Coal Combustion Residuals Landfill
Liner Documentation for Landfill Expansion

Antelope Valley Station Landfill

Prepared for
Basin Electric Power Cooperative

May 2022

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Certifications

I hereby certify that I have or my agent has examined the facility and, being familiar with the provisions of 40 CFR 257 Subpart D, attest that this Coal Combustion Residuals landfill expansion design of the liner system and leachate collection and removal system is in accordance with good engineering practice, including consideration of applicable industry standards. I certify that the liner system and leachate collection and removal system design meets the requirements of 40 CFR § 257.70.

REGISTERED PROFESSIONAL ENGINEER
Seth W. Hueckman
PE-10057
DATE 05/27/2022
NORTH DAKOTA

Seth W. Hueckman
Barr Engineering Co.
ND Registration Number PE-10057

Dated this 27th day of May 2022

Seth W. Hueckman

Digitally signed by Seth W. Hueckman
Date: 2022.06.01 09:24:18 -05'00'

1 Introduction

Antelope Valley Station (AVS) is a lignite coal-fired power plant consisting of two units that generate about 900 megawatts (MW) combined. The power plant, owned and operated by Basin Electric Power Cooperative (Basin Electric), is located approximately eight miles northwest of Beulah in Mercer County, North Dakota. Coal ash from AVS is disposed at the Section 7 Landfill, regulated as a coal combustion residuals (CCR) landfill under Permit No. 0160 issued by the North Dakota Department of Environmental Quality (NDDEQ). CCR management is subject to Federal Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments per 40 CFR 257 Subpart D.

The existing landfill was first permitted by the North Dakota Department of Health, now NDDEQ, for solid waste disposal in 1995. The existing landfill currently consists of four cells, Cells 1-4. The first phase of liner construction was completed in 1996 and the final phase of the existing landfill liner was completed in 2015. Future Cells 5-8 are a lateral expansion to the existing landfill. The existing landfill and lateral expansion are considered to be one CCR unit (Cells 1-8). This CCR landfill certification report has been developed to satisfy the requirements of 40 CFR § 257.70, liner design and leachate collection and removal system design criteria for a CCR landfill lateral expansion, as they apply to the lateral expansion (Cells 5-8) of the existing CCR landfill. The lateral expansion will be a composite lined facility with a compacted clay liner overlain by geomembrane liner.

2 Liner System Design

The landfill lateral expansion composite liner system is configured as follows (from the top down):

- 12-inch drainage layer or geocomposite;
- 60-mil high density polyethylene (HDPE) geomembrane barrier layer; and
- 2-foot compacted clay barrier layer

3 Liner System and Leachate Collection and Removal System Performance

The composite liner and leachate collection and removal system design meet the requirements of 40 CFR § 257.70(a) and subsequently 40 CFR § 257.70(b) & (c) as described below:

(b) A composite liner must consist of two components; the upper component consisting of, at a minimum, a 30-mil geomembrane liner (GM), and the lower component consisting of at least two-foot layer of compacted soil with a hydraulic conductivity of no more than 1 x 10^-7 centimeters per second (cm/sec). GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. The GM or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner.

The lateral expansion composite liner system includes a 60-mil HDPE geomembrane layer overlying and in direct and uniform contact with a 2-foot (minimum) compacted clay barrier layer. The clay barrier layer will be compacted and will achieve a hydraulic conductivity of no more than 1 x 10^-7 cm/sec. Construction quality testing will be performed in accordance with the Construction Quality Assurance Manual (Barr, 2021a) and documented in the construction documentation report.

The composite liner must be:

(b)(1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeological forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of operation;

The 60-mil HDPE geomembrane component of the composite liner system meets the geomembrane liner requirements prescribed in the rule. The literature and manufacturer's data on chemical compatibility demonstrate acceptability of HDPE geomembranes for lining of CCR landfills.

