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October 7, 2016

Tennessee Valley Authority
1101 Market Street
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Initial Safety Factor Assessment
Middle Pond A
EPA Final CCR Rule
TVA Gallatin Fossil Plant
Gallatin, Tennessee

1.0 PURPOSE

This letter documents AECOM's certification of the initial safety factor assessment for the TVA Gallatin Fossil Plant's Middle Pond A. Based on this assessment, the Middle Pond A is in compliance with the factors of safety specified in the Final CCR Rule at 40 CFR 257.73(e)(1)(i) and (ii).

2.0 INITIAL SAFETY FACTOR ASSESSMENT

The initial safety factor assessment conducted pursuant to 40 CFR 257.73(e) addresses the following factors of safety:

- Long-term, maximum storage pool loading condition;
- Maximum surcharge pool loading condition;
- Seismic factor of safety loading condition; and
- Liquefaction factor of safety loading condition.

AECOM compiled and reviewed available historical site, topographic and geotechnical data for the TVA Gallatin Fossil Plant's Middle Pond A as of October 7, 2016. A complete listing of documents reviewed is included in the attached references.

Based upon its review of these available documents, AECOM identified a cross section which is identified as the most critical cross section. This cross section is designated Section S-S'. It was analyzed for the loading conditions specified in 40 CFR 257.73(e)(1)(i) through (iv).

3.0 SUMMARY OF FINDINGS

The attached calculation package presents the safety factor assessment for Section S-S' for the loading conditions specified in 40 CFR 257.73(e)(1)(i) through (iv). The calculated factors of safety are shown in the following table. The results show that the calculated factors of safety for Section S-S' exceed the minimum safety factors required under 40 CFR 257.73(e)(1)(i) through (iv).

Plant	Facility	Critical Cross Section	EPA Criteria	EPA Required Factor of Safety (FOS)	Calculated FOS
GAF	Middle Pond A	S-S’	Long-term maximum storage pool loading condition	1.50	5.63
			Maximum surcharge pool loading condition	1.40	5.63[1]
			Seismic factor of safety loading condition	1.00	2.88
			Liquefaction factor of safety loading condition	1.20	3.68

[1]-Note that maximum surcharge elevations at cross section S-S’ did not reach the ground surface for the IDF event. Accordingly, no surcharge was induced for this condition. Therefore, the factor of safety for the maximum surcharge pool loading condition would be equivalent to the factor of safety for the long-term maximum storage pool loading condition.

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Gabriel W. Lang, being a Professional Engineer in good standing in the State of Tennessee, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;
2. that the information contained herein is accurate as of the date of my signature below; and
3. that the initial safety factor assessment for the TVA Gallatin Fossil Plant’s Middle Pond A presented in the table above meets the requirements of the factors of safety specified in 40 CFR 257.73(e)(1)(i) and (ii).

SIGNATURE ______________________________________ DATE 10/7/2016__ ____

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ATTACHMENTS: Initial Safety Factor Assessment 40 CFR 257.73(e); Existing CCR Surface Impoundment - Middle Pond A and Bottom Ash Pond; TVA Gallatin Fossil Plant

GABRIEL WILLAM LANG
No 114323
10/7/16

COAL COMBUSTION PRODUCT DISPOSAL PROGRAM
Gallatin Fossil Plant, Gallatin, Tennessee

Initial Safety Factor Assessment
40 CFR 257.73(e)
Existing CCR Surface Impoundment-
Middle Pond A and Bottom Ash Pond
TVA Gallatin Fossil Plant

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10/7/16

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October 7, 2016 – Rev0

Prepared by

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1.0 Introduction

1.1 Objective

On April 17, 2015 the “Final Rule: Disposal of Coal Combustion Residuals (CCR) from Electric Utilities” (CCR Rule) was published in the Federal Register by the Environmental Protection Agency (EPA). AECOM has been contracted by TVA to analyze the Structural Integrity Criteria for the Gallatin Fossil Plant (GAF) CCR surface impoundments and evaluate compliance with §257.73 of the CCR Rule.

1.2 Outline of CCR Rule Requirements

As required by §257.73 of the EPA Final CCR Rule, an initial structural integrity evaluation is required by October 17, 2016 and must include an initial safety factor assessment for each existing CCR surface impoundment that meets the conditions of paragraph (b) as follows:

1. Has a height of five feet or more and a storage volume of 20 acre-feet or more or
2. Has a height of 20 feet or more.

The safety factor assessment must document whether the calculated factors of safety for each existing CCR surface impoundment perimeter dike demonstrate the minimum static and seismic safety factors specified in paragraphs (e)(1)(i) through (e)(1)(iv) of the CCR Rule for the critical cross section of the embankment

In addition, in accordance with paragraph (f)(2), the owner or operator of the existing CCR surface impoundment may elect to use a previously completed assessment to serve as the initial assessment required by paragraph (e) of the CCR Rule provided that the previous assessment(s) was completed no earlier than 42 months prior to October of 2016 and meets the applicable requirements of paragraph (e) of the EPA Final CCR Rule. Note that only the static slope stability analyses load cases are covered in this assessment.

1.3 Description of Structure

GAF is a coal-fired, electric-generating plant. The plant is located at 1499 Steam Plant Road in Sumner County, Tennesseee on the north bank of the Cumberland River, approximately four miles southeast of the City of Gallatin. The plant occupies the Odom’s Bend peninsula, which is surrounded to the east, west, and south by the Cumberland River. TVA has determined that Middle Pond A and Bottom Ash Pond are CCR surface impountments and are subject to the CCR Rule. A plan view showing the location of Middle Pond A and Bottom Ash Pond is shown in **Figure 1**.

Figure 1: Aerial View of Ash Pond Complex

Based on the 2015 aerial survey, Middle Pond A covers an area of approximately 32 acres Middle Pond A is located to the east of Ash Pond E, to the south of Ash Pond A, to the west of railroad tracks, and to the north of Bottom Ash Pond. The majority of Middle Pond A has been in-filled, with very little free water volume. Existing haul roads form a dike between Middle Pond A and the Bottom Ash Pond. The maximum height of the dike is approximately 5 feet and it is inclined at approximately 3H:1V. The Bottom Ash Pond is located to the south of Middle Pond A, to the west of railroad tracks, and to the north of the coal stack. A significant portion of the Bottom Ash Pond is incised. However, dike is formed between the Bottom Ash Pond and a reservoir to the west by the existing landfill haul road. The dike height is approximately 30 feet and is inclined at 2.5H:1V to 6H:1V.

