



Stantec Consulting Services Inc.
3052 Beaumont Circle, Lexington KY 40513

October 9, 2018
File: rpt_004_Jet_175567301
Revision 0

Tennessee Valley Authority (TVA)
1101 Market Street
Chattanooga, Tennessee 37402

**RE: Placement Above the Uppermost Aquifer Demonstration
Ash Pond 2
EPA Final Coal Combustion Residuals (CCR) Rule
TVA Shawnee Fossil Plant
West Paducah, Kentucky**

1.0 PURPOSE

As described in 40 CFR § 257.60(a), an owner or operator of an existing CCR surface impoundment is required to demonstrate that the unit is located no less than five feet above the upper limit of the uppermost aquifer. This letter documents Stantec's certification that Ash Pond 2 at the TVA Shawnee Fossil Plant (SHF) complies with the location restrictions for aquifer separation in the EPA Final CCR Rule at 40 CFR § 257.60(a)

2.0 SUMMARY OF FINDINGS

The attached demonstration documents that Ash Pond 2 meets the requirements set forth in 40 CFR § 257.60(a).

3.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Don W. Fuller II, being a Professional Engineer in good standing in the State of Kentucky, 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 TVA Shawnee Ash Pond 2 meets the requirements specified in 40 CFR 257.60(a).

October 9, 2018
Page 2 of 2
rpt_004_175567301

Re: **Placement Above the Uppermost Aquifer Demonstration
Ash Pond 2
EPA Final Coal Combustion Residuals (CCR) Rule
TVA Shawnee Fossil Plant
West Paducah, Kentucky**

SIGNATURE



DATE 10/9/2018

ADDRESS:

Stantec Consulting Services Inc.
3052 Beaumont Centre Circle
Lexington, Kentucky 40513-1703

TELEPHONE:

(859) 422-3000

ATTACHMENTS:

Wetlands Location Demonstration Report



**Placement Above the
Uppermost Aquifer
Demonstration**

Ash Pond 2
Shawnee Fossil Plant
Paducah, Kentucky



Prepared for:
Tennessee Valley Authority

Prepared by:
Stantec Consulting Services Inc.

October 9, 2018
Revision 0

Table of Contents

1.0	INTRODUCTION	1
1.1	OBJECTIVE.....	1
1.2	UNIT DESCRIPTION.....	2
1.3	APPROACH AND METHODS.....	2
2.0	UPPERMOST AQUIFER (UMA)	3
2.1	DEFINITION	3
2.2	IDENTIFICATION	3
2.3	UPPER LIMIT	4
2.4	DESKTOP REVIEW OF STRUCTURE.....	5
2.5	FIELD INVESTIGATION	5
2.6	STRUCTURE OF THE TOP OF THE UMA.....	8
3.0	AFFECTED BOUNDARY (BASE OF CCR UNIT).....	9
4.0	SEPARATION.....	10
4.1	ISOPACH	10
4.2	DISCUSSION	10
5.0	CONCLUSIONS.....	12
6.0	REFERENCES.....	13

LIST OF TABLES

Table 1. Estimated Elevation of the Top of the RGA..... 7

LIST OF FIGURES

Figure 1. Site Location Map

Figure 2. Site Map

Figure 3. Geologic Map

Figure 4. Interpolated Top of RGA

Figure 5. Affected Boundary (Base of CCR Unit)

Figure 6. Isopach Map of Aquifer Separation

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Introduction
October 9, 2018

1.0 INTRODUCTION

On April 17, 2015, EPA published the “Disposal of Coal Combustion Residuals (CCR) from Electric Utilities” final rule in the Federal Register. The Tennessee Valley Authority (TVA) contracted Stantec Consulting Services Inc. (Stantec) to evaluate Ash Pond 2 at the Shawnee Fossil Plant (SHF) regarding the requirements for the Uppermost Aquifer Location Restriction as required by the EPA Final CCR Rule, 40 C.F.R. §257.60.

1.1 OBJECTIVE

As required by §257.60 of the EPA Final CCR Rule, an owner or operator of new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units is required by October 17, 2018 to demonstrate whether the unit is located no less than five feet above the upper limit of the UMA. This report concludes that Ash Pond 2 complies with the location restriction for placement above the uppermost aquifer. Relevant sections of the EPA Final CCR Rule are cited below to provide context and additional detail regarding the objective.

The EPA Final CCR Rule § 257.53 provides definitions of CCR and CCR surface impoundments.

“Coal combustion residuals (CCR) means fly ash, bottom ash, boiler slag, and flue gas desulfurization materials generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers.” (§257.53)

“CCR surface impoundment means a natural topographic depression, manmade excavation, or diked area, which is designed to hold an accumulation of CCR and liquids, and the unit treats, stores, or disposes of CCR.” (§257.53)

The EPA Final CCR Rule § 257.60 (a) requires that the CCR unit is constructed:

“...with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table).” (257.60 (a))

TVA must demonstrate that that the requirements of paragraph (a) of section 257.60 are met, and the demonstration must be certified by a qualified professional engineer (P.E.) (§ 257.60 (b)). The demonstration and certification must be completed no later than October 17, 2018 (§ 257.60 (c)(1)).

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Introduction
October 9, 2018

1.2 UNIT DESCRIPTION

SHF is a coal-fired, electric-generating plant. The plant is located in McCracken County, Kentucky along the south shore of the Ohio River near river mile 946 and just east of the confluence of Little Bayou Creek (LBC) with the Ohio River.

Ash Pond 2 includes the Main Ash Pond and the Stilling Pond and is located at the northwest corner and northern edge of the plant. It is bordered on the north by the Ohio River and the west by LBC. Ash Pond 2 is formed by the Perimeter Dike along the east, north, and west and by the Consolidated Waste Dry Stack to the south. Ash Pond 2 encompasses approximately 100 acres. The unit is considered an active CCR surface impoundment. It is used for storage of fly ash and bottom ash from coal burning at SHF. It is also used for clarification and treatment of plant waters and stormwater runoff from the plant, Consolidated Waste Dry Stack (Special Waste Landfill), and Coal Yard Drainage Basin (Stantec, 2017b).

