AECOM
564 White Pond Drive
Akron, OH 44320-1100
www.aecom.com

330-836-9111 tel
330-836-9115 fax

October 15, 2018

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

Engineer's Certification of Unstable Area Demonstration
Slag Ponds 2A and 2B, and Slag Stilling Pond 2C
EPA Final CCR Rule
TVA Paradise Fossil Plant
Drakesboro, Kentucky

1.0 PURPOSE

The purpose of this demonstration is to certify that the Unstable Area Demonstration for the TVA Paradise Fossil Plant (PAF) Slag Ponds 2A and 2B and Slag Stilling Pond 2C is in compliance with the unstable area location requirements in the EPA Final CCR Rule at 40 CFR §257.64.

2.0 BACKGROUND

As required by 40 CFR §257.64 of the EPA Final CCR Rule, by October 17, 2018, an owner or operator of an existing surface impoundment or landfill must complete the unstable area demonstration. An existing CCR surface impoundment or landfill must not be located in an unstable areas unless the owner or operator demonstrates that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit so that the integrity of the structural components of the CCR unit will not be disrupted.

In support of the above assessment, AECOM completed the evaluation described in the referenced "Engineer's Certification of Unstable Area Demonstration (40 CFR §257.64) for Coal Combustion Residuals (CCR), TVA Paradise Fossil Plant, Existing Surface Impoundments – Slag Ponds 2A and 2B and Slag Stilling Pond 2C", dated October 15, 2018. A complete listing of documents reviewed and utilized as part of this assessment is included in the References at the end of the report.

3.0 SUMMARY OF FINDINGS

Based upon the findings of the referenced Engineer's Certification of Unstable Areas Demonstration, AECOM has concluded Slag Ponds 2A and 2B, and Slag Stilling Pond 2C meet the requirement of the EPA Final CCR Rule 40 CFR § 257.64(a).

Rest of Page Left Intentionally Blank

AECOM
564 White Pond Drive
Akron, OH 44320-1100
www.aecom.com

330-836-9111 tel
330-836-9115 fax

4.0 Qualified Professional Engineer Certification

I, Nicholas Golden, being a Professional Engineer in good standing in the State of Kentucky, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this certification has been prepared in accordance with generally accepted engineering practices; that the information contained herein is accurate as of the date of my signature below; and that Slag Ponds 2A and 2B, and Slag Stilling Pond 2C meet the unstable areas requirements of 40 CFR §257.64(a).

SIGNATURE _____ DATE 10/15/18

ADDRESS: AECOM
564 White Pond Drive,
Akron, OH 44320

TELEPHONE: (330)-836-9111

ATTACHMENTS: Engineer's Certification of Unstable Area Demonstration (40 CFR §257.64) for Coal Combustion Residuals (CCR) Existing Surface Impoundments – Slag Ponds 2A and 2B and Slag Stilling Pond 2C

COAL COMBUSTION PRODUCT DISPOSAL PROGRAM

TENNESSEE VALLEY AUTHORITY – PARADISE FOSSIL PLANT
SLAG PONDS 2A AND 2B, AND SLAG STILLING POND 2C
DRAKESBORO, KENTUCKY

ENGINEER'S CERTIFICATE OF UNSTABLE AREA DEMONSTRATION (40 CFR §257.64) FOR COAL COMBUSTION RESIDUALS (CCR)

EXISTING SURFACE IMPOUNDMENTS

Prepared for

TVA

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

October 15, 2018 – Rev 0

Prepared by

AECOM

TABLE OF CONTENTS

FIGURES

1.0 BACKGROUND

1.1 OBJECTIVE

The purpose of this Unstable Areas Demonstration is to evaluate compliance with 40 CFR § 257.64(a) of the Environmental Protection Agency Final Coal Combustion Residuals Rule (EPA Final CCR Rule). This Report is based on existing documentation such as construction drawings, record drawings, and any other pertinent data and/or investigations to support historic conditions and operations at Slag Ponds 2A and 2B, and Slag Stilling Pond 2C at the Tennessee Valley Authority (TVA) Paradise Fossil Plant (PAF). Supporting documentation used in this evaluation is referenced in Section 6 of this document.

1.2 RULE REQUIREMENT

According to 40 CFR § 257.64(a) of the EPA Final CCR Rule, any existing CCR surface impoundments must not be located in an unstable area unless the owner or operator demonstrates that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.

