharge into the existing or future ponds, water quality units will be installed.

Ground cover, temporary plastic covers, and storm water pumping systems are used during the landfill operations to control and manage storm water during operations. Details of the SWMS during operations are presented in the Operations Plan [RLC, 2017] which includes a description of the site storm water systems and monitoring requirements, best management practices (BMPs), and the site NPDES 1200-Z Permit [SCS, 2017].

As part of site closure, remaining elements of the permanent SWMS will be constructed. Appendix B includes the information for the permanent SWMS. The permanent SWMS incorporates the ponds, pipes and ditches on the MSE berm, and additional features for the final grades such as additional ditches, downdrains, headwalls, water quality units, culverts, and pipes. Prior to closure construction, the verification of existing conditions at the time of closure, and the recommendations presented in Appendix B will be revisited and the design revised as needed to comply with future goals and site conditions.

After the permanent SWMS elements have been constructed, water will discharge to the landfill ditches, downdrains, and culverts that discharge to the storm water ponds[7], and to water quality units (Appendix B).

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[5] Downchutes.

[6] The existing surface water infrastructure that can be used or retrofitted will become a part of the SWMS at the Landfill after closure. As part of final closure design, the existing surface water infrastructure will be evaluated and modified or enhanced as needed to meet the goals at the time of closure.

[7] One existing pond is located south of the entrance facilities near the northwest corner of the Landfill. The second existing pond is located on the south side of the landfill. A third, new pond will be constructed on the north side of the landfill.

3.5.4 Leachate Management System

Leachate is generated by the percolation of liquid through waste. Precipitation or other water that contacts the waste is also considered leachate.

3.5.4.1 Leachate Monitoring

Leachate samples from the LCRSs are monitored to: (i) comply with the requirements of the SWDP, and leachate disposal permits; (ii) provide comparative data for interpreting monitoring data collected from the secondary collection systems; and (iii) provide a basis for the selection of groundwater monitoring parameters.

Liquid samples from the LSCSs are monitored to: (i) detect and if present, characterize the liquid in the LSCS; and (ii) determine whether the detected liquid consists of leachate from the primary liner or liquid from other sources.

RL groundwater sampling activities along with the corresponding primary and secondary leachate sump sampling activities are performed pursuant to the RL Environmental Monitoring Plan, which describes the RL leachate monitoring system, including, but not limited to: leachate monitoring locations, monitoring parameters, data evaluation methods, and sampling and analytical procedures. This information is reported to the DEQ in the Annual Environmental Monitoring Report (AEMR).

In addition to the leachate sampling and monitoring activities discussed above, leachate sampling requirements may vary depending on the sampling location and permit revisions.

The LCRS and LSCS are currently sampled at 10 locations, including (i) leachate pond; (ii) leachate pond secondary collection system; and (iii) 8 sump side-slope riser locations (i.e., 1/5P, 6/7P, 8P, 9P, 4/5S, 6/7S, 8S and 9S). After construction of the FGPM's Phase 2 in 2018, RLC will add two new monitoring locations at the new sump that will be located in the east side of the FGPM area, which will be designated 3A P and 3A S for the LCRS and LSCS, respectively.

3.5.4.2 Leachate Extraction System

The LCRS sumps collect leachate from landfill modules and pumps in the sumps discharge the leachate to a double-lined collection pond for treatment and disposal. The

LSCSs are a system used to detect and contain potential leaks through the landfill primary liner.

Leachate Sumps

As described in RLC [2017], leachate in Modules 1 thorugh 5 drains to a primary leachate sump (Sump 1/5 P) on the south side of Module 4. This sump was constructed with dual side-slope riser pipes and is equipped with a dedicated electric submersible pump that discharges to a leachate force main that discharges into the leachate pond.

Leachate in Modules 6 and 7 drains to a primary leachate sump (Sump 6/7 P) on the south side of the modules. Sump 6/7 P is equipped with a dedicated electric submersible pump that discharges to a separate leachate header leading into the leachate pond.

Leachate in Module 8 drains to a primary leachate sump (Sump 8P) located near the northeast corner of this module. Sump 8P is equipped with a dedicated electric submersible pump that discharges into a force main shared with Module 7 that leads to the leachate pond.

Leachate in Module 9 drains to a primary leachate sump (Sump 9P) located in the southwest corner of this module. Sump 9P is equipped with a dedicated electric submersible pump that discharges into a force main that discharges into the leachate pond.

Construction of the FGPM adds a new sump in the eastern portion of the FGPM area to collect leachate from the eastern portion of the FGPM area. The new sump pump will discharge into the leachate pond. The remainder of the FGPM area drains to the Module 9 sump.

Each LCRS sump is equipped with a flow meter and monitored with the Supervisory Control and Data Acquisition (SCADA) system [RLC, 2017].

Modules 4, 5, 6, 7, 8, and 9 have a LSCS that drains to secondary collection sumps, named 4/5 S, 6/7 S, 8 S, 9 S, which are located below the primary leachate sumps for the various Modules and are also equipped with electrical pumps discharging to the primary leachate sumps named 1/5 P, 6/7 P, 8 P, 9 P.

The new sump in the Phase 2 FGPM area will be underlain by a LSCS located below the primary leachate sump in the FGPM area. The LSCS sump will be constructed with a side-slope riser and equipped with a dedicated electric submersible pump that will discharge to the corresponding primary leachate sump. The new sump in the east side of FGPM area will be labelled 3A P and 3A S for the LCRS and LSCS, respectively.

Leachate Storage Pond

The leachate pond is located near the southwestern corner of the landfill and has a surface area of approximately 4.6 acres at the pond's full elevation 153.0. At the designed maximum liquid depth of approximately 18 feet, the leachate pond has a storage capacity of approximately 19,962,000 gallons.

The leachate pond liner is comprised of a primary 60 mil HDPE liner as well as a composite secondary leak detection liner system. The composite secondary leak detection liner system consists of a 60 mil HDPE liner located on top of 2 feet of low hydraulic conductivity soil.

The secondary leak detection system can convey potential leakage through the primary liner system to a secondary sump that is approximately 12 inches deep and 18 feet square [RLC, 2017]. Within this secondary sump is a 12–inch diameter side-slope riser pipe that lies in the eastern slope of the pond. The secondary sump pump is accessed from the end of the side-slope riser pipe sticking out above ground on the eastern side of the leachate pond berm.

Leachate Operations

The SCADA system monitors and logs leachate sump levels and the pumped leachate volumes. This system is designed to send notifications to key personnel in the case of pump failures and/or compliance level exceedances. The site collects leachate data both manually and with the SCADA system.

The primary and secondary leachate sump pumps are designed to run in an automatic mode to manage collected leachate. Each sump has a pressure transducer that senses the level of leachate in the sump. Each sump has its specific setting for high leachate level pump-on, low leachate level pump-off, and leachate alarm level which triggers a beacon light. Sump pumps run automatically based on pre-programmed set points to convey leachate from the sumps into the force main system.

Leachate Inspection

The SCADA system is the primary method of monitoring leachate at RLC. However, site personnel visually monitor the LCRS during normal daily operations. LCRS maintenance items are documented on the Daily Item Inspection Form.

At each primary and secondary leachate sump, the site technician inspects the following:

1. Observe exterior plumbing connections of the leachate sump for leachate leaks, verify that the sump has no alarms, check the control panels for proper function and display, and correct valve positions at each sump riser.
2. After examination of each location, review the SCADA information from each primary & secondary sump for:
    a. Level reading at sump.
    b. Hour meter reading at sump.
    c. Totalizer reading for gallons pumped.
3. Initially evaluate level data to confirm compliance at each sump. Provide timely notification to the DM, OM, and EP manager if the liquid levels are near, or exceed, compliance levels.
4. Evaluate if there are maintenance or repairs needed to any sump location; document any conditions/adjustments/repairs needed on the daily inspection form.

The SCADA system logs and stores leachate volumes and liquid levels for review and reporting purposes.

LCRS Maintenance and Repairs

RLC personnel typically perform repairs and maintenance needed for the leachate pump systems and associated equipment. Should there be an electrical or pump issue that cannot be repaired by RLC personnel, third party contractors are contracted to repair the identified issue.

Routine maintenance includes testing and reviewing of panels for proper system operation and detection of failures. Observations are documented to include maintenance

recommendations. Based on reported findings, the DM and OM develop plans and schedules to address noted issues.

3.5.5 Landfill Gas Management System

Landfill gas (LFG) is generated by anaerobic decomposition of organic materials in the landfill. The major components of LFG are methane, carbon dioxide, nitrogen and hydrogen with minor amounts of other trace gases. The methane and hydrogen gases are of most concern because they can ignite at concentration levels between 5 and 15 percent, and between 4 and 75 percent, respectively. LFG is managed and monitored using the landfill containment system (liner and final cover), a LFG extraction system, cover placement, and LFG monitoring probes.

3.5.5.1 Landfill Gas Monitoring

To limit potential LFG off-site migration, gas is monitored in probes located around the perimeter of the landfill (Appendix A). In addition, on-site buildings are equipped with combustible gas detection and alarm systems. The GCCS and flare station are monitored and adjusted on a monthly basis. Additional details of the monitoring program are included in the RL Title V Permit (#36-0011-TV-01).

3.5.5.2 Landfill Gas Extraction

To comply with the federal MSW landfill New Source Performance Standards (NSPS), an active LFG collection and control system (GCCS) was installed to manage emissions while collecting methane for electrical energy generation by the LFG to Energy (GTE) facility.

The GCCS includes a combination of horizontal collectors and vertical LFG wells, the GTE facility, and LFG flare(s). An enclosed flare with a 3,200 standard cubic feet per minute (scfm) rated capacity and a utility flare rated for 1,000 scfm are used to combust excess LFG that is not able to be combusted by the GTE facility. The flare system works in conjunction with the GTE facility and is designed to manage the LFG in the event the GTE facility is not in service.

The GCCS is designed to limit LFG migration, fugitive emissions, and to reduce odors. The following are general components that comprise RL's GCCS:

- Vertical LFG collection wells;
- LFG horizontal collectors;
- Condensate sumps;
- Six 3516 Caterpillar Engines;
- Utility LFG Flare; and
- Enclosed LFG Flare.

3.6 Containment System Configurations

The RL containment systems isolate waste from the surrounding environment and provide containment, collection, and removal of leachate and LFG. Figure 2 presents the boundaries of landfill disposal Modules 1 through 9. Figures 3 and 4 show the containment system elements (composite liner and final cover) for the landfill Modules presented on Figure 2. As shown on Figure 3, with the exception of clay-lined Modules 1, 2 and 3, Modules 4 through 9 feature Subtitle D composite liner systems. The FGPM area that overlies portions of Modules 1, 2, and 3 has a geomembrane liner.

3.7 Site Facilities

On-site structures, are located in the southwestern portion of the landfill site (leachate pond) and adjacent to the RL entrance which include administrative buildings, scale house, recycling and dropoff facilities, storage, and the gas to energy facility.

4. PHYSICAL SETTING

4.1 Topography

The natural, predevelopment topography at of the landfill site was relatively flat with elevation ranging between 150 feet and 130 feet. The landfill is designed with a maximum fill contour elevation of 284 feet (Figure 2).

4.2 Site Geology

In the general vicinity of the landfill, the following geologic units, from oldest to youngest (bottom to top), are present [SCS, 2010]:

- Nestucca Formation (upper Eocene-age), which is composed predominantly of basaltic lava flows with localized occurrences of marine sediments.
- Pliocene-age sands and gravels, which overlie the Nestucca Formation and underlie more recent alluvial sediments, which consist mostly of sandy gravels and gravelly sands, with localized interbeds of clayey and silty gravels and clay and silt lenses. The sand-and-gravel material is generally well-graded, angular to subrounded, and in places, cemented.
- Alluvial Willamette Silt (early to middle Quaternary-age) associated with the Willamette River and its tributaries. The Willamette Silt composes the upper and lower river terraces near the landfill and consists of bedded silts, clays, clayey silts and silty clays.
- Late alluvium (Quaternary-age) associated with the recent floodplain of the South Yamhill River. These materials are similar to the Willamette Silt described above.

4.3 Seismicity

Title 40 of the Code of Federal Regulations (CFR), Part 258 (40CFR258 or Subtitle D) requires municipal solid waste (MSW) landfills located in a seismic impact zone to be designed to resist the maximum horizontal acceleration in lithified earth material (i.e., bedrock) for the site. A “Seismic impact zone” is defined as an area with a ten percent, or greater, probability that the maximum horizontal acceleration in lithified earth material expressed as a percentage of the earth’s gravitational pull will exceed 0.10g (10 percent of gravity) in 250 years. The maximum horizontal acceleration is depicted on a seismic

hazard map with a 90 percent or greater probability that the acceleration of 0.10g will not be exceeded in 250 years, or the maximum expected horizontal acceleration based on site-specific seismic hazard assessment. To meet the Subtitle D requirements cited above, a probabilistic seismic hazard analysis (PSHA) is required.

The PSHA complies with the requirements in Subtitle D (i.e., 40CFR258) and was used to characterize the maximum horizontal acceleration in lithified earth material for the site (i.e., 0.10g in 250 years). Following Subtitle D, the ground motion with a 90 percent chance of not being exceeded in 250 years is estimated using the site-specific PSHA. This hazard level corresponds to an annual probability of exceedance of 0.00042.

Following the Subtitle D requirements, the estimated acceleration at RL is 0.415g (41.5% of gravity) and the design earthquake is a magnitude 8.5. This design earthquake was used to design the base liner. Further details are presented in the Geosyntec [2012] report.

In 2015, the DEQ requested that the new portions of the Landfill such as the FGPM area and the final cover for the areas of the Landfill that have not been closed be designed to a higher level of acceleration and a magnitude 9.0 earthquake to address the Oregon Resilience Plan. The selected higher level of acceleration was the 84th percentile ground motion which corresponds to the median plus one standard deviation ground motion. The resulting peak ground acceleration for lithified earth material in this scenario was predicted to be 0.44g. Further details are presented in the Geosyntec [2016] report.

4.4 Hydrogeology

At the RL, groundwater occurs in two water bearing zones (WBZs): (i) upper (shallow) silt-clay alluvial deposits (both the Willamette Silt and the late-Quaternary alluvium); and (ii) lower (deep) sand-gravel deposits. Groundwater elevations measured in site groundwater monitoring wells and piezometers since January 1993 have been used to evaluate the hydraulic parameters and flow characteristics of both WBZs [SCS, 2010].

4.4.1 Upper (Shallow) Silt-Clay WBZ

Across most of RL, the groundwater flow direction and gradient in the upper silt-clay WBZ show minor seasonal and spatial variability, typically in response to variations in seasonal precipitation patterns. The direction of groundwater flow in the upper silt-clay WBZ is typically south-southeast, toward the South Yamhill River. In the extreme southwestern portion of the site, groundwater flow is predominantly toward the east. The

historical seasonal range of groundwater gradients is generally from 0.005 to 0.01 foot per foot (ft/ft).