Ash Pond 2 at SHF meets the EPA definition of a CCR surface impoundment because it is a manmade area designed to hold an accumulation of CCR and liquids and is used to treat, store or dispose of CCR.

1.3 APPROACH AND METHODS

The following factors have been considered to determine whether Ash Pond 2 located at SHF meets the requirements for placement above the UMA:

- Identification of the UMA at SHF;
- Identification of the upper limit of the UMA at SHF;
- Evaluation of the elevation of the top of the UMA within the extent of Ash Pond 2;
- Evaluation of the elevation of the bottom of CCR within the extent of Ash Pond 2; and
- Comparison of the elevations of the bottom of the CCR and the top of the UMA within the extent of Ash Pond 2.

The following methods were used to determine whether Ash Pond 2 meets the requirements for placement above the UMA:

- Desktop review of historical documents;
- Field investigation consisting of soil borings;
- Incorporation of investigation results with historical data; and
- Assessment of compliance with the EPA Final CCR Rule.

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Uppermost Aquifer (UMA)
October 9, 2018

2.0 UPPERMOST AQUIFER (UMA)

2.1 DEFINITION

The EPA Final CCR Rule § 257.53 provides the following definitions of aquifer and uppermost aquifer (UMA):

“Aquifer means a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs.”

“Uppermost aquifer means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility’s property boundary. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season”

2.2 IDENTIFICATION

AECOM prepared a letter dated October 16, 2017 (AECOM, 2017) including a qualified professional engineer certification which stated that:

“Based upon review of the available information, the groundwater monitoring system at the Ash Pond 2 (Main Ash Pond/Stilling Pond) and Consolidated Waste Dry Stack meets the performance standard specified in 40 CFR § 257.91, based on the following criteria...The wells provide samples from the uppermost aquifer (257.91(a) and 257.53)” (AECOM, 2017).

The groundwater monitoring system referenced in this letter includes five monitoring wells: D11B, D-30B, D-74B, SHF-101G, and SHF-102G. The letter indicates that the screened formation for these monitoring wells is the Regional Gravel Aquifer (RGA). A copy of this certification is available on the TVA Shawnee Coal Combustion Residuals website.

Regionally, the RGA has been described as chert clasts in a matrix of poorly sorted sand with lenses of clay and silt (Sexton, 2006). The clasts have been described to range in size from approximately ½ inch to 12 inches (gravel to boulder size) (Kellberg, 1951). Regionally, the RGA is generally coarser grained near the base (Finch, 1967).

The RGA in the five monitoring wells included in the certified groundwater monitoring system (D11B, D-30B, D-74B, SHF-101G, and SHF-102G) was generally described as cherty gravel with sand. The chert clasts were described to range in size from 1.5 to 3.5 inches and were subangular to rounded. The sand within the RGA in these borings ranged from fine to coarse grained.

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Uppermost Aquifer (UMA)
October 9, 2018

2.3 UPPER LIMIT

According to the EPA Final CCR Rule, the upper limit of the UMA is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season. For a confined aquifer the top of the UMA is defined based on the structure of the top of the aquifer.

Recent groundwater elevation data collected from monitoring wells completed in the RGA was reviewed to evaluate if groundwater within the RGA is generally present under confined or unconfined conditions. Water levels were measured by Amec Foster Wheeler (Amec) at five monitoring wells completed in the RGA at SHF during eleven groundwater monitoring events between November 2016 and October 2017. The groundwater elevations measured during these gauging events ranged from 287.08 to 322.94 feet above mean sea level (msl) (Stantec, 2018). The groundwater elevations measured were above the elevation of the top of the RGA at the gauging locations (except for the September elevation at D-11B) indicating confined conditions (Stantec, 2018).

The review of groundwater elevation data indicates that groundwater within the RGA is generally present under confined conditions. The top of the UMA beneath Ash Pond 2 is defined based on the structure of the top of the RGA.

For this demonstration, the top of the RGA was identified as a transition from coarse grained material consistent with the RGA (as discussed in section 2.2) to finer grained material consistent with the alluvium and Upper Continental Deposits that are present above the RGA at SHF. Generalized characteristics of the alluvium and Upper Continental Deposits at SHF are discussed below.

Alluvium

Alluvium is present within the Ohio River flood plain. Regionally, this alluvium has been described as mainly silt and clay with minor amounts of sand and gravel (Davis et Al., 1987). The sand is generally fine grained and clayey and may be micaceous (Finch, 1967).

In the area of SHF, this alluvium consists mainly of fine grained sand and sandy clay. The sand is often micaceous with an orangish or reddish brown appearance.

Upper Continental Deposits (UCD)

Regionally, the Upper Continental Deposits (UCD) have been described as mainly clayey silt with interbedded sand and sparse gravel (DOE, 2015). Sand within the UCD generally ranges from very fine to medium grained (Hansen, 1966). The sparse gravel grains in the UCD are primarily chert and may be derived from the RGA but exhibit a greater degree of weathering than the chert in the RGA (Sexton, 2006). The UCD is often micaceous (Hansen, 1966).

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Uppermost Aquifer (UMA)
October 9, 2018

In the area of SHF, the upper portion of the UCD consists mainly of clay (lean, sandy lean and fat). The clay includes traces of chert gravel (SHF-102G and D-27). Near the contact with the RGA, transitional layers of sandy silt and silty sand may be encountered (for example see boring logs STN-9, STN-10, STN-12, STN15 from Stantec, 2010).

2.4 DESKTOP REVIEW OF STRUCTURE

Stantec reviewed boring logs for borings and wells completed at SHF and identified 114 borings with indications of the elevation of the top of the RGA. These boring logs and reports completed by others have been furnished to Stantec by TVA which Stantec has used, as furnished, in preparing this demonstration report. The subset of these borings located in the vicinity of Ash Pond 2 are shown on Figure 4.

Review of these data indicated several details regarding the structure of the top of the RGA.

