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

March 26, 2021
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Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

RE: Placement Above the Uppermost Aquifer Demonstration
New CCR Landfill
TVA Shawnee Fossil Plant
Paducah, McCracken County, Kentucky

1.0 PURPOSE

As described in 40 CFR § 257.60, an owner or operator of a new CCR landfill is required to demonstrate that the unit is located no less than five feet about the upper limit of the uppermost aquifer. This letter documents Stantec's certification that the TVA Shawnee Fossil Plant's (SHF) new CCR landfill complies with requirements in the EPA Final CCR Rule 40 CFR § 257.60.

2.0 SUMMARY OF FINDINGS

The attached demonstration documents that the New CCR Landfill meets the requirements set forth in 40 CFR § 257.60.

3.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Michael J. Steele, being a Professional Engineer in good standing in the Commonwealth 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 SHF New CCR Landfill meets the requirements specified in 40 CFR § 257.60.

RE: Placement Above the Uppermost Aquifer Demonstration
New CCR Landfill
TVA Shawnee Fossil Plant
Paducah, McCracken County, Kentucky

SIGNATURE _____ DATE 3/26/2021

ADDRESS: Stantec Consulting Services Inc.
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Lexington, Kentucky 40513

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ATTACHMENTS: Placement Above the Uppermost Aquifer Demonstration

Placement Above the Uppermost Aquifer Demonstration
TVA Shawnee New CCR Landfill

New CCR Landfill
TVA Shawnee Fossil Plant
Paducah, McCracken County, Kentucky

Prepared for:
Tennessee Valley Authority
Chattanooga Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

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1.0 INTRODUCTION

On April 17, 2015, the EPA published the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" final rule (EPA Final CCR Rule) in the Federal Register. The Tennessee Valley Authority (TVA) contracted with Stantec Consulting Services Inc. (Stantec) to evaluate the new coal combustion residuals (CCR) landfill unit at the Shawnee Fossil Plant (SHF) for compliance with the uppermost aquifer placement restriction requirements of the EPA Final CCR Rule.

1.1 OBJECTIVE

As required by § 257.60 of the EPA Final CCR Rule, an owner or operator of a new CCR landfill is required to demonstrate that the unit is located no less than five feet above the upper limit of the uppermost aquifer (UMA). The objective of this report is to document that the new CCR landfill complies with the UMA placement restriction requirements.

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, just east of the confluence of Little Bayou Creek with the Ohio River.

The new CCR landfill will be located on the Shawnee East Site, which consists of about 205 acres that TVA acquired in 2016 next to the eastern boundary of the SHF reservation. The CCR landfill will be constructed in three stages over a total footprint of 88 acres. The embankment will be about 115 feet tall with maximum 4H:1V slopes and will accommodate about 8 million cubic yards of CCR material (fly ash, bottom ash, and gypsum) across an estimated 25-year operational life.

2.0 CRITERIA

The EPA Final CCR Rule § 257.60 requirements for placement above the UMA are:

> ***40 CFR § 257.60(a).*** *New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be 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).*

The EPA Final CCR Rule § 257.53 provides the following definitions of aquifer and 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.*

3.0 DEMONSTRATION

The following factors have been considered to determine whether the new CCR landfill meets the requirements for placement above the UMA:

- Identification of the UMA at the site;
- Identification of the upper limit of the UMA at the site;
- Evaluation of the elevation of the top of the UMA within the extent of the new CCR landfill;
- Evaluation of the elevation of the bottom of CCR unit within the extent of the new CCR landfill; and
- Comparison of the elevations of the bottom of CCR and the upper limit of the UMA within the extent of the new CCR landfill.

3.1 IDENTIFICATION

Site explorations were conducted at the new CCR landfill site (Stantec 2018) to characterize local and regional geology and hydrogeology, characterize hydrostratigraphic units, and identify the UMA.

Below the phreatic surface, six hydrostratigraphic units have been identified. From shallow to deep, these include Upper Clay, Upper Silt/Sand, Lower Clay, Lower Silt/Sand, Regional Gravel Aquifer (RGA), and the McNairy Formation. Each of these units is discussed below and compared to criteria for identification of the UMA.

Terminology adopted for this project derives from various technically useful descriptions or groupings of soils to support characterization and design. Figure 1 correlates this terminology to referenced published sources.

