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April 13,2018

Tennessee Valley Authority
1101 Market Street
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Initial Safety Factor Assessment
Main Ash Pond
EPA Final CCR Rule
TVA Bull Run Fossil Plant
Anderson County, Tennessee

1.0 PURPOSE

This letter documents AECOM's certification of the initial safety factor assessment for the TVA Bull Run Fossil Plant's Main Ash Pond. Based on this assessment, the Main Ash Pond is in compliance with the factors of safety specified in the Final CCR Rule at 40 CFR 257.73(e)(1)(i) through (iv) per 257.100 (e)(3)(v).

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; and
- 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 Bull Run Fossil Plant's Main Ash Pond as of April 13, 2018. A complete listing of documents reviewed is included in the attached references.

Based upon its review of these available documents, AECOM identified a critical cross section for the Main Ash Pond designated as Section S-S'. This cross sections was analyzed for the loading conditions specified in 40 CFR 257.73(e)(1)(i) through (iv) per 257.100 (e)(3)(v).

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), respectively. 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
BRF	Main Ash Pond	S-S'	Long-term maximum storage pool loading condition	1.50	1.74
			Maximum surcharge pool loading condition	1.40	1.69
			Seismic factor of safety loading condition	1.00	1.15
			Liquefaction factor of safety loading condition	1.20	1.86

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Thomas A. Kovacic, PE, 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 Bull Run Fossil Plant's Main Ash Pond presented in the table above meets the requirements of the static and seismic factors of safety specified in 40 CFR 257.73(e)(1)(i) through (iv) per 257.100(e)(3)(v).

SIGNATURE ____________________ DATE 04/13/2018

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ATTACHMENTS: *Initial Safety Factor Assessment 40 CFR 257.100(e)(3)(v) – Inactive CCR Surface Impoundment - Main Ash Pond, TVA Bull Run Fossil Plant*

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COAL COMBUSTION PRODUCT DISPOSAL PROGRAM
Bull Run Fossil Plant, Anderson County, Tennessee

Initial Safety Factor Assessment
40 CFR 257.100(e)(3)(v)
Inactive CCR Surface Impoundment - Main Ash Pond
TVA Bull Run Fossil Plant

Prepared for

TVA

Tennessee Valley Authority
1101 Market Street
Chattanooga, TN 37402-2801

April 13, 2018 – Rev0

Prepared by

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April 13, 2018

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1.0 Introduction

1.1 Objective

This assessment presents the results of AECOM's analysis of the inactive surface impoundment, Main Ash Pond, at Bull Run Fossil Plant (BRF) in Anderson County, Tennessee. AECOM was contracted by the Tennessee Valley Authority (TVA) to perform an initial safety factor assessment of the BRF Main Ash Pond based on the requirements of the recently published United States Environmental Protection Agency (EPA) Coal Combustion Residual (CCR) Rule 40 Code of Federal Regulations (CFR) §257.100(e)(3)(v). These regulations require that the initial safety factor assessment for inactive CCR surface impoundment be completed by April 17, 2018.

1.2 Outline of Rule Requirements

This report presents the results of AECOM's analyses for the Main Ash Pond at TVA BRF Plant. This analysis was completed in response to the Environmental Protection Agency (EPA) adopting the Federal Register 40 CFR Parts 257 and 261 to regulate the disposal of coal combustion residuals (CCR) as solid waste in April of 2015 and revised in August of 2016 for regulation of inactive CCR impoundments. As required by 257.100, owners and operators of inactive CCR surface impoundments must conduct a geotechnical assessment in accordance with the following:

Regulatory Citations:

40 CFR §257.100(e)(3)(v)

- *No later than April 17, 2018, complete the initial hazard potential classification, structural stability, and safety factor assessments as set forth by § 257.73(a)(2), (b), (d), (e), and (f).*

40 CFR §257.73(e)(1)

- *Conduct initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve minimum safety factors specified in (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.*

A safety factor assessment was performed by AECOM to evaluate the potential for slope instabilities, in accordance with the Environmental Protection Agency (EPA) regulation 40 CFR 257.100(e)(3)(v).

1.3 Description of the Structure

The Bull Run Fossil Plant (BRF) is a coal-fired, electric-generating plant with a summer net capability of 863 megawatts. The plant is located at 1265 Edgemoor Road in the town of

Clinton, Anderson County, Tennessee. The Clinch River runs along the western side of the plant and Bull Run Creek, a tributary of Clinch River, runs along the southern side of the plant.