- The top of the RGA surface generally dips towards the river at approximately 20-30 feet per mile.
- The lowest elevations of the top of the gravel were encountered between SHF-101G and D-74B where the gravel was found to be thin. These locations are near the former discharge channel of LBC (USGS, 1932; USGS, 1954).
- The highest elevations of the top of the gravel were encountered near the northwestern edge of Ash Pond 2 (D-10 and STN-8). Boring logs for D-10 and STN-8 were reported in Lindquist and Bohac(1989) and Stantec (2010), respectively. The elevation of the RGA indicated by these historical data points was significantly higher than adjacent data points and was a poor fit to the overall trend of the surface. Additionally, the data points which defined the local high spot were drilled using hollow-stem auger methods and were not consistently sampled continuously. This area was identified for further investigation. The results of the investigation related to this area are discussed below.

2.5 FIELD INVESTIGATION

Three confirmation borings were completed to confirm the depth of CCR material and depth of the UMA along the western edge of Ash Pond 2 adjacent to historic borings STN-8, STN-10 and D-10 (Figure 4).

Results

Stantec and Cascade mobilized to SHF on Monday July 17, 2017 and began drilling on Tuesday July 18, 2017. The drilling was completed using Sonic drilling methods. The drilling was overseen by a Stantec professional geologist licensed by the Commonwealth of Kentucky. The identification of the RGA was confirmed with a registered professional geologist familiar with local geology and the RGA. The confirmation borings (STN-AQ-201, STN-AQ-202 and STN-AQ-203) were each drilled to 47 feet below grade. Boring logs are included in a memorandum summarizing the test boring completion (Stantec, 2017a).

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Uppermost Aquifer (UMA)
October 9, 2018

STN-AQ-201

Boring STN-AQ-201 was drilled near the location of the geotechnical boring STN-8. The ground surface elevation at STN-8 was 351.9 feet mean sea level (msl). The Report of Geotechnical Exploration and Slope Stability Evaluation for SHF (Stantec, 2010) included a cross section through STN-8 (C-C'). This cross section indicated that the projected elevation of the bottom of the CCR material was 324.4 feet msl and that the CCR material was projected to be directly on top of native sand. The boring log for STN-8 described this native sand as poorly graded with silt and gravel.

Silty sand was encountered in confirmation boring STN-AQ-201 from 25.5 to 42 feet below grade (326.5 to 310 feet msl). The RGA was identified in this boring at 42 feet below grade (approximately 310 feet msl). This indicates that the top of the RGA is approximately 14 feet below the projected bottom of the CCR material in this area of Ash Pond 2.

STN-AQ-202

Boring STN-AQ-202 was drilled near the location of the geotechnical boring STN-10. The ground surface elevation at STN-10 was 350.7 feet msl. The Report of Geotechnical Exploration and Slope Stability Evaluation for SHF (Stantec, 2010) included a cross section through STN-10 (D-D'). This cross section indicated that the projected elevation of the bottom of the CCR material was 327.2 feet msl and that the CCR material was projected to be directly on top of native sand. The boring log for STN-10 described this native sand as poorly graded with silt.

The RGA was identified in STN-AQ-202 at 43 feet below grade (approximately 308 feet msl). This indicates that the top of the RGA is approximately 19 feet below the projected bottom of the CCR material in this area of Ash Pond 2. Native material encountered below the CCR material and above the RGA in this boring included lean clay, clayey sand, sandy lean clay, and fine grained sand.

STN-AQ-203

Boring STN-AQ-203 was drilled near the location of well D-10. The ground surface elevation at D-10 is 351 feet msl. This boring was completed using hollow stem-auger and was likely not sampled continuously during drilling. The boring log for D-10 indicated that coal ash was present directly above sand and gravel with variable amounts of clay and silt at 323 feet msl. The log also indicated that the sand and gravel was identified as the RGA.

The RGA was identified in STN-AQ-203 at 45 feet below grade (approximately 306 feet msl). This indicates that the top of the RGA is approximately 18 feet below the projected bottom of the CCR material in this area of Ash Pond 2. Native material encountered below the CCR material and above the RGA in this boring included silty lean clay, silty sand, clay, clayey sand, and sand with clay.

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Uppermost Aquifer (UMA)
October 9, 2018

Discussion

The results of the confirmation drilling indicated that the top of the RGA is more than 5 feet below the bottom of the CCR material along the western edge of Ash Pond 2. Continuous sonic core and detailed field logging of these borings have allowed for differentiation between the fine-grained alluvium sediments and the chert gravel of the RGA along the western edge of Ash Pond 2.

The boring logs for STN-8, STN-10 and D-10 seem to have grouped native materials encountered into one undifferentiated layer. The detailed results from STN-AQ-201 through STN-AQ-203 allow for revision of the original interpretation of the boring logs for wells STN-8, STN-10, and D-10.

Table 1 summarizes the estimated elevation of the top of the RGA at borings and wells located near the west edge of Ash Pond 2. The results of the confirmation drilling are consistent with elevations of the RGA identified in other borings and wells and fit the trend in the elevation of the top of the RGA. The elevations originally indicated in STN-8, STN-10 and D-10 represented anomalously high points relative to these other borings.

Table 1. Estimated Elevation of the Top of the RGA

Well	Estimated Top of RGA (feet MSL)	Location Description
STN-8	324.4*	
STN-10	327.2*	
D-10	323	
STN-AQ-201	310	Adjacent to STN-8
STN-AQ-202	308	Adjacent to STN-10
STN-AQ-203	305	Adjacent to D-10
STN-11	297.3	225 feet south of D-10
CPT-5	311.5	645 feet east-southeast of D-10
D-75B	305.54	760 feet southeast of D-10
MLS-29	307.6	170 feet north of STN-8
STN-5	295.6	500 feet northeast of STN-8
STN-6	315.1	100 feet northwest of STN-8

Notes: * The RGA was not differentiated from fine grained alluvial sediments in this boring. The elevation listed corresponds to the projected bottom of CCR material and top of "Native Sand" as indicated in the geotechnical cross section (Stantec, 2010).

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Uppermost Aquifer (UMA)
October 9, 2018

2.6 STRUCTURE OF THE TOP OF THE UMA

Estimated elevations of the top of the RGA from borings and wells are summarized on Figure 4. Confirmation drilling (Section 2.5) was used to identify accurate elevations of the top of the RGA in the western edge of Ash Pond 2 where historical information had anomalous results. The elevation of the RGA as encountered at borings STN-AQ-201, STN-AQ-202, and STN-AQ-203 was added to the stratigraphic data set and the estimated elevations from well D-10 and boring STN-8 were removed from the data set.