2.0 Project Reconnaissance

2.1 Review of Existing Data

The existing data review included the following documents:

- AECOM (2016b). Basis of Design Ash Pond Lowering and Flow Diversion, Gallatin Fossil Plant, Sumner County, Tennessee, Revision 0.
- MACTEC Engineering and Consulting, Inc. (2004). Report of Geotechnical Exploration, Ash Disposal Area and Potential On-site and Off-site Borrow Areas, Gallatin Fossil Plant, Gallatin, Tennessee.

- Stantec Consulting Services Inc. (2010). Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond/ Stilling Pond Complex, Gallatin Fossil Plant – Gallatin, Tennessee. .
- URS Corporation (2013). Geotechnical Site Evaluation Report for Ash Haul Road Projects A and B. Prepared for TVA.
- Dewberry Consultants LLC (2013). Coal Combustion Residue Impoundment, Round 11-Dam Assessment Report.
- URS Corporation (2014). Ash Pond A and E Dikes, Geotechnical Site Evaluation Report (Rev. 0).
- AECOM (2016). Geotechnical Exploration Report for CCR Compliance, Middle Pond A and Bottom Ash Pond.
- URS (2012). Ash Pond A and E Dikes. Geotechnical Site Evaluation Report. Gallatin Fossil Plant. Sumner County, Tennessee. Prepared for Tennessee Valley Authority.

2.2 Data Gaps

During the existing data review, AECOM did not identify data gaps that would require additional geotechnical drilling, sampling, laboratory testing, or field surveying.

3.0 Summary of Field Investigations and Laboratory Testing

In 2016, an additional geotechnical exploration was performed to characterize the perimeter dikes and the divider dikes (between Middle Pond A and Bottom Ash Pond; and between Middle Pond A and Ash Pond A). AECOM performed drilling and sampling of the perimeter dikes and the divider dikes. The exploration consisted of drilling two soil borings using hollow stem augers (HSA) and two cone penetration tests (CPT) with pore water pressure dissipation and shear wave velocity measurements. .

In 2012, URS completed a geotechnical exploration and analysis on the divider and perimeter dikes of Ash Pond A (URS, 2012). The geotechnical exploration was performed along the crest and near the exterior toe of the Ash Pond A dikes and incorporated the earlier work performed by Stantec (2010). The exploration work on the dikes of Ash Pond A included six (6) Hollow Stem Auger (HSA) Standard Penetration Test (SPT) soil borings, disturbed and undisturbed soil sampling, in-situ testing activities that included four (4) Marchetti dilatometer testing (DMT) and seven (7) cone penetration testing (CPT), laboratory testing, and the installation and monitoring of five (5) open stand-pipe piezometers and six (6) vibrating wire piezometers. Subsurface data gathered by URS in 2012 was used to supplement historical data previously gathered at Ash Pond A. The geotechnical explorations, laboratory testing, and conclusions presented in this report were used as the basis for this analysis.

Recent LiDAR and photography flight topographic survey data gathered by TVA's survey subconsultant, Tuck Mapping Solutions, Inc. of Big Stone Gap, Virginia, was provided by TVA. The LiDAR and photography survey was completed July 8, 2015 and the data was used to update the Gallatin site topography basemap from which the stability cross sections were developed. Bathymetry topographic survey data for the Ash Pond and Stilling Ponds was provided to AECOM by TVA in December, 2014.

Laboratory tests included index testing of the disturbed soil samples. Index testing included two Atterberg limit tests (ASTM D4318), four sieve analysis tests (ASTM D422), and two No. 200 sieve wash tests (ASTM D1140).

The results of the field investigation and laboratory index testing indicated similar materials were encountered during the additional geotechnical exploration to the materials encountered during prior explorations that involved extensive drilling and laboratory testing scopes.

4.0 Detailed Task Analysis Criteria

4.1 Material Properties

Based on the results of the subsurface explorations, the materials that make up the Middle Pond A and Bottom Ash Pond dikes are summarized below in **Table 1.**

Table 1: Generalized Subsurface Conditions

Materials	Approximate Depth (feet below ground surface)	Consistency/ Relative Density
Dike fill – Consists of bottom ash fill and sluiced bottom ash	19 to 38 feet	Loose to very dense
Residuum – Clay, slightly silty	29 to 58 feet	Stiff to very stiff
Bedrock - Limestone	Below 58 feet	Hard

The index testing performed by AECOM (2016) indicated the materials sampled at Middle Pond A and the Bottom Ash Pond are similar to the materials encountered and tested previously in prior geotechnical explorations. Accordingly, the shear strength parameters determined from previous explorations at Ash Pond A were used to complete the most recent stability analysis. It should be noted that multiple shear strength envelopes were developed for Bottom Ash by URS (2012) depending on placement method and compactive effort. Sluiced Bottom Ash had the lowest shear strength of the tested materials. At Middle Pond A and the Bottom Ash Pond, the subsurface data suggests that some of the Bottom Ash materials have been compacted in place rather than sluiced. However, sluiced Bottom Ash shear strength parameters have conservatively been assigned. The strength parameters used in the analysis are presented below in **Table 2**. The derivation of the shear strength parameters is provided in the above referenced report completed by URS (2012).

Table 2: Strength Parameters for Stability Analysis

Soil Horizon	Wet Unit Weight (pcf)	Effective Stress Strength Parameters		Total Stress Strength Parameters	
		c' (psf)	ϕ' (degrees)	c (psf)	ϕ (degrees)
Bottom Ash	105	0	30	0	30
Residuum	125	200	27	1,000	0
Bedrock (Limestone)	Impenetrable				

4.2 Critical Cross Section Selection

The cross section locations were selected to be representative of the most critical cross sections, such as the maximum embankment height, the steepest embankment slopes, and the least resisting force at and beyond the downstream toe. The number and location of cross sections also reflects engineering judgment to obtain appropriate geo-spatial coverage. A total of two cross sections were constructed for these analyses as described below and shown in **Figure 2**.

