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# Coal Combustion Residuals Unit Structural Stability Assessment

Virginia Electric and Power Company  
Chesterfield Power Station  
Upper (East) Pond  
Chesterfield County, Virginia

GAI Project Number: C1500035.00

October 2016



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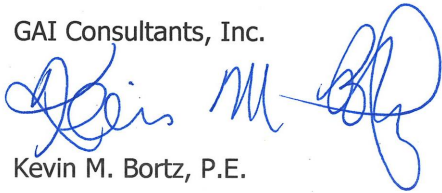
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## Certification/Statement of Professional Opinion

This Structural Stability Assessment (Assessment) for the Chesterfield Power Station Upper (East) Pond was prepared by GAI Consultants, Inc. (GAI). The Assessment was based on certain information that, other than for information GAI originally prepared, GAI has relied on but not independently verified. This Certification/Statement of Professional Opinion is therefore limited to the information available to GAI 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 § 257.73(d) of the United States Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," 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.

GAI Consultants, Inc.



Kevin M. Bortz, P.E.

Assistant Engineering Manager

Date 10/13/2016



## Acronyms

Assessment	Coal Combustion Residuals Structural Stability Assessment
CCR	Coal Combustion Residuals
CCR Rule	"Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" 40 CFR 257 Subpart D (2015)
CFR	Code of Federal Regulations
DCR	Virginia Department of Conservation and Recreation
DCR Dam Permit	Virginia Department of Conservation and Recreation Dam Permit for Dam Inventory No. 04145
DEQ	Virginia Department of Environmental Quality
Dominion	Virginia Electric and Power Company d/b/a Dominion
EPA	United States Environmental Protection Agency
GAI	GAI Consultants, Inc.
IDFCSP	Inflow Design Flood Control System Plan
Station	Dominion Chesterfield Power Station
UEP	Upper (East) Pond
VPDES	Virginia Pollutant Discharge Elimination System
VPDES Permit	Virginia Pollutant Discharge Elimination System Permit No. VA0004146

## 1.0 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, VA. The station includes the Upper (East) Pond (UEP) impoundment, which is used for the long term storage of coal combustion residuals (CCR).

The UEP is located on Dominion property at the Chesterfield Power Station in Chesterfield County, Virginia (coordinates 37° 22' 15.2" North and 77° 22' 8.3" West) and is bounded by the Old Channel of the James River on the south, Henricus Historical Park on the east, and Aiken Swamp on the north.

The UEP 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 UEP is also regulated as a dam by the Virginia Department of Conservation and Recreation (DCR) with Inventory Number 04145 (DCR Dam Permit).

## 2.0 Purpose

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

## 3.0 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;
- ▶ Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;
- ▶ [Embankments] mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;
- ▶ 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;
- ▶ 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 1,000-year flood for a significant hazard potential CCR surface impoundment.
- ▶ 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; 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.

## 4.0 Structural Stability Assessment

This Assessment is based on a review of material as noted, and on additional analyses performed for this Assessment.

### 4.1 Stable Foundations

Material underlying the UEP, comprising the embankment foundation, is discussed in the UEP's *History of Construction* (GAI, 2016a). GAI analyses of embankment stability (Virginia Department of Environmental Quality (DEQ) VPDES Permit No. VA0004146; Dominion, 2016) show that the UEP meets the factor of safety requirements in CCR Rule § 257.73(e)(1), exceeding the minimum values 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 UEP has been routinely inspected and monitored by Station personnel and Dominion personnel (Dominion, 2014) in accordance with the requirements in the DCR Dam Permit, and no foundation instability has been reported. Based on the analyses and inspections, it is GAI's opinion that foundations are stable, and signify that the foundations were designed, constructed, operated, and maintained to be stable.

The UEP is surrounded completely by its embankment. There are no abutments.

### 4.2 Slope Protection

The external UEP embankment slopes are vegetated to protect against erosion. Internal UEP embankment slopes are vegetated with the exception of concrete-lined perimeter stormwater runoff drainage channels and riprap wave protection within the stormwater sediment pond situated at the eastern end of the UEP.