In accordance with 40 CFR § 257.64(b), the owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

- 40 CFR § 257.64(b)(1) – On-site or local soil conditions that may result in significant differential settling;
- 40 CFR § 257.64(b)(2) – On-site or local geologic or geomorphologic features, and
- 40 CFR § 257.64(b)(3) – On-site or local human made features or events (both surface and subsurface).

Section 257.64(c) requires that the owner or operator to obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section. In accordance with 40 CFR § 257.64(d)(1), the owner or operator must complete the required demonstration no later than October 17, 2018.

1.3 SITE DESCRIPTION

PAF is located in Drakesboro, Kentucky along the southwestern side of the Green River and State Route 176. Slag Ponds 2A and 2B and Slag Stilling Pond 2C are located within the northeast corner of PAF. The plant features three units, constructed between 1963 and 1970, and three large natural-draft cooling towers. Units 1 and 2 were retired in 2017. The slag ponds are surrounded by the coal storage yard to the west, the Green River to the east, Red Water Pond 2 to the north, and the main power plant to the south. The plant sits inside the eastern border of Muhlenberg County as depicted below in **Figure 1**.

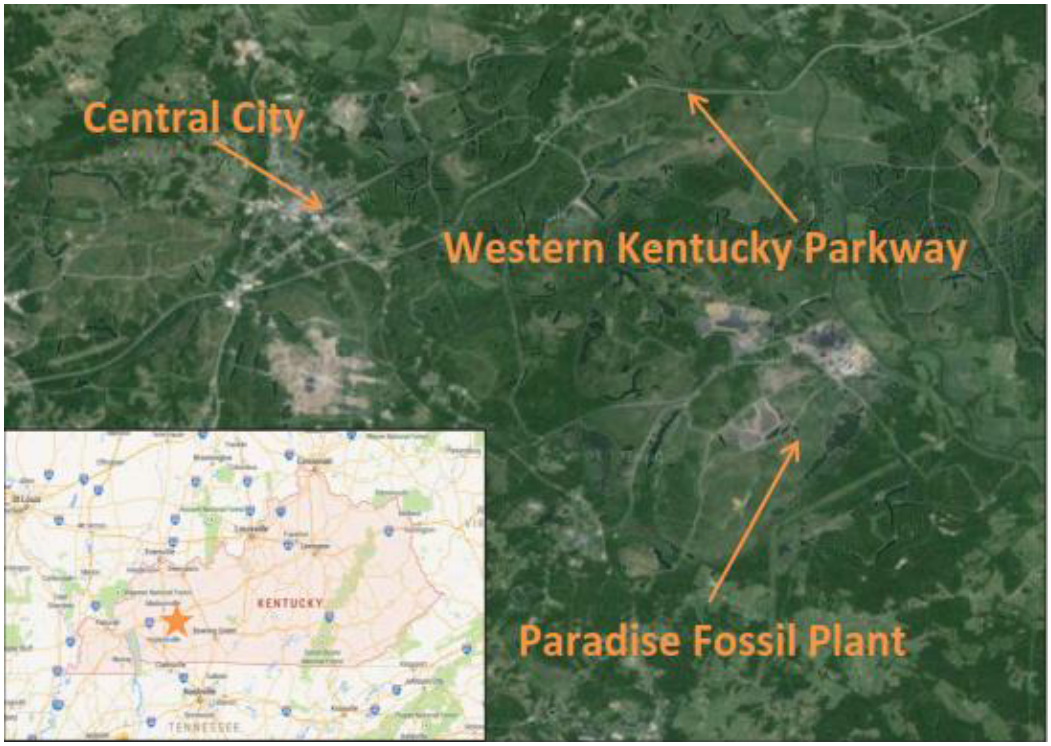

Figure 1: PAF Aerial View

Slag Ponds 2A and 2B and Slag Stilling Pond 2C serve as an ash pond management facility for the storage and settling of boiler slag. Influent to this impoundment consists of sluiced boiler slag, which flows into the southeastern portion of Slag Pond 2A via a series of ash inlets. Slag Ponds 2A and 2B also receive process water from many areas surrounding the ponds such as the Red Water Pond and Coal Yard Runoff Ponds. Water flows from Slag Pond 2A to Slag Pond 2B to Slag Stilling Pond 2C. Slag Stilling Pond 2C discharges to the Green River via Kentucky Pollutant Discharge Elimination System (KYPDES) permit no. KY0004201 at Outfall 002.

