HISTORY OF CONSTRUCTION

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Bremo Power Station CCR Surface Impoundment: East Ash Pond

Submitted To: Bremo Power Station
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Bremo Bluff, VA 23022

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Richmond, VA 23227

April 2018

Project No. 15-20347

Golder Associates

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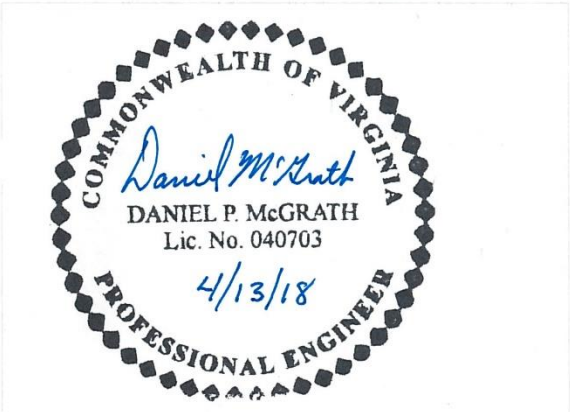
1.0 CERTIFICATION

This History of Construction for the Bremo Power Station's East Ash Pond was prepared by Golder Associates Inc. (Golder). The document and Certification/Statement of Professional Opinion are based on and limited to information that Golder has relied on from Dominion Energy and others, but not independently verified, as well as work products produced by Golder.

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 this document 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 document was prepared consistent with the requirements in §257.73(c) of the United States Environmental Protection Agency's (EPA'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 §257.73(c)], as well as with the requirements in §257.100 resulting from the EPA's "Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vacatur" published in the Federal Register on August 5, 2016 with an effective date of October 4, 2016 (40 CFR §257.100).

The use of the word "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.

Daniel McGrath	Associate and Senior Consultant
Print Name	Title
Daniel McGrath	4/13/18
Signature	Date



2.0 INTRODUCTION

This History of Construction was prepared for the Bremo Power Station's (Station) inactive Coal Combustion Residuals (CCR) surface impoundment, the East Ash Pond (EAP). This History of Construction was prepared in accordance with 40 CFR Part §257, Subpart D and is consistent with the requirements of 40 CFR §257.73(c) and 40 CFR §257.100(e)(3)(iv).

The Station, owned and operated by Virginia Electric and Power Company d/b/a Dominion Energy Virginia (Dominion), is located in Fluvanna County at 1038 Bremo Road, east of Route 15 (James Madison Highway) and north of the James River. The Station includes an inactive CCR surface impoundment, the EAP, as defined by the Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule and Direct Final Rule (40 CFR §257; the CCR rule). All elevations noted in this report are in feet relative to the North American Vertical Datum of 1988 (NAVD-88).

3.0 HISTORY OF CONSTRUCTION

3.1 CCR Unit

The EAP is located at the Station, as shown in the attached 2013 United States Geological Survey (USGS) 7½-minute topographic quadrangle map (Appendix A). The EAP is owned and operated by Virginia Electric and Power Company d/b/a Dominion Energy Virginia (Dominion). Dominion's address, as well as contact information for the Station, are provided below.

Virginia Electric and Power Company
5000 Dominion Boulevard
Glen Allen, VA 23060

Mr. David A. Craymer
Vice President, Power Generation System Operations
Virginia Electric and Power Company
5000 Dominion Boulevard
Glen Allen, VA 23060

The EAP was removed from service in the mid-1980's. The west and center portions of the pond were covered with soil and the east portion was used for stormwater management.

The EAP surface impoundment is regulated under the following permits:

- Virginia Department of Environmental Quality (DEQ) Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0004138
- DEQ VPDES Construction General Permit No. VAR10H875
- Virginia Department of Conservation and Recreation (DCR) Operations and Maintenance Certificate, Inventory No. 00815

The long-term management of the EAP, which includes closure and groundwater monitoring, will be governed by the Virginia DEQ Solid Waste Management Regulations (VSWMR) Permit No. 618, once issued. The embankments will continue to be regulated by DCR under the Impounding Structure Regulations (4VAC50-20 *et seq.*) if required by DCR based on final height and impounded volume.

3.2 Watershed

The EAP is located within the Middle James – Buffalo Watershed (USGS Hydrologic Unit Code 02080203), which is approximately 1,273,600 acres. The EAP has a contributing drainage area of approximately 82 acres.