Average groundwater flow velocities in the upper silt-clay WBZ range from 0.1 to 24.2 feet per year (ft/yr) using an average seasonal gradient of 0.0075 ft/ft, hydraulic conductivity values ranging from 2.08×10^{-7} to 4.68×10^{-4} centimeters per second (cm/s), and an effective porosity of 15 percent [SCS, 2010].

Slug testing of groundwater wells installed in October 2000 to monitor the north poplar tree farm indicate that higher hydraulic conductivities (mean value of 6.8×10^{-3} cm/s) occur in this area. Seams of coarser-grained sediments (i.e., silty sand and fine sand) were encountered at various depth intervals in the upper silt-clay WBZ, which probably accounts for the elevated hydraulic conductivity values in the area.

Historical groundwater-level data for monitoring wells, screened in the upper silt-clay WBZ near the South Yamhill River, indicate that temporal fluctuations of approximately 10 to 15 feet occur. Generally, groundwater elevations measured in those wells are higher than the river elevation, indicating that groundwater in the upper silt-clay WBZ discharges to the river. The relationship between the South Yamhill River and groundwater indicates that the South Yamhill River acts as a hydraulic boundary to groundwater flow in the upper silt-clay WBZ.

4.4.2 Lower (Deep) Sand-Gravel WBZ

The groundwater flow direction and gradient in the lower sand-gravel WBZ do not vary significantly as a result of seasonal changes in precipitation. In most areas of RL, groundwater flows toward the southeast, in the direction of the South Yamhill River, and shifts southward as it approaches the river. The historical seasonal range of groundwater gradients is generally from 0.0088 to 0.012 ft/ft.

The average groundwater flow velocity in the lower sand-gravel WBZ is 124 ft/yr using an average seasonal gradient of 0.01 ft/ft, a hydraulic conductivity value of 3.6×10^{-3} cm/s, and an effective porosity of 30 percent [SCS, 2010].

Interpretation of RL stratigraphic information indicates that the lower sand-gravel WBZ does not receive direct recharge from precipitation in the vicinity of the RL due to the presence of the overlying silt-clay WBZ, which has a relatively low hydraulic conductivity. Furthermore, because the lower sand-gravel stratigraphic unit partially

transects the river, the river most likely represents a hydraulic barrier for groundwater in the lower sand-gravel zone. Historically, groundwater elevations measured in wells screened in the lower sand-gravel WBZ near the South Yamhill River were consistently higher than the river elevation. The differences in elevation suggest that groundwater in the lower sand-gravel WBZ was discharging to the river during those time periods.

RL has a production well designated as PW-1, located near the facility entrance. The well is completed in and pumps water from the lower sand-gravel WBZ. There are also two production wells (MB-1 and MB-2) on the former Bernard property on the east side of the RL entrance. MB-1 is active, but MB-2 was disconnected. During the dry season, when PW-1 and MB-1 are used most frequently, groundwater elevations in the sand-gravel WBZ are affected in the northwest corner of RL by production well pumping.

4.4.3 Vertical Hydraulic Gradient

Trends in water level elevations between the upper and lower WBZs (exhibited by adjacent piezometers and monitoring well pairs designated A and B) are generally similar, with periods of high and low elevations occurring at the same time of the year. The highest water levels in the upper silt-clay and lower sand-gravel WBZs generally occur in the spring, while the lowest elevations occur in the fall. The fluctuations are directly influenced by precipitation. Although seasonal trends are similar in the two WBZs, the magnitude of the water level fluctuation varies significantly, and the vertical groundwater gradients typically change from upward to downward during the course of a year. The variability indicates a low degree of hydraulic connection between the upper and lower WBZs.

4.5 Wetlands and Floodplain

The RL is located in the vicinity of wetlands and adjacent to the 100-year floodplain of the South Yamhill River.

The landfill is protected from river flooding by a flood control berm constructed along the south, east, and north boundaries of the landfill. Floodplain information is documented in Federal Emergency Management Agency Panel 41071C0415D; Rev. 12-10-1146P-410249 05/09/2013.

Wetlands information for the RL is presented in the documents below and is incorporated by reference:

- Wetland Delineation Report for the Riverbend Landfill (Module 11 Expansion), Yamhill County; T5S R5W S1 TL 100 and 200; WD#2012-0149. Oregon Department of State Lands (DSL) concurrence October 1, 2015.
- Wetland Delineation Report for the Riverbend Landfill (Riverbend Floodplain Enhancement), Yamhill County; T5S R5W S1 TL 100 and 200; WD#2012-0149. DSL concurrence August 31, 2012.
- Wetland Delineation Report for the Riverbend Landfill Expansion Project, Yamhill County; T5S R5W S1 Portion of Tax Lots 101, 200, 400, 401 & 500; S11 Portion of Tax Lots 100 & 600; WD#07-0733. DSL concurrence 21 April 2009.

5. FINAL ENGINEERED CLOSURE PLAN

5.1 Closure Requirements

5.1.1 Federal Requirements

Federal closure requirements are contained in Part 258.60(a)-(b):

"(a) Owners or operators of all MSWLF units must install a final cover system that is designed to minimize infiltration and erosion. The final cover system must be designed and constructed to:

(1) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x 10^{-5}cm/sec, whichever is less, and

(2) Minimize infiltration through the closed MSWLF by the use of an infiltration layer that contains a minimum 18-inches of earthen material, and

(3) Minimize erosion of the final cover by the use of an erosion layer that contains a minimum 6 inches of earthen material that is capable of sustaining native plant growth.

(b) The Director of an approved State may approve an alternative final cover design."

5.1.2 Oregon-Specific Requirements

Oregon adopts the above federal requirements, and has additional closure requirements in Section 34 94 0110(2) of the OARs:

"(2) Requirements for closure plans. A closure plan shall specify the procedures necessary to completely close the municipal solid waste landfill at the end of its intended operating life.

(a) Requirements for the "worst-case" closure plan shall include all elements specified in 40 CFR §258.60, and consist of at least the following:

(A) A description of the steps necessary to close all municipal solid waste landfill units at any point during their active life;

(B) A description of the final cover system that is designed to minimize infiltration and erosion;

(C) An estimate of the largest area of the municipal solid waste landfill unit ever requiring a final cover;

(D) An estimate of the maximum inventory of wastes ever on-site over the active life of the landfill facility; and

(E) A schedule for completing all activities necessary to satisfy the closure criteria in 40 CFR §258.60."

Section 340-94-0120(2) of the OARs also requires that:

"(2) Unless otherwise approved or required in writing by the Department, no person shall permanently close or abandon a municipal solid waste landfill, except in the following manner:

(a) All areas containing solid waste not already closed in a manner approved by the Department shall be covered with at least three feet of compacted soil of a type approved by the Department graded to a minimum two percent and maximum 30 percent slope unless the Department authorizes a lesser depth or an alternative final cover design. In applying this standard, the Department will consider the potential for adverse impact from the disposal site on public health, safety or the environment, and the ability for the permittee to generate the funds necessary to comply with this standard before the disposal site closes. A permittee may request that the Department approve a lesser depth of cover material or an alternative final cover design based on the type of waste, climate, geological setting, degree of environmental impact;

(b) Final cover material shall be applied to each portion of a municipal solid waste landfill within 60 days after said portion reaches approved maximum fill elevation, except in the event of inclement weather, in which case final cover shall be applied as soon as practicable;

(c) The finished surface of the closed areas shall consist of soils of a type or types consistent with the planned future use and approved by the Department. Unless otherwise approved by the Department, a vegetative cover of native grasses shall be promptly established over the finished surface of the closed site;

(d) All surface water must be diverted around the area of the disposal site used for waste disposal or in some other way prevented from contacting the waste material;

(e) All systems required by the Department to control or contain discharges to the environment must be completed and operational."

5.2 Objectives

The main objectives of this FECP are:

- To allow the operator to update the RL closure schedule;
- To allow the operator to update an estimate of closure costs;
- To enable the regulatory agencies to assess the reasonableness of the closure schedule and cost estimate; and
- To allow an Oregon licensed professional engineer to certify the accuracy of the cost estimate.

5.3 Largest Area Requiring Closure

The landfill's footprint, including recently-developed Module 9 is approximately 87.4 acres; with development of the FGPM and Module 9 over areas that had been previously closed, the area of the landfill that needs to be closed is approximately 70.5 acres (Figure 2) and is subject of this FECP.

5.4 Maximum Inventory of Waste

HDR [2017] states that disposal records indicate that approximately 12 Million cy of waste have been landfilled as of January 2017. The estimated remaining available constructed capacity airspace as of July 2017, including the capacity gained with the FGPM is approximately 0.5 Million cy.

5.5 Remaining Capacity and Site Life

HDR [2017] states that final closure of RL is not anticipated to take place in the next five years, based on the following:

- RLC received an expansion on May 30, 2013 for the RL which increased the site's permitted airspace by approximately 1.0 Million cy, and increased the area of the landfill to a total footprint of approximately 87.4 acres of the 700-plus acre property. The FGPM approved by DEQ in a letter dated June 29, 2017, which increased the landfill's airspace by approximately 0.5 Million cy. As of July 2017, the site is actively diverting waste and has approximately 28 months of remaining permitted capacity based on current disposal rates.
- RLC is in the process of permitting an expansion modification to the permitted footprint, which will provide approximately 16 years[8] of additional capacity based on projected disposal rates.

5.6 Closure Components

Closure components and activities at the RL will include the following:

- Final grading;
- Construction of the final cover system;
- Construction of the remaining portion of the LFG extraction system; and
- Construction of the final storm water management system (SWMS).

5.6.1 Final Grading

The final grading plan for the RL is presented on Figure 2. In conformance with the final cover design, prior to constructing the final cover, the landfill surface will be graded to:

- A maximum slope of 3H:1V[9] or flatter; and

[8] E-mail from WM to Geosyntec dated 1 November 2017.
[9] In a portion of the FGPM area, the slopes are 3H:1V and are expected to flatten over time.

- A minimum slope of 2 percent.

Together with the perimeter road on the flood control berm and on the MSE berm, access roads on the waste slopes will be continued to the top deck to provide post-closure access to the site. As designed, the highest elevation of the closed landfill will be about 284 feet.

5.6.2 Final Cover Objectives

A final cover will be placed over the final lift of waste at the RL to perform the following functions:

- Separates the waste from the environment;
- Adjusts the landfill surface topography to provide appropriate slopes to promote run-off and controlled drainage of storm water;
- Controls erosion by conveying run-off at non-scouring flow rates;
- Minimizes storm water infiltration into the waste;
- Minimizes leachate generation; and
- Controls and contains landfill gas (LFG).

5.6.3 Regulatory Criteria for Final Covers

5.6.3.1 General

The federal (Subtitle D) regulations, as a minimum, require two layers in the final cover system for a municipal solid waste (MSW) landfill, i.e., an infiltration (barrier) layer and an erosion (vegetation, protective) layer. The State of Oregon states that *"If a municipal solid waste landfill is subject to 40 CFR, Part 258 as provided in 40 CFR §258.1, the owner or operator shall comply with closure and post-closure care requirements in 40 CFR, Part 258, Subpart F. All municipal solid waste permittees shall also comply with this rule."* Thus, the federal and state requirements will be discussed for each layer separately[10].

[10] As will be discussed in Section 5.6.4, two final cover alternatives are presented herein and other equivalent engineered alternatives such as Closure Turf by AGRU may be considered at the time of closure.

5.6.3.2 Foundation Layer

A foundation layer for the final cover is not required by Subtitle D. Section 340-94-120(2)(a) of the OARs requires that *"All areas containing solid waste… shall be covered with at least three feet of compacted soil of a type approved by the Department graded to a minimum two percent and maximum 30 percent slope…"* Thus, the foundation layer is not required by the DEQ.

The foundation layer for the final cover provides a firm, smooth surface for the placement of the barrier layer and limits the effects of subsequent differential settlement and subsidence acting on the barrier layer.

5.6.3.3 Infiltration Layer

The infiltration (barrier) layer of the final cover system limits the potential for infiltration of moisture into the landfill and contains landfill gases.

Subtitle D requirements for the infiltration (barrier) layer in the final cover are contained in §258.60(a)(1) and (b)(1). Applicable portions of these regulations are cited below.

> *"(a) Owner or operator of all MSWLF units must install. . . an infiltration layer as follows:*
>
> > *(1) The infiltration layer must be comprised of a minimum of 18 inches of earthen material that has a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x 10^{-5} cm/sec, whichever is less. . .*
>
> *(b) The Director of an approved State may approve an alternative final cover design that includes:*
>
> > *(1) An infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraph (a)(1) of this section. . ."*

To design the 18-in. thick soil infiltration (barrier) layer to meet the required hydraulic conductivity for a particular waste disposal unit that has accepted waste prior to 9 October 1993, the hydraulic conductivity of the bottom liner of the disposal unit needs to be evaluated and be used as a basis for the infiltration layer design in accordance with the

criteria specified in the aforementioned regulations. However, in the case for which the bottom liner of a disposal unit or lateral expansion is constructed after 9 October 1993, the barrier layer design for that unit falls under the same requirements that apply to the bottom liner under the Subtitle D regulations since the barrier layer must be designed in accordance with the previously cited regulations. In this case, the barrier layer should be designed similar to a bottom liner, which should be constructed as a composite liner and defined as follows (§258.40(b) of Subtitle D):

> *". . . a system consisting of two components; the upper component must consist of a minimum 30-mil flexible membrane liner (FML), and the lower component must consist of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 10^{-7} cm/s. FML components consisting of HDPE shall be at least 60-mil thick. The FML component must be installed in direct and uniform contact with the compacted soil component."*

The barrier layer should also be in compliance with the regulations previously mentioned in Section 340-94-120(2)(a) of the OARs, which requires that *"All areas containing solid waste… shall be covered with at least three feet of compacted soil of a type approved by the Department graded to a minimum two percent and maximum 30 percent slope…"*

5.6.3.4 Drainage Layer

Oregon and federal regulations do not specifically require a drainage layer in the final cover system. However, construction of a drainage layer improves the slope stability of the landfill final cover system by removing the infiltration water that passes through the erosion (vegetative) cover and thus minimizing the hydraulic head over the barrier layer.

5.6.3.5 Erosion Layer

Subtitle D requirements for the erosion (protective, vegetative) layer of the final cover are contained in §258.60(a)(2) and §258.60(b)(2). Applicable portions of these regulations are given below.

> *"(a) Owner or operator of all MSWLF units must install. . . an erosion layer. . . as follows:. . .*
>
> > *(2) The erosion layer must consist of a minimum of 6 inches of earthen material that is capable of sustaining native plant growth. . .*

(b) The Director of an approved State may approve an alternative final cover design that includes. . .