Figure 2. Site Overview

Slag Ponds 2A and 2B, and Slag Stilling Pond 2C share the same perimeter dike and are separated by two interior dikes. The dikes share similar characteristics in that they have similar designed dimensions and were constructed with compacted mine spoils. The dike crests range in elevation were the dikes of 2A is generally higher and the dikes of 2C tend to be lower. The dike slopes are generally no steeper than 3H:1V. The top of the dikes serve as access roads, covered with either gravel or bottom ash. The dike sides are generally covered with grassy vegetation and riprap along shorelines and outlet structures.

In 2015, an Initial Annual (Intermediate) Inspection was performed for Slag Ponds 2A and 2B, and Slag Stilling Pond 2C. Based on the inspection report, the slopes are generally covered with either dense grass or riprap; no trees or large, bushy vegetation are present on the slopes. No evidence of burrowing animals was observed. No evidence of actual or potential structural weakness of the inspected units was observed.

Water discharges into the Green River through the east perimeter dike of the Slag Ponds with three spillways located in Slag Stilling Pond 2C.

An emergency overflow spillway was built at the eastern dike of Slag Stilling Pond 2C in 2014.The emergency spillway is a grouted rip-rap spillway on a depressed section of the dike with an approximate elevation of 410 MSL.

2.0 SITE ASSESSMENT

Per §257.64(b), the unstable areas demonstration must consider features or events when determining whether the area is unstable. An investigation of publicly available information and a site reconnaissance were performed in order to meet the requirements of §257.64(b).

Available historical information included an original geotechnical exploration completed for the facility in 1983, historic monitoring well installation logs completed by Law Engineering in 1995

and Stantec in 2010, an Intermediate Dam Safety Inspection report completed by URS in 2012, a Dam Safety Assessment of CCW Impoundments performed by Obrien and Gere in 2013, and a report of Geotechnical Engineering for the proposed Jet Filter Facility completed in 2013.

In 1983 TVA performed a study entitled "Paradise Steam Plant – Coal Receiving Facility – Soil Investigation for Ash Pond Dike Adjacent to Barge Dock Cell" this report included boring logs for eight borings (SS-1 through SS-8 and companion auger borings for undisturbed testing.) Borings were drilled along the eastern side of the dike of the Slag Pond 2B was relocated (moved toward the west away from Green River) to its current configuration sometime after 1983. The borings were drilled along the dike before it was relocated. For the purposes of this analysis, it is assumed that the boring log and laboratory testing information was still representative of the materials at the site. Based according to this information, the Slag Pond 2B east dike was constructed using mine spoils placed over alluvial deposits consisting of clays and sands overlying a thin interval of residuum.

These three hydraulically-connected ponds consist of combined incised/diked impoundments with a total surface area of approximately 32 acres. The three ponds are separated by divider dikes; Pond 2A is west of the divider dike and Pond 2B is east of the divider dike. The stilling pond is situated to the east of a divider dike along the southeastern corner of Pond 2B. With the exception of the divider dike, Pond 2A is incised below surrounding grades. Pond 2B is formed by perimeter earthen (clay) dikes with a maximum height of 10 ft. Outboard slopes were designed at 3 Height (H):1 Vertical (V). Pond 2B is impounded with earth dikes on all sides except the south. The maximum embankment height is approximately 24 ft along the east side with approximately 3H:1V exterior slopes. The stilling pond has an outer earthen dike along its east side with maximum height of approximately 20 feet and maximum slope of 2H:1V.

URS completed a Jet Filter Facility Geotechnical Report in 2013 to obtain subsurface data for the design of the proposed facility. As part of the study, a total of 39 soil borings, 7 offset borings, and 8 seismic cone penetration test borings were advanced. Generally, the borings were advanced south and west of the Slag Ponds and Slag Pond Dike system. However, 8 borings from that exploration, B-28, B-29, B-30, B-31, B-32, B-35, B-36, and B-37 were advanced closest to the Slag Ponds and were reviewed to obtain a general understanding of the subsurface conditions. The overburden at these borings consisted of ash fill underlain by clayey or sandy alluvium to refusal. In this case, borings B-29 through B-32 were advanced relatively close to Red Water Pond #2, and encountered sandstone bedrock at elevations varying from 384 feet MSL to 392 feet MSL. Borings B-35 through B-37 were advanced relatively close to Slag Ponds 2A and 2B, and encountered bedrock consisting of sandstone or shale at greater depths, specifically elevation 331 feet MSL to 365 feet MSL.