Interpolation of data between data points is an industry standard approach for estimating geologic surfaces utilizing geologic data from borings and wells. The stratigraphy data points identified in Figure 4 were interpolated to produce a raster representing the elevation of the top of the RGA using a natural neighbor method (ESRI, 2016).

Figure 4 presents the interpolated surface representing the structure of the top of the RGA. The figure also includes labels for the data points used to produce the surface. Beneath Ash Pond 2, the interpolated elevation of the top of the UMA ranges from 281 to 315.

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Affected Boundary (Base of CCR Unit)
October 9, 2018

3.0 AFFECTED BOUNDARY (BASE OF CCR UNIT)

To determine if the CCR unit meets the requirement for placement above the UMA, the affected boundary (base elevation of the CCR material) must be identified.

Stantec developed a raster surface representing the affected boundary (Figure 5). The surface was created by digitizing TVA drawing 10N206-R7 (TVA, 1952). The grades were then refined by incorporating native soil elevations from the Report of Geotechnical Exploration and Slope Stability Evaluation (Stantec, 2010) and ground surface elevation contours from USGS maps of the Joppa Quadrangle (Finch, 1967; USGS, 1954), and construction details for the perimeter dikes, where applicable.

Within the extent of Ash Pond 2, the contours representing the bottom of the CCR unit ranged from 310 to 325 feet msl. The lowest elevations of the surface were indicated to occur along the eastern part of Ash Pond 2 in the former discharge channel of LBC (USGS, 1932).

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Separation
October 9, 2018

4.0 SEPARATION

4.1 ISOPACH

The raster representing the top of the UMA (Section 2.6 and Figure 4) was subtracted from the raster representing the base of the CCR unit (Section 3.0 and Figure 5) to calculate the thickness of material between the base of CCR and top of RGA. This information was used to produce an isopach map with five-foot contour intervals (Figure 6) representing the separation of the base of the CCR unit from the top of the UMA. The interpolated separation between the base of the CCR unit and the UMA was greater than 5 feet throughout the extent of Ash Pond 2. The areas of the smallest interpolated separation distances are located along the southeastern and western corners of Ash Pond 2. Identification of separation distance relies on interpolation of data between data points.

4.2 DISCUSSION

The following factors were considered to determine whether the Ash Pond 2 located at SHF meets the requirements for placement above the UMA:

- Identification of the UMA at SHF.
 - RGA (AECOM, 2017).
- Identification of the upper limit of the UMA at SHF.
 - Geologic and gauging data indicate that groundwater within the RGA is confined (AMEC, 2017). The upper limit of the UMA is consistent with the stratigraphic top of the RGA.
- Interpolated elevation of the top of the UMA within the extent of Ash Pond 2.
 - The elevation of the top of the UMA ranges from 281 to 315 feet msl within the extent of Ash Pond 2 based on interpolation of data from boring logs including the results of three borings completed in support of this evaluation (Sections 2.3 through 2.6).
- Interpolated elevation of the base of the CCR unit within the extent of Ash Pond 2.
 - Within the extent of Ash Pond 2, contours representing the base of the CCR unit ranged from 310 to 325 feet msl based on interpretation of pre-construction contours and design drawings.

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Separation
October 9, 2018

- Comparison of the elevations of the base of the CCR unit and the top of the UMA within the extent of Ash Pond 2.
 - The interpolated isopach map (Figure 6) representing the thickness of the deposits separating the CCR material from the top of the UMA indicates that the separation distance between the base of the CCR unit and the UMA is greater than five feet (Section 4.1) throughout the extent of Ash Pond 2.

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

Conclusions
October 9, 2018

5.0 CONCLUSIONS

Based on this assessment of the UMA and the CCR unit, the requirements of §257.60 of the EPA Final CCR Rule for placement above the UMA at Ash Pond 2 at SHF have been met.

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

References
October 9, 2018

6.0 REFERENCES

- AECOM. (2017). Groundwater Monitoring System Ash Pond 2 (Main Ash Pond/Stilling Pond) and Consolidated Waste Dry Stack Multiunit TVA Shawnee Fossil Plant West Paducah, Kentucky.
- Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec) (2017, February). 10-Day Report For Shawnee Fossil Plant Background Monitoring Round #0 – Tennessee Valley Authority – Coal Combustion Residuals Ground-Water Quality Monitoring Program.
- Davis, R.W.; Lambert, T. WM.; and Hansen, J. Jr. (1987). Subsurface Geology and Ground-Water Resources of the Jackson Purchase Region, Kentucky. Geological Survey Water-Supply Paper 1987.
- Environmental Protection Agency (EPA) (2015). Federal Register, Vol. 80, No. 74, Part II. 40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule.
- Environmental Systems Research Institute, Inc. (ESRI) (2016). How Natural Neighbor works – ArcMap 10.3. (<http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/how-natural-neighbor-works.htm>)
- Finch, W.I. (1967). Geologic Map of Part of the Joppa Quadrangle, McCracken County, Kentucky.
- Hansen, Arnold J., Jr. (1966). Availability of Ground Water in the Kentucky Parts of the Joppa and Metropolis Quadrangles, Jackson Purchase Region, Kentucky. Hydrologic Investigations Atlas HA-171.
- Kellberg, J.M (1951). Geology of the Shawnee Steam Plant Site; Central Planning. 29-3. Lindquist, Katherine F.; Bohac, Charles E.; TVA Engineering Laboratory (1989). Shawnee Groundwater Assessment, Phase 1. Report No. WR28-2-35-110. Norris, Tennessee.
- Lindquist, Kathrine F.; Bohac, Charles E. and Steve Young; TVA (1992). Shawnee Groundwater Assessment, Phase II. Report No. WR28-1-35-112. Norris, Tennessee.
- Triad Environmental Consultants, Inc. (2017, June). Consolidated waste Dry Stack and Ash Pond 2 – Historical Sash Volume Surfaces – Shawnee Fossil Plant – Paducah, Kentucky
- Sexton, J.L., 2006. Lithologic and Stratigraphic Compilation of Near-Surface Sediments for the Paducah Gaseous Diffusion Plant, McCracken County, KY. University of Kentucky Master's Thesis, Paper 295.