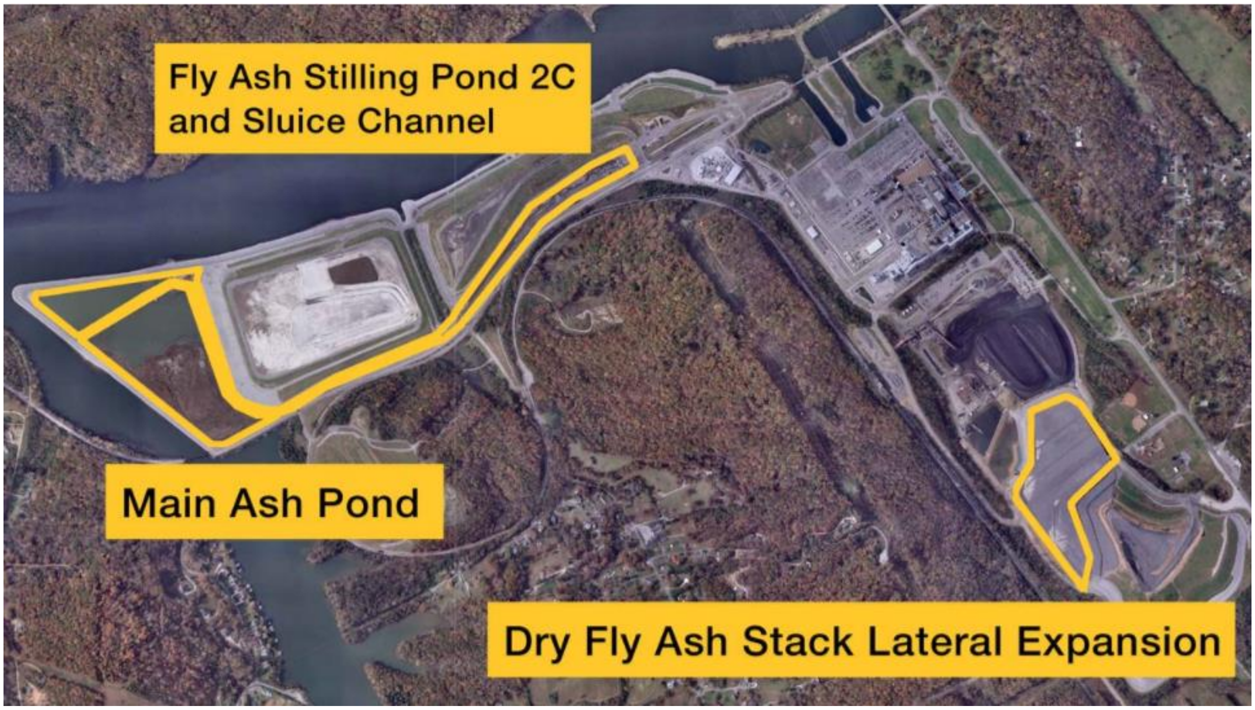


Figure 1: Aerial View of Ash Pond Complex

The Main Ash Pond is an inactive CCR surface impoundment scheduled for closure in 2018. This area was constructed when the plant went online in 1966. Sluiced fly ash started being placed in this area after 1971. In 1976, an internal dike was constructed to form the Fly Ash Stilling Pond 2C in the southwest corner of the Main Ash Pond. The downstream slopes of the starter dike extend at an approximate 2.5H:1V slope to elevation 800 ft. The downstream slopes of the raised dike extend at an approximate slope of 2H:1V to elevation 810 ft. Sluiced ash is impounded behind the initial dikes to elevations up to 820 ft. A Process Water Conveyance Channel runs along the interior toe of the Raised Dike.

2.0 Project Reconnaissance

2.1 Review of Existing Data

As part of the CCR Rule assessment for the Main Ash Pond, AECOM reviewed available historical information and assessment reports. The existing data review included the following documents:

- AECOM (2018). *Safety Factor Assessment - Inactive CCR Surface Impoundments – Main Ash Pond, TVA Bull Run Fossil Plant, Rev0*. April, 2018.

- Geocomp Consulting, Inc. (2017). *Tennessee Valley Authority Seismic Assessment Supplemental Site Exploration - Bull Run Fossil Plant Bottom Ash Disposal Area, Gypsum Disposal Area, and Fly Ash Pond Final Report*. September, 2017.
- Stantec Consulting Services Inc. (2010). *Report of Geotechnical Exploration, Bottom Ash Disposal Area 1, Gypsum Disposal Area 2A, and Fly Ash Pond Area 2, Bull Run Fossil Plant*. April, 2010.

2.2 Data Gaps

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

3.0 Summary of Relevant Field Investigations and Laboratory Testing

In 2009, Stantec (2010) conducted a subsurface investigation consisting of drilling a total of four (4) soil test borings along the crest and toe of the southeastern perimeter dike of the Main Ash Pond. The borings were drilled using Hollow Stem Augers (HSA) and Standard Penetration Tests (SPT) were performed at select depths. The encountered soils were sampled using split-spoons and undisturbed sampling was also performed for the purpose of running laboratory testing. Further, Stantec installed several standpipe piezometers at various depths along the pond dike. The open standpipe piezometers consisted of a 2-inch diameter hollow PVC pipe with a slotted screen (generally 5-feet in length). The screened interval was placed in a sand pack and a bentonite seal was installed above the sand pack (Stantec, 2010). A pressure transducer was installed within the slotted screen to measure the water elevation within the pipe.

Geocomp conducted a seismic stability assessment for the Main Ash Pond at BRF and a final report was issued in September, 2017 (Geocomp, 2017) presenting the details and results of the assessment. A subsurface investigation was conducted by Geocomp as part of their scope for the project to further evaluate the on-site soils and understand their behavior when subjected to seismic loading. The subsurface exploration for the Main Ash Pond consisted of drilling four (4) soil borings using the mud rotary drilling method, and conducting one (1) Seismic Cone Penetration sounding (SCPTu). Standard Penetration Tests (SPT) were performed at select depth. The encountered soils were sampled using split-spoons and undisturbed sampling was also performed using an Osterberg sampler or Shelby tubes. The field testing was performed at the crest and toe of the Main Ash Pond dike between July 17 and August 15, 2015. Samples obtained during the field exploration program were tested in a soil laboratory for classification, static and cyclic strength, and consolidation properties. The laboratory tests were assigned to check field visual classifications, determine maximum past pressures for the native cohesive soils, measure shear strengths, and determine the strength behavior of the natural and man-made deposits for cyclic loading (Geocomp, 2017).