AECOM performed multiple site reconnaissance visits between October 2015 and March 2016. The purposes of the site visits were to observe the existing site conditions and finalize any recommendations. During the site visits, observations were made of the Slag Ponds, including upstream and downstream slopes and crests.

A review of available information obtained from the Kentucky Division of Mine Safety (DMS) and online maps from the Kentucky Mine Mapping Information System was previously performed by

AECOM. AECOM did not identify any historical underground or strip mining operations beneath Slag Ponds 2A and 2B and Slag Stilling Pond 2C.

AECOM conducted a geotechnical exploration in November 2015 that included advancing 7 hollow stem auger (HSA) borings and 6 seismic cone penetration test (SCPTu) soundings at the crest and downstream slopes of the Slag Pond dike. The borings were located to provide good geo-spatial coverage of the dike, and the soundings were located immediately adjacent or very near the borings as companions. In addition, 10 individual vibrating wire transducers were installed at multiple boring locations. Each boring performed as part of the 2016 exploration was initially advanced using 4-¾ inch inside diameter, hollow stem augers. At depths below 25 feet, mud rotary techniques were utilized using a tri-cone roller bit. The specific gravity of the bentonite mixture used as drilling mud was measured during drilling and maintained between 1.09 and 1.15. Three of the seven borings were extended 10 feet into the bedrock by means of NQ coring.

3.0 FOUNDATION CONDITIONS

3.1 SITE GEOLOGY

Published geological information from the Kentucky Geological Survey by the University of Kentucky (UK) indicates that the site is underlain by two geologic formations of Pennsylvanian age, the Carbondale and Shelburn Formations.

Rocks of the Pennsylvanian age generally consist of alternating sequences of shale, sandstone, limestone, and coal. The depositions of sediments occur in stream channel and deltaic complexes. The formation is characterized by up-ward coarsening beds of shale, sandstone, and coal.

The geology of the area encompassing the Slag Ponds includes alluvial deposits underlain by Pennsylvanian age bedrock formations. Geologic mapping indicates the site is primarily underlain by two geologic formation of Pennsylvanian age, the Carbondale and Shelburn Formations. The Carbondale Formation within the slag ponds consists of sandstone that is light- to medium-gray, fine- to medium-grained, thin- to thick bedded, micaceous and weathers to a yellowish-brown to grayish-brown medium dense to dense sand.

The Shelburn Formation underlies the Carbondale Formation, and typically consists of sandstone that is bright orange-brown, very fine- to medium-grained, laminated to thick-bedded, micaceous, and weathers to a dark brown to purple medium dense to dense sand. Underlying the Shelburn sandstone is a shale unit that is typically light-gray to black and carbonaceous. Coal underlies the shale unit, and is typically bright and blocky.

The Green River occupies a relatively flat-bottomed, alluvium-filled valley formed by the erosion of weak Pennsylvanian shales (Ryder, 1974). During Pleistocene time, the Green River was filled with coarse-grained deposits (fine sand to gravel) derived from the glaciers to the north and transported to the area by the Ohio River. Eventually, the Green River drainage basin

became choked with sediment, causing impoundment of the north-flowing streams and deposition of finer-grained sediments (clay and silt) overlying the coarse deposits.

3.2 SUBSURFACE CONDITIONS

(b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable.

3.2.1 §257.64(B)(1) SOIL CONDITIONS

(b)(1) the owner or operator must consider the on-site or local soil conditions that may result in significant differential settling in determining whether an area is unstable.

The original impoundments embankments consisted of lean clay (CL), clayey sand (SC), or clayey gravel (GC) with varying quantities of gravel sized rock fragments indicating that the original embankment was constructed using the local mine spoil materials. The mine spoil fill soil extends to depths of 15 to 30 feet below the dike crests and 6 to 10 feet below the ground surface at the downstream bench. Consolidation testing indicates the mine spoils are normally to overly consolidated and very stiff in consistency (AECOM 2017).