(2) An erosion layer that provides equivalent protection from wind and water erosion as the erosion layer specified in paragraph (a)(2) of this section."

Section 340-94-120(2)(c) of the OARs requires that *"…a vegetative cover of native grasses shall be promptly established over the finished surface of the closed site. . ."* This language can be interpreted as the DEQ requirement for the vegetative layer.

5.6.3.6 Interpretation

Based on the above review of the state and federal criteria for the design of final covers, and the review of the state-approved final cover system for the 2005 and 2006 closure areas, Geosyntec concludes that the final cover system for the RL FECP will consist of (from bottom to top): (i) a foundation layer; (ii) a geomembrane infiltration (barrier) layer; (iii) a drainage layer; and (iv) an earthen vegetative layer.

5.6.4 Final Cover System Configuration

Two alternative final cover configurations meeting the regulatory requirements of the final cover system are proposed for the RL. The selection of the configuration will depend on interface strength testing results that allow the configuration to meet the static and seismic slope stability requirements for the site.

The first configuration of the final cover system will consist of the following elements (in order from bottom to top) (Figure 4):

- Foundation Layer – an 18-in. thick foundation soil layer;
- Barrier Layer – a 60-mil thick linear low density polyethylene (LLDPE) geomembrane with ridges on one side and studs on the other;
- Drainage Layer – an 8-oz/sy geotextile placed over the studded surface of the LLDPE geomembrane creates a drainage channel between the geomembrane and the geotextile; and
- Erosion (Vegetative) Layer – an 18-in. thick soil layer, the top 6 in. of which is capable of supporting vegetation.

The second configuration of the final cover system will consist of the following elements (in order from bottom to top) (Figure 4):

- Foundation Layer – an 18-in. thick foundation soil layer;
- Barrier Layer – a 60-mil thick linear low density polyethylene (LLDPE) geomembrane textured on both sides;
- Drainage Layer – a 12-in. thick gravel layer with an 8-oz/sy geotextile placed over the layer; and
- Erosion (Vegetative) Layer – an 18-in. thick soil layer, the top 6 in. of which is capable of supporting vegetation.

The erosion layer will be vegetated with native vegetation that is similar to the vegetation that grows in the areas surrounding the landfill. Plants will be selected for their suitability to local climate, percentage of surface coverage, root zone depths, hardiness and low maintenance requirements.

5.7 Landfill Gas Management System Components

The GCCS is expected to be expanded as presented in Appendix D. As shown, the majority of the GCCS is installed by the time final closure begins. The GCCS components are:

- Vertical LFG collection wells;
- Well-head assemblies to permit the conditions at each LFG collection well to be monitored (well pressure and LFG composition) and the LFG flow rate to be controlled;
- LFG lateral pipes connecting the LFG well-head assemblies to the main LFG header pipes;
- LFG header pipes connecting the lateral pipes to the GTE facility and flare station;
- GTE facility and LFG flare station; and
- Condensate collection and control system.

Since most components of the GCCS are installed and constructed during the operation of the landfill, the components required for the FECP closure include:

- LFG collection wells;
- Well-head assemblies; and
- LFG lateral pipes.

5.8 Leachate Management System Components

The leachate management system will remain in operation during closure of the RL. No major modifications to the leachate management system are anticipated.

5.9 Permanent Storm Water Management System Components

The SWMS components required for additional areas of final cover include the following:

- Ditches located on, or around the perimeter of, the final cover;
- Culverts, headwalls, splash walls, water quality units, and drop inlets;
- Lined conveyance downdrains[11] constructed on the final cover surface; and
- Vegetation.

Appendix B includes the information for the permanent SWMS. The permanent SWMS incorporates three ponds; pipes, ditches, downdrains, and headwalls; and water quality units. Prior to closure construction, the basis of design, a verification of existing conditions at the time that closure is ready to take place, and the recommendations presented in Appendix B will be revisited, and the design revised as needed, to comply with future goals and site conditions at the time.

5.10 Slope Stability Analyses

This section first summarizes the landfill mass slope stability analyses followed by the landfill final cover system slope stability analyses. Both static and seismic slope stability analyses are addressed.

[11] Articulated concrete blocks.

5.10.1.1 Landfill Mass Stability

The report entitled *Phase 1 MSE Berm Updated Permit Design Report, Riverbend Landfill, McMinnville, Oregon*, prepared by Geosyntec and dated 22 March 2012 [Geosyntec, 2012] presents the static and seismic slope stability evaluation for the landfill to the grades presented in the report.

The report entitled *Final Grading Plan Modification Permit Application Report, Riverbend Landfill, McMinnville, Oregon*, prepared by Geosyntec and dated 14 November 2016 [Geosyntec, 2016] presents the static and seismic slope stability evaluation for the FGPM grades presented in the report.

Slope stability was evaluated using the limit equilibrium procedures based on the Spencer [1967] method of slices. Spencer's method satisfies all conditions of force and moment equilibrium [Duncan, 1992]. Two-dimensional slope stability analyses were performed using the software program SLOPE/W [Geo-Slope International, Ltd., 2004]. The program employs a user-directed search routine to determine the potential critical slip surface with the minimum factor of safety. SLOPE/W was used to automatically search for critical shear surfaces through the berm, the waste, through the subgrade, and through the liner system.

To estimate seismic deformations, Geosyntec followed the procedures developed by Newmark [1965] and modified by Makdisi and Seed [1978]. The procedures are based on the concept of yield acceleration (k_y or the horizontal coefficient that results in a static factor of safety of 1.0). The shear stress time histories computed by DMOD at the level of the potential failure surfaces were divided by the overlying mass and double-integrated using the computer software YSLIP_PM [Yan et al., 1997] for different yield accelerations to generate graphs of yield acceleration versus seismic deformation.

The design earthquake for the site was estimated based on the results of a seismic hazard evaluation that satisfies Subtitle D and Oregon requirements which is presented in Appendix D of the Geosyntec [2012] report. The seismic deformations were estimated for the design earthquake for the site and presented in Appendix E of the Geosyntec [2012] report.

In 2015, in addition to the Subtitle D requirements, the DEQ requested that the new portions of the landfill such as the FGPM area and the final cover for the areas of the landfill that have not been closed be designed to a higher level of acceleration associated

with a magnitude 9.0 earthquake to address the Oregon Resilience Plan. The selected higher level of acceleration was the 84th percentile ground motion which corresponds to the median plus one standard deviation ground motion. The resulting peak ground acceleration for lithified earth material in this scenario is predicted to be 0.44g. Further details are presented in the Geosyntec [2016] report.

The slope stability analysis results showed that static factors of safety exceeded the minimum acceptable factor of safety of 1.5 and the seismic deformations meet the acceptable limit equal to or less than 12 inches.

The slope stability presented in the Geosyntec [2012] report was further supported by numerous supplemental evaluations which were performed and presented in the following reports listed below that are incorporated by reference:

- Geosyntec Consultants, Inc., *Letter-Report: Response to Comments Related to: Seismicity and Seismic Slope Stability – Phase 1 MSE Berm, Riverbend Landfill, McMinnville, Oregon*; Geosyntec Project WG1597; 22 June 2012.
- Geosyntec Consultants, Inc., *Letter-Report: Response to Comments Related to: Review comments provided by Hart Crowser, Inc. dated 14 August 2012; Riverbend Landfill, McMinnville, Oregon*; Geosyntec Project WG1597; 26 September 2012.
- Geosyntec Consultants, Inc., *Letter-Report: Response to Comments Related to Review Comments Provided by Hart Crowser, Inc., Dated 5 October 2012; Riverbend Landfill; McMinnville, Oregon*; Geosyntec Project No. WG1597; 23 October 2012.
- Geosyntec Consultants, Inc., *Letter-Report: Reply to Review Comments provided by Kleinfelder West, Inc.; Supplemental Third-Party Technical Review Comments on Geotechnical/Seismic Aspects for Application for Phase 1 MSE Berm and Application for Final Grading Plan; Riverbend Landfill, McMinnville, Oregon; DEQ Solid Waste Permit Number 345*; 7 November 2012.
- Geosyntec Consultants, Inc., *Letter-Report: Reply to Review Comments provided by Hart Crowser dated 9 November 2012, Riverbend Landfill, McMinnville, Oregon, DEQ Solid Waste Permit Number 345*; 7 December 2012.
- Geosyntec Consultants, Inc., *Letter-Report: Response to 18 December 2012 Comments by Mr. Doug Lindquist (Hart Crowser)*; 26 December 2012.

- Geosyntec Consultants, Inc., *Letter-Report: Response to 2 January 2013 Comments by Mr. Doug Lindquist (Hart Crowser)*; 9 January 2013.
- Geosyntec Consultants, Inc., *Letter-Report: Response to 11 January, 2013 email from Bob Schwarz (ODEQ) Regarding Item 5 on Kleinfelder December 21st, 2012 Letter*; 16 January 2013.
- Geosyntec Consultants, Inc., *Letter-Report: Response to Comments from Dr. Zia Zafir and Mr. Peter Stroud (Kleinfelder) in Letter Dated 6 February 2013*; 13 February 2013.
- Geosyntec Consultants, Inc., *Letter-Report: Response to prioritized questions from Mr. Bob Schwarz (Oregon Department of Environmental Quality - ODEQ) transmitted by e-mail on 5 February 2013*; 14 February 2013.
- Geosyntec Consultants, Inc., *Letter-Report: Response to Request for Information on Effect of Unit Weight on Slope Stability by Mr. Bob Schwarz (Oregon Department of Environmental Quality) During 25 March 2013 Phone Call*; 27 March 2013.
- Geosyntec Consultants, Inc., *Letter-Report: Response to Request for Information on Deterministic M9.0 earthquake by Mr. Doug Lindquist (Hart Crowser)*; 27 March 2013.
- Geosyntec Consultants, Inc., *Letter-Report: Response to 1 November 2013 Comments by Kleinfelder on Slope Deformation report by Geosyntec*; 30 January 2014.

Appendix E supplements the landfill stability analyses presented previously for the permitted grades. The slope stability presented in the Geosyntec [2016] report supports the slope stability of the FGPM and is also incorporated.

5.10.1.2 Landfill Final Cover Stability

Both static and seismic slope stability of the final cover system were also performed as a part of this FECP; detailed analyses are presented in Appendix E-2. Static stability analysis was evaluated for the cover system under short-term and long-term static conditions. The evaluation was based on the procedures presented by Matasovic [1991].

The generally-accepted static slope stability factors of safety are equal to or greater than 1.3 for short-term, and equal to or greater than 1.5 for long-term. Seismic stability analysis evaluated the potential displacements caused by the design earthquake; the estimated deformations at the final cover level under seismic loading from the Subtitle D design earthquake are between 7 and 36 inches for the final cover alternative that includes an Agru Supergripnet geomembrane. The U.S. EPA [1995] states *"As cover deformations are readily observable and damage to the cover is repairable, larger deformations are typically considered acceptable along interfaces in the cover system than along liner system interfaces."*

The results of both static and seismic slope stability analyses for the final cover system are presented in Appendix E. Based on these results, it can be concluded that the final cover slopes are stable.

On a long-term basis, the 3H:1V or flatter slopes will further flatten with time due to waste settlement; the flattening will improve static and seismic slope stability of the cover system.

5.11 Settlement Analyses

The decomposition of waste over time results in settlement of the landfill grades. Waste settlement has two components: primary settlement and secondary settlement. Primary settlement is assumed to continue for a few months after waste placement whereas secondary settlement continues for a long period of time. Therefore, the final grades will be mostly affected by secondary settlement.

Appendix C includes the settlement evaluation for the final grading plan, which includes estimated settlements at the end of the 30-year post-closure maintenance period. Based on the settlement calculations, over time, the final slopes are expected to flatten from the permitted final grades. However, positive drainage flow is maintained after settlement so the surface water can flow to the outside perimeter and be collected by the permanent storm water management system. Thus, the analysis indicates that the final cover system will perform as designed under anticipated settlements of waste and foundation. As part of post-closure maintenance, areas of ponding that may develop will need to be repaired due to settlements (e.g., reestablishment of pipe slopes and channels transitions and connections to address landfill settlement).

5.12 Final Cover Construction Considerations

The final cover will be designed and constructed to function with the minimum maintenance possible. A construction quality assurance (CQA) program will be instituted prior to final cover construction to document that proper construction techniques and procedures are used and to verify that the materials and installation techniques used meet the project and regulatory agency specifications. The CQA program will be carried out in compliance with an approved CQA plan (Appendix H). After completion of the final cover construction, a CQA report will be prepared and submitted to the DEQ for approval. The final CQA report will be signed and sealed by a State of Oregon licensed professional engineer.

5.13 Additional Closure Activities

5.13.1 Decommissioning of Environmental Control Systems

It is planned for the environmental control systems existing at the time of closure will be left in place during closure and none will be decommissioned. However, if decommissioning is required due to closure activities, components of environmental control systems which have come in contact with leachate or LFG will be cleaned and reused, or disposed of appropriately at the time of closure. Should the decommissioning of groundwater, leachate, or LFG monitoring wells become necessary, the appropriate regulatory agencies will be notified, permits obtained, and appropriate procedures employed.

5.13.2 Structure Removal

As part of closure activities, structures not required for post-closure care activities, post-closure land uses, or other post-closure uses will be dismantled and removed. Dismantling and removal of these structures will occur progressively as landfill closure operations are performed in accordance with the closure schedule. All personal property will be removed, office supplies recovered, and utilities disconnected as appropriate. Temporary structures will be cleaned as necessary before they are removed. Any monitoring facilities requiring off-site disposal will be cleaned on-site, residues will be hauled off for off-site disposal at a suitable site/facility.

5.13.3 Site Security and Access

The landfill site is secured by a fence blocking accessible locations with a lockable gate at the entrance and signs identifying the site as a landfill. The remainder of the site is inaccessible to vehicles. These facilities will remain in-place during closure. Groundwater monitoring wells are secured with locking caps.

The site security system of perimeter fencing, access gates with locks, and informational signs will already be established at the time of closure. Sixty (60) days prior to closure, signs will be placed at points of access to the site stating the intended date of closure as well as the location of alternative permitted solid waste management facilities. After the final receipt of waste, points of access to the site shall be restricted to authorized traffic only. Locked gates will be periodically monitored by security personnel and entry will only be permitted to authorized personnel throughout the closure period.

5.14 Closure Administrative Activities

5.14.1 Notification of Closure

In accordance with §258.60(e) of Subtitle D, before beginning closure, RLC will notify the DEQ that a notice of the intent to close the unit has been placed in the operating record.

5.14.2 Recording

Before closing the landfill, the Plan will be submitted to the DEQ. The Plan may require an update to include items specified under applicable closure regulations in effect when closure of the landfill occurs.