Grouted-in-place vibrating wire piezometer (VWPZ) strings were also installed by Geocomp at location of the analytical cross section (see **Section 4.2**) as part of their subsurface exploration. The multi-level VWPZ strings consisted of multiple vibrating wire pressure transducers attached to a 1-inch diameter hollow PVC tremie pipe at selected depths (Geocomp, 2017).

The geotechnical explorations, laboratory testing, and conclusions presented in this report were used as the basis for this analysis.

4.0 Detailed Task Analysis Criteria

4.1 Material Properties

Based upon the results of historical subsurface explorations, the subsurface conditions encountered at the Main Ash Pond generally consist of starter and raised clay dikes underlain by alluvial clays. The alluvial clays are underlain by shale bedrock. A summary of the subsurface conditions encountered at the Main Ash Pond perimeter dike are summarized in Table 1. A detailed description of the subsurface profile is presented in Geocomp (2017) and Stantec (2010). Soil classifications provided are based on the Unified Soil Classification System (USCS).

Table 1: Generalized Subsurface Conditions

Materials	Approximate Elevation (ft msl)	Apparent Density / Consistency
Raised Dike Clay Fill Material – Dike constructed above and adjacent to the inside of the starter clay dike. Consists of moist, red brown, brown or dark gray lean clay (CL).	Elevation 808.7 to Elevation 796.0	Stiff
Bottom Ash Fill Material – Compacted material consisting of silty, poorly graded sand (SP-SM and SM) as bottom ash with varying amounts of fly ash and organics.	Elevation 794.9 to Elevation 785.1	Medium Dense
Starter Dike Clay Fill Material – Consists primarily of moist, brown and gray lean clay and sandy lean clay (CL).	Elevation 800.8 to Elevation 770.9	Stiff
Alluvial Clay – Consists of moist to wet, brown and dark gray alluvial sandy lean clay (CL).	Elevation 772.5 to Elevation 764.8	Stiff
Gravel Deposit – Consists of wet, brown gray sandy gravel (GP).	Elevation 767.6 to Elevation 766.2	Very Dense
Weathered Shale Bedrock	Elevation 766.2 to Elevation 764.3 (refusal elevation)	--

Material properties for slope stability modeling were primarily based upon historical field and laboratory test results from Geocomp (2017), and employing engineering judgment and local experience. The selection of the shear strength parameters for these materials is provided in AECOM (2018) and a summary of these parameters is provided in **Table 2**.

Table 2: Material Properties for Slope Stability Analysis

Material	Unit Weight (pcf)	Effective (Drained)		Total (Undrained)		Post-Liquefaction	
		c' (psf)	Φ' (°)	c (psf)	Φ (°)	c (psf)	Φ (°)
Sluiced Fly Ash	94	0	28	150	11	Residual Shear Strength Ratio S_r / σ_{vo}' = 0.23	
Raised Dike 1	126	50	35	1,200	0	1,050	0
Raised Dike 2	126	50	35	1,200	0	1,050	0
Bottom Ash Fill	95	0	35	0	35	Residual Shear Strength Ratio, S_r / σ_{vo}' = 0.46	
Starter Dike 1	127	50	30	1,080	0	950	0
Starter Dike 2	127	50	32	1,920	0	1,690	0
Starter Dike 3	127	50	29	1,200	0	1,050	0
Alluvial Clay	124	50	32	800	0	700	0
Rock Buttress	115	0	40	0	40	0	40
Weathered Bedrock	Impenetrable						

The shear strength selection criteria and derivation can be found in the Safety Factor Assessment - Inactive CCR Surface Impoundments - Main Ash Pond, TVA Bull Run Fossil Plant, Rev0 report (AECOM, 2018).

4.2 Selection of Critical Cross Sections

Historic steady-state slope stability models of the Main Ash Pond were available from Stantec (2010) and Geocomp (2017). One (1) analytical cross-section (**Cross Section S-S'**) was previously developed for the Main Ash Pond using the site geometry, material properties, and boundary conditions determined from the field explorations, laboratory testing, and review of historical data. The design cross section was selected to be representative of the most critical dam geometries, such as the maximum embankment height, the steepest embankment slopes, the thickest interval of ash in the foundation, and the least resisting force at and beyond the downstream toe. The existing stability cross section has been reviewed and revised based upon the latest topography and bathymetry data provided by TVA. The location of the cross sections is shown in **Figure 2**.

The summary of the initial safety factor slope stability analyses is provided below in **Table 3**.

Table 3: Initial Safety Factor Slope Stability Results

Cross Section	CCR Unit	CCR Rule Loading Condition	Factor of Safety (Global Failure, Exterior Slope)	Reference
S-S’	Main Ash Pond	Long-Term Maximum Storage Pool	1.74	AECOM (2018)
		Maximum Surcharge Pool	1.69	
		Seismic	1.15	
		Liquefaction	1.86	

