Prepared for

**Dominion**
5000 Dominion Boulevard
Glen Allen, Virginia 23060

# COAL COMBUSTION RESIDUALS STRUCTURAL STABILITY ASSESSMENT

*for*

# VIRGINIA ELECTRIC AND POWER COMPANY CHESTERFIELD POWER STATION LOWER ASH POND CHESTERFIELD COUNTY, VIRGINIA

*Prepared by*

Geosyntec consultants
engineers | scientists | innovators

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MV1373
October 2016

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## 1. CERTIFICATION/STATEMENT OF PROFESSIONAL OPINION

The Structural Stability Assessment (Assessment) for the Chesterfield Power Station Lower Ash Pond was prepared by Geosyntec Consultants, Inc. (Geosyntec). The Assessment was based on certain information that, other than for information Geosyntec originally prepared, Geosyntec has relied on but not independently verified. This Certification/Statement of Professional Opinion is therefore limited to the information available to Geosyntec at the time the Assessment was written. On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the Commonwealth of Virginia that the Assessment has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances, at the same time, and in the same locale. It is my professional opinion that the Assessment was prepared consistent with the requirements of section 257.73 of the United States Environmental Protection Agency's "Disposal of Coal Combustion Residuals From Electric Utilities," published in the Federal Register on April 17, 2015 with an effective date of October 19, 2015 (40 CFR 257 Subpart D).

The use of the words "certification" and/or "certify" in this document shall be interpreted and construed as a Statement of Professional Opinion and is not and shall not be interpreted or construed as a guarantee, warranty or legal opinion.

Geosyntec Consultants, Inc.


Scott Sheridan, P.E.
Principal

Date 10/14/2016

## 2. INTRODUCTION

The Chesterfield Power Station (Station) is owned by Virginia Electric and Power Company d/b/a Dominion Virginia Power (Dominion) and is located in Chesterfield County, Virginia. The Station includes the Lower Ash Pond (LAP) impoundment, which is a component of the Station's wastewater treatment system utilized to manage and settle solids, including CCRs.

The LAP is located on Dominion property at the Chesterfield Power Station in Chesterfield County, Virginia (coordinates 37.3737° North and 77.3795° West) and is bounded by the Old Channel of the James River and the Upper Pond to the south, Henricus Park Road to the east, Coxendale Road to the north, and the thermal channel to the west.

The LAP is regulated as an existing CCR surface impoundment under the Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" [40 CFR 257 Subpart D] published in the Federal Register on April 17, 2015 with an effective date of October 19, 2015 (CCR Rule). The LAP is also regulated as a dam by the Virginia Department of Conservation and Recreation (DCR) with Inventory Number 00823 (DCR Dam Permit).

## 3. PURPOSE

This CCR Structural Stability Assessment (Assessment) is prepared pursuant to the requirements in the CCR Rule, § 257.73(d)(1) [40 CFR § 257.73(d)(1)].

## 4. STRUCTURAL STABILITY ASSESSMENT REQUIREMENTS

In accordance with § 257.73(d)(1), a CCR surface impoundment owner or operator is required to conduct initial and periodic structural stability assessments to establish whether the CCR unit can safely store the maximum volume of CCR and CCR wastewater "which can be impounded therein". The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with:

- Stable foundations and abutments (Section 5.1);
- Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown (Section 5.2);

- [Embankments] mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit (Section 5.3);
- Vegetated slopes of [embankments] and surrounding areas not to exceed a height of six inches above the slope of the [embankment], except for slopes which have an alternate form or forms of slope protection (Section 5.4);
- A single spillway or a combination of spillways designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the 1000-year flood for a significant hazard potential CCR surface impoundment (Section 5.5);
- Hydraulic structures underlying the base of the CCR unit or passing through the [embankment] of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure (Section 5.6); and
- For CCR units with downstream slopes, which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body (Section 5.7).

## 5. STRUCTURAL STABILITY ASSESSMENT

The following sections address the requirements listed in Section 4.

### 5.1 Stable Foundations

The material underlying the LAP, comprising the embankment foundation, is addressed in the Field Investigation and Laboratory Testing Report (Geosyntec, 2016a). The embankment foundation is constructed of material excavated from within the LAP footprint and meets the factor of safety requirements in CCR Rule § 257.73(e)(1) (limits of 1.50 for the long-term, maximum storage pool loading condition, 1.40 for the maximum surcharge pool loading condition, 1.00 for the seismic factor of safety, and 1.20 for liquefaction).

