

Ash Disposal Area Final Closure Plan Boardman Coal Plant

Prepared for:

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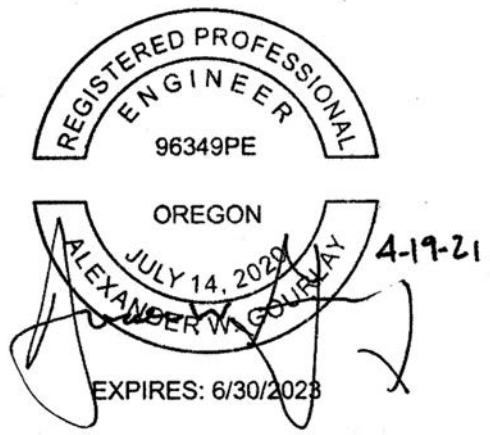
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Revision History

Revision	Revision date	Details	Authorized	Name	Position
Final	April 19, 2021	Revised Closure Plan based on Final Closure Design		Alexander W. Gourlay, PE	

Distribution List

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1. Introduction

AECOM Technical Services, Inc. (AECOM) has prepared this updated Closure Plan for the proposed closure of the Ash Disposal Area (ADA), an existing coal combustion residuals (CCR) landfill at the Boardman Coal Plant (BCP), near Boardman, Oregon, for Portland General Electric Company (PGE).

The initial Closure Plan for BCP (CH2M, 2015) was prepared by CH2M for PGE. PGE subsequently contacted AECOM in 2020 to prepare a final closure design and an update to the Closure Plan. For consistency and ease of reading, AECOM edited the initial Closure Plan rather than quote from it. AECOM acknowledges and incorporates by reference the CH2M origin work in this document and, by AECOM's certification, affirms any statements and conclusions in this document that may have been presented initially by CH2M (CH2M, 2015).

This Closure Plan is the final revision of the plan and describes the design of and construction activities involved in the closure-in-place of the ADA. The final design and the planned construction of the closure of the ADA is in accordance with the Regulatory Standards identified in Section 2 of this Closure Plan.

1.1 Site Description

PGE is the owner and operator of the BCP, a 617-megawatt, coal-fired power plant. The BCP is located adjacent to and to the north of the Carty Reservoir on Six Mile Canyon, approximately 12 miles south of the Columbia River and the town of Boardman, Oregon. The plant was constructed in the late 1970s and was placed into operation on August 3, 1980.

The ADA is an unlined ash disposal landfill, located just south of Carty Reservoir (Exhibit 1). The ADA is approximately 43 acres in size and is used for the disposal of surplus and off-spec fly ash and bottom ash materials generated by the BCP that are not otherwise beneficially used. The ADA has been in use for approximately 40 years.

The ADA was constructed as an incised landfill, where soil materials over the footprint of the landfill were excavated to create perimeter embankments (berms). The ash materials contained in the ADA extend to a maximum elevation of approximately 10 to 12 feet above the surrounding natural grade. The side slopes of the landfilled ash were constructed to an approximate 3:1 Horizontal:Vertical (H:V) slope.

The ADA operates under the Water Pollution Control Facilities permit (No. 100189) issued by the Oregon Department of Environmental Quality (DEQ). In accordance with the Water Pollution Control Facilities Permit, there is no storm water discharge from the ADA, and storm water is allowed to infiltrate into the ADA. Currently, the west end of the ADA serves as a detention basin for managing storm water run-off from within the unit limits.

The ADA is located on gently sloping ground with elevations ranging from 715 feet above mean sea level on the south end to 695 feet on the north end. The natural ground is "hummocky," which is typical of dune sand topography in this area. Dune sands are apparent today on the north end of the ADA.¹ The ADA is located in Section 33, Township 2 North, Range 24 East, just southwest of the City of Boardman, Oregon.

¹ Shannon & Wilson, Inc. 1979. *Geotechnical Investigation Ash Disposal Area Boardman Plant Unit #1*. September.

The BCP ceased coal combustion on October 16, 2020. Following cessation of coal-burning operations, final volumes of CCR stored within the plant will be transferred to the ADA with the final transfer occurring on April 9, 2021.