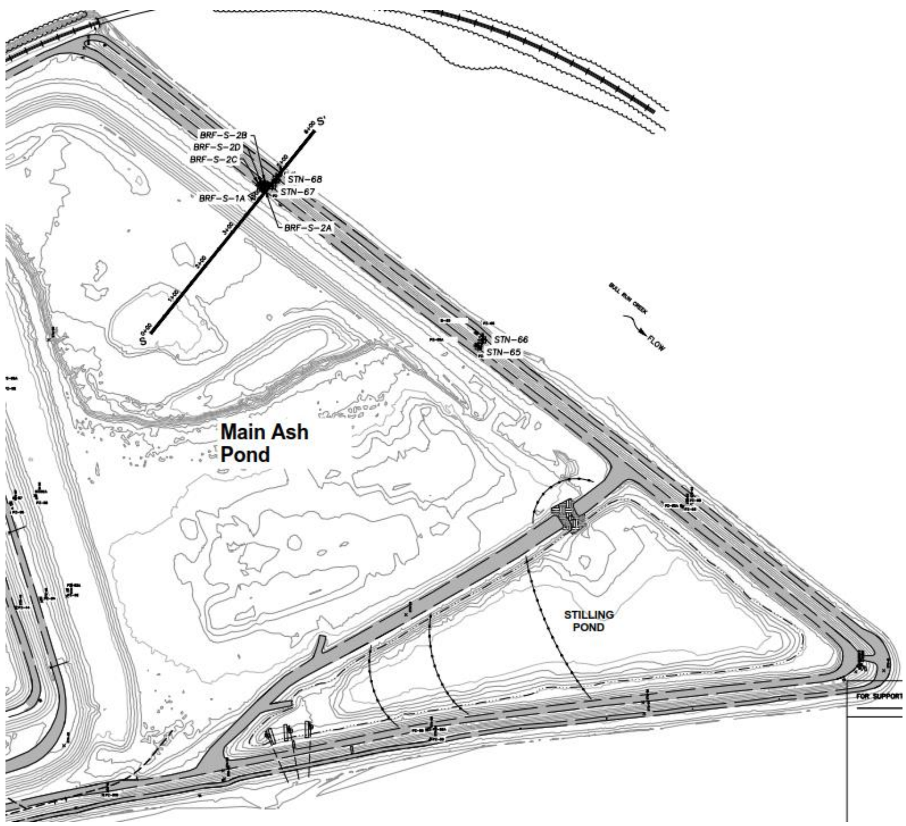


Figure 2: Plan View of Analytical Cross Section

4.3 Water Levels

Based on information reported by Geosyntec (2017), the Process Water Conveyance Channel at **Cross Section S-S'** has an impounded water elevation of 805 ft as estimated by TVA considering an approximate one foot water depth along the Channel. Even though the Main Ash Pond normal pool elevation is approximately at 801 ft (as provided by TVA), AECOM conservatively considered the Process Water Conveyance Channel pool elevation as the normal pool elevation for the Main Ash Pond in the analyses.

For the pond's maximum surcharge pool condition, AECOM assumed it to be at El. 809 ft, which corresponds to the approximate top of the Raised Dike at **Cross Section S-S'**. Further, based on information provided by TVA, AECOM considered a normal pool elevation in Bull Run Creek of El. 795 ft. The piezometric level at the analytical cross section was determined based on multi-level VWPZ strings that were installed by Geocomp (2017) as well as existing open standpipe piezometers which were installed by Stantec (2010).

4.4 Analysis Methodology

The slope stability analysis was performed using SLOPE/W 2016 of the Geostudio suite of programs (version 8.16). The program uses limit equilibrium theory and industry standard procedures to determine factors of safety for failure surface geometries. For the cross section evaluated, circular and block (i.e. non-circular) slip surface geometries were analyzed by defining entry/exit limits or search blocks to develop the failure surfaces. The stability analysis was performed using 2-dimensional limit equilibrium analysis based on the method of slices according to Spencer's Method.

4.4.1 Long-Term Maximum Storage Pool §257.73 (e)(1)(i) per §257.100 (e)(3)(v)

This case models the Main Ash Pond dike under static, long-term conditions, at normal water level within the Main Ash Pond (considered to be at El.805 ft as explained in **Section 4.3**). For this loading condition, drained (effective stress) shear strength parameters were used for all materials. The required minimum factor of safety corresponds to the entry for "Long-Term, Maximum Storage Pool" in **Table 4**.

4.4.2 Maximum Surcharge Pool §257.73 (e)(1)(ii) per §257.100 (e)(3)(v)

This case models the conditions under short-term surcharge pool conditions, with the water level in the Main Ash Pond corresponding to the maximum surcharge pool. For this case, AECOM assumed the maximum surcharge pool to be at El.809 ft, which corresponds to the approximate top of the Raised Dike at **Cross Section S-S'**.

The change in water level from the normal pool case to the maximum surcharge pool condition is relatively small (4 vertical ft). The small effect created by this change is not expected to generate an undrained stress condition in the dikes or the foundation soils. Therefore, drained (effective stress) shear strength parameters were used for all materials under the maximum surcharge pool loading condition as well. The required minimum factor of safety corresponds to the entry for "Maximum Surcharge Pool" loading condition in **Table 4**.

4.4.3 Seismic Factor of Safety §257.73 (e)(1)(iii) per §257.100 (e)(3)(v)

This analysis incorporates a horizontal seismic coefficient, k_h, selected to be representative of expected loading during the design earthquake event (i.e., a "pseudo-static" analysis). The design earthquake event is one with a 2% probability of exceedance in 50 years (approximately 2,500 year recurrence interval), as required by the CCR Rule. Given that earthen structures are expected to have natural frequencies on the order of 1 sec, AECOM selected the horizontal seismic coefficient as the horizontal spectral response acceleration for 1.0-second period (5% of critical damping) at the subject site. This method was also discussed in the CCR Rule under Section III (D)(s)(b)(2) (Seismic Factor of Safety, Page 21316). Using the seismic unified hazard tool available on the United States Geological Survey website (https://earthquake.usgs.gov/hazards/interactive/), AECOM determined that the horizontal spectral response acceleration for 1.0-second period associated with a 2% probability of exceedance in 50 years at the subject site (latitude-longitude coordinates of 35.999482°, -84.154149°) would be 0.104g based on the 2008 hazard curves.

