LINER DESIGN DOCUMENTATION AND CERTIFICATION

LINER DESIGN DOCUMENTATION AND CERTIFICATION

Ash Pond 91 CCR Surface Impoundment
Coal Creek Station
Great River Energy

Submitted To: Great River Energy
Coal Creek Station
2875 Third Street SW
Underwood, North Dakota 58576

Submitted By: Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, Colorado 80228

October 13, 2016 **1649586**

Golder Associates

Table of Contents

1.0 INTRODUCTION

This report presents documentation and certification of the liner design for the Ash Pond 91 CCR Surface Impoundment (Ash Pond 91) at Great River Energy's (GRE) Coal Creek Station (CCS). The Ash Pond 91 System at CCS is an existing (i.e. received coal combustion residuals both before and after October 14, 2015) coal combustion residual (CCR) surface impoundment. This report addresses the requirements of 40 CFR Section 257.71 (§257.71), Liner Design Criteria for Existing CCR Surface Impoundments.

Coal Creek Station is located in McLean County, approximately 10 miles northwest of Washburn, North Dakota. The lined Ash Pond 91 footprint compromises approximately 75 acres, and is used as a combined dewatering and storage facility for CCRs including fly ash, bottom ash, and flue-gas desulfurization (FGD) material.

2.0 SUMMARY OF LINER DESIGN CRITERIA

A composite liner system was installed over a majority of Ash Pond 91 (approximately 68 acres) in 1993. In 2015, a permit modification was approved allowing for the installation of a composite liner between Ash Pond 91 and the adjacent Upstream Raise CCR Surface Impoundment (Upstream Raise). Construction associated with this design/permit change began in the summer of 2015 and the composite liner between Ash Pond 91 and the Upstream Raise was completed in 2016.

Regulation §257.71(a)(1) requires documentation that each existing CCR surface impoundment is constructed with one of the following liner systems.

- A liner consisting of a minimum of 2 feet of compacted soil with a hydraulic conductivity of no more than $1x10^{-7}$ centimeters per second (cm/sec).
- A composite liner that meets the requirements of §257.70(b), consisting of:
  - An upper component composed of at least a 30-mil geomembrane liner (GM) or 60-mil if using high density polyethylene (HDPE) installed in direct and uniform contact with the compacted soil or lower liner component, and
  - A lower component consisting of at least a 2-foot layer of compacted soil with a hydraulic conductivity less than or equal to $1x10^{-7}$ cm/sec.
- An alternative composite liner that meets the requirements of §257.70(c), consisting of:
  - An upper component composed of at least a 30-mil geomembrane liner (GM) or 60-mil if using high density polyethylene (HDPE) installed in direct and uniform contact with the compacted soil or lower liner component, and
  - A lower component, that is not a GM, with a liquid flow rate no greater than the liquid flow rate of 2 feet of compacted soil with a hydraulic conductivity of less than or equal to $1x10^{-7}$ cm/sec.

Additionally, composite liners and alternative composite liners must meet the following criteria regarding compatibility, engineering properties and installation, outlined in §257.70(b):

- 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 hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;
- Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component including on slopes;
- 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
- Installed to cover all surrounding earth likely to be in contact with the CCR or leachate.

3.0 ASH POND 91 LINER EVALUATION

The liner components for the composite liner installed in 1993 and the composite liner completed in 2016 are discussed in more detail below.

3.1 Ash Pond 91 Liner (1993 Construction)

Ash Pond 91 was lined in 1993 with a liner system consisting of an upper component of 40-mil thick HDPE geomembrane liner and the lower component consisting of a minimum of 2 feet of compacted clay. Design and technical specifications for the composite liner of Ash Pond 91 CCR Surface Impoundment are contained in the Cooperative Power Association Final Construction Report – Evaporation Pond 93 and Ash Pond 91 (CPA 1993).

Clay fill was placed a minimum of 2 feet thick in horizontal loose lifts of no more than 7 inches in thickness and compacted to above the optimum moisture content and to at least 95% maximum density as determined from a Standard Proctor (CPA 1993). The thickness of the clay liner was surveyed to confirm that a minimum of 2 feet of material was placed. Testing conducted on the clay liner during construction consisted of grain size distribution, Proctor compaction curves, Atterberg limits, and field density and moisture testing. Field density measurements ranged between 95% and 100%.

Both “brown” clay borrowed from the CCS site and “gray” clay borrowed from the Falkirk mine were used to construct the clay liner over Ash Pond 91. Field hydraulic conductivity testing of the clay liner materials provided a range in hydraulic conductivity results between 4.8×10^{-9} cm/sec and 1×10^{-7} cm/sec (CPA 1993). The “brown” clay samples had maximum densities of between 95 pounds per cubic foot (pcf) and 114 pcf, with optimum moisture contents between 14% and 27%. The “gray” clay samples had maximum densities of between 98 pcf and 102 pcf, with optimum moisture contents between 16% and 24%.

The composite liner system of Ash Pond 91 installed in 1993 meets and exceeds liner requirements outlined in §257.71(a)(1)(i). In addition to complying with the requirement to have a minimum of 2 feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec, the liner system has a 40-mil HDPE geomembrane liner in direct contact with the compacted clay layer.