EXHIBIT 1. PGE Boardman Power Plant Site Map

2. Regulatory Standards for ADA Closure

The ADA Closure project falls under the jurisdiction of the Code of Federal Regulations (CFR) Title 40 – Protection of Environment, Chapter I – Environmental Protection Agency (EPA), Subchapter I – Solid Wastes, Part 257 – Criteria for Classification of Solid Waste Disposal Facilities and Practices, Subpart A – Classification of Solid Waste Disposal Facilities and Practices, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments (referred to herein as the CCR Rules). Specifically, the ADA will be closed-in-place by leaving the CCR in place and constructing an Alternative Final Cover in accordance with §257.102 of the CCR Rules.

2.1 Written Closure Plan – 40 CFR §257.102(b)(1)

The following is excerpted directly from the CCR Rules regarding content of the Closure Plan.

40 CFR § 257.102(b)(1). *Written Closure Plan – (1) Content of the Plan. The owner or operator of a CCR unit must prepare a written closure plan that describes the steps necessary to close the CCR unit at any point during the active life of the CCR unit consistent with recognized and generally accepted good engineering practices. The written closure plan must include, at a minimum, the information specified in paragraphs (b)(1)(i) through (vi) of this section.*

- (i) A narrative description of how the CCR unit will be closed in accordance with this section.*
- (ii) If closure of the CCR unit will be accomplished through the removal of CCR from the CCR unit, a description of the procedures to remove the CCR and decontaminate the CCR unit in accordance with paragraph (c) of this section.*
- (iii) If closure of the CCR unit will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with paragraph (d) of this section, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in paragraph (d) of this section.*
- (iv) An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit.*
- (v) An estimate of the largest area of the CCR unit ever requiring a final cover as required by paragraph (d) of this section at any time during the CCR unit's active life.*
- (vi) A schedule for completing all activities necessary to satisfy the closure criteria in this section, including an estimate of the year in which all closure activities for the CCR unit will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR unit, including identification of major milestones such as coordinating and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phase of CCR surface impoundment closure, or installation of the final cover system, and the estimate timeframes to complete each step or phase of CCR unit closure.*

2.2 Closure-In-Place Regulatory Performance Standards

As required by §257.102(b)(1)(ii and iii) of the CCR Rule, an identification of the type of closure selected (Closure-by-Removal or Closure-in-Place) and description of this closure shall be discussed in the written Closure Plan.

The ADA will be closed by leaving the CCR in place in accordance with the closure performance standards, as specified in §257.102(d)(1):

The owner or operator of a CCR unit must ensure that, at a minimum, the CCR unit is closed in a manner that will:

- 1. Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated runoff to the ground, surface waters or to the atmosphere.*
- 2. Preclude the probability of future impoundment of water, sediment, or slurry.*
- 3. Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during closure and post-closure care period.*
- 4. Minimize the need for further maintenance of the CCR unit.*
- 5. Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.*

3. Closure Plan - 40 CFR §257.102(b)(1)

The ADA will be closed by leaving the CCR in place in accordance with the closure performance standards, as specified in §257.102(d). The following subsections provide the details of the ADA, the closure design and planned construction of the closure of the ADA in accordance with the 40 CFR §257.102(b)(1) of the CCR Rules.

AECOM has prepared a written certification that the Closure Plan meets the requirements of §257.102(b)(4) of the CCR Rule. The certification has been included as Appendix A.

3.1 Closure Design Narrative - §257.102(b)(1)(i)

The following subsection provides a general narrative for closure of the ADA. The Construction Drawings, Construction Specifications, and Construction Quality Assurance Plan, provided as separate documents, provide details for design and construction activities identified in this section. The closure construction activities will include the following:

- Regrading and contouring of the CCR within the ADA;
- Modifications to the on-site storm water perimeter channels;
- Construction of a storm water outfall channel;
- Installation of a composite geosynthetic Alternative Final Cover system;
- Modifications to the existing perimeter access road; and
- Diversion and channelization of the storm water run-on flows.