The analyses utilized peak undrained strength parameters for soils that are not considered to be rapidly draining materials (such as the clay fill soils and alluvial clay soils). The phreatic surface and pore water pressures corresponding to the steady-state pool from the static analyses were utilized. The required minimum factor of safety corresponds to the entry for "Seismic Factor of Safety" in **Table 4**.

4.4.4 Liquefaction Factor of Safety §257.73 (e)(1)(iv) per §257.100 (e)(3)(v)

The purpose of the post-liquefaction stability analysis is to assess stability conditions immediately following the design seismic event. No horizontal seismic coefficient is included in these analyses, but selection of strength parameters for the analyses takes into account the potential for the softening/weakening of the soils as a result of pore pressures generated in sand-like materials (sluiced fly ash and bottom ash), or cyclic softening in clay-like materials (raised dike, starter dike and alluvial clay soils) due to the earthquake shaking.

In accordance with the findings of Geocomp (2017), the materials in the raised and starter dikes and the alluvial Clay deposits are considered to exhibit clay-like behavior and, therefore, are not susceptible to liquefaction. Cyclic softening of the clay-like dikes and alluvial clays is expected to occur at or above the maximum design earthquake (MDE) shaking level, with strength reduction of up 12% is expected based on cyclic laboratory tests made on undisturbed samples from the site. The bottom ash fill layer at the base of the raised dike and the retained sluiced fly ash are considered to exhibit sand-like behavior and, therefore, are susceptible to liquefaction. The selection of the shear strength parameters for these materials is provided in AECOM (2018). The required minimum factor of safety corresponds to the entry for "Liquefaction Factor of Safety" in **Table 4**.

4.5 Acceptance Criteria

The following summary is taken from the EPA's CCR Rule §257.7.100(e)(3)(v). The factor of safety assessment criteria are outlined in **Table 4** below.

Table 4: 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) per §257.100 (e)(3)(v)
Maximum Surcharge Pool	1.40	§257.73 (e)(1)(ii) per §257.100 (e) (3)(v)
Seismic Factor of Safety	1.00	§257.73 (e)(1)(iii) per §257.100 (e)(3)(v)
Liquefaction Factor of Safety	1.20	§257.73 (e)(1)(iv) per §257.100 (e)(3)(v)

5.0 Analysis Assumptions

- 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 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 the Main 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 ft vertically below the ground surface.
- The phreatic surfaces were established in the stability models using straight-line interpolation between the pond pool elevation and Bull Run Creek pool elevation.
- The materials in the raised and starter dikes and the foundation alluvial clays would be subjected to cyclic softening due to the design seismic event, and thereby, reducing its undrained shear strength by up to 12% of the peak values in accordance with the findings of Geocomp (2017).
- The bottom ash fill layer at the base of the raised dike and the retained sluiced fly ash are considered to exhibit sand-like behavior and, therefore, are susceptible to liquefaction in accordance with the findings of Geocomp (2017).

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 the Main 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 ft vertically below the ground surface. The detailed graphic output from SLOPE/W is provided in **Appendix A**. A summary of the static and seismic safety factor evaluation results is provided in **Table 5**.

Table 5: Initial Factor of Safety Assessment Results

Facility	Critical Cross Section	Loading Condition	CCR Rule Factor of Safety	Calculated Factor of Safety
Main Ash Pond	S-S'	Long-Term Maximum Storage Pool [§257.73 (e)(1)(i) per §257.100 (e)(3)(v)]	1.50	1.74
		Maximum Surcharge Pool [§257.73 (e)(1)(ii) per §257.100 (e)(3)(v)]	1.40	1.69
		Seismic Factor of Safety [§257.73 (e)(1)(iii) per §257.100 (e)(3)(v)]	1.00	1.15
		Liquefaction Factor of Safety [§257.73 (e)(1)(iv) per §257.100 (e)(3)(v)]	1.20	1.86

7.0 Conclusions

This report documents the static and seismic safety factor evaluation of BRF's Main Ash Pond. The evaluation was performed in accordance with section §257.100 (e)(3)(v) of the CCR Rule. The initial safety factor results for the Main Ash Pond met or exceeded the required safety factors at the cross section 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 the Main Ash Pond meets the initial safety factor requirements of EPA 40 CFR §257.100 (e)(3)(v).

8.0 References

1. AECOM (2018). *Safety Factor Assessment - Inactive CCR Surface Impoundments – Main Ash Pond, TVA Bull Run Fossil Plant, Rev0*. April, 2018.
2. Geocomp Consulting, Inc. (2017). *Tennessee Valley Authority Seismic Assessment Supplemental Site Exploration - Bull Run Fossil Plant Bottom Ash Disposal Area, Gypsum Disposal Area, and Fly Ash Pond Final Report.* September, 2017.
3. Stantec Consulting Services Inc. (2010). *Report of Geotechnical Exploration, Bottom Ash Disposal Area 1, Gypsum Disposal Area 2A, and Fly Ash Pond Area 2, Bull Run Fossil Plant*. April, 2010.