The dike embankment is underlain predominantly by moist, medium stiff, silty, lean clay (CL) alluvium. The clayey alluvium has been deposited between elevations of approximately 386 feet to 327 ft. msl, and contains an irregular interval of sandy alluvium. The interval alluvial sand consists of medium dense to dense, fine to coarse grained silty sand (SM) to poorly graded sand (SP). The interval layer was encountered irregularly between elevations 360 ft. msl and 340 ft. msl, and varying in thickness between 4 to 9 feet. The overall clayey alluvium thickness varies from 15 to 35 feet.

Below the clayey alluvium at irregular intervals on the northern half of the Slag Ponds (north of the Still Pond 2C weir) and below the crest of the southern half of the Slag Ponds, residuum was encountered consisting of stiff to very stiff, silty, sandy, lean clay (CL). The residuum varies in thickness from 3 to 10 feet.

The embankment fill of the existing Divider Dike is composed of alluvial clays excavated from the banks of the Green River. The existing embankment has crest elevations varying from 416 feet to 420 feet with an approximate height of 19.5 feet to 23.5 feet. The embankment fill of the Divider Dike consists of moist, medium to stiff, low to medium plasticity clay (CL).

Beneath the embankment fill, the Divider Dike is underlain by original ash, residuum, alluvium, and bedrock.

In 2015, an Initial Annual (Intermediate) Inspection was performed for Slag Ponds 2A and 2B, and Slag Stilling Pond 2C was completed by TVA. Based on the inspection report, no evidence of actual or potential structural weakness of the inspected units was observed. No changes that may have affected the operational stability of the impounding structure were identified since the last inspection of the unit. Refer to the Initial Structural Stability Assessment prepared for CCR

certification by AECOM for additional information on embankments and soil conditions present within the Slag Ponds.

3.2.2 §257.64(B)(2) SITE GEOLOGIC/GEOMORPHIC FEATURES

(b)(2) *the owner or operator must consider on-site or local geologic or geomorphologic features*

PAF is located in the central portion of western Kentucky along the west shore of the Green River just north (downstream) of the confluence of the Green River and Jacob's Creek. The region is underlain by coal rich Pennsylvanian age bedrock formations. Strip mining operations have significantly altered the topography and geology within the vicinity of the plant and, as such, portions of the site are likely underlain by mine spoils. Geologic mapping indicates the plant and surrounding areas are underlain by the Sturgis and Carbondale Formations in general order of descending geology. The Sturgis Formation is described as consisting of interlayered medium- to coarse-grained micaceous sandstone, silty and clayey shale, coal, and underclay. The Carbondale Formation generally consists of cyclic sequences of fine-grained sandstone, sandy shale, coal, and silty underclay. Although not depicted on the geologic mapping, alluvial deposits are likely present along the banks of the Green River. The geologic mapping indicates this alluvium generally consists of gravel, sand, silt, and clay and may be as much as 90 feet thick.

Beneath the residuum and the alluvial deposits, bedrock was encountered. Results from recovered cores consisted of two distinct bedrock units. One consists of moderately hard, fine to coarse grained, thinly bedded sandstone with occasional shale and clay seams, which appear to be part of the Carbondale Formation. The other consists of durable, dark gray, thinly bedded, laminated shale with occasional clay seams. The shale appears to be part of the Shelburn Formation.

Refer to the Initial Structural Stability Assessment and Seismic Impact Zone Demonstration prepared for CCR certification by AECOM for additional information.

3.3 §257.64(B)(3) NATURAL AND MAN MADE UNSTABLE AREAS

(b)(3) the owner or operator must consider on-site or local man-made features or events (both surface and subsurface)

AECOM analyzed publicly available information, historical drawing and recent geotechnical, structural and safety reports in order to determine the presence of unstable areas. The following sections examine potential natural and man-made unstable areas that may be present within the site.

3.3.1 NATURAL UNSTABLE AREAS

No known natural unstable areas are present within the impoundments. Published geological information from the Kentucky Geological Survey by the University of Kentucky (UK) indicates

that the site is underlain by two geologic formations of Pennsylvanian age, the Carbondale and Shelburn Formations.

Rocks of the Pennsylvanian age generally consist of alternating sequences of shale, sandstone, limestone, and coal. The depositions of sediments occur in stream channel and deltaic complexes. The formation is characterized by up-ward coarsening beds of shale, sandstone, and coal.