3.1.1 ADA Regrading and Contouring

The regrading and contouring of the ADA were designed to minimize the required excavation of the existing CCR stored in the ADA and to achieve a near cut and fill balance. The perimeter slopes were flattened to a 4:1 horizontal to vertical (H:V) slope and top slopes of the ADA were contoured to achieve a minimum top slope of approximately 1.0 percent, as shown on Figures 1 and 2. The contouring of the top of the ADA will result in storm water run-off, in all directions, that will be captured and conveyed in a perimeter storm water conveyance channel as described in the following sections of this Closure Plan.

3.1.2 On-Site Storm Water Perimeter Channels

The current configuration of the ADA includes perimeter storm water conveyance channels (v-ditches) at the toe of the perimeter 3:1 H:V slope along the upstream side of the perimeter containment berms. The existing perimeter storm water v-ditches will be excavated to increase the channel slope and create a trapezoidal channel section that will contain the storm water design flow, as described in the following sections of this Closure Plan, and include a minimum of one (1) foot of dry freeboard. The perimeter storm water conveyance channel consists of two (2) channel segments that originate at the southeast corner of the ADA. One channel segment conveys storm water along the east side of the ADA, along the north side of the ADA, along a portion of the west side of the ADA, and ultimately into the outfall channel. The second channel segment conveys storm water along the south side of the ADA, along a portion of the west side of the ADA, and ultimately into the outfall channel. At the outfall channel location, the two channel segments converge into a flat channel section (stilling basin). On-site storm water run-off is discharged from the ADA at the outfall location and allowed to return to a natural sheet flow regime, where the storm water will infiltrate into the natural soils and/or flow into Carty Reservoir.

3.1.3 On-Site Storm Water Outfall

The storm water outfall will be constructed by excavating into the perimeter berm down to the elevation of the storm water conveyance channel invert. The excavation of the perimeter berm will create an access road channel crossing. The access road at the outfall location will be armored with a concrete pavement to provide a stable driving surface for vehicles. The outfall has a bottom width of 30 feet, and 10 percent side slopes to accommodate vehicle traffic through the outfall channel. Storm water routed through the outfall channel will transition to natural surrounding grade as sheet flow, as described above. Minor soil filling and regrading on the downstream side of the perimeter berm at the northwest corner of the ADA will prevent storm water run-off from being routed along the toe of the ADA perimeter berm.

3.1.4 Perimeter Access Road

The alignment of the existing perimeter access road will not be changed as part of the ADA closure. The existing access road is situated on top of the perimeter berm around the ADA and is approximately 20 feet in width. The existing perimeter berms were constructed using soil materials excavated from the bottom of the ADA and serve as containment berm for the CCR contained in the ADA. The perimeter berms are elevated above the surrounding grade and vary in height from approximately one (1) to five (5) feet above the surrounding grade elevation. The Alternative Final Cover system will be anchored into the perimeter berm. Additionally, a layer of aggregate base materials will be deployed on the access road to provide a stable driving surface. As previously discussed, the perimeter berm on the west side of the ADA will be excavated to accommodate the outfall channel.

3.1.5 Off-Site Storm Water Diversion

The off-site storm water flow direction is from south to north. Therefore, the off-site storm water along the west, east and north sides of the ADA is flowing adjacent to or away from the ADA. With the existing elevated perimeter berms, the off-site stormwater along the east and west sides of the ADA is adequately diverted from running on to the ADA. There is a small contributing watershed to the south of the ADA. Storm water generated from this watershed currently accumulates along the south side of the ADA in a low-lying area. The closure design includes a small diversion channel on the south side of the ADA that provides a drainage path for the low-lying area. Additionally, the elevated perimeter berm prevents storm water originating from the southern watershed area from running on to the ADA.

3.2 Closure Type: Closure-in-Place - §257.102(b)(1)(ii or iii)

The closure type selected for the ADA is to leave the CCR in place in accordance with the provisions of §257.102(b)(1)(iii) and to install an Alternative Final Cover system in accordance with the provisions of §257.102(d)(3)(ii). The design, performance equivalency, and procedures for installation of the cover system are described in Section 3.7.