Appendix A

Slope Stability Analysis Results

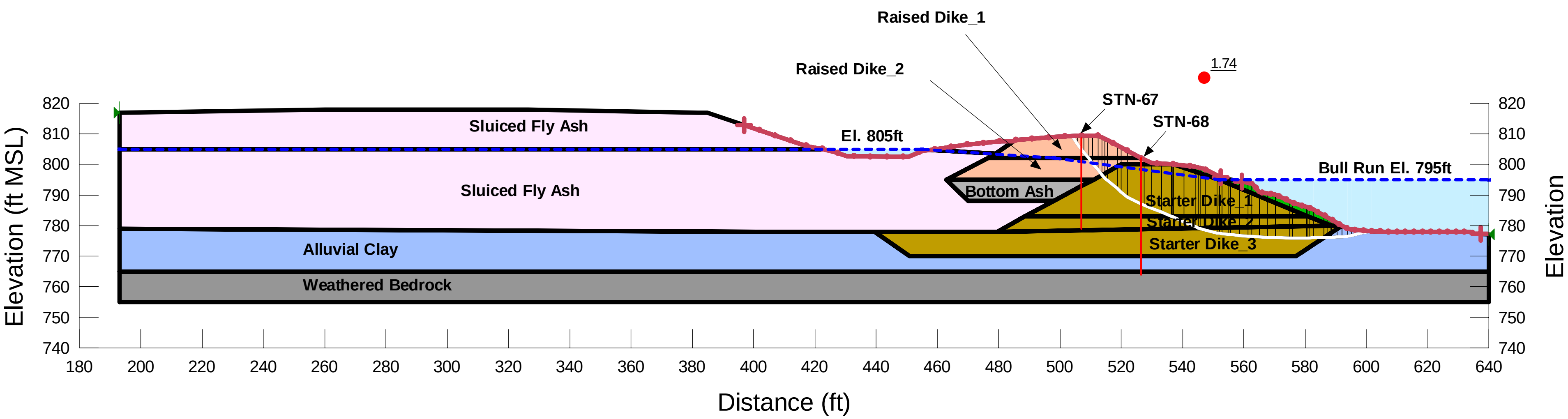
Initial Safety Factor Assessment
Tennessee Valley Authority Bull Run Facility
Main Ash Pond

Cross Section S-S'
Long-Term Max. Storage Pool - Circular Failure

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Alluvial Clay	Mohr-Coulomb	124	50	32
	Bottom Ash	Mohr-Coulomb	95	0	35
	Raised Dike_1	Mohr-Coulomb	126	50	35
	Raised Dike_2	Mohr-Coulomb	126	50	35
	Rock Buttress	Mohr-Coulomb	115	0	40
	Sluiced Fly Ash	Mohr-Coulomb	94	0	28
	Starter Dike_1	Mohr-Coulomb	127	50	30
	Starter Dike_2	Mohr-Coulomb	127	50	32
	Starter Dike_3	Mohr-Coulomb	127	50	29
	Weathered Bedrock	Bedrock (Impenetrable)			

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.74
Minimum Slip Surface Depth: 10 ft



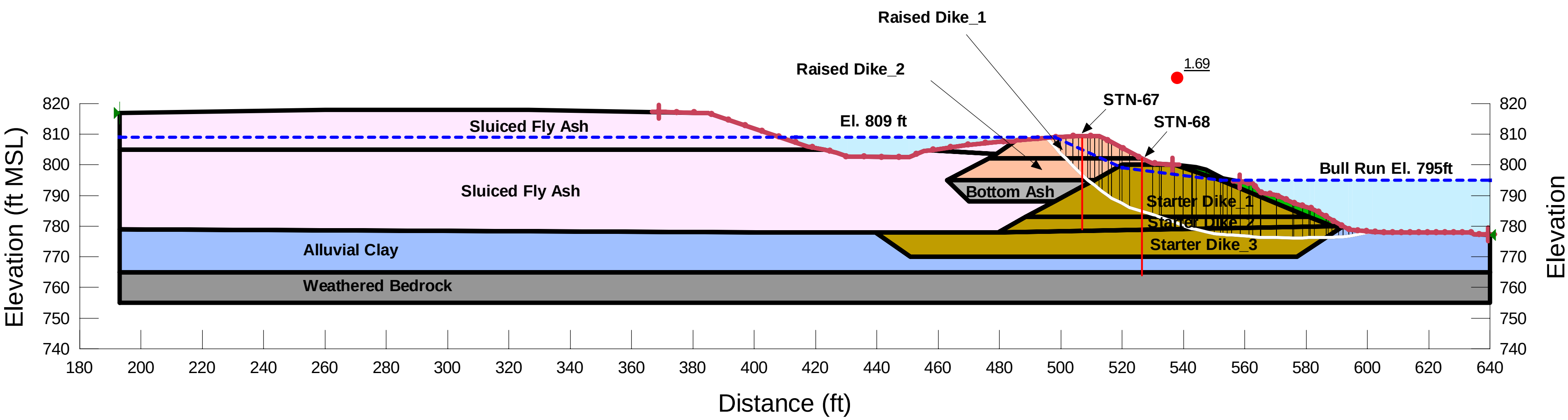
Initial Safety Factor Assessment
Tennessee Valley Authority Bull Run Facility
Main Ash Pond

Cross Section S-S'
Max. Surcharge Pool - Circular Failure

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Alluvial Clay	Mohr-Coulomb	124	50	32
	Bottom Ash	Mohr-Coulomb	95	0	35
	Raised Dike_1	Mohr-Coulomb	126	50	35
	Raised Dike_2	Mohr-Coulomb	126	50	35
	Rock Buttress	Mohr-Coulomb	115	0	40
	Sluiced Fly Ash	Mohr-Coulomb	94	0	28
	Starter Dike_1	Mohr-Coulomb	127	50	30
	Starter Dike_2	Mohr-Coulomb	127	50	32
	Starter Dike_3	Mohr-Coulomb	127	50	29
	Weathered Bedrock	Bedrock (Impenetrable)			

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.69
Minimum Slip Surface Depth: 10 ft