Dominion performed an annual inspection in accordance with the requirements of the DCR Dam Permit on July 9, 2014 (Dominion, 2014). As part of this inspection, Dominion evaluated the vegetation on the slopes of the impoundment embankment. The slope vegetation above the riprap was noted to be in good condition for the upstream slope of the dam embankment (near the outfall structure), and the downstream slopes of the north embankment were observed to be stable, well vegetated, and well maintained. The inspection states that the embankment slopes are well maintained. An inspection performed on July 28, 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 a year.

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

### 4.3 Embankment Compaction

Borings drilled through the embankment (Schnabel, 2014) were used to estimate embankment compaction. During drilling, Standard Penetration Testing resistance was measured and compared to the estimated relative density of the embankment. This correlation ranges from 70 percent near the crest of the embankment to 100 percent at increasing depths. From this evaluation and the results of the stability analyses (DEQ VPDES Permit No. VA0004146; Dominion, 2016), GAI's opinion is that the embankment compaction was designed, constructed, operated, and maintained to be stable.

### 4.4 Vegetated Slopes

CCR Rule § 257.73(d)(1)(iv) currently states that vegetation on slopes and surrounding areas cannot exceed six inches in height. The EPA is seeking *remand with vacatur* of the vegetation height restriction. Current operations at the UEP, as regulated by the VPDES Permit, call for grass to be mowed 2-3 times per year to control vegetation height (DEQ VPDES Permit No. VA0004146). The

vegetated slopes are operated and maintained to be stable and to provide for visual observation of any instability.

#### **4.5 Spillway Capacity and Underlying Hydraulic Structures**

The UEP spillway is situated in the stormwater sediment pond and is controlled by a 6 foot by 6 foot concrete riser tower with six 16-inch diameter orifice openings. The tower is drained by a 24-inch diameter concrete pipe that discharges to VPDES Permit Outfall 005. The "Report of 2014 Safety Inspection" for the Chesterfield Power Station Upper Ash Pond Dam stated that "the sediment pond and outfall (discharge) structure at the east end of the facility are ...in very good condition" (Dominion, 2014). The "Annual Inspection Report for Virginia Regulated Impounding Structures" from July 2015 states that there is no deterioration, leakage, or obstruction to the outfall structure (Dominion, 2015).

The Inflow Design Flood Control System Plan (IDFSCP) (GAI, 2016b) 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. The IDFSCP also demonstrates that interior perimeter channels and culverts that maintain structural integrity of the UEP embankment adequately manage the peak discharge from the 1,000-year flood.

It is GAI's opinion that the spillway system and underlying hydraulic structures in the UEP were designed, constructed, operated, and maintained to be stable.

#### **4.6 Adjacent Water Bodies**

The downstream slopes of the embankment surrounding the UEP are subject to inundation by the James River. A rapid drawdown stability assessment was conducted on the UEP embankment facing the James River using the 100-year flood level in the James River. The target factor of safety for a rapid drawdown condition is 1.2 (U.S. Army Corps of Engineers, 2003). The rapid drawdown factor of safety for this condition is 1.55, meeting the target factor of safety. Calculations are included in Appendix A.

### **5.0 Corrective Measures**

Based on a review of available material and additional analyses performed for this Assessment, at this time no deficiencies were detected in the structural stability analysis of the UEP and no corrective measures are required.

### **6.0 Conclusion**

It is GAI's opinion, based on a review of available material and additional analyses performed for this Assessment, that the UEP surface impoundment design, construction, and operations and maintenance procedures are consistent with good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded and meet the requirements of 40 CFR 257.73(d).