Closure construction of the RL will be conducted under the supervision of a CQA Officer who will be an Oregon licensed professional engineer. The CQA Officer will direct and certify preparation of the closure report for submission to the DEQ. The report will contain the following:

- A description of the closure activities and principal events;
- Construction record drawings;
- Test results;

- The date closure was completed;
- A description and discussion of deviations from the approved FECP;
- Topographic map;
- Location and telephone number where the FECP can be obtained; and
- Drawings, specifications, and approved revisions.

The reports will contain a certification that the information presented is accurate to the best of the CQA Officer's knowledge, and a professional opinion as to whether the closure meets the requirements and intent of the approved FECP and associated construction documents.

Upon closure of the RL, a notation will be placed on the deed or title to the landfill facility in perpetuity, to notify potential purchasers of the property that the site is a landfill and that future use of the site is restricted under §258.61(c)(3) of Title 40 of the CFR (i.e., Subtitle D).

5.14.3 Schedule for Closure

Federal and state regulations related to the schedule of closure activities are contained in §258.60 of Subtitle D and Section 340-94-110(2)(a)(A) of the OARs. §258.60(f) requires that *"The owner or operator must begin closure activities of each MSWLF unit no later than 30 days after the date on which the MSWLF unit receives the known final receipt of waste. . ."* Further, §258.60(g) requires *"The owner or operator of all MSWLF units must complete closure activities of each MSWLF unit in accordance with the closure plan within 180 days following the beginning of closure. . ."*

The closure work will be performed in accordance with the proved FECP and modifications to closure activities set forth in this FECP shall be limited to minor design changes and unforeseen events during closure. No changes that may affect the performance of the closure design will be implemented without prior approval of the regulatory agencies. The final CQA report submitted to the regulatory agencies after closure construction will document changes to the design.

Pursuant to OAR 340-94-110(2)(a)(A), listed below is a general schedule of activities necessary to close the landfill in accordance with this FECP.

- Preparatory Grading – Grading of the areas to be closed may not be compatible with FECP design requirements. Time may be required for placing or re-grading waste or soil to an acceptable closure configuration.
- Contractor Selection – Following DEQ approval of this FECP, contract documents, including construction drawings and specifications, would be issued for bid to select a contractor to perform the closure construction.
- Closure Construction – Construction will begin following contractor selection and contract execution. However, construction will be weather-dependent because most construction activities can effectively only be performed between June and October. Therefore, depending on the timing of the preceding activities, there could be a discontinuity before construction can start.
- Preparation of Construction Report – After construction, a third-party professional engineer licensed in the State of Oregon will prepare a report documenting that closure construction complied with the approved final engineered closure plan.
- DEQ Inspection – Pursuant to OAR 340-94-120(4)(b), and within 30 days of receipt of the closure report requesting approval of the closure, DEQ shall inspect the facility to verify that closure was completed consistent with the approved FECP and the provisions of OAR 340 93 and -94. If DEQ determines that closure was properly completed, DEQ will approve the closure in writing. Closure will not be considered complete until such approval has been made. The date of the approval notice will also represent the date of commencement of the post-closure period.

5.14.4 Cost Estimate for Closure

The closure cost is primarily attributed to the construction of the final cover layers and ancillary facilities, such as LFG monitoring and control system, SWMS components, and security/structure components. Construction quality assurance (CQA) costs are also included in the closure cost estimate. The closure cost estimate includes construction of:

- The final cover system;
- SWMS elements (e.g., downdrains, channels, energy dissipaters, water quality units, etc.);

- Final LFG extraction system elements; and
- Hydroseeding.

Closure components listed above are itemized in the "FECP" cost estimate presented in Appendix I. Individual items are summarized in the following categories:

- Earthwork;
- Geosynthetics;
- SWMS;
- Temporary and Permanent Erosion Controls;
- LFG Management System;
- Water (Groundwater and Surface Water) Monitoring System;
- CQA, Engineering, Surveying and Other Professional Services; and
- Miscellaneous.

The closure cost estimate is based on the following assumptions:

- The area of the RL to receive final cover is approximately 70.5 acres;
- Some unit costs were adjusted for inflation from the DEQ-approved August 2017 RL Closure and Post-Closure Plans [HDR, 2017];
- Available third party pricing; and
- Professional engineering judgment of current costs.

Actual costs will likely vary because of factors beyond the reasonable control of RLC, including market conditions, construction conditions, material availability, oil prices, labor relations, and other unforeseeable events at the time of closure construction. Therefore, the FECP cost estimate will be amended for those factors or changes in landfill operations, the change in the anticipated closure date, or at a minimum, annually to adjust for inflation.

The 2017 cost to close the remaining areas of the RL (i.e., approximately 70.5 acres) is estimated to be $10,676,594. Details of the FECP closure cost estimate are presented in Appendix I.

5.14.5 Maintenance of Closure Plan

To comply with the State (OARs 340) and Federal (Subtitle D) regulations, this document, once approved by the DEQ, will be kept by RLC in the RL operating record and updated as needed. The FECP will be accessible at the RLC office (13469 SW Highway 18, McMinnville, Oregon 97128; phone number 503-472-8788) during landfill operating hours. Once the landfill is closed, the documentation will be available at the RLC/WMI office in Portland.

5.14.6 Change of Ownership

If RLC transfers ownvership of the RL to another party during closure, RLC will notify the DEQ of the transfer with 10 days [DEQ, 2009], and will notify the new owner of the existence of the standards and of the conditions and agreements signed to assure compliance.

6. FINAL ENGINEERED POST-CLOSURE PLAN

6.1 Final Engineered Post-Closure Requirements

6.1.1 Federal Requirements

Federal post-closure plan requirements are specified in 40 CFR 258.61(a)-(c) below:

(a) Following closure of each MSWLF unit, the owner or operator must conduct post¬closure care. Post-closure care must be conducted for 30 years, except as provided under paragraph (b) of this section, and consist of at least the following:

(1) Maintaining the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover;

(2) Maintaining and operating the leachate collection system in accordance with the requirements in §258.40, if applicable. The Director of an approved State may allow the owner or operator to stop managing leachate if the owner or operator demonstrates that leachate no longer poses a threat to human health and the environment;

(3) Monitoring the ground water in accordance with the requirements of subpart E of this part and maintaining the ground-water monitoring system, if applicable; and

(4) Maintaining and operating the gas monitoring system in accordance with the requirements of §258.23.

6.1.2 Oregon-Specific Requirements

Oregon adopts the federal requirements described above, and has additional post-closure requirements in OAR 340-94-115(3):

(3) Requirements for post-closure plans. Post-closure plans shall identify the post-closure activities which will be carried on to properly monitor and maintain the closed municipal solid waste landfill site:

(a) Requirements for the "Subtitle D" post-closure plan shall include all elements specified in 40 CFR §258.61, and consist of at least the following:

(A) Maintaining the integrity and effectiveness of any final cover;

(B) Maintaining and operating the leachate collection system;

(C) Monitoring the groundwater;

(D) Maintaining and operating the gas monitoring system;

(E) Monitoring and providing security for the landfill site; and

(F) Description of the planned uses of the property during the post-closure care period.

And in OAR 340-94-130(b):

(1) Post-closure requirements:

(a) Upon completion or closure of a landfill, a detailed description of the site including a plat shall be filed with the appropriate county land recording authority by the permittee. The description should include the general types and location of wastes deposited, depth of waste and other information of probable interest to future land owners;

(b) During the post-closure care period, the permittee must, at a minimum:

(A) Maintain the approved final contours and drainage system of the site;

(B) Consistent with final use, ensure that a healthy vegetative cover is established and maintained over the site;

(C) Operate and maintain each leachate and gas collection, removal and treatment system present at the site;

(D) Operate and maintain each groundwater and surface water monitoring system present at the site;

(E) Comply with all conditions of the closure permit issued by the Department.

(2) Post-closure care period. Post-closure care must continue for 30 years after the date of completion of closure of the land disposal site, unless otherwise approved or required by the Department according to OAR 340-094-100(4) and (5).

6.2 Objectives

The main objectives of the FEPP are:

- To provide a basis for the operator to establish a preliminary estimate of post-closure monitoring, maintenance, and inspection costs;
- To allow a licensed professional to certify to the accuracy of the cost estimate; and
- To enable the regulatory agencies to evaluate the reasonableness of the cost estimate.

6.3 Post-closure Activities

The following activities are expected to be performed during the post-closure period to check that environmental protection systems continue to function as intended.

6.3.1 Operations, Maintenance and Administrative Requirements

As required in Part 340-094-115 of the OARs, the following general operations, maintenance, and administrative requirements are anticipated:

- Final cover maintenance, including; labor, equipment, and supplies for minor re-grading, re-seeding, and fertilizing;
- Final cover surveying to check settlement and grades;
- MSE berm stability monitoring;
- MSE berm inspections;

- MSE berm maintenance (vegetated face seeding, pavement crack sealing, surface water improvements cleaning, etc.)
- General facility and final cover mowing;
- Maintenance of surface water management features;
- Building security, repairs, and demolition;
- Fence and road maintenance;
- On-site utilities (excluding LFG and leachate equipment);
- Third-party inspections, reports and management;
- Internal administration;
- Insurance; and
- Permitting costs.

6.3.2 Groundwater and Storm Water Monitoring

The following activities, associated with groundwater and storm water monitoring, are anticipated:

- Semi-annual groundwater sampling, sample analyses, quality assurance review, statistical evaluation, and reporting;
- Two storm water sampling events per year at three sampling locations (with sample analyses for E. coli and total suspended solids, quality assurance review, and reporting) and monthly storm water inspections and documentation;
- Monthly storm water observations;
- Contingency for the redevelopment of groundwater monitoring wells; and
- Contingency for groundwater monitoring well decommissioning and replacement as needed.

6.3.3 Leachate Collection, Treatment, and Disposal

The leachate collection and removal system is expected to remain active for the 30-year post-closure period. However, leachate production is expected to decrease dramatically

during that period because the Modules would be covered with a geomembrane. The following general activities associated with the collection, treatment and disposal of leachate and the maintenance and repair of the systems are anticipated:

- Leachate sampling, sample analyses, quality assurance review, and reporting; and
- Leachate hauling for off-site treatment and disposal at approved facilities.

6.3.4 Landfill Gas Collection and Control System

RL includes a GTE facility. It has been assumed that the revenue from operating the facility will compensate for associated operational and decommissioning costs of the facility. Therefore, this facility has not been included in this plan.

The following GCCS operations, maintenance, monitoring, and decommissioning items are included in the post-closure cost estimate:

- Surface emissions monitoring and reporting;
- LFG migration monitoring and reporting;
- LFG probe repair and contingency for replacement;
- GCCS operation, inspection, maintenance and repairs;
- Blower maintenance and repairs;
- Blower replacement contingency;
- Electric power;
- Flare maintenance and repair;
- One-time conversion from active to passive operation;
- One-time system decommissioning;
- Annual New Source Performance Standards (NSPS) monitoring; and
- Title V Air Operating Permit compliance, reporting and fees.

6.4 Post-Closure Landfill Inspection and Maintenance

6.4.1 General

This section describes the inspection and maintenance procedures and methods to be used during post-closure care at the RL. These procedures will be used for the final cover, storm water management system (SWMS), leachate management system, LFG management system (or GCCS), and groundwater quality monitoring systems.

Post-closure care at the RL will be provided by RLC for at least 30 years from the date of the landfill final closure or as required by the DEQ.

During the 30-year post-closure maintenance period, the RL will be periodically inspected, maintained and repaired, as necessary. Inspection of the closed RL will be performed by RLC personnel to meet post-closure requirements.

6.4.2 Inspection Frequency

Generally, during the first years after landfill closure, the frequency of inspections will be at least quarterly and adjusted as necessary based on results of initial inspections and landfill conditions. After conditions are confirmed to be stable, semiannual and then annual general inspections will be performed throughout the post-closure care period.

Additional inspections will be scheduled as needed after periods of extremely wet or dry weather, extreme storm events, and major seismic events (magnitude 5.0 or larger) to verify there has been no damage from the event.

6.4.3 Reporting Procedures

The inspection and maintenance procedures depend upon timely and accurate reporting of inspections and timely implementation of maintenance and repair actions. An inspection report shall be prepared following each inspection giving a detailed description and approximate location of deficiencies. Corrective measures taken to remedy each deficiency shall also be described in the inspection report.

Post-Closure inspection reports will be generated and entered into the operating record of the RL. A Post-Closure Inspection Log presented in Table 1 (or similar) will be used to document inspection activities.

If the periodic inspection at the RL indicates that corrective action is required to repair or restore a component, maintenance will be performed. A Post-Closure Maintenance Log presented in Table 2 (or similar) will be used to document maintenance and repair activities at the RL. The table lists specific problems that may occur and the corresponding maintenance procedures, heavy equipment, and materials that may be required to perform maintenance.

When a problem is noted, corrective action will be taken as soon as practicable. Maintenance work will be documented and documentation will be physically attached to the inspection records that noted the required work. This documentation should include the type of maintenance performed, how it was performed, and a list of materials and equipment used to perform the maintenance.

The operating record shall be maintained at the RL by RLC for the duration of the post-closure maintenance period. The operating record will be available to local, state, and federal regulatory agencies upon request.

6.4.4 Post-Closure Maintenance Equipment

RLC will obtain necessary construction equipment from local rental agencies or contractors to perform required post-closure maintenance activities. Alternatively, RLC may retain certain construction equipment at the RL during the post-closure maintenance period.

Additional equipment or other resources necessary for inspection and maintenance procedures will be available during the RL post-closure maintenance period.

6.4.5 Final Cover

6.4.5.1 General

The Subtitle D requirements in Section 258.61(a)(1) state that post-closure maintenance should include: *". . .maintaining the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover. . ."*

The functions of the final cover are to: (i) limit liquid infiltration; (ii) control LFG emissions; (iii) isolate the buried wastes; and (iv) promote surface water runoff while controlling erosion and accommodating settlement and subsidence. The purpose of the post-closure maintenance procedures described herein is to maintain the integrity of the completed final cover system throughout the post-closure maintenance period.

Post-closure maintenance activities are anticipated as a result of the following conditions:

- Elective intrusion into or through the final cover system associated with maintenance of environmental control systems;
- Settlement-related sags and SWMS interruptions that interfere with the controlled runoff of surface waters from the closed landfill surface;
- Surface erosion;
- Cracking of final cover soils;
- Local surficial slumping on slopes; and
- Any condition that compromises the integrity of the final closure systems.

6.4.5.2 Inspection Procedures

Routine inspection of the final cover will be conducted to identify areas where maintenance is required to minimize the effect and extent of the above conditions. During cover inspections, the following particular areas will be noted:

- Areas where vegetation has died off;
- Areas where erosion is apparent;
- Areas where seepage is apparent; and
- Areas where odors are emitted from the surface.