3.3 Foundation and Abutments

The EAP was constructed by excavating into the alluvial terrace and using the excavated material to construct the pond embankments. The vertical expansion dikes in the upper fill on the eastern half of the EAP were generally comprised of compacted ash covered by soil.

In the alluvial terrace around the pond, alluvial soils generally consisting of clayey silts were encountered, and appear to occur in thicknesses ranging up to about 20 feet where not removed from the excavated areas. A few borings encountered rounded gravel in what was interpreted to be the bottom of the alluvial deposit. Borrow activities for the pond may have thinned the clayey silts and/or locally exposed underlying gravel channels or residual materials. The clayey silts would generally be of relatively low permeability compared to other materials, especially zones of alluvial gravel, fractured rock, or disintegrated rock. The natural soil material from the pond footprint, used for the embankment fill, consists of low-plasticity fines (CL and ML) with increasing amounts of sand with fines (SM and SC) in the eastern portion of pond embankment.

The EAP embankment soil fill material properties were interpreted based on subsurface data and site reconnaissance taken from previous Golder investigations, analyses, and reports included in Golder's March 2017 Virginia Department of Conservation and Recreation (DCR) Impounding Structure Design Report Supporting Documents (Golder 2017), and are presented in Tables 1 and 2 below.

Table 1: Summary of Primary Geotechnical Testing Data

Property	No. Tests	Min.	Max.	Avg.	Median
Depth Range (ft)	-	9	49.6	22.3	17
Water Content (%)	8	12	30	24	24
Gravel (> 4.75 mm) (%)	5	0	6	1	0
Sand (%)	5	5	49	26	27
Fines (< 0.075 mm) (%)	6	51	95	74	75
Specific Gravity	2	2.71	2.76	2.74	2.74
Liquid Limit (LL) (%)	8	19	44	33	32
Plastic Limit (PL) (%)	8	15	33	22	22
Plasticity Index (PI)	8	4	18	11	11
Non-plastic Results	1	1 of 8			

Table 2: Summary of Secondary Geotechnical Data

Property		No. of Points	Min.	Max.	Avg.	Median
Drilling	SPT N (bpf)	40	0	18	8	8
CPT Based	*Peak φ' (°)*	1539	23.1	47.1	33.8	33.5
	Su (tsf)		0.4	8.3	2.4	2.1
	SPT N_{60} (bpf)		2	69	18	15
	Norm. CPT Tip (Qtn)		3.2	481.4	48.2	27.8

Secondary Laboratory Testing Data			
Sample ID & Depth (ft)	**Sample Description**	**Effective Strength**	**Total Strength**
GB-2 UD-01 8-10 ft	Dike Fill, (CL) sandy SILTY CLAY	φ' = 28.3° c' = 1.7 psi	φ = 20.1° c = 2.0 psi
GB-3 UD-01 16-18 ft	Dike Fill, (CL-ML) SILTY CLAY to CLAYEY SILT and SAND	φ' = 26.4° c '= 0.6 psi	φ = 17.7° c = 1.0 psi

3.4 Construction Details

The EAP was constructed in multiple stages, with subsequent construction periods expanding the pond footprint and raising portions of the pond embankments. The original EAP, in service from the 1930's to approximately 1956, was constructed by excavating into the alluvial terrace and using the excavated material from within the pond footprint to construct the west dike and western portion of an existing south dike. The natural terrace elevation was approximately 211 feet. The pond was excavated approximately 15 feet below grade, or to an elevation of approximately 196 feet. The eastern limit of the original pond was controlled by the property line, which was roughly 600 feet east of the existing west dike.

In 1956-58, additional property was acquired to the east and the original EAP was expanded. Terrace material was excavated approximately 15 feet below grade and the material was used to construct a dike

along the east side of the former excavation and extend the south dike to connect to the east abutment. The dikes had a crest elevation of approximately 234 feet, or 22 feet above the original terrace. A concrete vertical intake structure and 24-inch reinforced concrete pipe spillway was installed through the splitter dike, constructed between the two excavations, roughly 400 feet from the east abutment.

In the late 1970's to early 1980's, ash was deposited up to the EAP dike crest elevation along the natural rising ground on the north side of the EAP, filling various drainage features, such as the future "Stump Pond" area and North Ash Pond dike area, with ash.