PLACEMENT ABOVE THE UPPERMOST AQUIFER DEMONSTRATION – SHF ASH POND 2

References

October 9, 2018

Stantec Consulting Services Inc. (2018). Annual Groundwater Monitoring and Corrective Action Report, Shawnee Fossil Plant, West Paducah, McCracken County, Kentucky.

Stantec Consulting Services Inc. (2017a). Location Restriction – Phase 2: Placement Above the Uppermost Aquifer, Summary of Test Boring Completion, Shawnee Fossil Plant - Ash Pond 2, West Paducah, McCracken County, Kentucky.

Stantec Consulting Services Inc. (2017b). History of Construction Shawnee Fossil Plant Ash Pond 2 West Paducah, Kentucky.

Stantec Consulting Services Inc. (2010). Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Pond 1 & 2 and Consolidated Waste Dry Stack, Shawnee Fossil Plant, Paducah, Kentucky.

Tennessee Valley Authority (TVA). (1985). Main Plant Dike for Ash Disposal Area Shawnee Steam Plant. TVA drawing number 10N206R7.

United States Department of Energy (2015). Paducah Gaseous Diffusion Plant Final Environmental Assessment for Potential Land and Facilities Transfers, McCracken County, Kentucky.

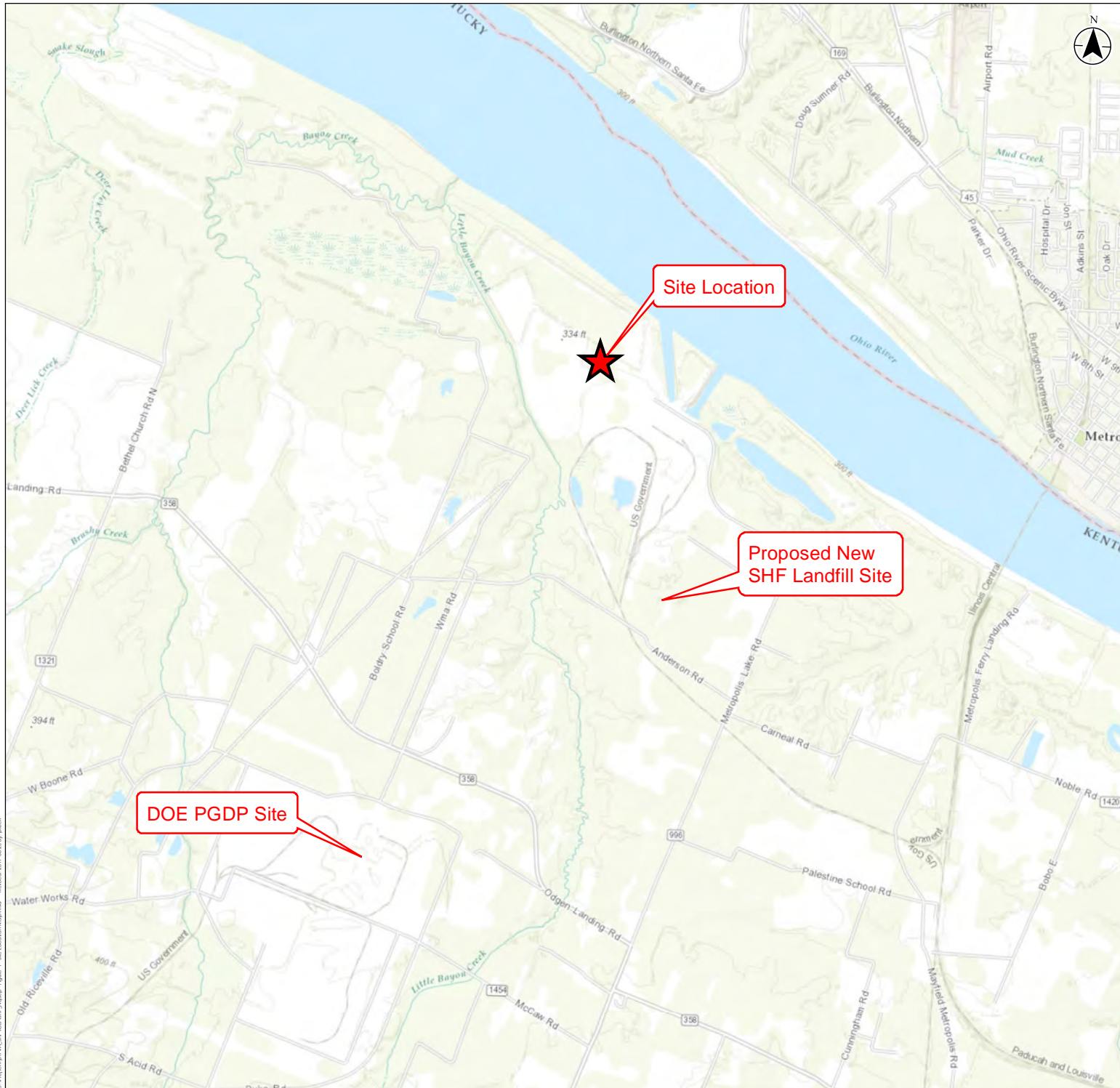
Portsmouth/Paducah Project Office. Pages 3-21 to 3-23. United States Geological Survey (USGS) (1954). Joppa Quadrangle – Kentucky – Illinois – Scale 1:24000

United States Geological Survey (USGS) (1932). La Center Quadrangle – Kentucky – Illinois – Scale 1:62500

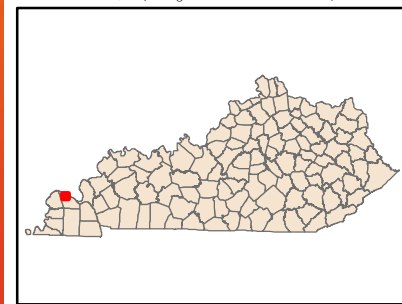
FIGURE 1
SITE LOCATION MAP

Legend

Shawnee Fossil Plant



Notes
 1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
 2. Topographic data: ArcGIS Online