The following action items and inspection practices and procedures will be instituted following closure:

- A final cover performance inspector will be designated who will be responsible for inventorying, monitoring, and coordinating repair of final cover irregularities;

- Employees with access to the site will be instructed to identify, observe, and report, in writing, to the final cover performance officer unusual surface conditions at the time they are observed; and
- Top deck and side-slope areas will be visually inspected by grid walking as needed and a report of findings will be prepared.

6.4.5.3 Maintenance and Repair Procedures

Final cover maintenance activities will be conducted in a manner to maintain the integrity of the as-built final cover system. Repair materials will be placed in a manner consistent with the original final cover design. If repairs to the final cover impact the LFG management system, repairs to the gas collection and control system (GCCS) will be conducted in accordance with Section 6.4.8.

Repairs of LFG headers and LFG wells may be necessary to maintain proper functioning of the environmental monitoring and control systems. Such repairs may necessitate intrusion into the final cover system. If intrusion into the final cover is required, procedures that may include cutting existing geosynthetics and installing new ones shall conform to the requirements of the final cover construction specifications and drawings. Repairs of the geomembrane shall be subjected to construction quality assurance (CQA) testing in accordance with the CQA Plan for construction of the final cover. Sags, ponding, surface erosion, or other settlement features will also be repaired.

6.4.6 Final Grading, Slope Protection, and Erosion Control

6.4.6.1 General

Repair or amending grades, slope protection, or erosion control will be conducted in accordance with the specifications and repair procedures for final cover presented below and in Section 6.4.5. Maintaining sufficient vegetation over the surface of the landfill is an integral component in maintaining adequate erosion protection.

6.4.6.2 Inspection Procedures

The vegetation will be inspected for landfill surface coverage and stress indications. The causes of these irregularities or deficiencies shall be ascertained at the time of environmental monitoring wherever possible. Landscaping monitoring parameters also

include soil quality control, rodent control, and a reseeding program, if necessary. Corrective action will be taken to remedy observed deficiencies.

Inspections of the vegetative (erosion control) layer will be conducted in conjunction with the final cover inspections discussed in Section 6.4.5. The final cover system performance officer shall also be responsible for documenting and monitoring the following procedures:

- Employees with access to the site will be instructed to identify, observe, and report in writing any unusual landfill surface conditions;
- The vegetative layer of the landfill will be visually inspected and a report of findings will be prepared; and
- The vegetative layer of the landfill will be visually inspected following unusual events and a report of findings will be prepared following any such unusual event.

The landscaping will be inspected for landfill surface coverage and stress indications. The causes of irregularities shall be ascertained at the time of environmental monitoring whenever possible.

6.4.6.3 Maintenance and Repair Procedures

Maintenance of the vegetative layer and the landscaping will be conducted by qualified personnel. Maintenance efforts are expected to be greatest during the vegetation establishment period and are projected to lessen thereafter. The inspection schedule after the establishment period is expected to decrease accordingly.

Vegetative (Erosion Control) Layer

It is anticipated that the 18 in. thick vegetative (erosion control) layer will require periodic maintenance throughout the post-closure maintenance period. Repairs to the vegetative layer will be performed in a manner consistent with the original vegetative layer construction procedures. Clean fill will be placed in loose lifts of 6 to 8 in. in thickness to re-establish grades to appropriate elevations, as necessary.

Landscaping

Landscaping will be established to promote long-term erosion control and to protect the final cover system. Routine inspection of the vegetation should be conducted during and after the plant establishment period.

Reseeding of the vegetated area will occur on an as needed basis. Reseeding may be necessary if slope reworking has occurred or in the event that weed pulling has caused the death or sparseness of the native vegetation. The reseeding efforts will be consistent with the intent of the original vegetation.

Inspection for the existence of a rodent population at the closed RL will be made routinely. If it is suspected that rodents are threatening the integrity of the vegetative (erosion control) layer, extermination procedures will commence. A qualified professional will be contracted to perform the necessary services.

6.4.7 Storm Water Management System

6.4.7.1 General

Post-closure inspection and maintenance of the storm water management system (SWMS) will continue to be implemented during the post-closure maintenance period. The inspection and maintenance programs outlined below provide a comprehensive set of procedures to monitor and maintain the integrity of the SWMS as necessary during the post-closure maintenance period.

Control of runoff, erosion and sediment during the landfill post-closure maintenance period will be accomplished through the use of drainage ditches, channels and culverts, diversion dikes, straw bale barriers, seeding, water quality units, and ponds. Flow from the developed areas will be intercepted by the channels and routed to the ponds and water quality units. The channels or ditches will be periodically maintained. Erosion will also be controlled during the landfill post-closure maintenance period by using permanent seeding of landfill slopes.

Maintenance and inspection of the SWMS also includes the ditches, headwalls, splash walls, and drop inlets constructed in the MSE berm. The inspection procedures will be the same as for the other portions of the closed landfill.

6.4.7.2 Inspection Procedures

For all SWMS components (e.g., pipes, culverts, downdrains, ditches, water quality units), an inspection report will be prepared following each inspection giving a detailed description and approximate location of deficiencies. Corrective measures taken to remedy each deficiency shall also be described in the inspection report. Repairs will be performed in accordance with manufacturer recommendations.

Inspection procedures for brow ditches, ditches, and channels include checking for erosion ruts, settlement cracks, and maintenance of positive flow.

Each culvert and drainage structure at the landfill will be inspected to identify any of the following deficiencies:

- Joint separation;
- Invert failure;
- Structural failure;
- Perforations; and
- Presence of silt and/or debris.

Corrective measures taken to remedy each deficiency shall also be described in the inspection report.

Downdrains convey storm flow from the top deck into perimeter drainage channels or culverts. These downdrains are constructed on the exterior face of the finished slopes. An inlet apron will be constructed of rock around each inlet to serve as a non-erodible approach for deck and bench runoff.

The top deck areas will be graded to allow for sheet flow away from the center of the deck area to the edges of the deck. The swales and berms on the top deck will be inspected and repaired with soil of suitable properties in a manner consistent with the repair of the final cover system and the vegetation (erosion control) layer.

The water quality units are equipped with low-level water outlets and emergency spillways. A visual inspection of each unit should be conducted to identify deficiencies such as invert failure, structural failure; and presence of silt and/or debris.

Existing and new storm water ponds are (and will be) equipped with low-level water outlets and emergency spillways. A visual inspection of each pond component will be conducted to identify deficiencies such as structural failure and presence of silt and/or debris.

6.4.7.3 Maintenance and Repair Procedures

Bench maintenance will consist of erosion control along the toe of the slope and re-grading of areas, which have been subjected to differential settlement. Re-grading will control ponding and help maintain drainage into the inlet structures. In areas where landfill settlement affects the bench grades, additional vegetative layer soil cover material will be placed and compacted to re-establish positive drainage, as needed.

Maintenance activities will include, as necessary, drainage channel and downdrain repairs, removal of silt and debris along drainage channels and in the storm water ponds, repair and replacement of erosion and sediment controls (e.g., silt fences, straw bales, riprap), and grading of the final cover erosion layer.

Typical water quality unit, culvert, downdrain and perimeter channel corrective measures for deficiencies include the following:

- Joint separation:
    - Use wider CSP band couplers with mastic or pumped grout; and
    - Attach patches with self-drilling/self-tapping screws or welds.
- Invert failure:
    - Replace unit;
    - Replace piping; and
    - Rotate pipe 180 degrees and patch as required.
- Structural failure:
    - Replace unit;
    - Reinstall pipe anchor supports; and
    - Replace section of drain.
- Clogging by silt/debris:

- Use vacuum pumps to clear extensively clogged culverts and water quality units; or
- Use a waterjet spray to force debris out of the drains and water quality units; or
- For smaller amounts of debris, use a bucket line; or
- Use a fire hose to flush out debris.

Small amounts of silt and debris may be removed by buckets or waterjet flushing. Extensive clogging may require either vacuum pump or waterjet spray.

A vacuum pump may be used to remove sediment from pipes and can be mounted on a vehicle. It requires a 200 to 300 gallon holding tank and a vacuum pump that has a 10 in. diameter flexible hose with a serrated metal end for breaking up caked sediment. This vacuum pump system can remove stones, leaves, litter, and sediment deposits. (Normal working depth of the vacuum pump system is up to 20 ft.)

A waterjet spray can be used to clear debris from the culvert system. Waterjet equipment is usually mounted on a self-contained vehicle with a high-pressure pump and a 200 300 gal water supply. A 3 in. flexible hose line with a metal nozzle that directs jets of water out in front is used to loosen debris in pipes or trenches. The nozzle can also emit umbrella-like jets of water at a reverse angle, which propels the nozzle forward as well as blasting debris backward. As the hose line is reeled in, the jetting action forces the debris downstream where it is removed by the vacuum pump equipment. (The typical length of hose is approximately 200 ft.)

Access roads for maintenance will be provided on the decks to reduce interference with any surface flows. It is important that maintenance vehicles utilize access roads and benches whenever possible to reduce surface rutting that could interfere with normal drainage patterns.

For open channels and the storm water ponds, the following corrective measures can be taken for deficiencies identified during the inspection:

- Cracking:
    - Construction of expansion/control joints; and

- Placement of sealants such as epoxy resins, asphaltic material, thermoplastics or silicones.

- Settlement:
  - Grouting injection; or
  - Removal of modular concrete blocks; and/or
  - Completion of replacement with subgrade work.

6.4.7.4 Storm Water Monitoring System

The storm water monitoring system is governed by the National Pollutant Discharge Elimination System (NPDES) general permit requirements. The maintenance required for the surface water monitoring system is that required for the SWMS (Section 6.4.7). The required inspection and maintenance programs will maintain the drainage system in proper working order and facilitate post-closure surface water monitoring activities.

6.4.8 Landfill Gas Management System

6.4.8.1 General

The federal requirements in 40 CFR 258.61(a)(4) of Subpart F require *"… maintaining and operating the gas monitoring system. . ."* a minimum of 30 years after the site is closed in accordance with the requirements of 40 CFR 258.23.

The GCCS is a vital environmental control system at the RL and will be in operation for the 30-year post-closure maintenance period, or as long as is required. The corresponding inspection and maintenance program includes maintenance requirements for pipe breakage due to landfill settlement and pipe blockage due to the formation of condensate, as well as management of the condensate.

6.4.8.2 Landfill Gas Extraction System

The LFG system will be installed as filling proceeds with wells installed either after the waste has been in place for 5 years or within 2 years of reaching final grades. Collectors will also be installed to address odor issues or to address migration detected by the perimeter monitoring system. The system is composed of the LFG vertical extraction wells, horizontal collectors, and associated piping. The system will be inspected and

maintained throughout the 30-year post-closure period or as long as gas continues to be detected at levels requiring control.

Inspection Procedures

The LFG management system will be inspected with a focus on well head assemblies, pipeline couplings, connections, pipeline leaks (which may be indicated by a methane odor, hissing sounds, elevated methane concentrations in surface air samples, or elevated oxygen readings in the collection system), pipeline breakage, cracking, abnormalities, or deformations. Regular inspections of the blower/flare station will also be performed to verify adequate and safe operation.

Maintenance Procedures

Maintenance procedures for elevated subsurface temperature regulations pertain to surface emissions monitoring and sealing of landfill surface cracks. Sealing surface cracks greatly reduces the ability of oxygen intrusion to occur. Wellhead monitoring of the LFG temperature and gas composition serves as an indicator of elevated subsurface temperatures.

Routine inspection and maintenance of the LFG extraction system will include adjustment to valves, testing of well pressures, checking for LFG leakage at the well-head, and checking the integrity of well penetrations through the final cover.

Surface repairs will be conducted in accordance with the final cover repair procedures. LFG wellhead flows can be reduced or completely shut off by valve adjustments to reduce oxygen intrusion, and therefore, lower subsurface temperatures.

Cracked, broken, or malfunctioning portions of the GCCS will be repaired upon detection in accordance with industry standards. GCCS repairs are dependent on the nature and extent of damages and may include removal and replacement of solid-wall sections of high-density polyethylene (HDPE) pipe, soil backfill, bentonite grout, and/or geomembrane boots. If it is determined that LFG wells are damaged beyond repair, they will be abandoned and/or re-drilled. Repairs to the LFG headers may include removal and replacement of damaged header pipe. These repair activities will be conducted in compliance with applicable state and federal regulations.

6.4.8.3 Landfill Gas Monitoring System

Inspection Procedures

The current LFG monitoring system consists of the LFG monitoring probes installed at strategic locations along the RL perimeter (Appendix A). Visual inspections of the LFG monitoring probes will be conducted during the post-closure maintenance period with attention to broken probes, end caps, sampling ports, and valve boxes.

LFG monitoring during the post-closure maintenance period will consist of monitoring the perimeter gas monitoring probes on a quarterly basis. During the post-closure period, probes that show "zero" combustible gas readings for 1 year will then be monitored on an annual basis.

All monitoring probes and on site structures will be sampled for methane. The results of LFG monitoring will be submitted to the DEQ within 90 days of sampling unless compliance levels are exceeded. If compliance levels are exceeded, immediate steps will be taken to protect public health and safety. Verbal notification will be made to DEQ within 24 hours and written notification of the DEQ will be made within seven days.

Maintenance Procedures

Repairs will be conducted upon detection. Monitoring probes may be re-drilled if they have sustained excessive damage. Repairs will be conducted in accordance with industry standards.

Data from surface monitoring and perimeter gas monitoring probes will be used to adjust the active LFG extraction system to meet applicable standards. The flare stations will be stack tested each year and adjusted or modified to meet applicable standards.

6.4.8.4 Landfill Gas Condensate

Inspection Procedures

The LFG condensate management system will be inspected monthly, in conjunction with the monthly inspections of the GCCS. LFG condensate piping and storage tanks will be visually inspected for leaks or breakage, and condensate pumps will be checked for proper

operation. Detection of odor and evidence of condensate leakage or minor spillage are indicators of the malfunctioning of the LFG condensate management system.

Maintenance Procedures

Maintenance and repairs to the LFG condensate management system will be made upon detection. Cracked, broken, or malfunctioning portions of the LFG condensate management system will be repaired in accordance with industry standards. If maintenance, such as storage tank repair, is required, RL personnel may be assisted by contractors as necessary to complete repairs as rapidly as possible.

6.4.9 Leachate Management System

6.4.9.1 General

The federal requirements in §258.61(a)(2) of Subtitle D state that post-closure maintenance, which must be conducted for at least 30 years, should include *". . .maintaining and operating the leachate collection system in accordance with requirements of §258.40. The Director of an approved State may allow the owner or operator to stop managing leachate if the owner or operator demonstrates that leachate no longer poses a threat to human health and the environment."*

The leachate management system (LMS) at the RL consists of a leachate pond and sumps, HDPE pipes, and pumps designed to transfer leachate from the leachate collection sumps to the leachate pond. The leachate in the leachate pond either evaporates during warm weather or is transferred to tanker trucks and shipped to offsite waste water treatment plants or Hillsboro Landfill as discussed in Section 2.5.4. After closure, the leachate will be shipped to offsite waste water treatment plants or another WM landfill.