By about 1982, the EAP was largely filled to the dike crest elevation, with standing water in the eastern portion and ash mounded several feet above the dike elevation and covered by a thin soil cap in the western portion. Using ash to create an inner, upper level perimeter dike stepped in from the west and south dike, a 10-acre vertical expansion was constructed, raising the dike crest elevation to approximately 252 feet. The eastern portion of the EAP was dredged to elevation approximately 229 feet and a second splitter dike was constructed over the ash about 600 feet from the east end, dividing the area east of the vertical expansion into ash storage on the west and stormwater management on the east. A general layout of the historical EAP construction is provided in Figure 1 below.

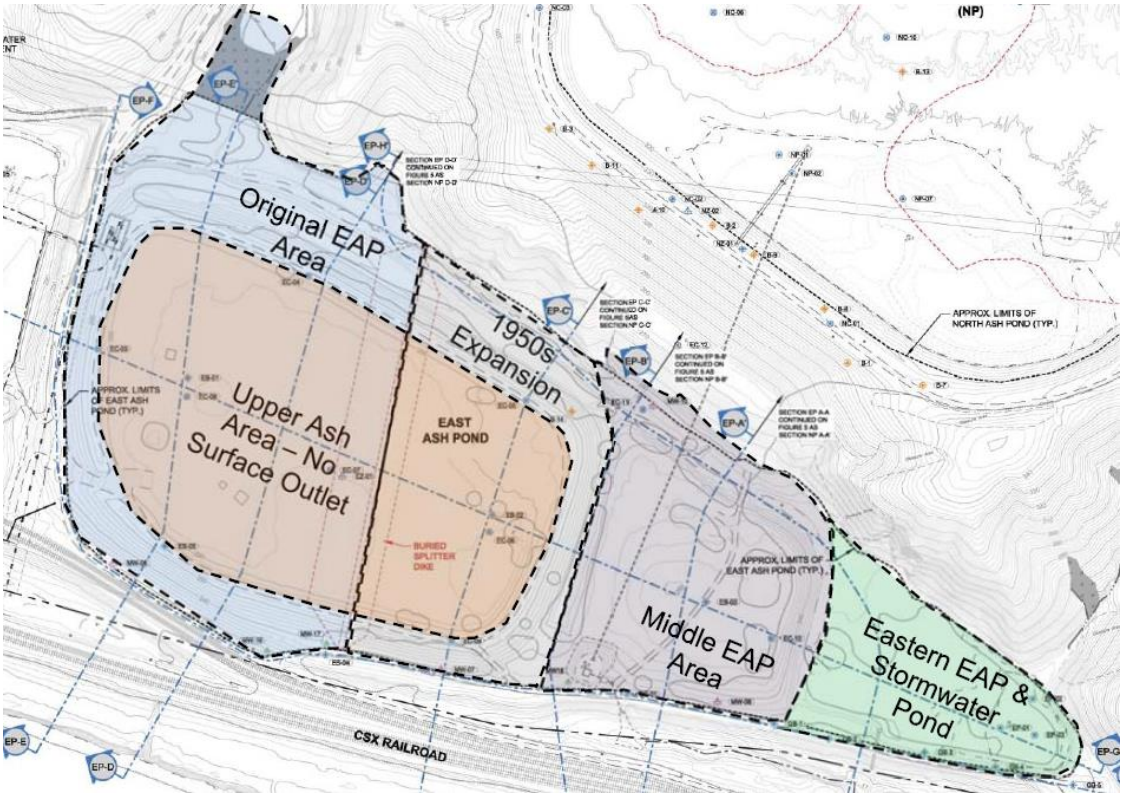


Figure 1: General Layout of the Historical East Ash Pond Construction

Within a few years of the EAP's vertical expansion, in the mid-1980s, the EAP was removed from service. The ash was covered with soil for closure. The eastern portion of the pond remained wet, allowing pass-through of drainage from the adjacent area to the north.

In the 1990's, timber piles were installed immediately adjacent to each other and parallel to the western end of the south dike crest, for a length of 175 feet, in response to stability concerns.

In 2012, a 26-inch diameter gas pipeline was horizontally bored from south of the James River to a distribution structure located near the north end of the west dike, and is understood to underlie the west dike of the EAP.

The primary spillway system is further discussed in Section 4.8. Historical record drawings for the construction of the EAP are provided in Appendix B.

The EAP is currently in the process of being closed in accordance with §257.102(c) by removing CCR materials, removing and treating free liquids, and repurposing the area as a lined stormwater management pond. Following CCR removal, the existing perimeter dikes will be regraded to a 3 horizontal to 1 vertical (3H:1V) slope to improve stability, and the existing outfall structure will be modified to accommodate a lower pool elevation. Closure details are included in the Closure Plan.