Project Location:
 McCracken County, KY Prepared by TCS on 2017-04-17

Client/Project
 Client: Tennessee Valley Authority
 Stantec No: 172676045

Figure No.
 1

Title
 Site Location Map
 Shawnee Fossil Plant

**FIGURE 2
SITE MAP**

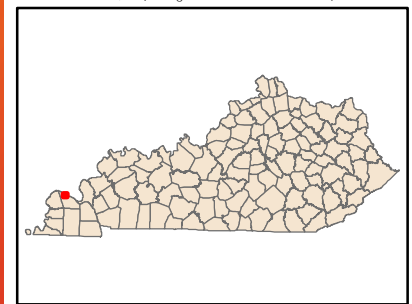


Legend

- Ash Pond 2
- Consolidated Waste Dry Stack
- SHF Site Boundary

Notes
 1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
 2. Aerial Imagery: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

0 1,900 3,800
 Feet
 1:30,000 (At Original document size of 8.5x11)



Project Location: McCracken County, KY Prepared by TCS on 2017-04-17

Client/Project
 Client: Tennessee Valley Authority
 Stantec No: 172676045

Figure No. 2

Title
 Site Layout Map
 Shawnee Fossil Plant











C:\shawnee\SHF\GIS\SHF_Archive\Figure 2 - SHF Layout Map.mxd - Revised: 2017-08-28 by pchill

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data. The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.

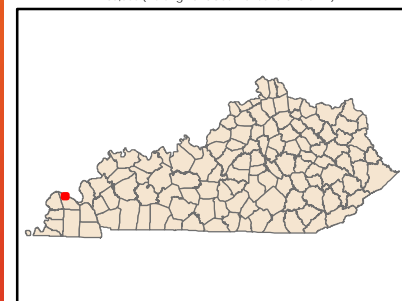
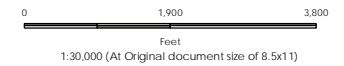
FIGURE 3
GEOLOGIC MAP

Legend

Stratigraphic Units

-  Alluvium
-  Sand
-  Artificial fill
-  Silt and sand deposits
-  Continental deposits
-  Loess
-  Surface Water or Pond
-  Ash Pond 2
-  Consolidated Waste Dry Stack
-  SHF Site Boundary

- Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
 2. Aerial Imagery: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation; Stratigraphic Units: KGS
 3. Adapted from Kentucky Geological Survey



Project Location: McCracken County, KY Prepared by TCS on 2017-04-17

Client/Project
Client: Tennessee Valley Authority
Stantec No: 172676045

Figure No:
3

Title
**Geologic Map
Shawnee Fossil Plant**



FIGURE 4
INTERPOLATED TOP OF RGA

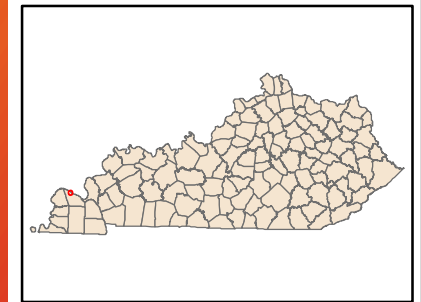
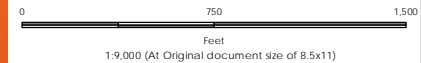


Legend

- Stratigraphy Data Point
- ⊕ Stratigraphy Data Point Not Used in Interpolation
- Ash Pond 2
- Consolidated Waste Dry Stack
- Top of RGA (C.I. = 5 ft.)

Well Boring ID (Estimated top of RGA (feet MSL))

- Notes
1. Coordinate System: NAD 1927 StatePlane Kentucky South FIPS 1602
 2. Aerial Imagery: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation
 3. Top of RGA surface interpolated from boring logs