LCRS side-slope risers and sump pumps will be operated, inspected, maintained, and tested regularly as long as there appears to be a potential for liquid flow into the LCRS sumps. Monitoring during post-closure will vary depending on conditions encountered during the year. In this regard, leachate production generally decreases with time after a final cover has been installed. Nonetheless, a certain period of time may be necessary for the moisture content to stabilize and for actual decreases in leachate production to occur.

At this time, it is anticipated that leachate will be transported to an approved wastewater treatment facility for treatment and disposal. Both the quantity and quality of leachate

shall be monitored. Therefore, the frequency of monitoring and testing to be performed will be determined at the time of closure based on results of current monitoring. Leachate samples will be analyzed for the same constituents as required by the terms of the operating permit. The results of the monitoring will be presented in reports submitted to the DEQ.

6.4.9.2 Inspection Procedures

A visual inspection of the LMS will be made by qualified RLC personnel or contracted maintenance crews. If repairs to the system are required, the necessary personnel will be notified. The focus of the inspections will be on the leachate collection and removal system (LCRS) pumping equipment and leachate evaporation pond.

As part of the visual inspection, the following items should be checked:

- Motor/pump electrical control panel for tripped breakers;
- Compressors for proper operation;
- Float switch for proper calibration;
- Leachate piping for evidence of any pipe leakage;
- Valve inspection for damage and leak;
- Leachate storage ponds and secondary containment systems for integrity and any evidence of leakage or damage; and
- Discharge piping for clogging or buildup of particulate matter on pipe walls.

6.4.9.3 Maintenance and Repair Procedures

Based on the results of the inspection activities, repairs and/or replacement of components of the LMS will be made as necessary. Identified worn or malfunctioning elements of the LMS will be repaired or replaced, as appropriate. The repair will be performed by qualified RLC personnel or contracted firm.

6.4.10 Groundwater Monitoring System

6.4.10.1 General

Water quality monitoring and reporting during the post-closure maintenance period will initially be conducted with the same frequency, at the same monitoring points, and for the same constituents as for the landfill when active. Adjustments to the number of monitoring points and/or monitoring frequencies may be proposed by RLC during the post-closure maintenance period, if a review and analysis of data obtained from initial monitoring activities indicate that a lesser number of points or a lesser frequency is technically justified. No adjustments will be made, however, without approval of the DEQ. As currently required, for each monitoring point, it will be determined whether there is statistically significant evidence of a release from the landfill for any monitoring parameter. If there is statistically significant evidence of a release, an evaluation monitoring and corrective action program will be implemented.

The groundwater monitoring wells have been designed to ease operation and facilitate minimal maintenance during and after landfilling operations and additional wells will be designed to meet this same criteria. Wells may be equipped with dedicated purging and sampling equipment.

Appendix A presents the current groundwater monitoring well network at the RL.

6.4.10.2 Inspection Procedures

The groundwater monitoring network will be inspected each time groundwater samples are collected from the wells. The sampling technician will inspect well caps, casings, and protective post-structures for signs of damage or deterioration and missing padlocks.

6.4.10.3 Maintenance and Repair Procedures

Depending upon the extent of deterioration or damage, the monitoring well will be either repaired or replaced as soon as practical after detecting the problem.

If a pump malfunctions during the 30-year post-closure maintenance period, it will be replaced. Damaged or inoperative caps and locks will be replaced as required. Other repairs, including possible well abandonment and re-drilling, will be conducted in accordance with regulatory standards.

6.4.11 Mechanically Stabilized Earthen (MSE) Berm

6.4.11.1 General

The MSE berm inspection and monitoring includes such items as stability monitoring, inspection of the surface water features and visual reconnaissance of the berm, and maintenance.

6.4.11.2 Stability Monitoring

Stability monitoring includes field work and data acquisition, data evaluation and reporting, and instrumentation repairs. Stability monitoring is performed to detect movement. As part of monitoring, the following items would be checked:

- Slope indicators;
- Piezometers; and
- Extensometers.

A report would be prepared and submitted by RLC. If the instrumentation were to stop working, it would be repaired.

6.4.11.3 Berm Inspection

Inspection of the MSE berm storm water control features would be performed during inspection of the landfill following similar procedures as described in Section 6.4.7. The MSE berm would also be inspected for movement (see Section 6.4.11.2), erosion, condition of the facing (e.g., welded wire forms, geogrids, vegetation, etc.), seepage, and condition of other features such as the asphalt paving. Based on the findings of the inspections, repairs will be made as necessary. The repair will be performed by qualified RLC personnel or contracted firm.

6.5 <u>Security</u>

During the post-closure maintenance period, should anyone enter the RL, exposed waste will not be observable and no uncontrolled health hazards will exist. However, to protect and maintain the integrity of the closed landfill, the security measures, implemented at closure, will continue through the post-closure maintenance period. These measures are

expected to include maintenance of the fences and gates to prevent access to unauthorized personnel.

6.6 Post-Closure Land Use

There are no specific development plans for post-closure use of the closed RL. Until there are specific plans, approvals, and assurances for public use of the former landfill, site access will be restricted to authorized personnel.

6.7 Post-Closure Cost Estimate

Part 258.72 of Subtitle D requires that *"The owner or operator must have a detailed written estimate, in current dollars, of the cost of hiring a third party to conduct post-closure care for the MSWLF unit in compliance with the post-closure plan developed under §258.61 of this part. The post-closure cost estimate used to demonstrate financial assurance in paragraph (b) of this section must account for the total costs of conducting post-closure care, including annual and periodic costs as described in the post-closure plan over the entire post-closure care period. . .*

(1) The cost estimate for post-closure care must be based on the most expensive costs of post-closure care during the post-closure care period."

The costs of post-closure maintenance at the RL will be primarily attributable to the inspection and maintenance of the systems and structures described in this plan.

The post-closure activities discussed in this FEPP are itemized in the Post-Closure Cost Estimate presented in Appendix I. Annual costs are estimated to be approximately $645,421. The estimated 30-year post-closure cost is $19,362,617. Based on the DEQ Worksheet for MSW Facilities, and using the MSW Reference Rate provided by the DEQ (Appendix I), the estimated 30-year post-closure cost has been discounted to $16,803,744. Although the site is not expected to close within the next year, to remain conservative, costs have been discounted for 30 years, beginning in 2018.

Actual costs will vary because of factors beyond the reasonable control of RLC, including market conditions, construction conditions, material availability, labor relations, and other unforeseeable events. Therefore, the estimate will be amended for those factors or changes in landfill operations, the change in the anticipated closure date, a change in the approved financial mechanism, or at a minimum, annually to adjust for inflation.

Post-Closure care cost estimates are based on the cost of hiring a third party to maintain, monitor, and inspect the closed landfill in accordance with the FECP and reflect the costs for design, materials, equipment, labor, administration, and quality assurance. The cost estimate used to demonstrate financial assurance was obtained by multiplying the annual cost of maintenance and monitoring anticipated during the post-closure period by 30 years. The cost estimate will be modified when changes to this FEPP or the landfill indicate an increase or decrease in post-closure maintenance costs.

6.8 Maintenance of Post-Closure Plan

The FEPP will be maintained at RL as long as the facility is open, during closure activities and for the post-closure maintenance period. However, if there are no offices located at RL during the post-closure period, the FEPP will be maintained at the WMI office in Portland, Oregon.

6.9 Change of Ownership

RLC and WMI are responsible for post-closure maintenance activities at the RL and related costs. If a change in ownership occurs during the post-closure maintenance period, RLC/WMI will notify the new owner concerning the existence of the conditions, regulatory standards and requirements relating to post-closure maintenance of RL, and signed agreements that are in place to assure continued compliance. RLC/WMI will also notify the DEQ and other appropriate regulatory agencies of the change in title within 30 days.

6.10 Completion of Post-Closure Care Period

Part 258.61(e) of Subtitle D and Section 17(b)((3)(5) of Title 11 of the HAR require that *"Following completion of the post-closure care period…, the owner or operator must notify the State Director that a certification, signed by an independent registered professional engineer…, verifying that post-closure care has been completed in accordance with the post-closure plan, has been placed in the operating record."*

Following completion of the post-closure maintenance period, RLC will submit a certification verifying that post-closure maintenance period was completed in accordance with the FEPP. The certificate, signed by a licensed professional engineer, will be submitted to the DEQ, the State enforcement agency (EA) for the landfill.

7. CLOSURE AND POST-CLOSURE CARE FUND

The federal (Subtitle D) and state (OAR 340) regulations require that RLC demonstrate the availability of financial resources to conduct closure and post-closure maintenance activities. Financial responsibility is essential for providing long-term assurance that the site will be closed and maintained during the 30-year post-closure period in a manner that continues to protect public health and safety, and the environment from pollution due to disposal of solid waste at the RL.

Part 258.74 of Subtitle D states that *"The mechanisms used to demonstrate financial assurance. . . must ensure that the funds necessary to meet the costs of closure, post-closure. . . will be available whenever they are needed. . ."*

RLC uses both Trust Fund and Surety Payment Bonds to satisfy the financial assurance obligations for closure and post-closure maintenance.

The current financial assurance status, current trust account statements (showing balances and transactions over the previous year), and bonds were provided to DEQ in HDR [2017].

8. REFERENCES

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Spencer, E. "A Method of Analysis of the Stability of Embankments Assuming Parallel Interslice Forces," *Geotechnique*, Volume 17, Number 1, March 1967.

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Yan, L., N. Matasovic, and E. Kavazanjian, Jr. *YSLIP_PM User's Guide* Research Report, Geosyntec Consultants, 21 p. April 1997.

9. LIMITATIONS

This report was prepared by Geosyntec Consultants, Inc. (Geosyntec) in general accordance with the accepted standard of practice, which existed in Oregon at the time the project was performed. Individual boreholes represent the information obtained at the location of drilling. It should be recognized that definition and evaluation of geotechnical and environmental conditions is a difficult and inexact art. Judgments leading to conclusions and recommendations are generally made with an incomplete knowledge of the conditions present. Geosyntec has prepared this report for the Client's exclusive use for this particular project and in accordance with generally accepted engineering practices within the area at the time of its investigation. No other representations, express or implied, and no warranty or guarantee is included or intended.

TABLES

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Table 1
POST-CLOSURE INSPECTION LOG
Riverbend Landfill

Item	Problem	Acceptable		Observations	Date and Nature of Repairs/Action
		Yes	No		
Cover Material	Erosion, inadequate protective vegetation, ponding				
Run-off Diversion Channels	Obstructions to flow, bank erosion, deterioration, excessive silting				
Drainage Ditches	Erosion, clogging, obstruction of culverts				
Area Inlet to and Outlet From Storm-Water Piping System	Erosion, deterioration, silting, blockage, clogging, damage to riprap at inlet and outlet				
Stormwater Run-off Piping (Onsite Stormwater Management)	Silting, deterioration, blockage, clogging, joints				
Stormwater Run-off Piping (Western Bypass Channel)	Silting, deterioration, blockage, clogging, joints				
Leachate Collection/Removal System	Cracks, deterioration, clogging, and blockage				
Leachate Collection and Removal System - Liquid Level Indicator Gauges	Inoperative, sticking				
MSE berm stability monitoring	Documentation of settlement and movement; trouble-shooting of instrumentation				
MSE berm inspection	Erosion of vegetated face, condition of facing elements, geosynthetics; cracking of pavement; silting, clogging of storm water control features				
Benchmarks	Dislocation, damage				
Facility Fence	Corrosion, damage, vandalism				
Gates and Locks	Corrosion, damage, vandalism				
Access Roads	Erosion, cracks, deterioration, excess rutting, loss of aggregate (where used)				
Warning Signs	Damaged, deteriorated, missing				
Locks on Groundwater and Gas Monitoring Wells	Corroded, broken				

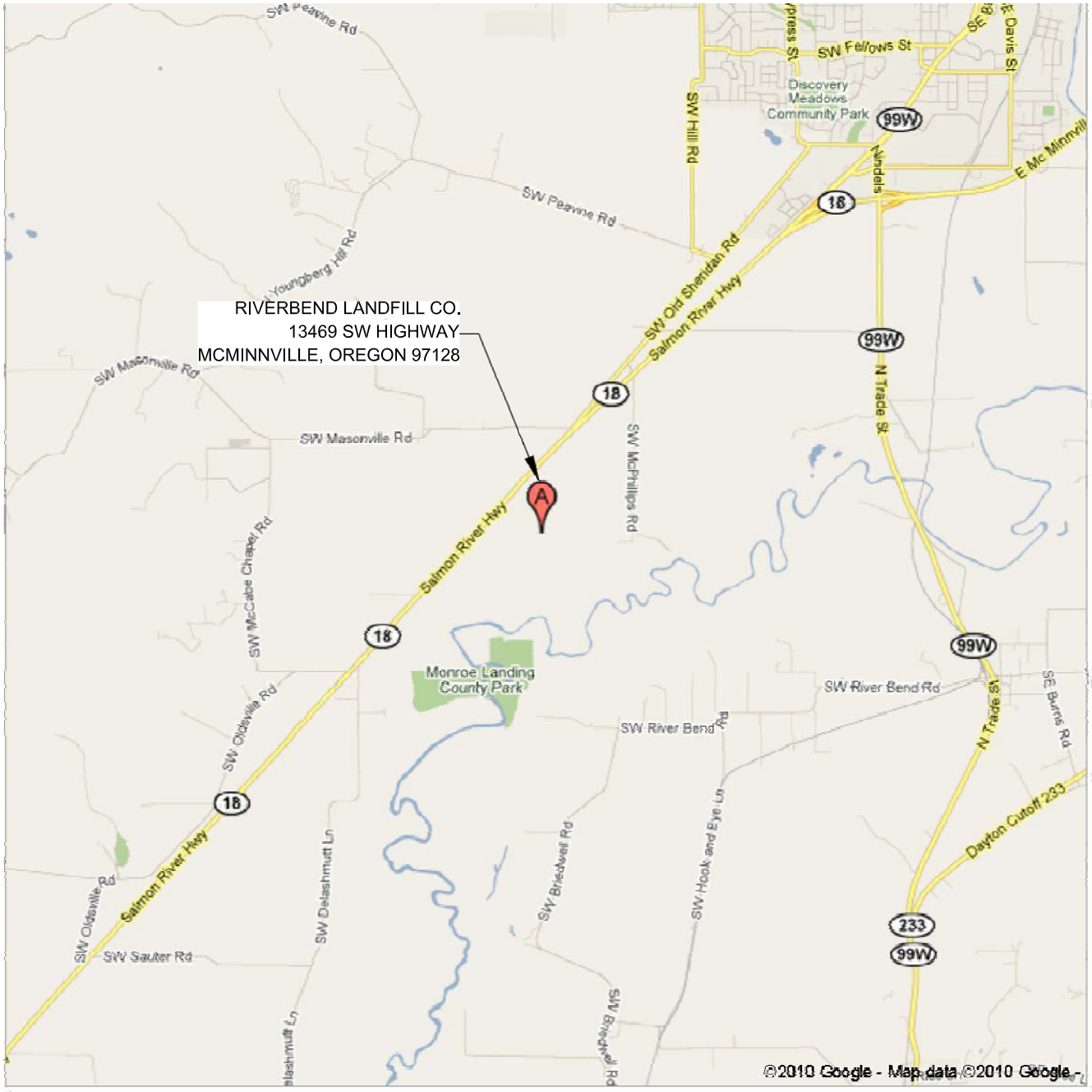
Table 2
POST-CLOSURE MAINTENANCE LOG
Riverbend Landfill