3.3 Maximum CCR Inventory - §257.102(b)(1)(iv)

The ADA was originally designed with an estimated maximum airspace for CCR of roughly 838,000 cubic yards (cy). However, the ADA has not been filled to the maximum airspace and the last CCR material is expected to be placed within this CCR unit sometime in April 2021. The current estimate of CCR is expected to be the maximum inventory of CCR within the ADA and is based on the PGE Coal Combustion Residuals Landfill Annual Inspection Report dated December 2020 (PGE 2020). According to PGE, the total CCR placed within the ADA is expected to be approximately 796,146 cy. The details of these estimates are provided in the Annual Inspection Reports (PGE 2020).

3.4 Estimate of Largest Area of Required Closure - §257.102(b)(1)(v)

The estimated largest area of Ash Disposal Area that would require final cover at any time during the active life of the landfill if the site was closed is approximately 43 acres. Figure 1 shows a site plan with the final closure cover grades and stormwater features. This acreage corresponds to the maximum area of the site planned for waste fill, which is the landfill footprint currently in use.

3.5 Schedule of ADA Closure - §257.102(b)(1)(vi)

The ADA will be closed in place using an Alternative Final Cover system by completing the following general steps by the completion dates provided in Table 1: Schedule of Closure Activities

Table 1 Schedule of Closure Activities

	Closure Activity	Estimated Completion Date
1.	Mass Grading of ADA	2 nd Quarter of 2021
2.	Final Cover Installation	3 rd Quarter of 2021
3.	Completion of Closure	3 rd Quarter of 2021

3.6 Closure-In-Place Design Performance

The applicable closure performance standards for Closure-in-Place of a CCR Unit are specified in §257.102(d)(1):

1. *Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated runoff to the ground, surface waters or to the atmosphere.*
2. *Preclude the probability of future impoundment of water, sediment, or slurry.*
3. *Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during closure and post-closure care period.*
4. *Minimize the need for further maintenance of the CCR unit.*
5. *Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.*

The deposition of the CCR within the ADA or other waste material will have ceased by April 2021, which will be followed by the grading of the ADA into the final configuration and placement of an Alternative Cover System. The final grading design of the ADA described in Section 3.1 and the use of an Alternative Cover System satisfy all five of the performance standards of §257.102(d)(1). The final geometry sheds water off the final cover and away from the ADA. The Alternative Final Cover includes a geomembrane infiltration layer, which will control post-closure infiltration into the ADA, with a permeability that is lower than the base of the ADA. The final configuration consists of outside slopes not steeper than 4:1 (horizontal to vertical), creating a stable final geometry for the placement and long-term integrity of the final cover. The use of an engineered synthetic turf with a sand infill provides protection from water and wind erosion and ultraviolet (UV) exposure of the underlying geomembrane layer. Finally, the use of an engineered synthetic turf reduces maintenance of the closed ADA by eliminating the need for re-

seeding and irrigation for cultivating vegetation growth. The application of this Alternative Final Cover System for the closure of the ADA uses conventional construction techniques and allows a relatively brief closure construction schedule, as summarized in Section 3.5.

3.7 Final Cover System

The closure of the ADA will include an Alternative Final Cover as allowed by §257.102(d)(3)(ii) of the CCR Rule. The Alternate Final Cover consist of a ClosureTurf® cover system, which is a patented multi-layer cover system that consists of the following components, from bottom to top:

- A 60-mil high-density polyethylene (HDPE) textured geomembrane
- An engineered synthetic turf material
- An engineered sand infill

The ClosureTurf® will be constructed over the prepared subgrade. The geomembrane materials are specified as a double-sided textured geomembrane (MicroSpike®). The engineered turf materials consist of an artificial turf material integrated with geotextile base materials. The geotextile base materials provide tensile strength to the engineered turf and provide support for the sand infill. The sand infill consists of a clean sand material in general accordance with the requirements of ASTM C33 fine aggregate.