- Section R-R' represents a section through the Bottom Ash Pond dike and Haul Road east and downstream toward the reservoir located south of Ash Pond E and north of the coal conveyer.
- Section S-S' represents a cross section through the Middle Pond A northern dike and downstream toward Ash Pond A.

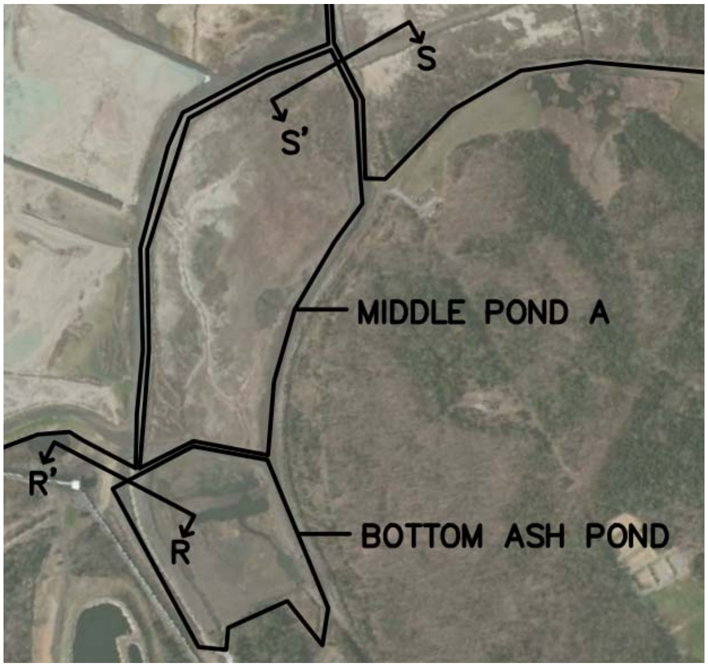

Figure 2: Plan View of Cross Sections

Cross section R-R' was selected as the critical cross section for the Bottom Ash Pond, while cross section S-S' was selected as the critical cross section for Middle Pond A. The results of the stability analysis performed by AECOM (2016) are summarized below in **Table 3**.

Table 3: Historic Slope Stability Results

Cross Section	CCR Unit	CCR Rule Loading Condition	Factor of Safety (Global Failure, Exterior Slope)	Reference
R-R'	Bottom Ash Pond	Long-term Maximum Storage Pool	5.31	AECOM (2016)
		Maximum Surcharge Pool	4.11	AECOM (2016)
		Seismic Factor of Safety	1.44	AECOM (2016)
		Liquefaction Factor of Safety	3.30	AECOM (2016)
S-S'	Middle Pond A	Long-term Maximum Storage Pool	5.63	AECOM (2016)
		Maximum Surcharge Pool	5.63[1]	AECOM (2016)
		Seismic Factor of Safety	2.88	AECOM (2016)
		Liquefaction Factor of Safety	3.68	AECOM (2016)

[1] -Note that maximum surcharge elevations at cross section S-S' did not reach the ground surface for the IDF event. Accordingly, no surcharge was induced for this condition. Therefore, the factor of safety for the maximum surcharge pool loading condition would be equivalent to the factor of safety for the long-term maximum storage pool loading condition.

4.3 Water Levels

In consideration of the Initial Inflow Design Flood analysis performed by AECOM (2016), the water elevations for Middle Pond A and the Bottom Ash Pond were defined to meet the requirements of the EPA CCR Rule §257.82(a). The Long Term Maximum Storage Pool elevation and Maximum Surcharge Pool level determined for Middle Pond A, the Bottom Ash Pond, and Ash Pond A are provided below in

Table 4. The basis of these elevations was instrumentation data, surveying, the 100 year, 24-hour storm events for Middle Pond A and Bottom Ash Pond and the 1,000 year, 6-hour storm event for Ash Pond A.

Table 4: GAF Middle Pond A and Bottom Ash Pond Water Elevations for Stability Modeling

Loading Condition	Bottom Ash Pond (feet, MSL)	Middle Pond A (feet, MSL)	Ash Pond A (feet, MSL)
Long-term Maximum Storage Pool	478	468.3	463
Maximum Surcharge Pool	480.3	473	468

A small reservoir is present downstream of the Bottom Ash Pond. The reservoir is not part of Pond E. Water elevations were estimated to be approximately 455 feet based on the existing topography and aerial maps. This reservoir was taken to be the tailwater for the analysis of the Bottom Ash Pond.

4.4 Analysis Methodology

AECOM performed the static slope stability analyses using the GeoStudio 2012, Version 8.15.5.11777 software package developed by Geoslope, Inc. of Calgary, Alberta, Canada. This package includes the SLOPE/W module for slope stability analysis. The analyses were performed in accordance with the guidelines in USACE Design Manuals EM 1110-2-1902 “Slope Stability” (United States Army Corps of Engineers, 2003).

The phreatic surface used in each stability analysis was based on a seepage analysis model performed using the SEEP/W module of the above referenced GeoStudio software. Seepage analysis parameters were determined from information published by the United States Bureau of Reclamation and historic laboratory testing. Values were then adjusted to calibrate the seepage models to the field CPT dissipation data. The calibration process was completed until parameters were determined which yielded a reasonable correlation to field readings.

4.4.1 Long-Term Maximum Storage Pool §257.73(e)(i)

A drained, effective stress analysis was performed for this load case to evaluate slope stability in the downstream direction. This assessment used a phreatic surface based on the seepage analysis discussed in **Section 4.4** and data provided in **Table 4** and **Section 4.3**.The required minimum factor of safety corresponds to the entry for “Long-Term Maximum Storage Pool” in **Table 5**.

4.4.2 Maximum Surcharge Pool §257.73(e)(ii)

The maximum surcharge pool load condition is created by a rapid pool level rise during a flood. It is a temporary water level, higher than the normal pool, which does not last long enough to develop steady-state seepage within the impoundment embankment and foundation (USACE, 2003). The pool is assumed to rise faster than water can flow in or out of fine-grained soils, and the surcharge pressure may cause shear-induced, excess pore pressures in the saturated zones. This assumption is based on the significance of the surcharge pressure with respect to the size of the dike. Surcharge pressures are discussed further in **Section 5.0**.