Problem	Maintenance Procedure	Equipment Requirements	Materials Requirements
SECURITY CONTROL:			
Fallen or broken fence	Repair or replace fence. Add fence post(s), if necessary	None	Fence, fence post, wire, concrete
EROSION DAMAGE:			
Bare spots on final cover or MSE berm	Revegetate; if unsuccessful use erosion mat and revegetate, check for landfill gas.	None	Erosion mat, seed, fertilizer mulch
Soil loss or along MSE berm	Backfill and place erosion mat and revegetate	Backhoe, front end loader, or grader	Backfill, erosion mat, seed, backfill mulch
CAP DEFORMATION RESULTING FROM SETTLEMENT, SUBSIDENCE, OR DEFORMATION:			
Cracks or Fissures	Backfill, revegetate	Grader, backhoe, front end loader	Backfill, seed, fertilizer mulch
Ponding	Backfill, revegetate	Grader, backhoe, front end loader	Backfill, seed, fertilizer mulch
Access Road	Backfill, repair	Grader, backhoe, front end loader	Backfill
RUNOFF CONTROL STRUCTURES:			
Clogged soil drainage ditches	Clear debris	Backhoe, grader, hand tools	Backfill, riprap
Clogged culvert, water quality units	Clear debris	Hand tools, vacuum truck	None
Clogged Inlet and Outlet structures	Clear debris	Hand tools, backhoe	None
Blocked channel and pipe	Clear debris	Hand tools, backhoe	None
Deteriorated culverts and pipe	Repair or replace culvert	Backhoe, hand tools	In accordance with manufacturer recommendations
Eroded soil drainage ditches	Regrade, place riprap or erosion mat, revegetate	Bulldozer , grader, or backhoe	Backfill soil, seed, fertilizer, mulch, erosion mat, riprap, geotextile

Table 2 (cont'd)
POSTCLOSURE MAINTENANCE LOG
Riverbend Landfill

Problem	Maintenance Procedure	Equipment Requirements	Materials Requirements
LEACHATE COLLECTION AND REMOVAL SYSTEM:			
Leachate header clogged	Flush, clear obstruction	Water truck or sewer rodder	Water
Broken sump pump	Repair or replace	Light crane	Sump pump
Faulty liquid level indicator gauge	Repair or replace	None	New gauge
Cracked or deteriorating structures	Repair or replace	None	Mortar
MSE BERM:			
Stormwater pipes, ditches, or drop inlets clogged	Flush, clear obstruction	Water truck or sewer rodder	Water
Stormwater ditches, headwalls, splash walls damaged	Repair asphalt or lining	Paver, light truck, hand tools	Asphalt or articulated concrete block, ready mix concrete, mastic, epoxy
Pavement cracked	Fill cracks	Light truck	Asphalt sealant
Facing damage	Repair	Light crane or lift, front end loader, hand compactor	Wire basket, geogrid, ersoion mat, backfill, hydroseed
Vegetation Dead or Large Size	Revegetate or remove	Hand tools, light crane or lift, front end loader or equivalent, hydroseeder	Seed, backfill
Instrumentation	Repair or replace	Drill rig	Casing
LANDFILL GAS MONITORING AND RECOVERY SYSTEM			
Corroded, broken well cap, casing or lock	Repair or replace	Hand tools	New cap, well casing, lock, lubricant
GROUNDWATER MONITORING			
Faulty pump operation	Repair of pump	Hand tools	Pump, wiring
Corroded, broken well cap, or lock	Repair or replace	Hand tools	New cap, lock, lubricant
SURVEY MONUMENTS			
Covered with debris, sod, etc.	Relocate, clean around, mark with visible marker	Hand tools	Wooden or metal markers
Damaged, destroyed	Replace, resurvey	Mixer, hand tools	Monument, concrete

FIGURES



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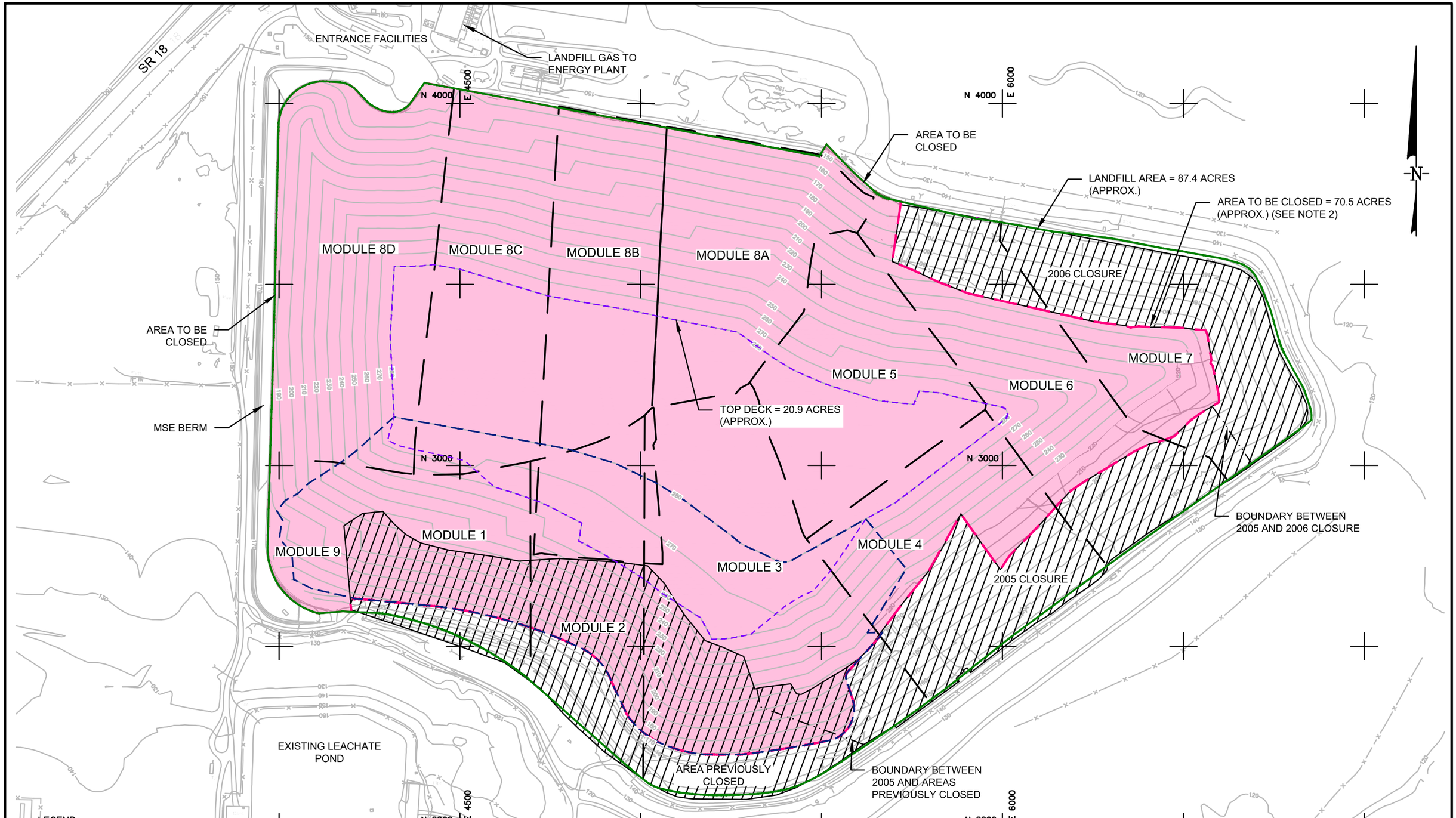
SITE VICINITY MAP RIVERBEND LANDFILL MCMINNVILLE, OREGON	FIGURE NO. 1 PROJECT NO. WG2423 DATE: OCTOBER 2017



LEGEND:

- FINAL GRADES
- APPROXIMATE EXISTING MODULES BOUNDARY
- LANDFILL FOOTPRINT = 87.4 ACRES (APPROX.)
- PREVIOUSLY CLOSED AREA
- AREA TO BE CLOSED = 70.5 ACRES (APPROX.) (SEE NOTE 2)
- FIINAL GRADING PLAN MODIFICATION (FGPM) LIMIT OF WASTE
- TOP DECK = 20.9 ACRES (APPROX.)

NOTES:

1. SITE TOPOGRAPHY PROVIDED BY WM (AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., DATED 19 MARCH 2017).
2. AT THE TIME OF FINAL CLOSURE, LIMITS OF EXISTING FINAL COVER SHALL BE CONFIRMED IN THE FIELD BEFORE CONSTRUCTION. NEW FINAL COVER SYSTEM SHALL CONNECT TO EXISTING FINAL COVER OR TO EXISTING LINER LIMIT TO PROVIDE FULL WASTE CONTAINMENT.
3. ENTRANCE FACILITIES INCLUDE ADMINISTRATIVE BUILDINGS, SCALE HOUSE, RECYCLING AND DROP-OFF FACILITIES, STORAGE, AND GAS TO ENERGY PLANT.

0 250
SCALE IN FEET

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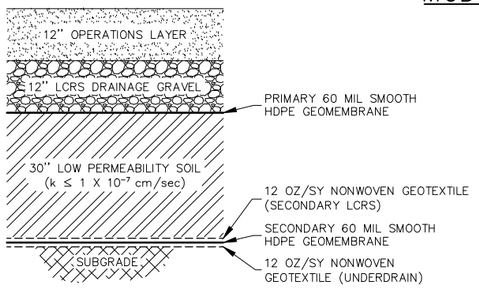
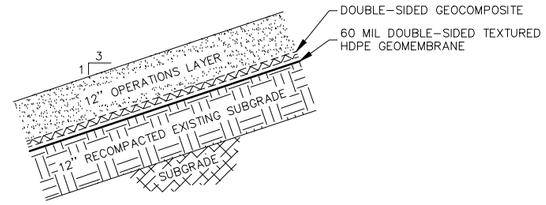
SITE PLAN & FINAL GRADING PLAN
RIVERBEND LANDFILL
MCMINNVILLE, OREGON

FIGURE NO.	2
PROJECT NO.	
DATE:	OCTOBER 2017

MODULE 4



FLOOR LINER

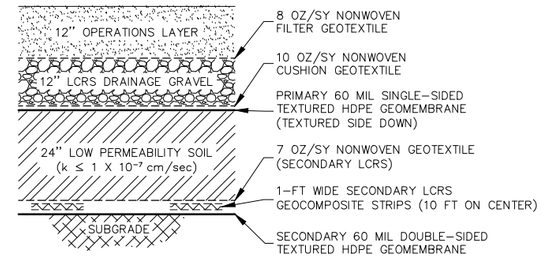


SIDESLOPE LINER

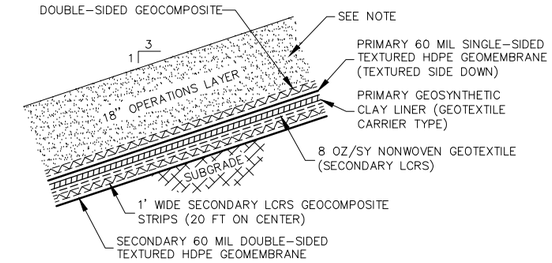
NOTE: MODULE 4 ALSO INCLUDES AN UNDERDRAIN SYSTEM.

SOURCES: "*RIVERBEND LANDFILL, MODULE 4 LINER AND MODULE 5 EXCAVATION, ENGINEERING DESIGN REPORT*," BY EMCON NORTHWEST, INC., JULY 1993; "CONTRACT DOCUMENTS FOR THE CONSTRUCTION OF MODULE 4 LINER AND MODULE 5 EXCAVATION PLANS, RIVERBEND SANITARY LANDFILL," BY EMCON NORTHWEST, INC., MAY 1993; LETTER FROM MARK SADLER OF EMCON NORTHWEST, INC. TO MONTY MORSHED OF OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY "RIVERBEND LANDFILL MODULE 4 CONSTRUCTION: DESIGN CLARIFICATIONS," 9 AUGUST 1993; AND "MODULE 4 LINING AND MODULE 5 EXCAVATION CONSTRUCTION REPORT," BY EMCON NORTHWEST, INC., 8 NOVEMBER 1993.

MODULE 8A



FLOOR LINER

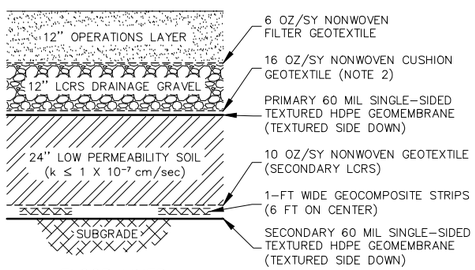


SIDESLOPE LINER

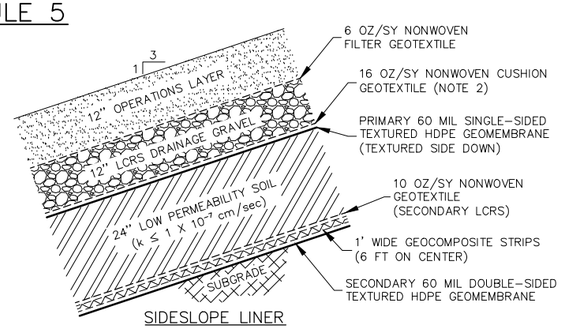
NOTE: DESIGN DOCUMENTS STATE THICKNESS OF OPERATIONS LAYER IS 12 INCHES; HOWEVER, CQA DOCUMENTS AND REDLINE DRAWINGS SHOW 18 INCHES.