The installation of the ClosureTurf® cover system includes the deployment of the underlying geomembrane materials, which are fusion seamed and anchored within a perimeter anchor trench. As the geomembrane materials are deployed, the installation of the engineered turf material and sand infill follow closely behind. The engineered turf materials are either fusion seamed or sewn together. The geomembrane and engineered turf materials are temporarily ballasted using sandbags until the sand infill is deployed. The sand infill is broadcast spread over the engineered turf materials and then consolidated into the engineered turf using power brooms resulting in a minimum ½-inch layer of sand infill.

3.7.1 Alternative Final Cover System Equivalency

According to the CCR Rules (40 CFR §257.102(d)(ii)), the Alternative Final Cover System of a CCR unit shall be designed to minimize infiltration and erosion and must satisfy the following three criteria:

1. Include an infiltration layer that achieves an equivalent reduction in infiltration to the prescriptive final cover infiltration layer; which would consist of a minimum 18-inches of earthen material with permeability less than or equal to the permeability of any bottom liner or natural subsoil, or a permeability of 1×10^{-5} centimeters per second (cm/s), whichever is less.
2. Include an erosion layer that provides an equivalent protection from wind or water erosion to the prescriptive final cover design of 6-inches of earthen material that is capable of sustaining plant growth.
3. Be capable of accommodating settling and subsidence (displacement movement) to minimize disruption of integrity of the final cover system.

The selected Alternative Final Cover System of ClosureTurf® provides an infiltration layer with lower permeability than the base soils and an erosion protection layer that protects the underlying geomembrane layer.

The HDPE geomembrane of the ClosureTurf® system satisfies the regulatory requirement for a low-permeability cover material because it is significantly less permeable than the natural soil subgrade of the ADA:

- Shannon & Wilson (1979) reported that the subgrade of the ADA predominantly consisted of loess (silty sand) and dune sand materials, ranging in dry density from 80.9 pounds per cubic feet (pcf) to 97.6 pcf, with an average of 87.8 pcf.
- The United States Bureau of Reclamation (USBR) in its Engineering Monograph Number 28, "*Petrographic and Engineering Properties of Loess*," dated November 1960 (USBR 1960), indicates that, at dry densities ranging from 100 to 80 pcf, the permeabilities of loess may range from 10 to 1000 feet per year, equivalent to approximately 1×10^{-5} to 1×10^{-3} cm/s.
- Therefore, the subgrade of the ADA was assigned a permeability of 1×10^{-5} cm/s, which is the lower end of range from USBR and, coincidentally, the minimum allowable subgrade permeability identified in the CCR Rule for purposes of infiltration layer equivalency demonstration.
- A leakage rate calculation for an HDPE geomembrane with an assumed number of holes (defects) of one per acre was performed, resulting in a calculated leakage rate of 3.6×10^{-6} cm/s.

Therefore, since the leakage rate through just one component (the geomembrane) of the ClosureTurf® system alternative liner is *less* than the estimated permeability of the natural soil subgrade, Criterion 1 is satisfied.

The engineered turf and sand infill materials of the ClosureTurf® system protect the geomembrane from damage caused by storm water erosion, wind erosion, wind uplift, and UV radiation exposure. Therefore, Criterion 2 is satisfied.

3.7.2 Final Cover System Stability and Integrity

The integrity of the cover system was evaluated for settlement and tangential sliding along slopes and while loaded with moving vehicles (veneer stability check). The durability of the ClosureTurf®, the uppermost layer, which will be exposed to UV, was evaluated through UV exposure aging and strength testing. These testing results along with information from review of literature review were evaluated and reported in a white paper by Geosyntec dated May 15, 2015 (Geosyntec 2015), which is available on the WatershedGeo website. The ClosureTurf® material is estimated to retain half of the as-manufactured strength for at least 176 years.

As indicated that steepest slopes for the final closed configuration of the ADA are 4H:1V and the liner materials include asperities that provide additional frictional strength of liner interfaces. The liner materials are also tolerable to large strains, however only small displacements from settlement are expected during post-closure period of the ADA. Therefore, Criterion 3 is satisfied.