## 7.0 References

- Dominion. 2014. *Report of 2014 Safety Inspection, Chesterfield Power Station Upper Ash Pond Dam.* -
- Dominion. 2015. *Annual Inspection Report For Virginia Regulated Impounding Structures.* -
- Dominion. 2016. Application for Virginia Department of Environmental Protection Solid Waste Permit - Number 619. January 2016.
- GAI Consultants Inc. 2015. *Dominion Chesterfield Power Station, Upper (East) Pond-Max Drawdown-Stability.*
- GAI Consultants Inc. 2016a. *Coal Combustion Residuals History of Construction, Upper (East) Pond, Chesterfield Power Station, Chesterfield County, Virginia.* October 2016.
- GAI Consultants Inc. 2016b. *Coal Combustion Residuals Inflow Design Flood Control System Plan, Upper (East) Pond, Chesterfield Power Station, Chesterfield County, Virginia.* October 2016.
- Tuck Mapping. 2016. March 3, 2016.
- United States Army Corps of Engineers. 2003. *Engineering and Design Slope Stability.* Manual No. 1110-2-1902.
- United States Environmental Protection Agency. 2015. *40 CFR Parts 257 and 261 Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule.* April 17, 2015.
- Virginia DCR Dam Permit. Inventory No. 04145.
- Virginia Power. 1992. *New Ash Pond Stop Log Conversion, DCR-91-20,* January 1992.
- Virginia VPDES Permit No. VA0004146. *Revised Closure Plan, Upper (East) Pond, September 2003.*



## **APPENDIX A**

### **Slope Stability Assessment with Adjacent Water Bodies**

SUBJECT: \_\_\_\_\_ CHESTERFIELD POWER STATION – RAPID DRAWDOWN ANALYSIS

BY \_\_\_\_\_ TIM \_\_\_\_\_ DATE \_\_\_\_\_ 06/14/16 \_\_\_\_\_ PROJ. NO. \_\_\_\_\_ C150035.00 \_\_\_\_\_

CHKD. BY \_\_\_\_\_ KRH \_\_\_\_\_ DATE \_\_\_\_\_ 06/21/16 \_\_\_\_\_ SHEET NO. \_\_\_\_\_ 1 \_\_\_\_\_ OF 6 \_\_\_\_\_



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## **OBJECTIVE:**

To evaluate the stability of the downstream portion of the embankment surrounding Dominion's Chesterfield Upper (East) Pond (UEP) Coal Combustion Residual storage facility at Chesterfield Power Station, Chesterfield County, Virginia. A rapid drawdown of the James River will be evaluated. The target factor of safety for a rapid drawdown condition is 1.2.

## **METHODOLOGY:**

Evaluate stability using two-dimensional limit equilibrium analysis with the software program SLOPE/W and the Morgenstern-Price Method. The analysis will be run based on conditions outlined in the CCR Rule (Reference 1).

## **REFERENCES:**

1. United States Environmental Protection Agency, 2015. *40 CFR Parts 257 Subpart D. Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments; Final Rule.* April 17, 2015.
2. Schnabel Engineering Associates, *Geotechnical Engineering and Groundwater Hydrology Services, Ash Disposal Pond, Chesterfield Power Station;* December 20, 1982.
3. Schnabel Engineering Associates, Inc. *Geotechnical Engineering Report: Upper Pond Stability Evaluation,* August 2014.
4. GAI Consultants Inc., 2003. *"Revised Closure Plan Upper (East) Pond, Chesterfield Power Station, Chesterfield County, Virginia."* September 2003.
5. United States Army Corps of Engineers Slope Stability Engineering Manual, EM 1110-2-1902, 2003.

## **BACKGROUND:**

In accordance with §257.74(d)(1)(vii), "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.

The downstream slope of the embankment is adjacent to the James River. The critical section is located in the southern area of the UEP near VPDES Outfall 005, including the sediment pond. The CCR does not state a target factor of safety for a rapid drawdown analysis. GAI will use Reference 5 to provide the target factor of safety of 1.2.