3.5 Engineering Drawings

Current detailed dimensional drawings of the EAP's existing conditions, extracted from Golder 2017, are provided in Appendix C.

3.6 Instrumentation

A network of pumps and dewatering wells has been installed within the EAP. The surface water and pore water collected in the EAP are conveyed to the on-site Centralized Source Water Treatment System (CSWTS) for treatment and compliance with permitted effluent limits prior to discharge through a permitted outfall. Groundwater monitoring wells have been installed around the pond to comply with the existing VPDES permit.

3.7 Stage-Storage Capacity Curve

Using the December 2017 aerial topographic survey, the available stage-storage capacity was computed from the top of the in-progress CCR excavation to the top of the embankment (elevation 230). The EAP stage-storage capacity data are provided in Table 3 and Figure 2, below.

Table 3: Stage-Storage Capacity

Elevation	Area, square feet (sf)	Incremental Volume, cubic feet (ft^3)	Incremental Volume, acre-feet (ac-ft)	Cumulative Volume, Ac-Ft
230	907,784	1,779,883	40.86	347.49
228	872,219	1,687,417	38.74	306.63
226	815,517	1,577,252	36.21	267.89
224	762,039	1,469,359	33.73	231.68
222	707,657	1,321,116	30.33	197.95
220	614,554	1,181,588	27.13	167.62
218	567,350	1,073,317	24.64	140.50
216	506,542	915,127	21.01	115.86
214	410,275	790,359	18.14	94.85
212	380,275	725,524	16.66	76.71
210	345,527	656,218	15.06	60.05
208	310,995	587,465	13.49	44.99
206	276,802	518,959	11.91	31.50
204	242,535	437,644	10.05	19.59
202	195,937	272,918	6.27	9.54
200	84,652	142,587	3.27	3.27
198	58,723	0	0	0