Materials below the phreatic surface were considered saturated and modeled using undrained material properties. The partially saturated zones above the phreatic surface were modeled using drained material properties. This assessment used a phreatic surface based on the seepage analysis discussed in **Section 4.4** and data provided in **Table 4** and **Section 4.3**.The required minimum factor of safety corresponds to the entry for "Maximum Surcharge Pool" loading condition in **Table 5**.

4.4.3 Seismic Factor of Safety §257.73(e)(iii)

The seismic factor of safety loading condition considers stability during horizontal seismic loading induced by the Maximum Design Earthquake, defined by the EPA CCR Rule as an event that produces a level of shaking with a probability of exceedance of 2% in 50 years, or a 2,500 year return period. Online United States Geologic Survey (USGS) seismic hazard mapping software (http://geohazards.usgs.gov/hazardtool/application.php) was used to obtain the spectral acceleration at a period of 1 second for the above referenced return period. This value, the peak transverse base acceleration taken at the base of the unit, was found to be 0.16g for this project site. The peak transverse base acceleration was amplified through the embankment to obtain the peak transverse crest acceleration based on data developed by Idriss (2008, personal communication based on Harder et. al (1998).

The horizontal seismic coefficient k_h used in the seismic factor of safety analysis was calculated using the method outlined by Makdisi-Seed (1978), which states that k_h is calculated by multiplying the peak transverse crest acceleration (determined as described above) by the ratio of maximum average acceleration for a potential sliding mass. K_h was calculated to be 0.119g for this project.

The seismic factor of safety analysis was performed with saturated and unsaturated, fine grained materials modeled using undrained shear strength parameters. The analysis was performed at Long-Term Maximum Storage Pool elevations and phreatic conditions described in **Section 4.4**. The required minimum factor of safety corresponds to the entry for "Seismic Factor of Safety" in **Table 5**.

4.4.4 Liquefaction Factor of Safety §257.73(e)(iv)

The purpose of post-liquefaction stability is to access stability conditions immediately following the design seismic event. Liquefaction triggering was performed using project SPT and CPT data. The SPT-based liquefaction procedure is based on the revised methodology by Youd et al. (2001) updated by Idriss and Boulanger (2008, 2014). The CPT based liquefaction procedure is based on Youd et al. (2001) and Idriss and Boulanger (2014). Both procedures consider a stress-based approach to evaluate the potential for liquefaction triggering, and compare the earthquake-induced cyclic stress ratios (CSR) with the cyclic resistance ratios (CRR) to obtain a factor of safety. Materials with a factor of safety against liquefaction less than

1.1 were considered to undergo liquefaction. Assumptions regarding the potential for materials to liquefy are provided in **Section 5.0**.

Liquefied materials were assigned a residual strength based on SPT and CPT data using a data figure from Idriss and Boulanger (2008). Saturated fine grained and coarse grained soils were assumed to undergo cyclic softening resulting in a reduction to 80% of undrained peak strength. Unsaturated, fine grained materials were modeled at peak, undrained strength. The analysis was performed at Long-Term, Maximum Storage Pool elevations and phreatic conditions described in **Section 4.4**. The required minimum factor of safety corresponds to the entry for “Liquefaction Factor of Safety” in **Table 5**.

4.5 Acceptance Criteria

The following summary is taken from the EPA’s CCR Rule §257.73(e). The factor of safety assessment criteria are outlined in **Table 5** below.

Table 5: Factor of Safety Criteria

Loading Condition	CCR Rule Required Factor of Safety	CCR Rule Reference
Long-term, maximum storage pool	1.50	§257.73(e)(1)(i)
Maximum surcharge pool	1.40	§257.73(e)(1)(ii)
Seismic Factor of Safety	1.00	§257.73(e)(1)(iii)
Liquefaction Factor of Safety	1.20	§257.73(e)(1)(iv)

5.0 Analysis Assumptions

The following assumptions apply to this analysis.

- The goal of the analyses was to identify failures which would likely result in the release of ash. Therefore, incipient motion in the downstream direction was considered, and upstream directional failures were not included.
- The long-term maximum storage pool elevation is the normal operating pool elevation for Middle Pond A and the Bottom Ash Pond.
- The maximum surcharge pool elevations were applied to the model based on the flood pool level determined for the 6-hour, 1,000 year storm for Middle Pond A and the 24-hour, 100 year storm for the Bottom Ash Pond. The surcharge pool was assumed not to last long enough for steady-state conditions to develop. Therefore, the phreatic surface obtained from the seepage analysis for the long-term maximum storage pool analysis was utilized within the embankment. A surcharge pressure was applied to the slow-draining soils along the ground surface, reflecting the difference in elevation between the flood pool and normal pool.
- During maximum surcharge pool loading analysis, the tailwater was conservatively maintained at the long term maximum pool or normal pool elevation, neglecting

potential added resistance at the toe resulting from short term, surcharge loading conditions

- The slope stability assessments presented in this report are focused on the potential for slope failures of significant mass, which could directly impact potential release of water and CCR materials from Middle Pond A and the Bottom Ash Pond.
- The search for a critical slip surface in the slope stability assessments was therefore restricted to consider only potential surfaces where the depth (measured at the base of at least one slice) is more than 10 feet vertically below the ground surface.
- For the seismic factor of safety analysis, it was assumed that undrained conditions were induced for saturated and unsaturated fine grained soils. Unsaturated coarse grained soils were modeled using drained shear strengths.
- For purposes of the liquefaction triggering analysis, the following materials were considered unsusceptible to liquefaction:
    - Well compacted, plastic soils in the dam embankment.
    - Riprap materials.
    - Compacted drains or filter zones comprised of clean gravel or rock fill.
    - Unsaturated granular soils.
    - Saturated, sand-like soils that exhibit dilative behavior over the anticipated range of confining stresses.
    - Clay-like soils with high plasticity (see Seed et al. 2003; Bray and Sancio 2006; MSHA 2010).
    - Clay-like soils that exhibit dilative behavior over the anticipated range of confining stresses (MSHA 2010).
- For the post liquefaction factor of safety analysis, it was assumed that saturated fine grained soils would be softened through cyclic loading to 80% of the peak, undrained strength.