Initial Safety Factor Assessment
Tennessee Valley Authority Bull Run Facility
Main Ash Pond

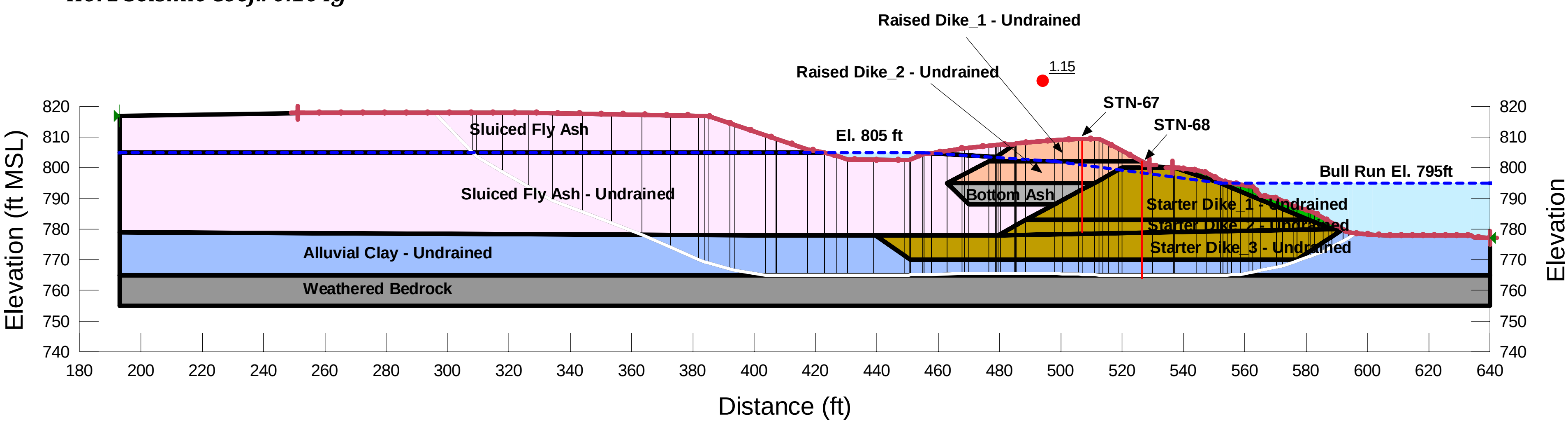
Cross Section S-S'
Seismic Loading Condition - Circular Failure

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Alluvial Clay - Undrained	Mohr-Coulomb	124	800	0
	Bottom Ash	Mohr-Coulomb	95	0	35
	Raised Dike_1 - Undrained	Mohr-Coulomb	126	1,200	0
	Raised Dike_2 - Undrained	Mohr-Coulomb	126	1,200	0
	Rock Buttress	Mohr-Coulomb	115	0	40
	Sluiced Fly Ash	Mohr-Coulomb	94	0	28
	Sluiced Fly Ash - Undrained	Mohr-Coulomb	94	150	11
	Starter Dike_1 - Undrained	Mohr-Coulomb	127	1,080	0
	Starter Dike_2 - Undrained	Mohr-Coulomb	127	1,920	0
	Starter Dike_3 - Undrained	Mohr-Coulomb	127	1,200	0
	Weathered Bedrock	Bedrock (Impenetrable)			

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.15
Minimum Slip Surface Depth: 10 ft

Horz Seismic Coef.: 0.104g



Initial Safety Factor Assessment
Tennessee Valley Authority Bull Run Facility
Main Ash Pond

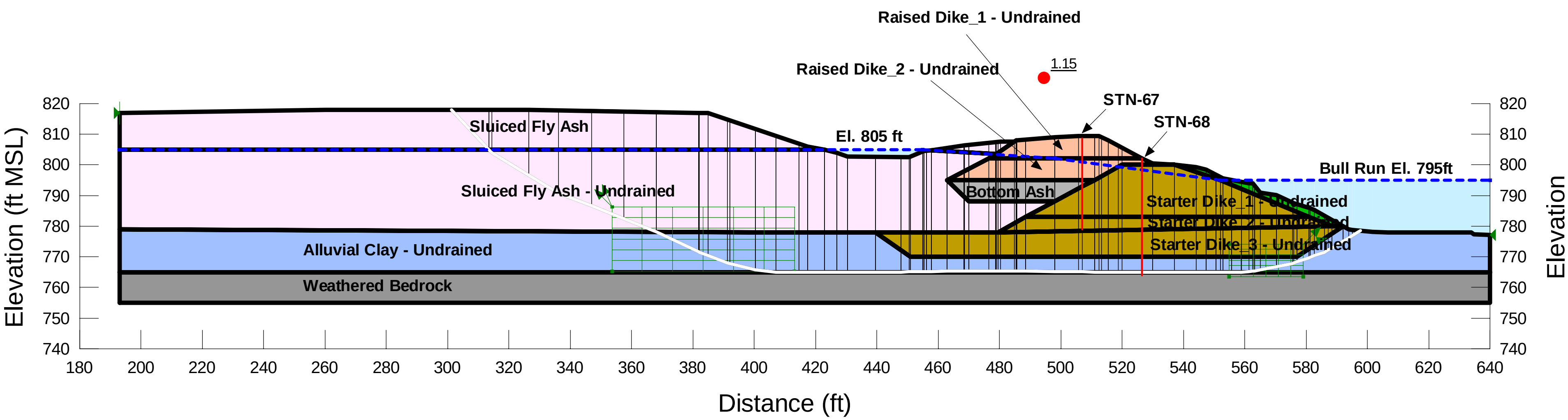
Cross Section S-S'
Seismic Loading Condition - Block Failure