Project Location: McCracken County, KY Prepared by TCS on 2017-04-17

Client/Project
Client: Tennessee Valley Authority
Stantec No: 172676045

Figure No:
4

Title
Top of Regional Gravel Aquifer Map
Shawnee Fossil Plant

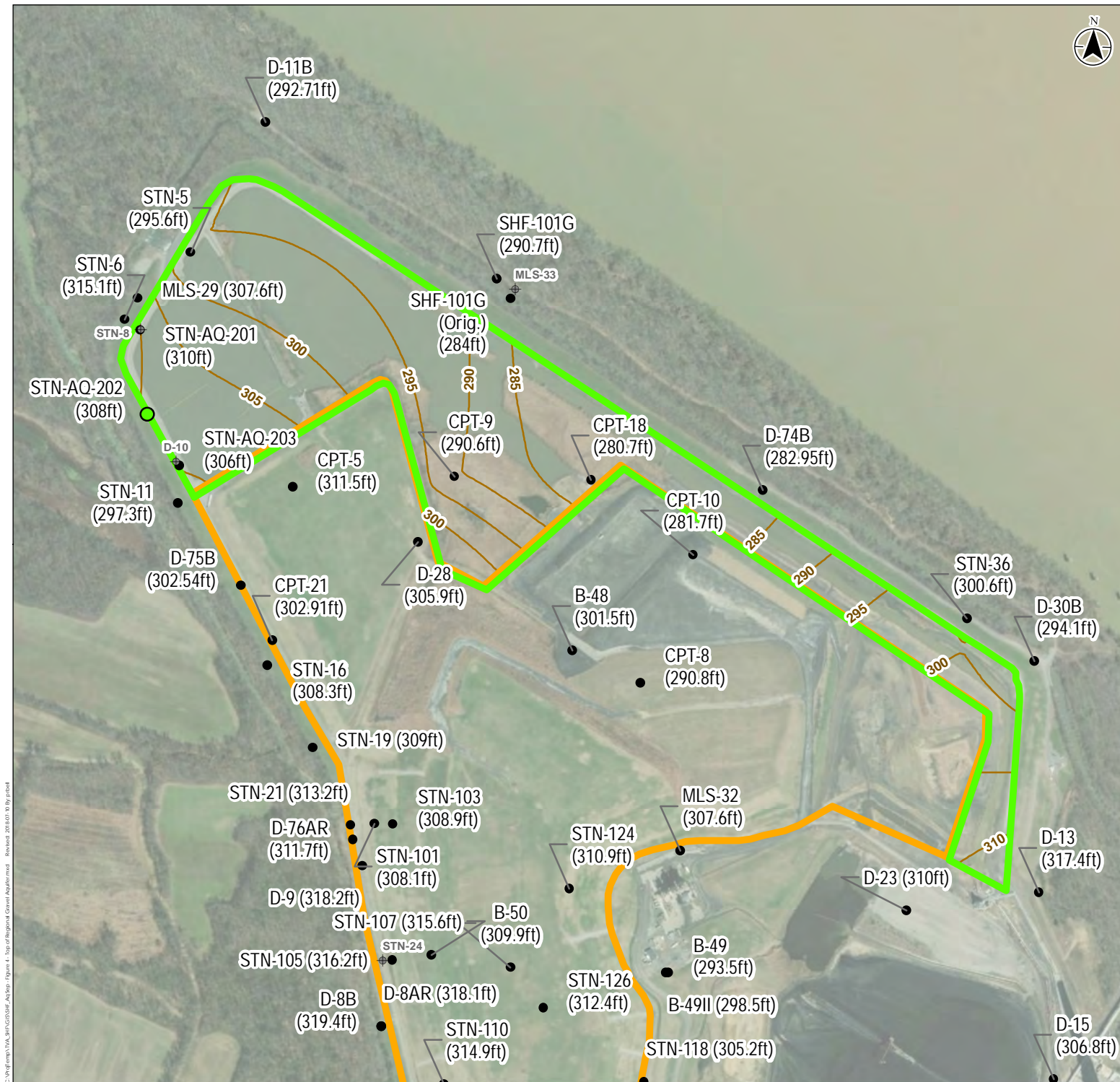
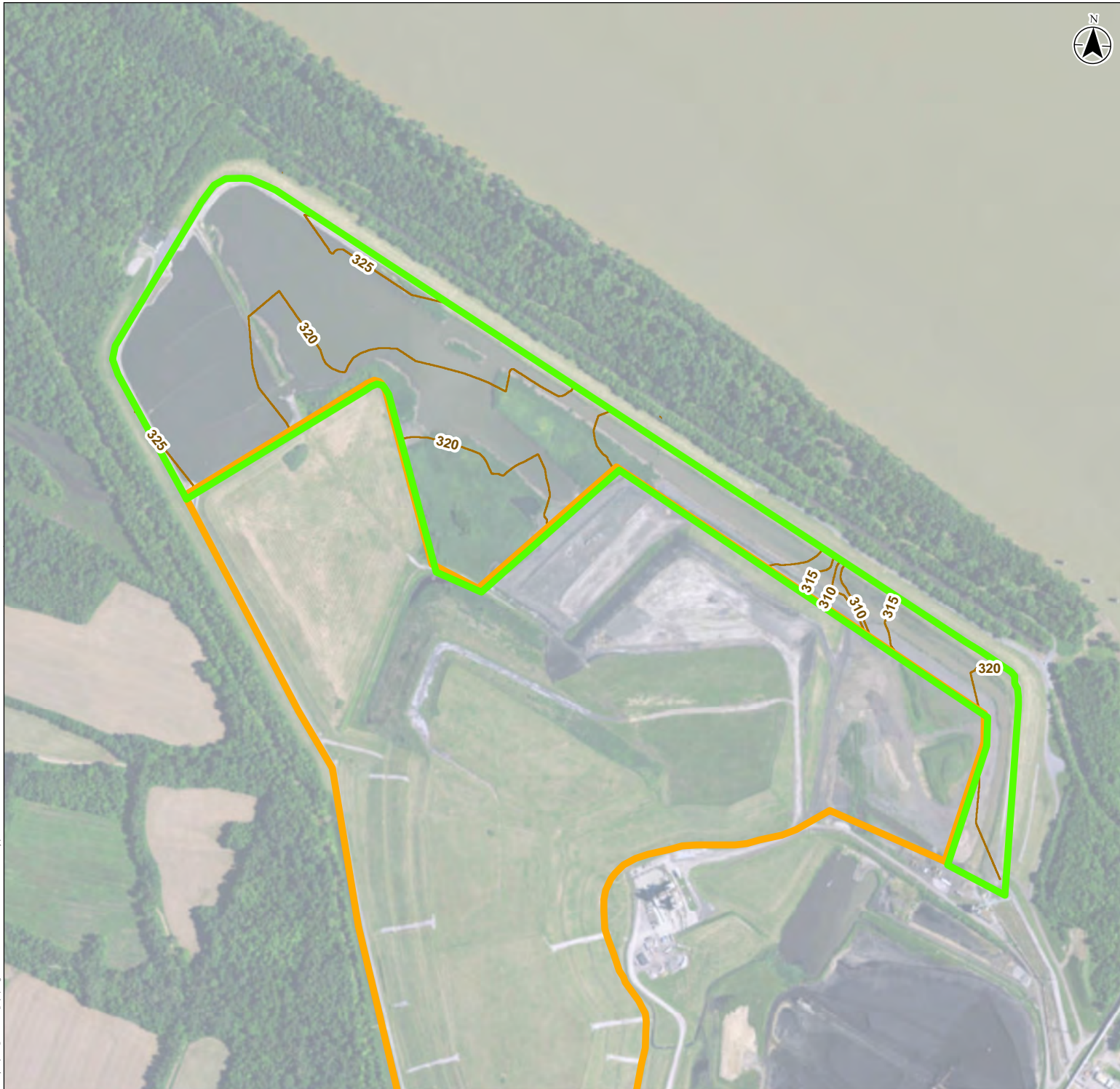


FIGURE 5
AFFECTED BOUNDARY
(BASE OF CCR UNIT)

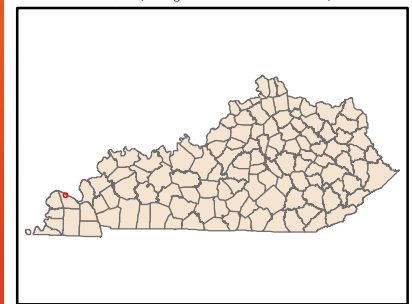
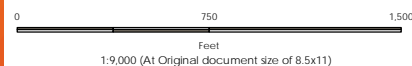


Legend

- Ash Pond 2
- Consolidated Waste Dry Stack
- Base of CCR (C.I. = 5 ft.)

Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
2. Aerial Imagery: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation
3. Base of CCR surface based on TVA drawing 10N206-R7, refined by incorporating native soil elevations from the 2010 geotechnical exploration (Stantec, 2010) and ground surface elevations from the USGS Geologic Map of part of the Joppa Quadrangle, McCracken County, Kentucky (1967), where applicable.



Project Location: McCracken County, KY Prepared by TCS on 2017-04-17

Client/Project
 Client: Tennessee Valley Authority
 Stantec No: 172676045

Figure No:
 5

Title
**Affected Boundary
 (Base of CCR Unit)
 Shawnee Fossil Plant**





C:\Users\pvt\OneDrive\Documents\Projects\172676045\172676045.dwg - Revised 2017-04-17 10:11:11 AM

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data. The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.

FIGURE 6
ISOPACH MAP OF AQUIFER SEPARATION

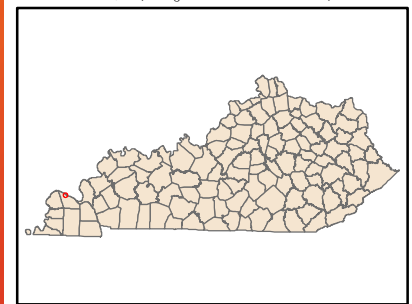
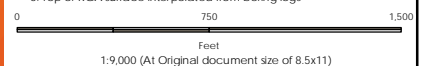


Legend

-  CCR Monitoring Well
-  Isopach thickness of Separation (Bottom of CCR - Top of RGA) (C.I. = 5 ft.)
-  Ash Pond 2
-  Consolidated Waste Dry Stack

Well Boring ID (Estimated top of RGA (feet MSL))

- Notes
1. Coordinate System: NAD 1983 StatePlane Kentucky FIPS 1600 Feet
 2. Aerial Imagery: Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation
 3. Top of RGA surface interpolated from boring logs

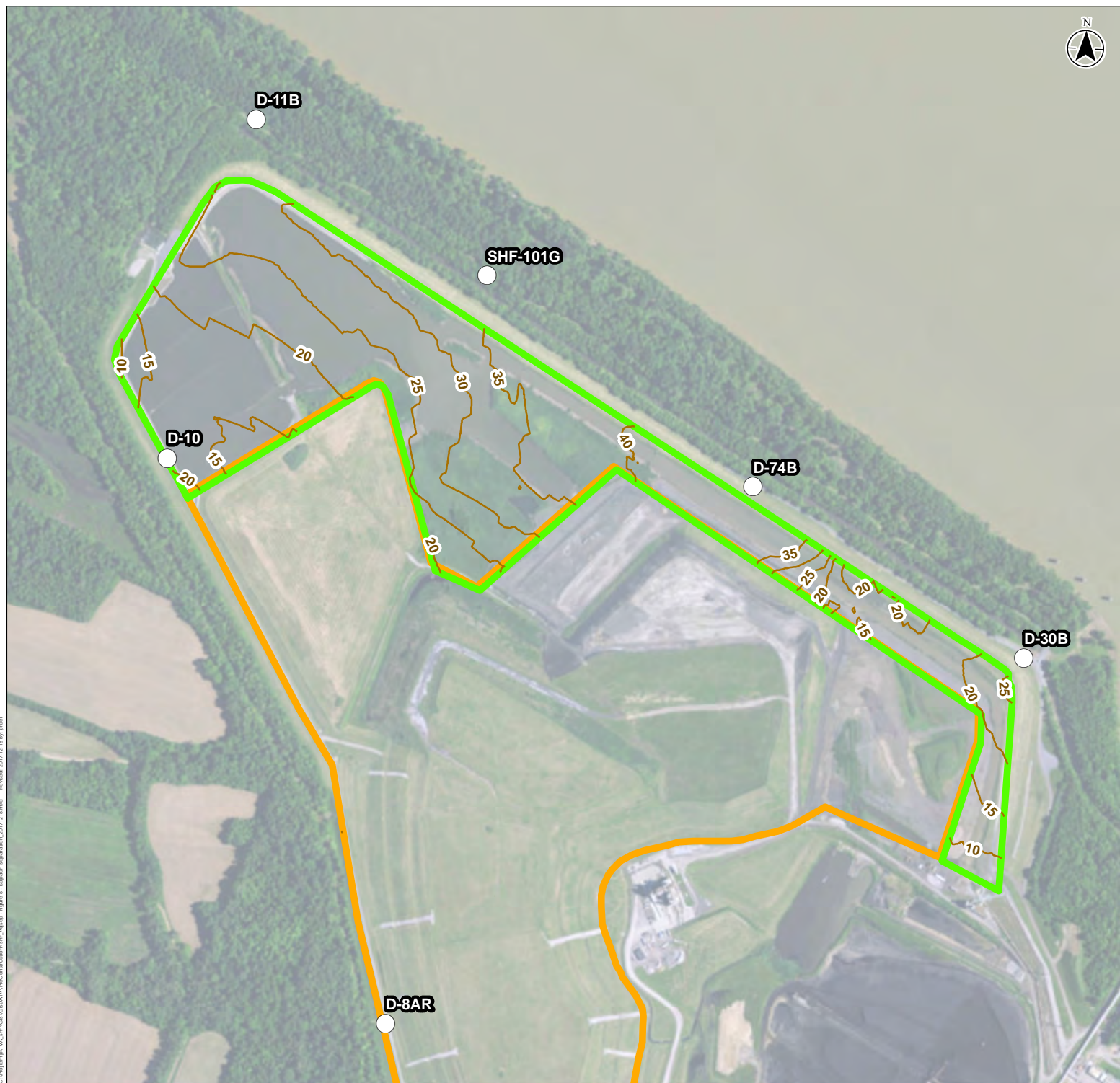


Project Location: McCracken County, KY Prepared by: TCS on 2017-04-17

Client/Project
Client: Tennessee Valley Authority
Stantec No: 172676045

Figure No:
6

Title
**Isopach Map of Separation
Shawnee Fossil Plant**



C:\p\shf\p\shf\GIS\CGDATA\vec\construction\shf_Ashp\fig\isopach\separation_20171218.mxd Revised: 2017-12-18 by: pshf

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data. The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.