Additionally, the LAP has been routinely inspected and monitored by Station personnel and Dominion personnel in accordance with the requirements in the DCR Dam Permit. Areas of concern have been evaluated by professional engineers with corrective actions proposed and documented. It is Geosyntec's opinion that foundations are stable, and signify that the foundations were constructed, designed and maintained to be stable.

The LAP is surrounded by an embankment on the east, south, and west sides. The north side of the LAP was constructed by excavating a cut slope along the road, and fill was not placed to create an embankment. Therefore abutments are located on the eastern and western ends of the north side of the LAP.

### 5.2 Slope Protection

The external LAP embankment slopes are either vegetated or covered with rip rap to protect against erosion. Internal LAP embankment slopes are vegetated.

Dominion performed annual inspections in accordance with the requirements of the DCR Dam Permit with the most recent inspections on November 19, 2014 (Dominion, 2014) and June 12, 2015 (Dominion, 2015). As part of the inspections, Dominion evaluated the vegetation on the slopes of the impoundment embankment. The slope vegetation and riprap were noted to be in good condition for the upstream slope of the dam embankment (near the outfall structure), and the downstream slopes of the embankment were observed to be stable, well vegetated, and well maintained. The inspection states that the embankment slopes are well maintained. Geosyntec also evaluated the slope vegetation and riprap and found them to be in good condition.

It is Geosyntec's opinion that the embankment slope protection is stable, and signifies that the embankment slope protection was designed, constructed, and maintained to be stable.

### 5.3 Embankment Compaction

Cone penetrometer testing through the embankment (Geosyntec, 2016a) were used to evaluate embankment compaction. Cone penetrometer soundings in the embankment were used to estimate the in-place total unit weight of the embankment fill. On average the top 10 feet of the embankment is characterized by a total unit weight of 120 pounds per cubic feet (pcf) and the lower 10 feet is characterized by a total unit weight of 115 pcf. Silty sands and sandy silts, characteristic of the embankment fill, exhibit an average total unit weight of 120 pcf. Therefore the embankment compaction on average ranges from 93 to 100 percent. In addition, standard penetration test blow counts indicated that the relative density of the embankment fill varies from loose to dense. Slope stability analyses presented in the Safety Factor Assessment (Geosyntec, 2016b) present the embankments to be stable; therefore, it is Geosyntec's opinion that the embankment compaction is sufficient and was constructed and maintained to be stable.

From this evaluation and the results of the stability analyses (Geosyntec, 2016b), Geosyntec's opinion is that the embankment compaction is designed, constructed, operated, and maintained to be stable.

### 5.4 Vegetated Slopes

As required by § 257.73(d)(1)(iv), vegetation on slopes and surrounding areas cannot exceed six inches in height. Current operations at the LAP, as regulated by the VPDES Permit, call for grass to be mowed 2-3 times per year to control vegetation height (VPDES Permit No. VA004146 and DCR Operations and Maintenance Certificate). The vegetated slopes are operated and maintained to be stable and to provide for visual observation of any instability. An inspection on June 12, 2015 (Dominion, 2015) noted that the upstream and downstream slopes of the embankment showed no erosion or woody vegetation, and that the slopes are mowed twice per year.

### 5.5 Spillway Capacity and Underlying Hydraulic Structures

The LAP outflow is controlled by a concrete discharge structure and an emergency spillway, both located near the southwestern corner of the LAP. The two stage riser structure has as its first stage a 6.25 feet by 0.8 feet weir opening at elevation 15.8 feet. The second stage is a horizontal grated opening at the 17.2 feet (the top of the riser) with dimensions of 5.9 feet by 5.4 feet. The riser feeds in to a 27-inch inside diameter steel and concrete pipe approximately 90 feet long, with an upstream invert elevation of 9.4 feet and a downstream invert elevation at 6.8 feet (Schnabel, 2015). This pipe discharges into Farrar Gut and is designated Outfall 004 under VPDES permit number VA0004146. A six-inch-deep, 40-foot-long emergency spillway is located over the discharge pipe. The bottom of the spillway sits at an elevation of 18 feet. The "Annual Inspection Report for Virginia Regulated Impounding Structures" from June 2015 states that there is no deterioration, leakage, or obstruction to the outfall structure (Dominion, 2015).

The Inflow Design Flood Control System Plan (Geosyntec, 2016c) contains routing calculations as part of a hydraulic capacity assessment, and demonstrates that the spillway adequately manages the peak discharge from the 1,000-year flood.

It is Geosyntec's opinion that the spillway system in the LAP was designed, constructed, operated, and maintained to be stable.