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Alluvial Clay - Undrained	Mohr-Coulomb	124	800	0
	Bottom Ash	Mohr-Coulomb	95	0	35
	Raised Dike_1 - Undrained	Mohr-Coulomb	126	1,200	0
	Raised Dike_2 - Undrained	Mohr-Coulomb	126	1,200	0
	Rock Buttress	Mohr-Coulomb	115	0	40
	Sluiced Fly Ash	Mohr-Coulomb	94	0	28
	Sluiced Fly Ash - Undrained	Mohr-Coulomb	94	150	11
	Starter Dike_1 - Undrained	Mohr-Coulomb	127	1,080	0
	Starter Dike_2 - Undrained	Mohr-Coulomb	127	1,920	0
	Starter Dike_3 - Undrained	Mohr-Coulomb	127	1,200	0
	Weathered Bedrock	Bedrock (Impenetrable)			

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.15
Minimum Slip Surface Depth: 10 ft

Horz Seismic Coef.: 0.104g



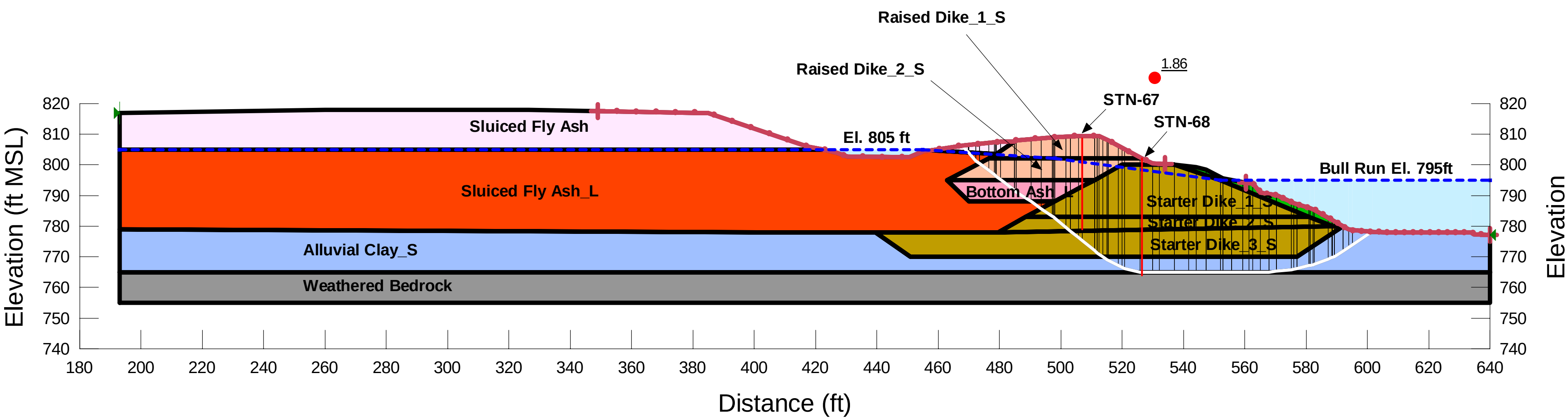
Initial Safety Factor Assessment
Tennessee Valley Authority Bull Run Facility
Main Ash Pond

Cross Section S-S'
Liquefaction Loading Condition - Circular Failure

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Minimum Strength (psf)
	Alluvial Clay_S	Mohr-Coulomb	124	700	0		
	Bottom Ash_L	S=f(overburden)	95			0.46	0
	Raised Dike_1_S	Mohr-Coulomb	126	1,050	0		
	Raised Dike_2_S	Mohr-Coulomb	126	1,050	0		
	Rock Buttress	Mohr-Coulomb	115	0	40		
	Sluiced Fly Ash	Mohr-Coulomb	94	0	28		
	Sluiced Fly Ash_L	S=f(overburden)	94			0.23	0
	Starter Dike_1_S	Mohr-Coulomb	127	950	0		
	Starter Dike_2_S	Mohr-Coulomb	127	1,690	0		
	Starter Dike_3_S	Mohr-Coulomb	127	1,050	0		
	Weathered Bedrock	Bedrock (Impenetrable)					

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 1.86
Minimum Slip Surface Depth: 10 ft



Initial Safety Factor Assessment
Tennessee Valley Authority Bull Run Facility
Main Ash Pond

Cross Section S-S'
Liquefaction Loading Condition - Block Failure

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Minimum Strength (psf)
	Alluvial Clay_S	Mohr-Coulomb	124	700	0		
	Bottom Ash_L	S=f(overburden)	95			0.46	0
	Raised Dike_1_S	Mohr-Coulomb	126	1,050	0		
	Raised Dike_2_S	Mohr-Coulomb	126	1,050	0		
	Rock Buttress	Mohr-Coulomb	115	0	40		
	Sluiced Fly Ash	Mohr-Coulomb	94	0	28		
	Sluiced Fly Ash_L	S=f(overburden)	94			0.23	0
	Starter Dike_1_S	Mohr-Coulomb	127	950	0		
	Starter Dike_2_S	Mohr-Coulomb	127	1,690	0		
	Starter Dike_3_S	Mohr-Coulomb	127	1,050	0		
	Weathered Bedrock	Bedrock (Impenetrable)					

Note:
The results of analysis shown here are based on available subsurface information, laboratory test results and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the borings.

Factor of Safety: 2.16
Minimum Slip Surface Depth: 10 ft