(b)(2) Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component including on the slopes;

The geomembrane barrier layer will be installed above stable 3 horizontal to 1 vertical side slopes (maximum). A dual-sided textured geomembrane will be utilized on the side slopes to improve stability of the geomembrane/clay interface and geomembrane/drainage layer interface. The geomembrane liner is designed to be a tensionless member with the overlying drainage materials as the interface friction angle of the geomembrane/drainage layer (both granular drainage material and geocomposite) is smaller than the geomembrane/clay liner interface strength. Prior to becoming covered and buttressed with waste fill, the granular drainage layer may be susceptible to erosion down the geomembrane interface during intense rain events. If such an event occurs, the drainage layer will be re-graded to a minimum of 12 inches prior to placing overlying waste materials to maintain the landfill design intent.

(b)(3) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

An unstable areas demonstration was prepared for the existing landfill in 2018 and the landfill expansion area in 2022 and the CCR landfill was determined to not be located in an unstable area (Barr, 2022). The landfill expansion will be constructed over mine spoils as is the case with the existing landfill. The spoils and groundwater conditions were examined and evaluated during the site investigation and included in the Site Characterization Report (Barr, 2021b). The findings indicate that the conditions are similar to those observed during the study and operation of the existing landfill. The potential for settlement was evaluated and found to be negligible based on observed conditions. Groundwater is not present within the spoil minimizing the potential for consolidation from dissipation of pore pressure following additional loading from the landfill. A sensitivity analysis was carried out and included in the Engineering Report

(Barr, 2021c); the calculations indicated a maximum potential settlement of 6 to 8 inches below the highest portion of the landfill.

The landfill width approaches 2,300 feet and the maximum settlement would be expected to occur below the highest point of the landfill along the north-south centerline of the landfill. The maximum strain across the half-width (approximately 1,150 feet) is less than 0.1 percent across the liner and drainage layer. Any observed deformation is not expected to adversely impact the geomembrane liner, drainage system, and flow gradient. Furthermore, the 2-foot-thick clay liner is constructed of material that is capable of undergoing plastic deformation rather than brittle deformation (i.e., tensile cracking). Therefore, if settlement occurs during loading, the clay liner is expected to self-heal and remain a continuous barrier. Additionally, the estimated settlement is less than the clay liner thickness which could accommodate deformation. However, the subsurface investigation did not identify conditions that suggest differential settlement is likely.

(b)(4) Installed to cover all the surrounding earth likely to be in contact with the CCR or leachate.

The composite liner system will be constructed to the top of the perimeter embankments. The landfill expansion will be constructed in four cells with a cell separation berm at the leading edge. The composite liner will terminate at locations where it will be joined to future lined areas. The cell separation berm and temporary geomembrane flap are designed to allow for easy attachment of new construction composite liner system to the existing composite liner system of the previous phase while maintaining CCR and leachate containment in the existing cell.

All ash and ash-contact surface water will be contained within the lined areas of the landfill and leachate pond. Ash-contact water and leachate generated from the landfill expansion will be controlled within the lined limits of the landfill. Surface run-off will be intercepted in perimeter ditches within the lined landfill limits and directed into the leachate collection system as described in the Run-on and Run-off Control System Plan (Barr, 2021d).

The leachate collection and removal system must be:

(d)(1) Designed and operated to maintain less than a 30-centimeter depth of leachate over the composite liner or alternative composite liner;

The leachate collection system in combination with the base composite liner has been designed to collect and convey leachate from each landfill expansion cell to the collection sumps, which is then pumped to the leachate pond. The granular drainage layer or geocomposite drains leachate to the perforated leachate collection pipes installed in the leachate collection trenches. To protect the pipes from damage, to prevent migration of fine particles into the drain pipes, and to provide increased flow performance, the pipes are embedded in drainage aggregate above a geotextile or geocomposite cushion layer and covered with a fine filter aggregate or geosynthetic filter layer. The granular drainage layer or geocomposite also functions as a protective layer to prevent equipment from damaging the geomembrane liner. The sumps incorporate a side-slope riser pumping system to eliminate piping penetrations of the landfill liner at the base.