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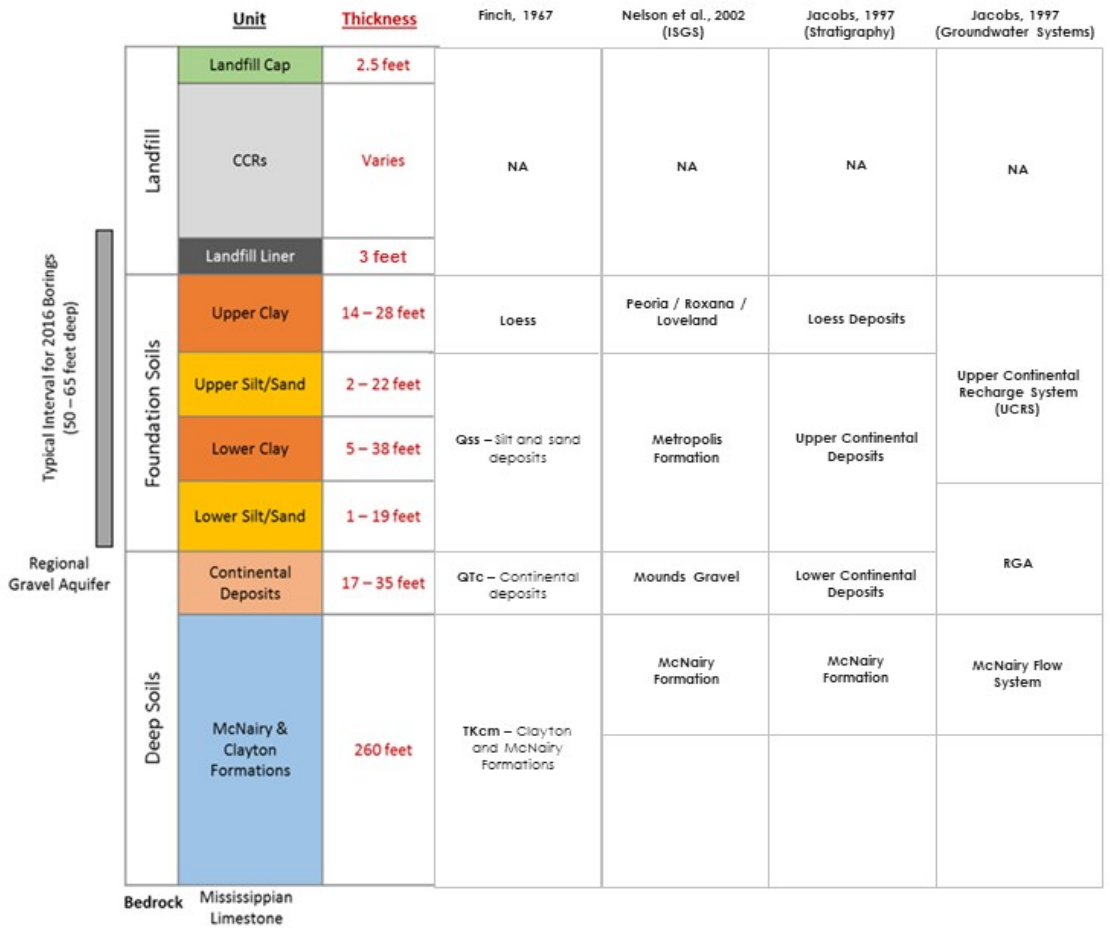
Figure 1. Stratigraphic Correlation of SHF New CCR Landfill and Subsurface



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Finch, W.I. (1967). Geologic Map of Part of the Joppa Quadrangle, McCracken County, Kentucky.

Jacobs EM Team (Jacobs). 1997. Ground-Water Conceptual Model for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky.

Nelson, W.J, J. M. Masters, and L.R. Follmer, 2002. Surficial Geology Map, Metropolis Quadrangle, Massac County, Illinois: Illinois Geological Quadrangle Map, IGQ Metropolis-SG, 1:24,000.

Upper Clay

The Upper Clay unit generally classifies as lean clay (CL). This unit is shallow, has relatively low permeability and is not always saturated across the landfill footprint. No water supply wells within the Upper Clay were identified near the site.

The Upper Clay unit is not the UMA because it does not consistently meet yield criteria to be considered an aquifer and is not used as a source of domestic water.

Upper Silt/Sand

The Upper Silt/Sand unit generally classifies as silty sand (SM) or lean silt (ML). Hydraulic conductivities calculated from slug tests conducted in SHF monitoring wells installed in the Upper Silt/Sand unit ranged from 4.47×10^{-6} centimeters per second (cm/s) to 3.95×10^{-3} cm/s. The results of the slug tests were used to calculate a geometric mean. The geometric mean for the Upper Silt/Sand unit is calculated to be 1.02×10^{-4} cm/s.