6.0 Analysis Results

The slope stability assessments presented in this report are focused on the potential for slope failures of significant mass, which could directly impact potential release of water and CCR materials from Middle Pond A and Bottom Ash Pond. The search for a critical slip surface in the slope stability assessments is thus restricted to consider only potential surfaces where the depth (measured at the base of at least one slice) is more than 10 feet vertically below the ground surface. The detailed graphic output from SLOPE/W is provided in **Appendix A**. A summary of the static safety factor evaluation results is provided in **Table 6**.

Table 6: Initial Factor of Safety Assessment Results

Facility	Critical Cross Section	Loading Condition	CCR Rule Required Factor of Safety	Calculated Factor of Safety
Bottom Ash Pond	R-R’	Long-term maximum storage pool [§257.73(e)(1)(i)]	1.50	5.31
		Maximum surcharge pool [§257.73(e)(1)(ii)]	1.40	4.11
		Seismic Factor of Safety [§257.73(e)(1)(iii)]	1.00	1.44
		Liquefaction Factor of Safety [§257.73(e)(1)(iv)]	1.20	3.30
Middle Pond A	S-S’	Long-term maximum storage pool [§257.73(e)(1)(i)]	1.50	5.63
		Maximum surcharge pool [§257.73(e)(1)(ii)]	1.40	5.63[2]
		Seismic Factor of Safety [§257.73(e)(1)(iii)]	1.00	2.88
		Liquefaction Factor of Safety [§257.73(e)(1)(iv)]	1.20	3.68

[2] -Note that maximum surcharge elevations at cross section S-S’ did not reach the ground surface for the IDF event. Accordingly, no surcharge was induced for this condition. Therefore, the factor of safety for the maximum surcharge pool loading condition would be equivalent to the factor of safety for the long-term maximum storage pool loading condition.

7.0 Conclusions

This report documents the static and seismic safety factor evaluation of GAF’s Middle Pond A and Bottom Ash Pond. The evaluation was performed in accordance with section §257.73(e) of the CCR Rule.

The initial safety factor results for Middle Pond A and Bottom Ash Pond met or exceeded the required safety factors at each cross section and at the critical cross sections evaluated for the long-term maximum storage pool [§257.73(e)(1)(i)], the maximum surcharge pool [§257.73(e)(1)(ii)], the seismic factor of safety [§257.73(e)(1)(iii)], and the liquefaction factor of safety [§257.73(e)(1)(iv)] loading conditions. These results demonstrate that Middle Pond A and Bottom Ash Pond meet the initial safety factor requirements of EPA 40 CFR §257.73(e).

8.0 References

1. AECOM Technical Services Inc. (AECOM) (2016). Geotechnical Exploration for CCR Compliance. Middle Pond A and Bottom Ash Pond. Gallatin Fossil Plant. Sumner County, Tennessee. Prepared for Tennessee Valley Authority, September 26.
2. AECOM (2016). Initial Inflow Design Flood Control Plan for Ash Pond A. Gallatin Fossil Plant. Sumner County, Tennessee. Prepared for Tennessee Valley Authority, September 30.
3. AECOM (2016). Initial Inflow Design Flood Control Plan for Bottom Ash Pond. Gallatin Fossil Plant. Sumner County, Tennessee. Prepared for Tennessee Valley Authority, September 30.
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7. GEO-SLOPE International, Ltd (2012). GeoStudio 2012, Version 8.15. Calgary, Alberta, Canada. www.geo-slope.com.
8. Stantec Consulting Services Inc. (2009). Report of Phase 1 Facility Assessment, Coal Combustion Product Impoundments and Disposal Facilities. Various Locations. Kentucky. Prepared for Tennessee Valley Authority, June 24.
9. Stantec Consulting Services Inc. (2010). Report of Geotechnical Exploration and Slope Stability Evaluation. Ash Pond/Stilling Pond Complex. Gallatin Fossil Plant. Sumner County, Tennessee. Prepared for Tennessee Valley Authority, May 27.
10. United States Army Corps of Engineers (USACE) (2005). ETL 1110-2-1902. Design Guidance for Levee Under-Seepage, Department of the Army. May 1
11. United States Army Corps of Engineers (USACE) (2003). Engineering and Design. Slope Stability. Engineering Manual EM 1110-2-1902, Department of the Army. October 3.
12. URS (2013). Geotechnical Site Evaluation Report for Ash Haul Road Projects A and B. Gallatin Fossil Plant. Sumner County, Tennessee. Prepared for Tennessee Valley Authority, December 11, 2013.
13. URS (2012). Ash Pond A and E Dikes. Geotechnical Site Evaluation Report. Gallatin Fossil Plant. Sumner County, Tennessee. Prepared for Tennessee Valley Authority, December 20, 2012.