The system has been designed to limit hydraulic head on the liner system to not more than 1 foot by limiting the leachate flow distances along the base of the landfill expansion cells to a maximum of 330 feet in combination with the specified hydraulic conductivity of the granular drainage layer (or geocomposite) and the 2-percent minimum liner slope to the leachate collection trench. The Hydrologic Evaluation of Landfill Performance (HELP) model was used to calculate the estimated leachate head levels for various landfill conditions (Barr, 2021c).

(d)(2) Constructed of materials that are chemically resistant to the CCR and any non-CCR waste managed in the CCR unit and the leachate expected to be generated, and of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste, waste cover materials, and equipment used at the CCR unit; and

The leachate collection pipes on the bottom of the landfill expansion will consist of 8-inch-diameter, perforated, SDR11 HDPE pipe. The sump manifold piping system and side slope riser pipes extending up from each sump will consist of 20-inch-diameter SDR11 HDPE pipe. The literature and manufacturer's data on chemical compatibility demonstrate acceptability of HDPE piping for CCR landfills.

Pipe strength computations show pipe deflection for the 8-inch collection pipes was calculated to be 1.7 percent (5 percent maximum for non-pressurized HDPE pipe). The factor of safety for buckling on the 8-inch pipes was calculated to be 5.6. The factor of safety for wall crushing on the 8-inch lateral pipes was calculated to be 1.7. Pipe deflection for 20-inch HDPE pipe was calculated to be 2.03 percent (5 percent maximum for non-pressurized HDPE pipe). The factor of safety for buckling on the 20-inch pipe was calculated to be 7.3. The factor of safety for wall crushing on the 20-inch pipe was calculated to be 2.3 (Barr, 2021c).

(d)(3) Designed and operated to minimize clogging during the active life and post-closure care period.

As discussed in (d)(1), the leachate collection system in combination with the base composite liner has been designed to collect and convey leachate from each landfill expansion cell to the collection sumps, which is then pumped to the leachate pond. The granular drainage layer or geocomposite drains leachate to the perforated leachate collection pipes installed in the leachate collection trenches. To protect the pipes from damage, to prevent migration of fine particles into the drain pipes, and to provide increased flow performance, the pipes are embedded in drainage aggregate above a geotextile or geocomposite cushion layer and covered with a fine filter aggregate or geosynthetic filter layer. Geotextile or geocomposite will be placed in the leachate collection pipe trenches. A layer of drainage aggregate, 3 inches thick minimum, will be placed above the geotextile or geocomposite in the trench and the pipe then placed and aligned. The remaining drainage aggregate will be placed after the pipe is fully installed. A fine filter material or geosynthetic filter layer will be placed between the drainage aggregate and overlying drainage layer material or waste to provide a filter to limit migration of particles that might otherwise clog the collection pipe.

4 Summary and Conclusion

The purpose of this report is to document the liner type and leachate collection and removal system design for the lateral expansion at AVS. Based on the design information, the lateral expansion liner and leachate collection and removal system meets the requirements for a composite liner and leachate collection system as required by 40 CFR § 257.70.

5 References

Barr, 2021a. Coal Combustion Residuals Landfill, Construction Quality Assurance Manual, Antelope Valley Station Landfill, April 2021.

Barr, 2021b. Coal Combustion Residuals Landfill, Site Characterization Report, Antelope Valley Station Landfill Expansion, April 2021.

Barr, 2021c. Coal Combustion Residuals, Engineering Report, Antelope Valley Station Landfill Lateral Expansion, April 2021.

Barr, 2021d. Coal Combustion Residuals Landfill, Run-on and Run-off Control System Plan, Antelope Valley Station Landfill, October 2021.

Barr, 2022. Coal Combustion Residuals Landfill, Location Restrictions Demonstrations, Antelope Valley Station Landfill Lateral Expansion, March 2022.