3.2 Ash Pond 91 Liner (2016 Construction)

An additional 7 acres of composite liner was installed in the southeast corner of Ash Pond 91 and in the area between Ash Pond 91 and the Upstream Raise in 2016. The liner completes a continuous composite-lined area between Ash Pond 91 and the Upstream Raise.

The composite liner system installed in 2016 consists of (from bottom to top):

- Geosynthetic clay liner (GCL)
- 60-mil HDPE geomembrane liner

Design and technical specifications for the composite liner of Ash Pond 91 are contained in the 2016 Ash Pond 91 Upstream Raise Construction specifications (Golder 2016a). Geomembrane and GCL material quality control certificates were reviewed for compliance with project specifications prior to installation. The construction quality assurance (CQA) technician verified that GCL and geomembrane were placed in accordance with the installation specifications and according to manufacturer's recommendations.

3.2.1 Alternative Composite Liner Demonstration – §257.70(c)

The composite liner constructed in 2016 consists of two components: 60-mil HDPE geomembrane underlain by a GCL. This alternative composite liner utilizes a GCL layer rather than 2 feet of compacted soil with a hydraulic conductivity of no more than $1x10^{-7}$ cm/sec. Per §257.70(c), the lower component (GCL) must have a liquid flow rate no greater than the liquid flow rate of 2 feet of compacted soil with a hydraulic conductivity of no more than $1x10^{-7}$ cm/sec.

Based on quality control samples, the installed GCL has an average hydraulic conductivity of $7.6x10^{-10}$ cm/sec at an average thickness of 0.80 cm (Golder 2016b). Utilizing Darcy's Law for gravity flow through porous media, a comparison between the alternative lower component (GCL) and 2 feet of compacted soil with a hydraulic conductivity of $1x10^{-7}$ cm/sec was performed for a range of potential heads above the liner. The results indicate that the GCL lower component is an approved alternative for anticipated hydraulic head conditions.

Head Above Liner (h) feet	Prescriptive (2 feet of $1x10^{-7}$cm/sec) Flow Rate per Unit Area (q) $cm^3/sec/cm^2$	Alternative (GCL) Flow Rate per Unit Area (q) $cm^3/sec/cm^2$
10	6.0E-07	2.9E-07
20	1.1E-06	5.8E-07
30	1.6E-06	8.7E-07
40	2.1E-06	1.2E-06
50	2.6E-06	1.4E-06
60	3.1E-06	1.7E-06
70	3.6E-06	2.0E-06
80	4.1E-06	2.3E-06

The composite liner system installed in the southeast corner of Ash Pond 91 and in the area between Ash Pond 91 and the Upstream Raise meets additional composite liner requirements outlined in §257.70(b):

- §257.70(b)(1) – The composite liner (60-mil HDPE geomembrane and GCL) is constructed of competent materials with appropriate strength and meet the composite liner design requirements for CCR materials outlined in §257.71.
- §257.70(b)(2) –Based on design information and visual observations of the Ash Pond 91 composite liner constructed in 2016, the composite liner system was constructed with soil-filled anchor trenches to provide shear resistance to movement of the liner system.
- §257.70(b)(3) – Embankment and subgrade materials were designed to be compacted to at least 95% maximum density as determined from a Standard Proctor and were compacted to meet those specifications based on field testing. Based on this information and visual observations, foundation materials appear to have been compacted to densities sufficient for loading conditions expected at Ash Pond 91.
- §257.70(b)(4) – Cross-over piping and operating procedures restrict operating the impoundment to within 2 feet of the top of the liner systems. Therefore, the composite liner is installed to cover surrounding earth that could come into contact with CCR material.

4.0 CERTIFICATION

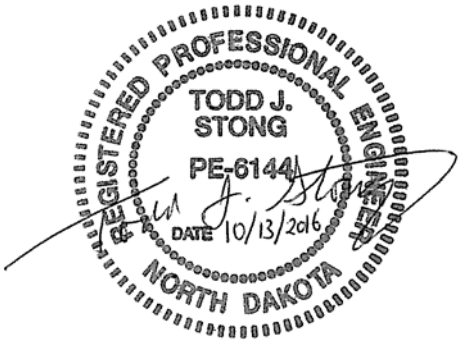
The undersigned attest to the completeness and accuracy of this liner design documentation, and certify that the installed liner in Ash Pond 91 meets the requirements detailed in 40 CFR §257.71(a)(1), and that Ash Pond 91 is a “lined” CCR surface impoundment.

GOLDER ASSOCIATES INC.

Todd Stong, PE
Associate and Senior Engineer

Craig Schuettpelz, PE
Senior Project Engineer

TS/CS/rjg



5.0 REFERENCES

CPA. 1993. *Cooperative Power Association Final Construction Report – Evaporation Pond 93 and Ash Pond 91*.

EPA. 2015. Environmental Protection Agency, Code of Federal Regulations Title 40 Part 257: Hazardous and Solid Waste Management System; *Disposal of Coal Combustion Residuals from Electric Utilities*. April.

Golder. 2016a. *Construction Specifications for Great River Energy Coal Creek Station, 2016 Ash Pond 91 Upstream Raise Construction – Earthworks*. July.

Golder. 2016b. *Submittal #P012 – GCL Permeability Test Data – 2016 Ash Pond 91 Upstream Raise Construction*. September.

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, Colorado 80228 USA
Tel: (303) 980-0540
Fax: (303) 985-2080

Golder Associates