AECOM has prepared a written certification that the design of the ClosureTurf® cover system meets the requirements for Alternative Final Cover as defined in §257.102(d)(iii) of the CCR Rule. The certification has been included as Appendix A.

4. Limitations

AECOM makes no performance representations on the ClosureTurf® system and any representations and associated warranties are from the manufacturer.

5. References

Code of Federal Regulations (CFR) Title 40 – Protection of Environment, Chapter I – Environmental Protection Agency (EPA), Subchapter I – Solid Wastes, Part 257 – Criteria for Classification of Solid Waste Disposal Facilities and Practices, Subpart A – Classification of Solid Waste Disposal Facilities and Practices, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments

Coal Combustion Residual Landfill at Boardman Generation Facility: Unstable Area Analysis” dated October 3, 2018, by CH2M (CH2M, 2018)

Geotechnical Investigation, Ash Disposal Area, Boardman Plant Unit #1, Morrow County, Oregon (Shannon & Wilson, 1979)

Closure Plan – Ash Disposal Area – PGE Boardman Power Plant, (CH2M, September 2015)

Boardman Coal Plant Ash Disposal Area Issued for Construction Drawings, dated January 2021, by AECOM

Construction Specifications Boardman Coal Plant Ash Disposal Area Closure, Revision: Issued for Construction, dated January 15, 2021, by AECOM

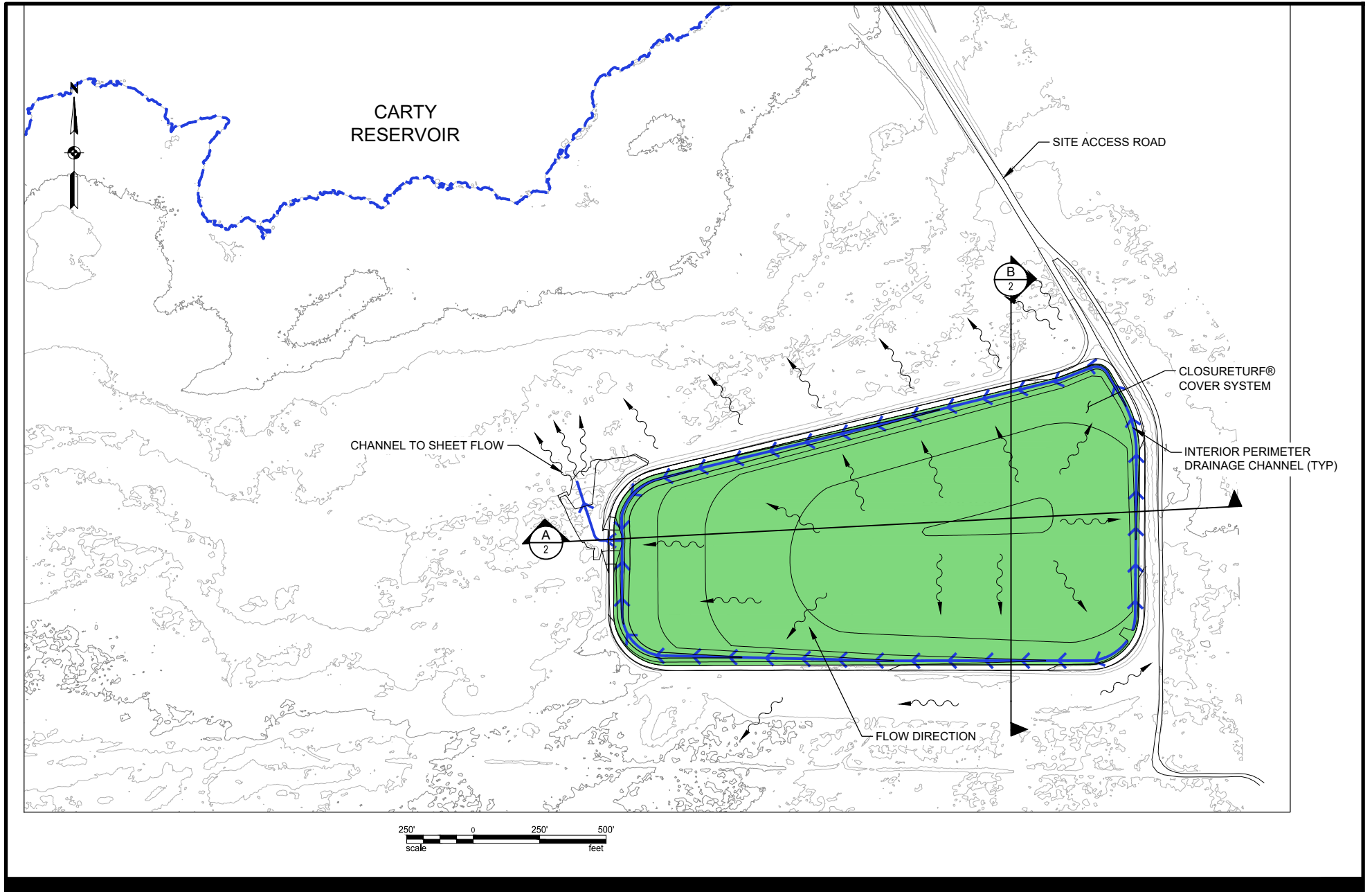
Construction Quality Assurance Plan Boardman Coal Plant Ash Disposal Area Closure, Revision: Issued for Construction, dated January 15, 2021, by AECOM