### 5.6 Adjacent Water Bodies

The downstream slopes of the embankment on the southwestern side of the LAP are bordered by an old channel of the James River that is currently a backwater area called Farrar Gut. Rapid drawdown of Farrar Gut is not anticipated during normal conditions; however, rapid drawdown may occur after a flood event. A rapid drawdown stability assessment was conducted on the LAP embankment facing Farrar Gut and the results are included in Appendix A. In order to determine the maximum water surface elevation at which the rapid drawdown would commence a hydraulic model of a 100-year flood event was conducted (Geosyntec, 2016d). The maximum water surface elevation was estimated to be 15.9 feet. The minimum allowable factor of safety for a rapid drawdown condition is 1.2 (USACOE, 2003). With a starting water surface elevation on the outside slope of the embankment of 15.9 feet, the minimum rapid drawdown factor of safety is 1.4 which is greater than the minimum allowable factor of safety.

## 6. CORRECTIVE MEASURES

Corrective measures are not required.

## 7. CONCLUSION

It is Geosyntec's opinion, based on a review of available material and additional analyses performed for this Assessment, that the LAP surface impoundment design, construction, and operations and maintenance procedures are consistent with good engineering practices for the volume of CCR and CCR wastewater contained within the LAP.

## 8. REFERENCES

Dominion, Annual Inspection Report for Virginia Regulated Impounding Structures, Chesterfield Power Station Lower Ash Pond Dam. 2014.

Dominion, Annual Inspection Report for Virginia Regulated Impounding Structures, Chesterfield Power Station Lower Ash Pond Dam. 2015.

Geosyntec Consultants, Field Investigation and Laboratory Testing Report, 2016a.

Geosyntec Consultants, Safety Factor Assessment Report, 2016b.

Geosyntec Consultants, Inflow Design Flood Control Report, 2016c.

Schnabel Engineering, Dam Breach Analysis Report and Inundation Mapping, Chesterfield Lower Ash Pond. 2015.

USACOE, Engineering and Design: Slope Stability, EM 1110-2-1902, U.S. Army Corps of Engineer, Washington, D.C. 2003.

Virginia DCR Dam Permit, Inventory No. 00823

# APPENDIX A

# RAPID DRAWDOWN ANALYSIS RESULTS


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## LEGEND

- B-1A – EXISTING SPT
- GSB-1 – AS-BUILT GEOSYNTEC LAP SPT
- GSB-12 – AS-BUILT GEOSYNTEC LVWWTS SPT
- GSC-1 – AS-BUILT GEOSYNTEC LAP CPT
- GSC-1F – AS-BUILT GEOSYNTEC LAP FFP CPT

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SCALE IN FEET

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DOMINION VIRGINIA POWER
CHESTERFIELD POWER STATION
CHESTER, VIRGINIA

TITLE: CROSS SECTION LOCATIONS

PROJECT: LOWER ASH POND - CCR RULE REQUIREMENTS

SITE: CHESTERFIELD POWER STATION
CHESTER, VIRGINIA

| | | | |
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| DESIGNED BY: KGW | DATE: September 2016 | | |
| DRAWN BY: JOC | PROJECT NO.: MV1373-08 | | |
| CHECKED BY: KGW | FILE: | | |
| REVIEWED BY: | | | |
| APPROVED BY: | FIGURE NO.: 1 | | |