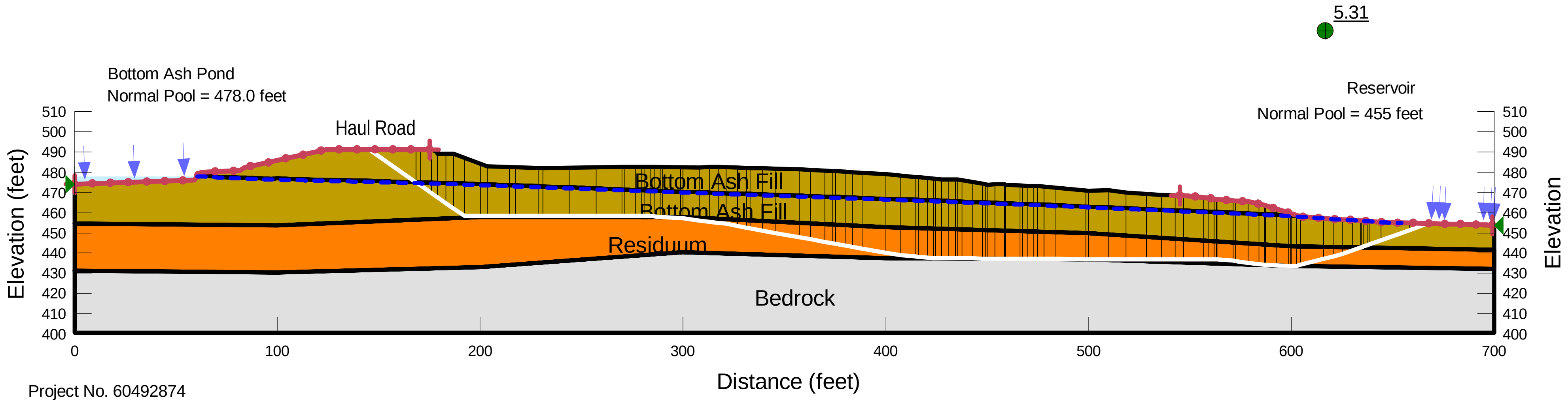
APPENDIX A

SLOPE STABILITY ANALYSIS

Tennessee Valley Authority
Gallatin Fossil Plant - CCR Rule Analysis
Bottom Ash Pond
Cross Section R-R'
Slope Stability Long-term Maximum Storage Pool (Global)

Method: Spencer
F of S: 5.31
Center: (616.81614, 549.90533)
Radius: 195.73752
Minimum Slip Surface Depth: 10 ft

Material	Model	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg.)
Bottom Ash Fill	Mohr-Coulomb	105 pcf	0 psf	30 °
Residuum	Mohr-Coulomb	120 pcf	200 psf	27 °



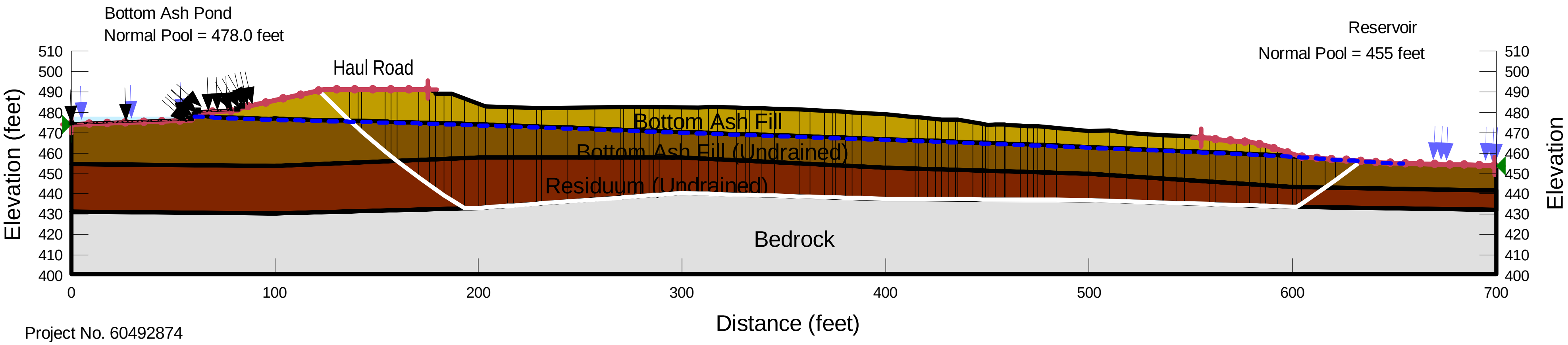
Project No. 60492874

Tennessee Valley Authority
Gallatin Fossil Plant - CCR Rule Analysis
Bottom Ash Pond
Cross Section R-R'
Slope Stability Maximum Surcharge Pool (Global)

Method: Spencer
F of S: 4.11
Center: (597.26518, 608.92329)
Radius: 383.99639
Minimum Slip Surface Depth: 10 ft

Material	Model	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg)
Bottom Ash Fill	Mohr-Coulomb	105 pcf	0 psf	30 °
Bottom Ash Fill (Undrained)	Mohr-Coulomb	105 pcf	0 psf	30 °
Residuum (Undrained)	Mohr-Coulomb	120 pcf	1,000 psf	0 °

Flood pool elevation modeled at 480.3 feet. Flood pool loading modeled as a surcharge caused by the weight of water normal to the slope.

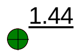


Project No. 60492874

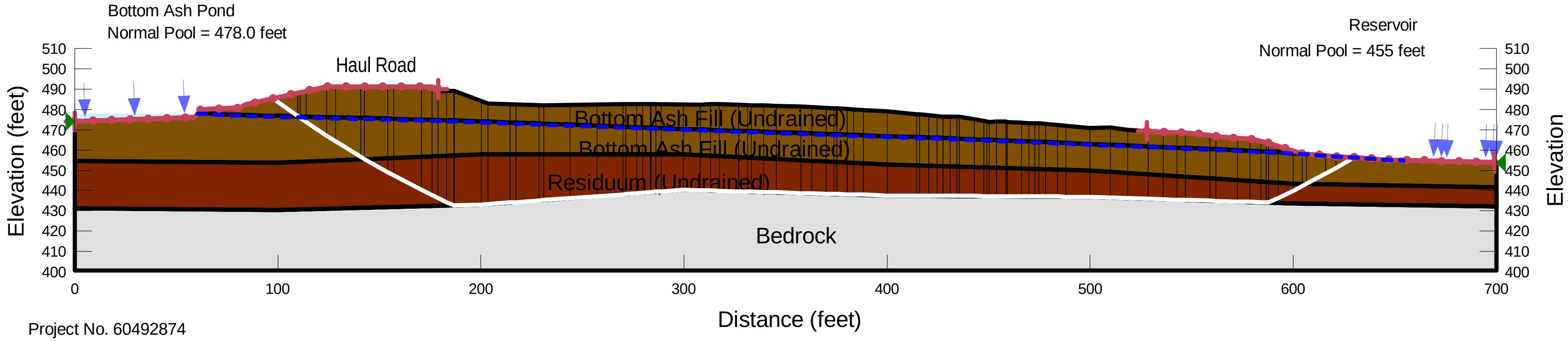
Tennessee Valley Authority
Gallatin Fossil Plant - CCR Rule Analysis
Bottom Ash Pond
Cross Section R-R'
Seismic Factor of Safety Stability