PGE Coal Combustion Residuals Landfill Annual Inspection Report, dated December 2020

Literature Review and Assessment of ClosureTurf® UV Longevity, Letter May 15, 2015, by Geosyntec Consultants (Geosyntec 2015)

“Petrographic and Engineering Properties of Loess,” Engineering Monograph Number 28, dated November 1960, by The United States Bureau of Reclamation (USBR 1960)

Figures

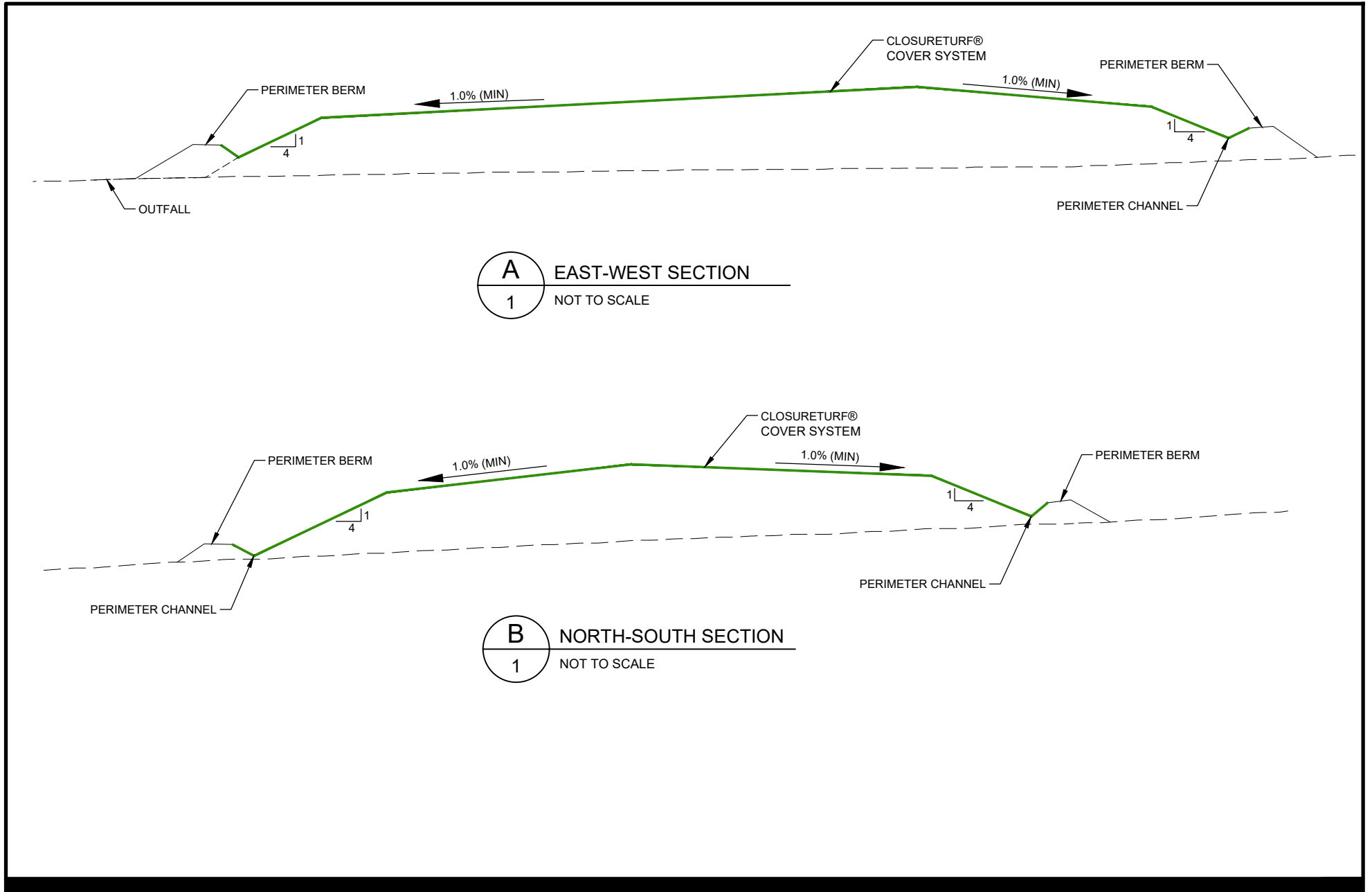


**BOARDMAN ADA
CLOSURE DESIGN**
PORTLAND GENERAL ELECTRIC, BOARDMAN, OR
60629868
Date: 2021-02-05

**BOARDMAN ADA
GRADING AND STORMWATER PLAN**



Figure: 1

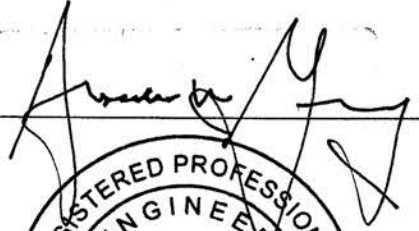


Appendix A

CERTIFICATION OF THE CLOSURE PLAN
Boardman Power Plant
Ash Disposal Area
[40 C.F.R. § 257.102(b)(4)]