## **ANALYSIS:**

Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) No. 514041C0351D (effective December 18, 2012) shows that the area bordering the UEP is designated as Zone A, which is an approximate study area subject to inundation by the 100-year

SUBJECT: \_\_\_\_\_ CHESTERFIELD POWER STATION – RAPID DRAWDOWN ANALYSIS

BY \_\_\_\_\_ TIM \_\_\_\_\_ DATE \_\_\_\_\_ 06/14/16 \_\_\_\_\_ PROJ. NO. \_\_\_\_\_ C150035.00 \_\_\_\_\_

CHKD. BY \_\_\_\_\_ KRH \_\_\_\_\_ DATE \_\_\_\_\_ 06/21/16 \_\_\_\_\_ SHEET NO. \_\_\_\_\_ 2 \_\_\_\_\_ OF 6 \_\_\_\_\_



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(or 1% annual recurrence) flood. The FIRM mapping shows that the 100-year water surface elevation can be estimated to be approximately elevation 19 feet. To model a rapid drawdown condition, the phreatic surface was set at the ground surface on the downstream side of the embankment. The phreatic surface used in the sediment pond is the normal pool elevation, which is equal to elevation 28.33 feet. Material strengths and parameters used in the analyses were obtained and/or developed from subsurface explorations and laboratory testing done by Schnabel (References 2 and 3) or parameters used in the 2003 Closure Plan, submitted by GAI (Reference 4).

Soil Type	$\gamma_T$ (pcf)	c=c' (psf)	$\phi=\phi'$ (Degrees)
Saturated CCR	90	0	24
Fill	125	0	30
Alluvium	120	0	30
SM-SC	135	0	35

The factor of safety for the embankment of the UEP under a rapid drawdown condition is equal to 1.55, which exceeds the target factor of safety of 1.2. Stability run is included in Attachment 1.

**SUMMARY:**

GAI performed a rapid drawdown analysis for the Structural Stability Assessment in accordance with the CCR Rule. The phreatic surface of the James River was based on the 100 year flood elevation. Stability runs are included as Attachment 1.

Based on the conditions in the CCR Rule, the UEP meets or exceeds the required factors of safety for a rapid drawdown condition.



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# **ATTACHMENT 1**

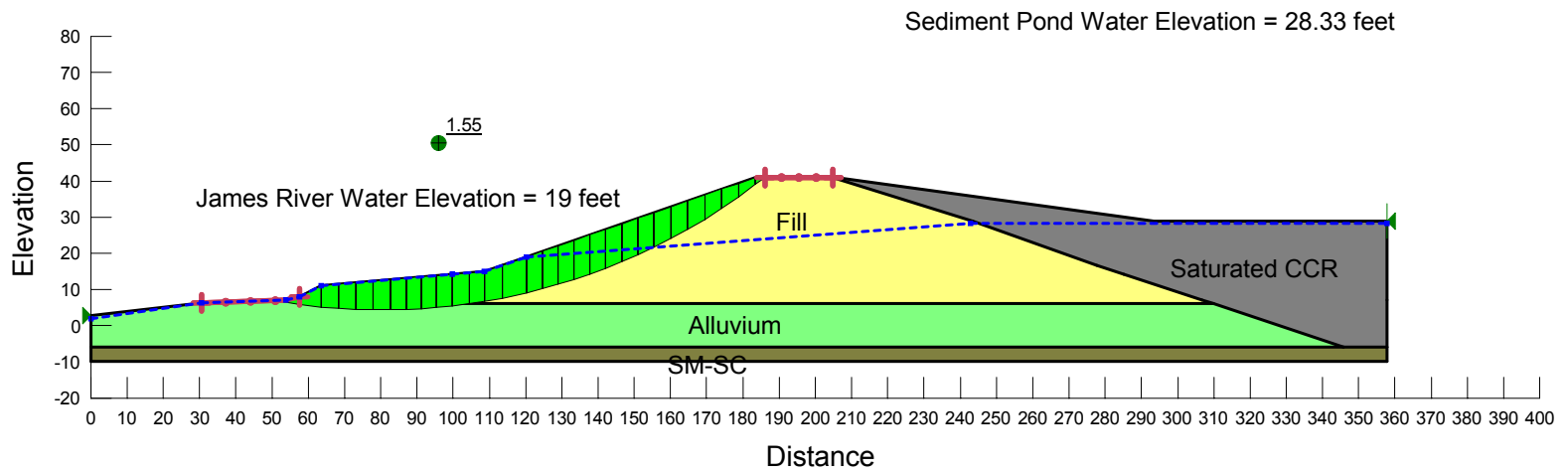
## **STABILITY ANALYSIS RESULTS**

Horizontal Scale: 500  
Vertical Scale: 500

Chesterfield Upper (East) Pond  
Structural Stability Assessment  
Rapid Drawdown  
South Dike  
C150035.00