Method: Spencer
F of S: 1.44
Center: (564.27678, 634.49206)
Radius: 480.1534
Minimum Slip Surface Depth: 10 ft

Material	Model	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg.)
Bottom Ash Fill (Undrained)	Mohr-Coulomb	105 pcf	0 psf	30 °
Residuum (Undrained)	Mohr-Coulomb	120 pcf	1,000 psf	0 °



Horizontal Seismic Coef.: 0.119

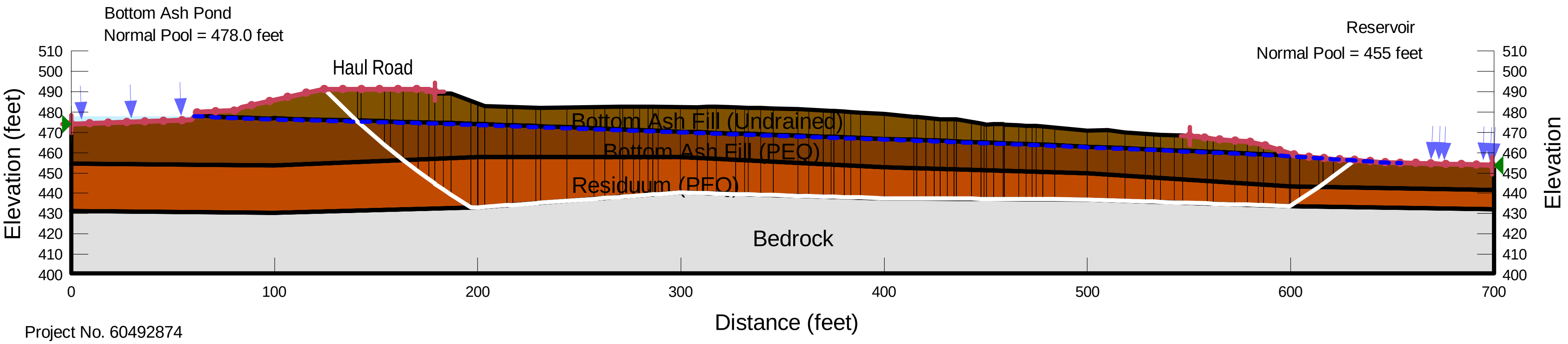


Project No. 60492874

Tennessee Valley Authority
Gallatin Fossil Plant - CCR Rule Analysis
Bottom Ash Pond
Cross Section R-R'
Liquefaction Factor of Safety Stability

Method: Spencer
F of S: 3.30
Center: (584.28528, 626.77065)
Radius: 380.64593
Minimum Slip Surface Depth: 10 ft

Material	Model	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg)
Bottom Ash Fill (Undrained)	Mohr-Coulomb	105 pcf	0 psf	30 °
Bottom Ash Fill (PEQ)	Mohr-Coulomb	105 pcf	0 psf	24 °
Residuum (PEQ)	Mohr-Coulomb	120 pcf	800 psf	0 °

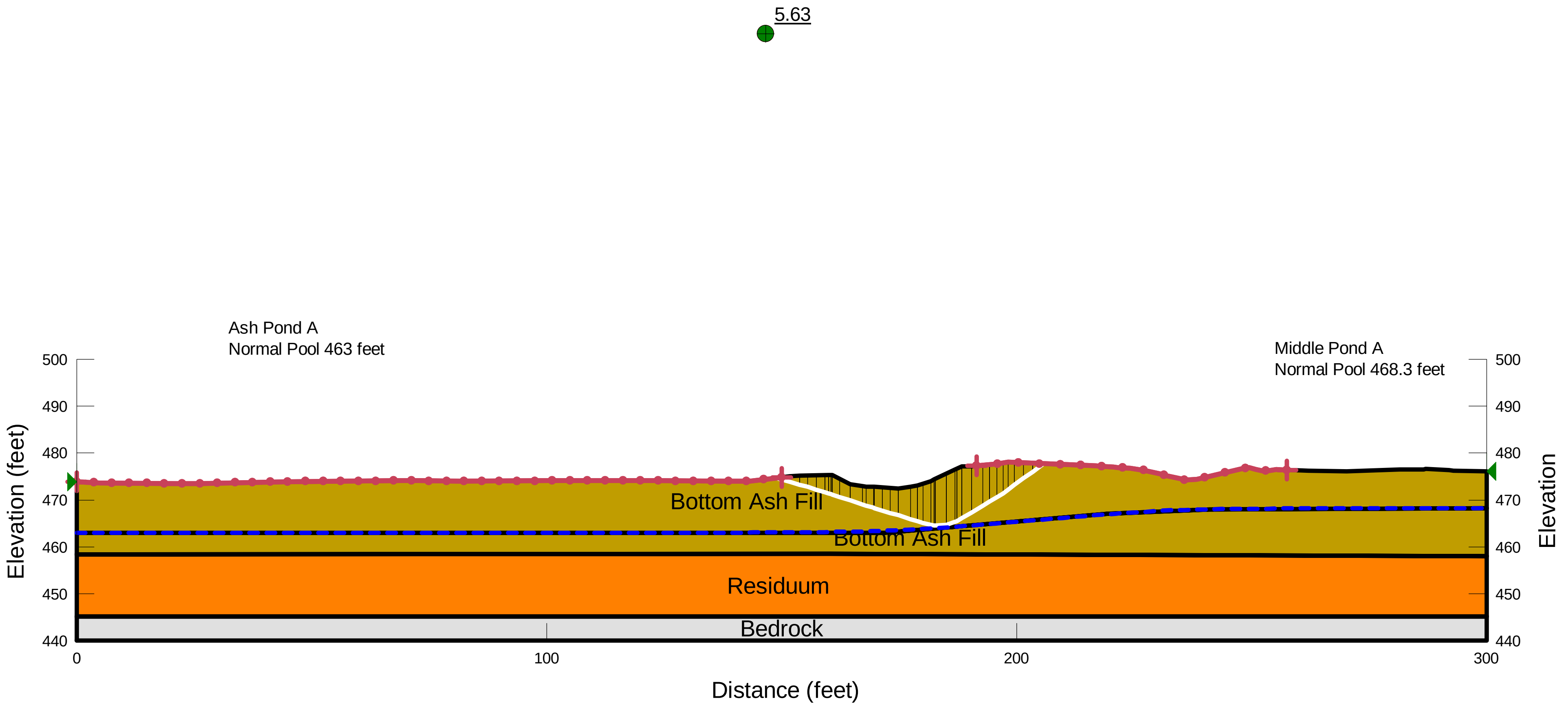


Project No. 60492874

Tennessee Valley Authority
Gallatin Fossil Plant - CCR Rule Analysis
Middle Pond A
Cross Section S-S'
Slope Stability Long-term Maximum Storage Pool