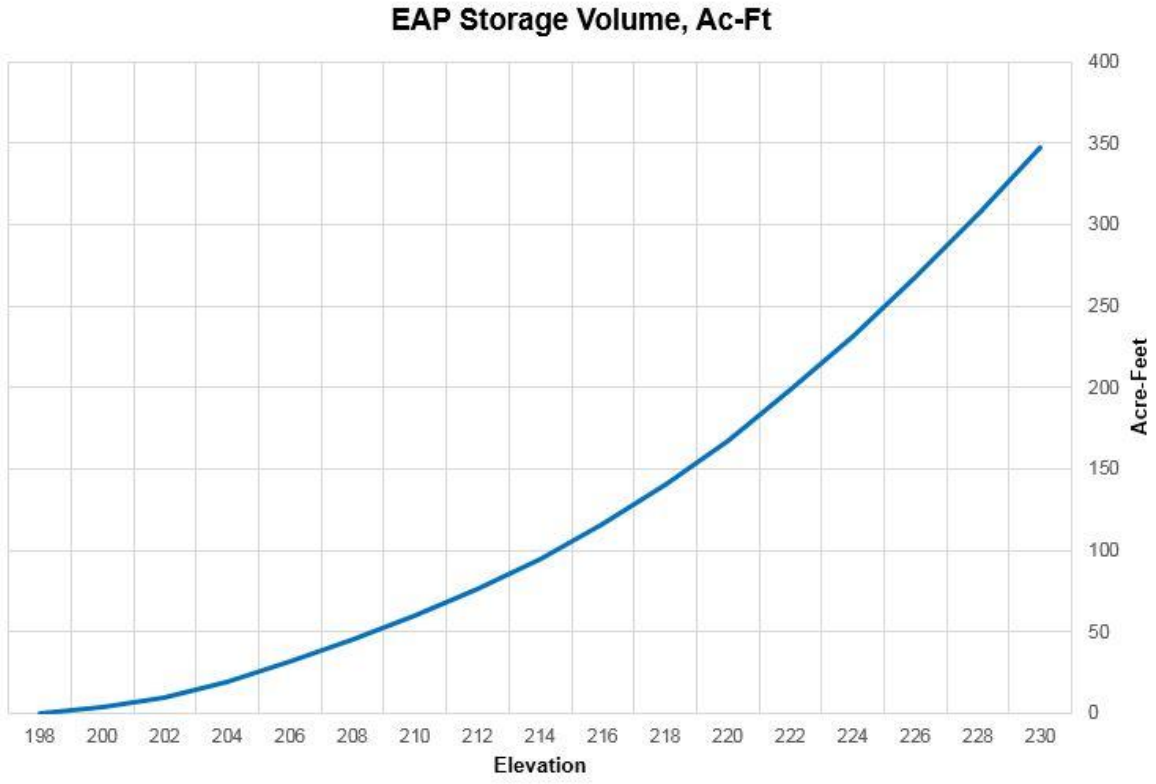


Figure 2: Stage-Storage Capacity Curve

3.8 Diversion and Spillway Details

The EAP was constructed by excavating into the alluvial terrace and using the excavated material from within the pond footprint to construct the pond embankments. The dikes abut rising natural ground on the north side of the pond. A small, intermittent stream drains into the eastern end of the pond. Outside of the dike segments, no additional diversions are in place.

Prior to closure activities, the primary spillway, an intake tower and 24-inch diameter reinforced concrete pipe, regulated the pool elevation in the eastern portion of the EAP. The intake tower, in the eastern end of the impoundment area, is constructed of concrete and regulated by concrete stop logs. The current lowest stoplog elevation is approximately 229.0. A 24-inch diameter pipe extends from the structure under the EAP dike to a drainage channel and ultimately through a permitted outfall. As of mid-2017, the EAP has been dewatered for closure activities and the 24-inch diameter pipe has been temporarily plugged to satisfy discharge permit requirements. Surface water and pore water within the EAP are pumped to the on-site CSWTS for treatment and discharge. There is no auxiliary spillway. The primary spillway capacity table and curve are shown in Figure 3 below. The analysis of the spillway capacity is included in Appendix B of the Inflow Design Flood Control System Plan.

Elevation, ft	Structure Rating, CFS
229	0.00
229.5	6.42
230	18.15
230.5	33.34
231	51.34
231.5	71.74
232	75.10
232.5	75.90
233	76.70
233.5	77.40
234	78.20

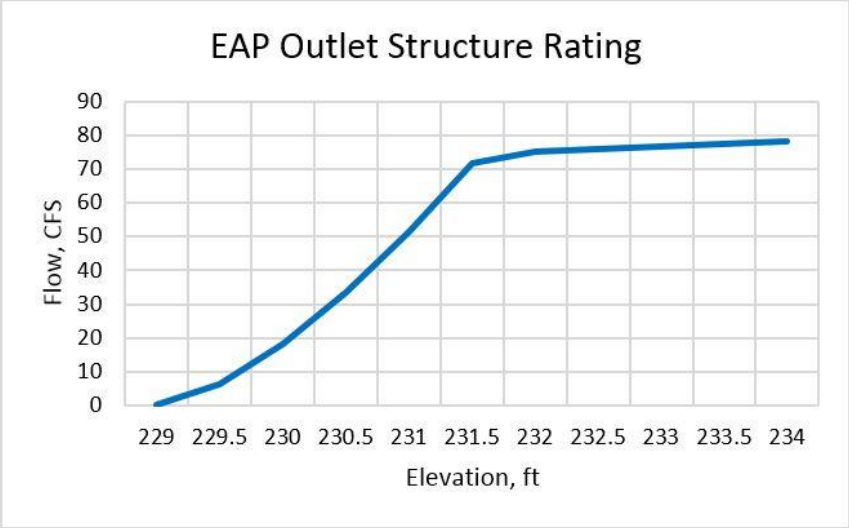


Figure 3: Riser Structure Rating

3.9 Surveillance, Maintenance, and Repair

Inspections and maintenance are currently conducted in accordance with 40 CFR §257.83. General construction specifications and provisions for future surveillance, maintenance, and repair of the EAP are included in the Closure Plan. Annual inspections by a Professional Engineer are conducted to satisfy the requirements of the DCR Dam Safety Regulations.

3.10 Structural Instability

The eastern portion of the south dike, for a distance of roughly 1,300 feet from the south abutment, is thickly wooded with slopes approximately 1.5H:1V. Some tree boles are curved, indicating past slope movement. Moderate erosion is evident at several locations. Toward the western end of the south dike, timber piles were installed immediately adjacent to each other and parallel to the dike crest to address past stability concerns with the dike. An apparent tension crack and minor seepage was noted in the slope above the timber piles during Golder's 2015 geotechnical exploration. The west dike appeared to be in a similar condition to the wooded portions of the south dike. Following CCR removal, trees along the existing perimeter dike will be removed and the dikes regraded to a 3H:1V slope to improve stability.

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