By: TIM 6/6/2016  
Ckd: KRH 6/22/2016  
4/6

Name: Saturated CCR Unit Weight: 90 pcf Cohesion: 0 psf Phi: 24 °  
Name: Fill Unit Weight: 125 pcf Cohesion: 0 psf Phi: 30 °  
Name: Alluvium Unit Weight: 120 pcf Cohesion: 0 psf Phi: 30 °  
Name: SM-SC Unit Weight: 135 pcf Cohesion: 0 psf Phi: 35 °

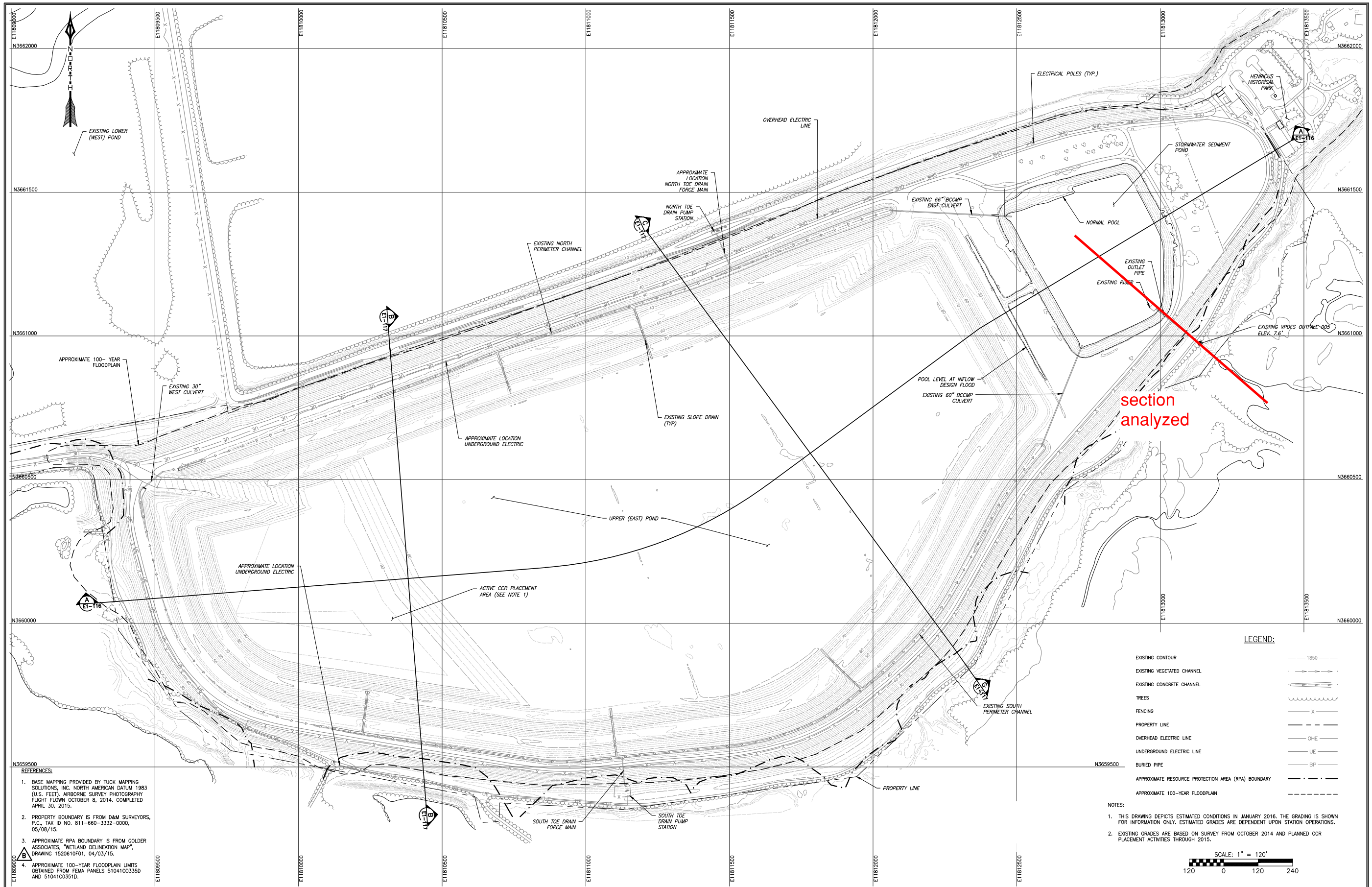




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# **ATTACHMENT 2**

## **DRAWINGS**

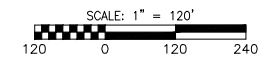


section analyzed

LEGEND:

- EXISTING CONTOUR ——— 1850 ———
- EXISTING VEGETATED CHANNEL ———
- EXISTING CONCRETE CHANNEL ———
- TREES ———
- FENCING LINE ——— X ———
- PROPERTY LINE ———
- OVERHEAD ELECTRIC LINE ——— OHE ———
- UNDERGROUND ELECTRIC LINE ——— UE ———
- BURIED PIPE ——— BP ———
- APPROXIMATE RESOURCE PROTECTION AREA (RPA) BOUNDARY ———
- APPROXIMATE 100-YEAR FLOODPLAIN ———


- NOTES:
- THIS DRAWING DEPICTS ESTIMATED CONDITIONS IN JANUARY 2016. THE GRADING IS SHOWN FOR INFORMATION ONLY. ESTIMATED GRADES ARE DEPENDENT UPON STATION OPERATIONS.
  - EXISTING GRADES ARE BASED ON SURVEY FROM OCTOBER 2014 AND PLANNED OCR PLACEMENT ACTIVITIES THROUGH 2015.



- REFERENCES:
- BASE MAPPING PROVIDED BY TUCK MAPPING SOLUTIONS, INC. NORTH AMERICAN DATUM 1983 (U.S. FEET). AIRBORNE SURVEY PHOTOGRAPHY FLIGHT FLOWN OCTOBER 8, 2014. COMPLETED APRIL 30, 2015.
  - PROPERTY BOUNDARY IS FROM D&M SURVEYORS, P.C., TAX ID NO. 811-660-3332-0000, 05/08/15.
  - APPROXIMATE RPA BOUNDARY IS FROM COLDER ASSOCIATES, "WETLAND DELINEATION MAP", DRAWING 1520610F01, 04/03/15.
  - APPROXIMATE 100-YEAR FLOODPLAIN LIMITS OBTAINED FROM FEMA PANELS 51041C0335D AND 51041C0351D.

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION:
REVISION RECORD					
This drawing was produced with computer aided drafting technology and is supported by electronic drawing files. Do not revise this drawing via manual drafting methods.					

DRAWING TITLE	
<b>PLAN VIEW - EXISTING CONDITIONS</b>	
PROJECT	CLIENT
UPPER (EAST) POND HISTORY OF CONSTRUCTION CHESTERFIELD POWER STATION CHESTERFIELD COUNTY, VIRGINIA	DOMINION GLEN ALLEN, VIRGINIA
ISSUING OFFICE: Murrysville   4200 Triangle Lane, Export, PA 15632-1358	



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NEIMAJC			C150035-00-000-00-C-E1-115
DWG TYPE:	SCALE:	ISSUE DATE:	ALT. CLIENT DRAWING NUMBER:
AS SHOWN		6/15/2016	
REVISION	SHEET NO.:	GAI DRAWING NUMBER:	
	1 OF 1	E1-115	

SCALE: 1" = 120'			
120 0 120 240			