Material	Model	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg.)
Bottom Ash Fill	Mohr-Coulomb	105 pcf	0 psf	30 °
Residuum	Mohr-Coulomb	120 pcf	200 psf	27 °

Method: Spencer
F of S: 5.63
Center: (146.59421, 569.38763)
Radius: 23.176049
Minimum Slip Surface Depth: 10 ft



Project No. 60492874

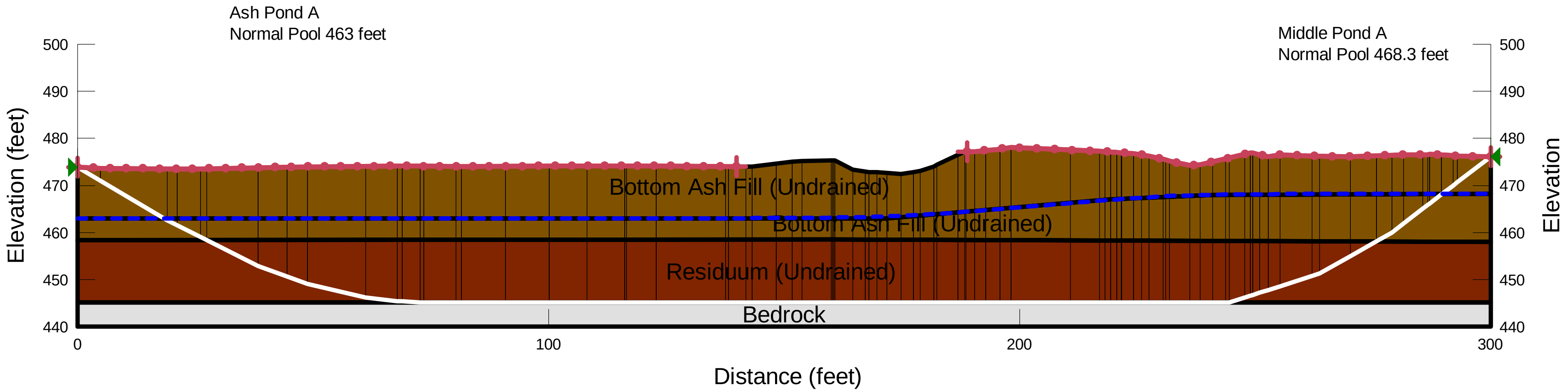
Tennessee Valley Authority
Gallatin Fossil Plant - CCR Rule Analysis
Middle Pond A
Cross Section S-S'
Seismic Factor of Safety Stability

Method: Spencer
F of S: 2.88
Center: (142.95984, 565.75325)
Radius: 110.54241
Minimum Slip Surface Depth: 10 ft

2.88

Material	Model	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg.)
Bottom Ash Fill (Undrained)	Mohr-Coulomb	105 pcf	0 psf	30°
Residuum (Undrained)	Mohr-Coulomb	120 pcf	1,000 psf	0°

Horizontal Seismic Coef.: 0.119g



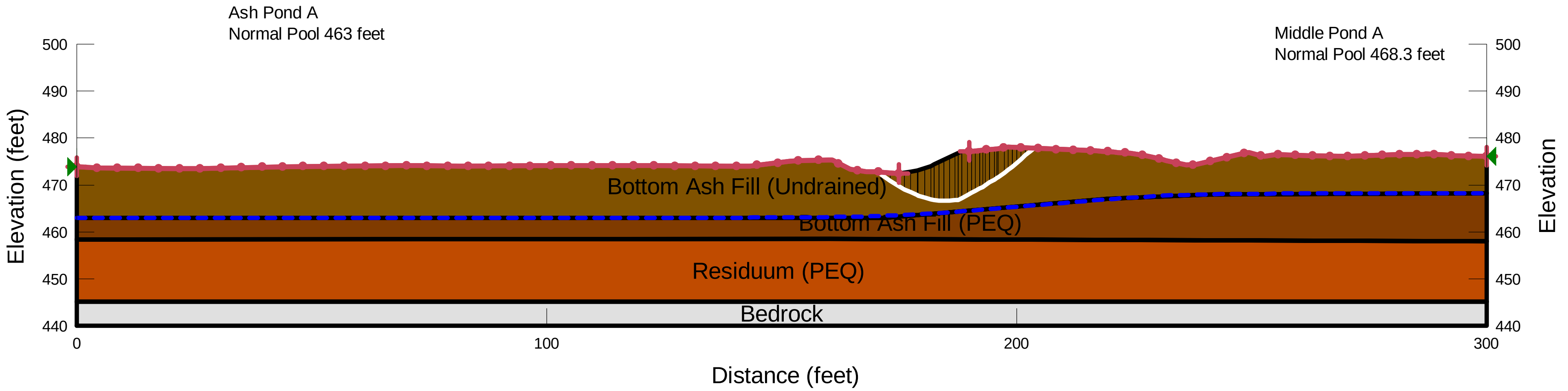
Project No. 60492874

Tennessee Valley Authority
Gallatin Fossil Plant - CCR Rule Analysis
Middle Pond A
Cross Section S-S'
Liquefaction Factor of Safety Stability

Method: Spencer
F of S: 3.68
Center: (136.98909, 570.81541)
Radius: 15.59604
Minimum Slip Surface Depth: 10 ft

Material	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg.)
Bottom Ash Fill (Undrained)	105 pcf	0 psf	30 °
Bottom Ash Fill (PEQ)	105 pcf	0 psf	24 °
Residuum (PEQ)	120 pcf	800 psf	0 °

3.68



Project No. 60492874