The geology of the area encompassing the Slag Ponds includes alluvial deposits underlain by Pennsylvanian age bedrock formations. Geologic mapping indicates the site is primarily underlain by two geologic formation of Pennsylvanian age, the Carbondale and Shelburn Formations. The Carbondale Formation within the slag ponds consists of sandstone that is light- to medium-gray, fine- to medium-grained, thin- to thick bedded, micaceous and weathers to a yellowish-brown to grayish-brown medium dense to dense sand.

The Shelburn Formation underlies the Carbondale Formation, and typically consists of sandstone that is bright orange-brown, very fine- to medium-grained, laminated to thick-bedded, micaceous, and weathers to a dark brown to purple medium dense to dense sand. Underlying the Shelburn sandstone is a shale unit that is typically light-gray to black and carbonaceous. Coal underlies the shale unit, and is typically bright and blocky.

AECOM has performed a stability analyses for Slag Ponds 2A and 2B, and Slag Stilling Pond 2C. Specifically, static and seismic slope stability of the system was evaluated. Analyses were performed for normal pool, flood pool, temporary loading, pseudo-static and post-earthquake conditions. The static and seismic assessment at the Slag Ponds determined Slag Ponds 2A and 2B exceed the minimum Factor of Safety requirements set forth in 40 CFR §257.63 and 40 CFR § 257.73. In addition, no evidence of actual or potential structural weakness of the inspected units was observed. No changes that may have affected the operational stability of the impounding structure were identified since the last inspection of the unit. Therefore there are no known natural unstable areas at Slag Ponds 2A/2B and Stilling Pond 2C.

3.3.2 MAN-MADE UNSTABLE AREAS

Past mining activities occurred in the upland areas of the Paradise Fossil Plant site which has left the western half of the property covered by up to 100 feet of mine spoils. Historical information and subsurface exploration performed within Slag Ponds 2A and 2B and Slag Stilling Pond 2C has determined no surface or underground mines are located beneath the slag ponds.

Refer to the History of Construction Report prepared for CCR certification by AECOM for additional information pertaining to potential man-made unstable areas.

4.0 HISTORICAL REMEDIAL ACTION

Per §257.64(b)(3), the unstable areas demonstration must consider on-site or local human made features or events when determining whether the area is unstable. Which includes the review of routine operations and inspections at the landfill to maintain precaution from human induced events or forces that might impair the integrity of structural components responsible for preventing unpermitted release of CCR into the environment. As such an examination of remedial actions performed at the site were considered.

No record or knowledge of historical structural instabilities have been identified within Slag Ponds 2A and 2B. This CCR unit is subject to TVA's CCP Storage Facilities Inspection Program. The inspection program includes scheduled formal, intermediate, and informal inspections as well as unscheduled special (emergency) inspections. Additionally, TVA plant personnel make daily observations and perform weekly reviews of the disposal areas. Maintenance is performed on an as-needed basis, and TVA documents all repair and maintenance activities.

5.0 CONCLUSIONS

AECOM has concluded that TVA PAF Slag Ponds 2A and 2B, and Slag Stilling Pond 2C meet the CCR Rule requirements set within 40 CFR § 257.64 Unstable Areas and poses no imminent threat.

6.0 REFERENCES

- AECOM, Slag Ponds 2A and 2B, History of Construction (40 CFR §257.73(c)) for CCR Certification, 2016.
- AECOM, Slag Ponds 2A and 2B, Initial Inflow Design Flood Control System Plan (40 CFR §257.82) for CCR Certification, 2016.
- AECOM, Slag Ponds, Geotechnical Exploration and Analysis CCR Rule Compliance (Rev. 0), 2016.
- AECOM, Slag Ponds 2A and 2B, Initial Structural Stability Assessment (40 CFR §257.73 (d)(1)) for Coal Combustion Residuals (CCR), 2016.
- Ryder, P.O., 1974, Ground water in the alluvium along the Green River between its mouth and Woodbury, Kentucky: U.S. Geological Survey Water-Resources Investigations Open-File Report 53-73, 5 p., 1 pi.
- Stantec, Report of Phase 1 Facility Assessment, June 2009.
- Stantec, Hazard Potential Classification Assessment, July 2015.
- TVA, GCP&S-SPP-27.4.1, Coal Combustion Products Inspection of CCP Storage Facilities, 2015.