I, Alexander Gourlay, being a Registered Professional Engineer in the State of Oregon, do hereby certify to the best of my knowledge, information, and belief, that, in accordance with the requirements of 40 C.F.R. § 257.102(b)(4), the Ash Disposal Area Closure Plan, dated April 19, 2021, meets the requirements of 40 C.F.R. § 257.102.

SIGNATURE _____



DATE _____

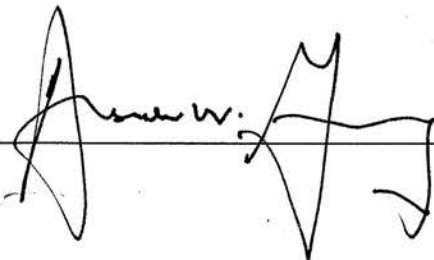
April 19, 2021



EXPIRES: 6/30/2023

CERTIFICATION OF DESIGN OF THE FINAL COVER SYSTEM
Boardman Power Plant
Ash Disposal Area
[40 C.F.R. § 257.102(d)(3)(iii)]

I, Alexander Gourlay, being a Registered Professional Engineer in the State of Oregon, do hereby certify to the best of my knowledge, information, and belief, that, in accordance with the requirements of 40 C.F.R. § 257.102(d)(3)(iii), the design of the final cover system, as included in the Ash Disposal Area Closure Plan, dated April 19, 2021, meets the requirements of 40 C.F.R. § 257.102.

SIGNATURE 

DATE 4-19-21