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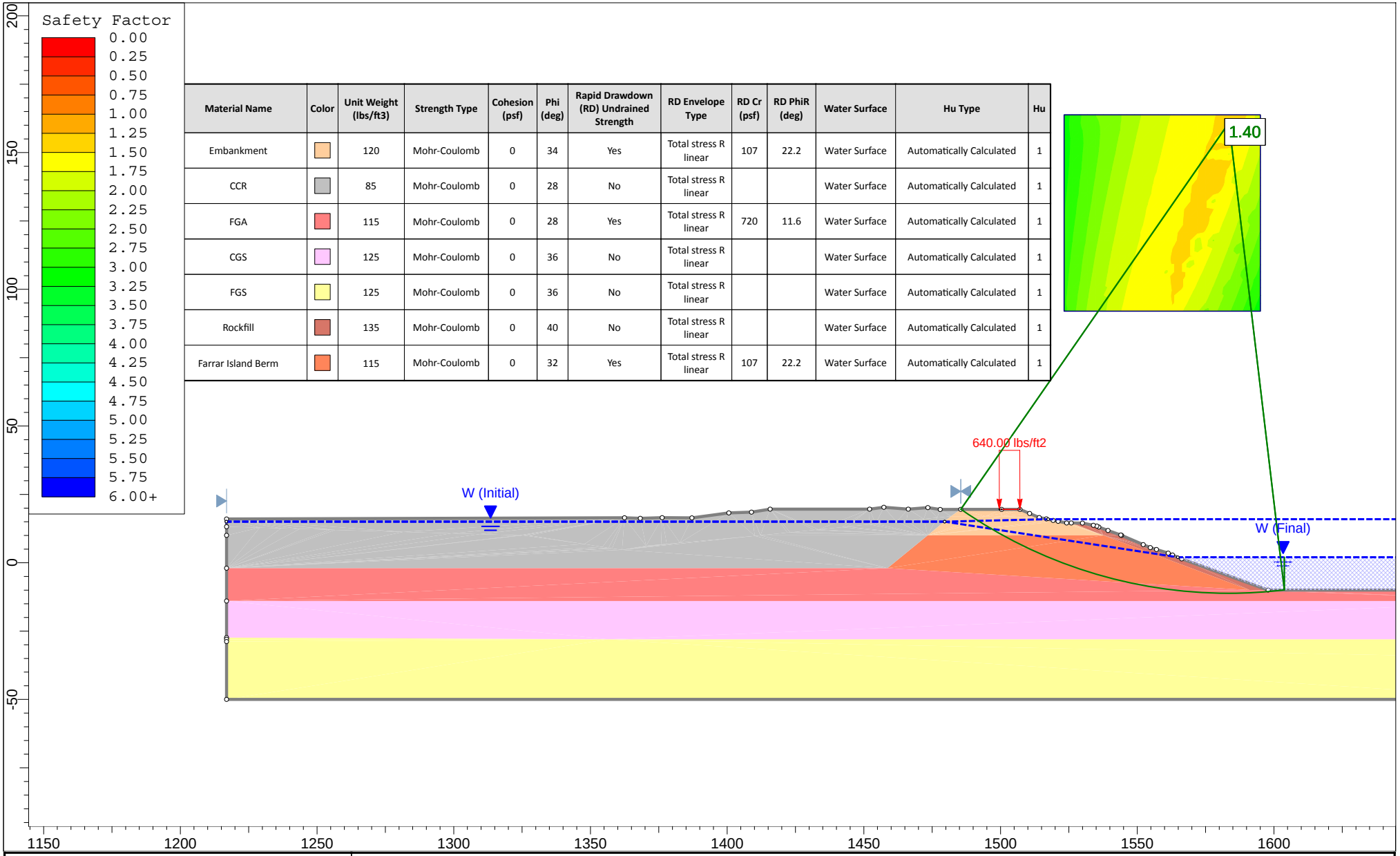


| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Rapid Drawdown (RD) Undrained Strength | RD Envelope Type | RD Cr (psf) | RD PhiR (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Embankment | | 120 | Mohr-Coulomb | 0 | 34 | Yes | Total stress R linear | 107 | 22.2 | Water Surface | Automatically Calculated | 1 |
| CCR | | 85 | Mohr-Coulomb | 0 | 28 | No | Total stress R linear | | | Water Surface | Automatically Calculated | 1 |
| FGA | | 115 | Mohr-Coulomb | 0 | 28 | Yes | Total stress R linear | 720 | 11.6 | Water Surface | Automatically Calculated | 1 |
| CGS | | 125 | Mohr-Coulomb | 0 | 36 | No | Total stress R linear | | | Water Surface | Automatically Calculated | 1 |
| FGS | | 125 | Mohr-Coulomb | 0 | 36 | No | Total stress R linear | | | Water Surface | Automatically Calculated | 1 |
| Rockfill | | 135 | Mohr-Coulomb | 0 | 40 | No | Total stress R linear | | | Water Surface | Automatically Calculated | 1 |
| Farrar Island Berm | | 115 | Mohr-Coulomb | 0 | 32 | Yes | Total stress R linear | 107 | 22.2 | Water Surface | Automatically Calculated | 1 |

| | | | |
|---|---|---|---|
| *Project* | Chesterfield Power Station - Lower Ash Pond | | |
| *Analysis Description* | Cross Section E - Rapid Drawdown | | |
| *Drawn By* | CL | *Scale* 1:582 | *Company* Geosyntec Consultants |
| *Date* | 09/29/2016 | | *File Name* Cross Section E - Rapid drawdown.slim |

SLIDEINTERPRET 6.019