SOURCES: "MODULE 8A DESIGN REPORT, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY EMCON/OWT SOLID WASTE SERVICES, APRIL 2002; "CONSTRUCTION CERTIFICATION REPORT, MODULE 8A CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY EMCON/OWT, INC., NOVEMBER 2002.

MODULE 5



FLOOR LINER



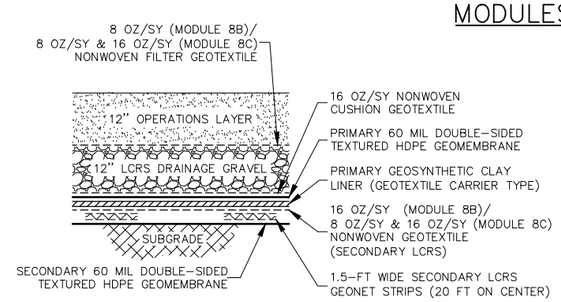
SIDESLOPE LINER

NOTES:

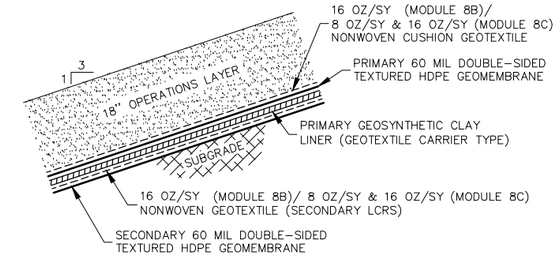
1. MODULE 5 ALSO INCLUDES AN UNDERDRAIN SYSTEM.
2. 16 OZ/SY NONWOVEN GEOTEXTILE SHOWN IN DESIGN DOCUMENTS BUT NOT IN CQA DOCUMENTS.

SOURCES: "ENGINEERING DESIGN REPORT, RIVERBEND LANDFILL: MODULE 5, McMINNVILLE, OREGON," BY DAMES & MOORE, 22 FEBRUARY 1995; "SPECIFICATIONS, RIVERBEND LANDFILL MODULE 5, McMINNVILLE, OREGON," BY DAMES & MOORE, 6 APRIL 1995, REVISION 1 – 30 MAY 1995; AND "REPORT ON CONSTRUCTION QUALITY ASSURANCE, RIVERBEND LANDFILL, MODULE 5 CONSTRUCTION, McMINNVILLE, OREGON," BY GOLDER CONSTRUCTION SERVICES, INC., 8 SEPTEMBER 1995.

MODULES 8B & 8C



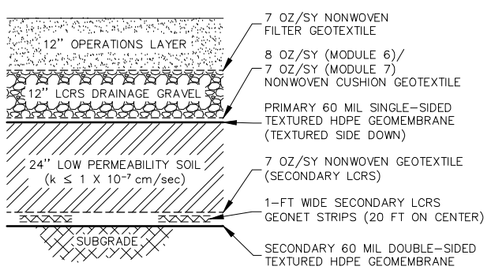
FLOOR LINER



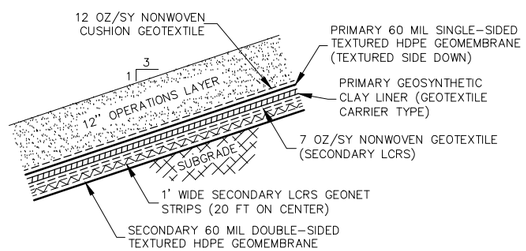
SIDESLOPE LINER

SOURCES: "CONSTRUCTION REPORT, MODULE 8B COMPOSITE LINER AND PHASE 2 OVERLINER CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY SHAW ENVIRONMENTAL, INC., SEPTEMBER 2005; "CONSTRUCTION REPORT, MODULE 8C AND PHASE 3 CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY KENNEC, INC., 4 OCTOBER 2007.

MODULES 6 & 7



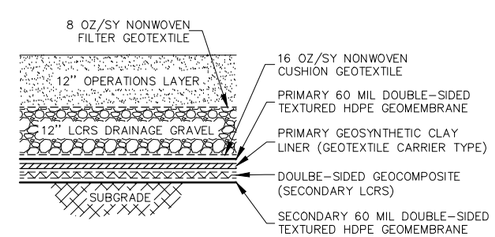
FLOOR LINER



SIDESLOPE LINER

SOURCES: "DESIGN REPORT, MODULES 6 AND 7 EXPANSION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY GEOSYNTEC CONSULTANTS, INC, 26 MARCH 1997; "REPORT OF CONSTRUCTION QUALITY ASSURANCE (CQA), MODULE 6 CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY GEOSYNTEC CONSULTANTS, INC., 30 SEPTEMBER 1997; "FINAL REPORT, CONSTRUCTION QUALITY ASSURANCE, MODULE 7 CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY GEOSYNTEC CONSULTANTS, INC., 7 OCTOBER 1998.

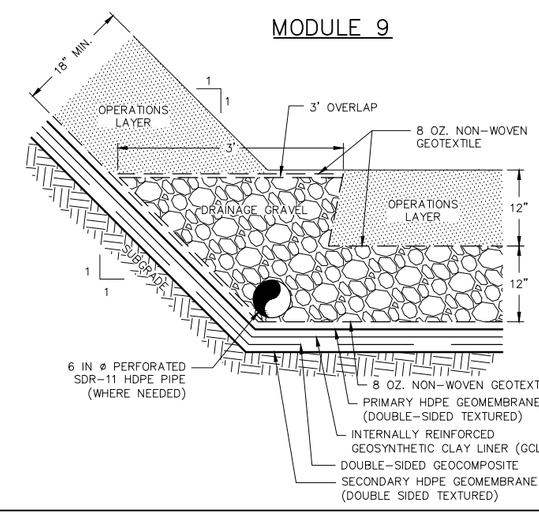
MODULE 8D



FLOOR & SIDESLOPE LINERS

SOURCES: "DESIGN REPORT, MODULE 8D AND PHASE 4 OVERLINER DESIGN REPORT, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY ENVIRONMENTAL INFORMATION LOGISTICS, LLC AND VISTA CONSULTANTS, LLC, MAY 2009; "CONSTRUCTION REPORT, MODULE 8D AND PHASE 4 OVERLINER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY VISTA CONSULTANTS, LLC, OCTOBER 2009.

MODULE 9



NOTES:

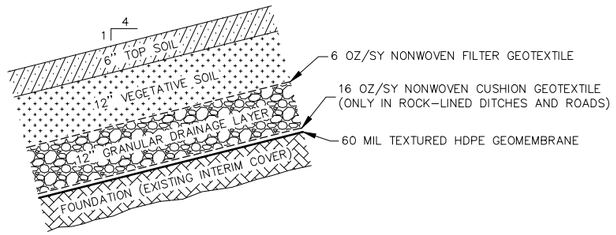
1. BASE CONTAINMENT SYSTEM INFORMATION FOR MODULES 1 AND 2 ARE NOT AVAILABLE.

2. MODULE 3 IS NOTED TO HAVE A 1-FT THCIK SOIL LINER (MAXIMUM PERMEABILITY OF 1 X 10^{-7} CM/SEC) OVERLAIN WITH A GEOTEXTILE, OVERLAIN WITH A 1-FT THICK GRAVEL LAYER, OVERLAIN WITH A GEOTEXTILE (SOURCES: "CONSTRUCTION REPORT, CONTRACT NO. 1, EXCAVATION PLAN, LINING PLAN, AND FLOOD CONTROL BERM EMBANKMENT, RIVERBEND SANITARY LANDFILL, YAMHILL, OREGON," BY SWEET-EDWARDS/EMCON, INC., 18 MAY 1990, AND 10 AUGUST 1993 FILE MEMO BY MARK SADLER OF EMCON, INCLUDED AS PART OF THE "RIVERBEND LANDFILL MODULE 4 CONSTRUCTION: DESIGN CLARIFICATIONS" LETTER FROM MARK SADLER OF EMCON NORTHWEST, INC. TO MONTY MORSHED OF THE OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY.

BASE CONTAINMENT SYSTEM DETAILS RIVERBEND LANDFILL McMINNVILLE, OREGON	Geosyntec consultants	
	FIGURE NO.	3
	PROJECT NO.	WG2423
	DATE:	OCTOBER 2017

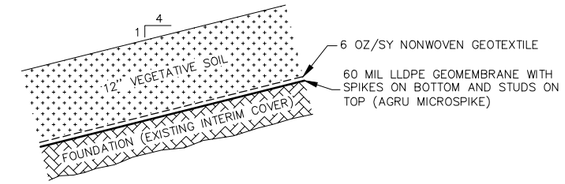
T:\projects\Geosyntec\Riverbend-Lateral Expansion\dwg\Final Closure\2423-Figure 3-4.dwg 11-02-17 neil

MODULES 1, 2, 3 SOUTH SLOPES
(1995 CLOSURE)



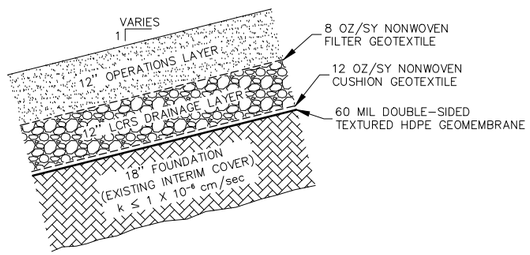
SOURCE: "CONSTRUCTION REPORT FOR CLOSURE OF MODULES 1, 2, AND 3, RIVERBEND LANDFILL," BY EMCON, 3 APRIL 1995.

MODULES 3, 4, 6 & 7 LOWER SLOPES
(2005 & 2006 CLOSURES)

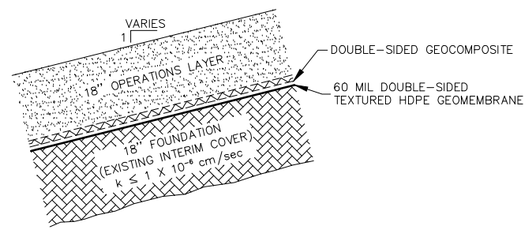


SOURCES: "CONSTRUCTION REPORT, 2005 CLOSURE FINAL COVER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY EMCON/OWT, INC., 20 DECEMBER 2005; "2006 FINAL CLOSURE DESIGN REPORT, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY GEOSYNTEC CONSULTANTS, INC., JUNE 2006; "CONSTRUCTION REPORT, 2006 FINAL COVER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY KENNEC, INC., APRIL 2007.

MODULES 1, 2, 3 NORTH SLOPE – PHASES 1A AND 1B OVERLINERS
(2003 & 2004 CLOSURES)



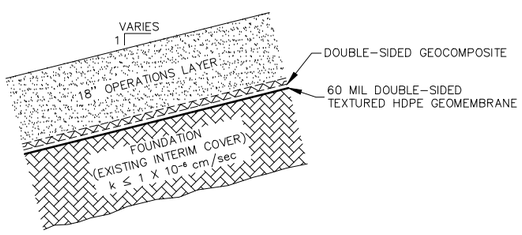
PHASE 1A OVERLINER



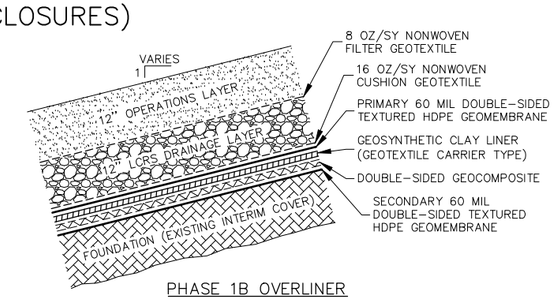
PHASE 1B OVERLINER

SOURCES: "CONSTRUCTION REPORT, PHASE 1A OVERLINER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY EMCON/OWT, INC., 11 NOVEMBER 2003; "CONSTRUCTION REPORT, PHASE 1B OVERLINER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY EMCON/OWT, INC., SEPTEMBER 2004.

MODULES 1, 2, 3 NORTH SLOPE – PHASES 2, 3, & 4 OVERLINERS
(2003 & 2004 CLOSURES)



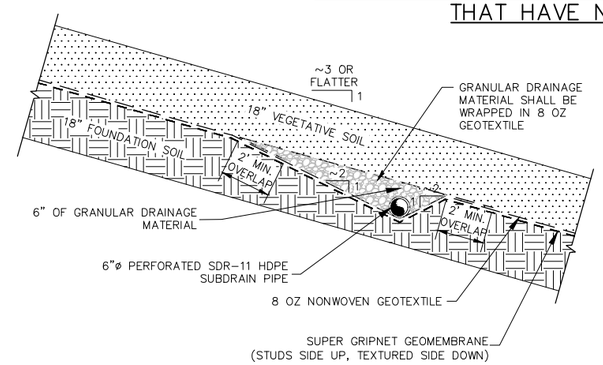
PHASES 2 & 3 OVERLINERS

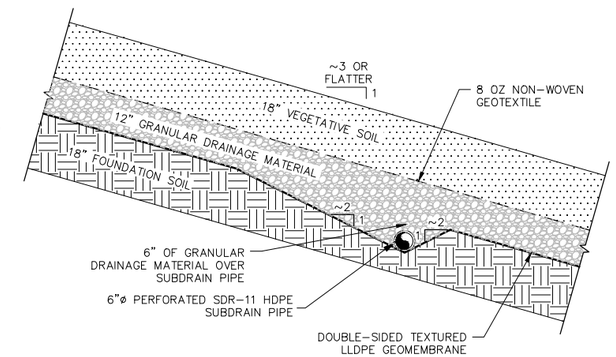


PHASE 1B OVERLINER

SOURCES: "CONSTRUCTION REPORT, MODULE 8B COMPOSITE LINER AND PHASE 2 OVERLINER CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY SHAW ENVIRONMENTAL, INC., SEPTEMBER 2005; "CONSTRUCTION REPORT, MODULE 8C AND PHASE 3 OVERLINER CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY KENNEC, INC., 4 OCTOBER 2007; "CONSTRUCTION REPORT, MODULE 8D AND PHASE 4 OVERLINER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY VISTA CONSULTANTS, LLC, OCTOBER 2009.

FINAL COVER ALTERNATIVES FOR AREAS OF LANDFILL THAT HAVE NOT BEEN CLOSED





NOTE: TWO FINAL COVER CONFIGURATIONS ARE PROPOSED FOR THE AREAS OF THE LANDFILL THAT HAVE NOT BEEN CLOSED. THE SELECTION OF THE CONFIGURATION WILL DEPEND ON THE RESULTS OF INTERFACE STRENGTH TESTS TO MEET THE STATIC AND SEISMIC SLOPE STABILITY REQUIREMENTS FOR THE SITE.

Geosyntec consultants

FINAL COVER AND OVERLINER SYSTEM DETAILS RIVERBEND LANDFILL McMINNVILLE, OREGON	FIGURE NO.	4
	PROJECT NO.	WG2423
	DATE:	OCTOBER 2017

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