The Upper Silt/Sand unit is not the UMA because it does not consistently meet yield criteria, may be discontinuous, and is no longer used as a source of domestic water near the new CCR landfill site. The United States Geological Survey (USGS) and the Kentucky Geological Survey (KGS) have evaluated this unit and determined that yields are not sufficient to supply modern households (USGS 1966). The Upper Silt/Sand unit also has a lower relative resource value than the underlying RGA (discussed below).

Lower Clay

The Lower Clay unit generally classifies as a lean clay (CL). This unit has relatively low permeability. No water supply wells within the Lower Clay were identified near the site.

The Lower Clay unit is not the UMA because it does not consistently meet yield criteria to be considered an aquifer and is not used as a source of domestic water.

Lower Silt/Sand

The Lower Silt/Sand unit generally classifies as silty sand (SM). The Lower Silt/Sand horizon is not the UMA because it may be discontinuous and is immediately underlain by a formation (RGA) with higher yield and higher resource value. Additionally, groundwater generally flows downward through this soil horizon into the RGA.

Regional Gravel Aquifer

The RGA hydrostratigraphic unit consists of a gravel layer. The RGA consists primary of cherty gravel and cobbles with variable amounts of sand and silt and it is consistently present and saturated beneath the new CCR landfill site. Regionally, the hydraulic conductivity of the RGA

has been estimated to be as high as 1 cm/sec (Martin Marietta Energy Systems, 1992) and yields as high as 1,000 gpm have been reported (Hansen, 1996). Groundwater generally flows horizontally within the RGA towards the Ohio River.

The RGA meets the criteria to be classified as the UMA because it has significantly higher anticipated yields than shallower hydrostratigraphic units and is generally recognized as the uppermost and primary aquifer in the region. Additionally, the primary groundwater flow path beneath the new CCR landfill is through the RGA. Although the RGA meets the general requirements to be classified as the UMA, it is not usable with regards to groundwater-quality criteria within the landfill's boundary because groundwater withdrawal for production and potable use is prohibited due to contamination emanating from the nearby Department of Energy (DOE) Paducah Gaseous Diffusion Plant (PGDP) facilities.

McNairy Formation

Based on available literature, the McNairy Formation consists primarily of laminated clay and is consistently present and saturated below the RGA across the proposed landfill site. Laboratory testing for hydraulic conductivity of a sample collected from the McNairy Formation at the site yielded a value of 1×10^{-8} cm/sec (Geo Trans, 1990). The reported range of hydraulic conductivity values for the adjacent DOE facilities is 1×10^{-6} cm/sec to 1×10^{-3} cm/sec (Geo Trans, 1990).

The McNairy Formation is not the UMA because it generally does not meet yield criteria to be considered an aquifer and is overlain by a formation (RGA) with higher yield and higher resource value.

3.2 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 (an aquifer that is fully saturated), the top of the UMA is defined based on the structure of the top of the hydrostratigraphic unit.

Recent data collected from SHF groundwater wells completed in the RGA was reviewed to evaluate if groundwater within the RGA is generally present under confined or unconfined conditions. The groundwater elevations measured during initial sampling following well installation ranged from about 316 feet above msl to about 330 feet above msl. The highest elevation for the top of the RGA in the borings logs was 313 feet above msl. The groundwater elevations measured were above the elevation of the top of the RGA at the gauging locations indicating confined conditions.

Based on the above evaluation, the upper limit of the UMA is the top of the RGA.

3.3 STRUCTURE OF THE TOP OF THE UMA

Beneath the new CCR landfill site, the elevation of the top of the UMA ranges from approximately 295.4 to 313.1 feet above msl.

3.4 BASE OF CCR UNIT

The base of the new CCR landfill slopes from the interior towards the exterior with the minimum elevations being along the exterior of the landfill. The minimum design subgrade elevation is 349 feet above msl.

3.5 SEPARATION

Based on the information presented above, the minimum separation between the base of the CCR unit and the top of the UMA is more than five feet, as required by the CCR Rule.

4.0 CONCLUSION

Based on the assessment documented in this demonstration, the TVA SHF new CCR landfill meets the requirements of § 257.60 of the EPA Final CCR Rule.

5.0 REFERENCES

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.

Geo Trans, Inc. (1990). Numerical Modeling of the Groundwater System Underlying the Shawnee Steam Plant, Paducah, Kentucky.

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