

September 10, 2021

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

**Subject: Engineer's Certification of Placement Above the Uppermost Aquifer Location Restriction Demonstration
North Rail Loop Landfill Cell 2
Tennessee Valley Authority Gallatin Fossil Plant
Gallatin, Tennessee**

1.0 PURPOSE

The purpose of this document is to certify that the Tennessee Valley Authority (TVA) Gallatin Fossil Plant (GAF) North Rail Loop (NRL) Landfill Cell 2 is in compliance with the placement above the uppermost aquifer location restriction requirements specified in 40 CFR § 257.60 of the United States Environmental Protection Agency (USEPA) Coal Combustion Residuals Rule (CCR Rule). Cell 2 is defined by the CCR Rule as a lateral expansion of the existing NRL Landfill (Cell 1). Presented below is the background, summary of findings, and certification.

2.0 BACKGROUND

In accordance with 40 CFR § 257.60(a), all new and existing CCR impoundments, new CCR landfills, and lateral expansions of 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).

3.0 SUMMARY OF FINDINGS

A Location Restriction Demonstration (Demonstration) has been prepared and is provided in **Attachment A**. The Demonstration shows that the NRL Landfill Cell 2 meets the requirements set forth in 40 CFR § 257.60(a).

4.0 CERTIFICATION

I, David E. Skeggs, being a Professional Engineer in good standing in the State of Tennessee, 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 the accepted practice of engineering; that the information contained herein is accurate as of the date of my signature below; and that the North Rail Loop Landfill Cell 2 meets the requirements of 40 CFR § 257.60(a).

SIGNATURE: _____

David E. Skeggs, PE

DATE: September 10, 2021

ADDRESS: 5438 Wade Park Boulevard
Suite 200
Raleigh, NC 27607

TELEPHONE: 919-461-1100

ATTACHMENTS: A – Placement Above the Uppermost Aquifer Location Restriction Demonstration



Attachment A
Placement Above the Uppermost Aquifer
Location Restriction Demonstration

TVA GALLATIN FOSSIL PLANT – SUMNER COUNTY, TENNESSEE

**PLACEMENT ABOVE THE UPPERMOST AQUIFER
LOCATION RESTRICTION DEMONSTRATION
40 CFR § 257.60
NORTH RAIL LOOP
LANDFILL CELL 2**

Prepared for



Tennessee Valley Authority
1101 Market St.
Chattanooga, TN 37402-2801

**Revision 0
September 10, 2021**

Prepared by



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1.0 INTRODUCTION

1.1 OBJECTIVE

This Location Restriction Demonstration (Demonstration) has been prepared for the North Rail Loop (NRL) Landfill Cell 2, which is a lateral expansion of the existing NRL Coal Combustion Residuals (CCR) Landfill (Cell 1), located at the Tennessee Valley Authority's (TVA) Gallatin Fossil Plant (GAF) in Sumner County, Tennessee.

The purpose of this Demonstration is to document compliance with the placement above the uppermost aquifer location restriction requirements set forth in 40 CFR § 257.60 of the United States Environmental Protection Agency (USEPA) CCR Rule.

1.2 CCR RULE REQUIREMENTS – 40 CFR § 257.60

§ 257.60 Placement above the uppermost aquifer

(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 owner or operator must demonstrate by the dates specified in paragraph (c) of this section that the CCR unit meets the minimum requirements for placement above the uppermost aquifer.

(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.

(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).



(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the internet requirements specified in § 257.107(e).

As required by 40 CFR § 257.60(a), TVA must demonstrate that the base of the NRL Landfill Cell 2 is at least 5 feet (ft) above the upper limit of the uppermost aquifer. The uppermost aquifer is defined by 40 CFR § 257.53 as “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.” This definition includes a shallow, deep, perched, confined or unconfined aquifer, provided it yields usable water. This demonstration must be made prior to receiving any CCR in the NRL Landfill Cell 2 per 40 CFR § 257.60(c)(2).

1.3 METHODOLOGY

This demonstration is made by first estimating the upper limit of the uppermost aquifer. This estimate was made using existing pertinent data from groundwater monitoring wells and piezometers in and around the footprint of the existing NRL Landfill. Once estimated, the upper limit of the uppermost aquifer was compared to the planned landfill liner grades to confirm adequate vertical separation as required by 40 CFR § 257.60(a).

1.4 SITE BACKGROUND

The NRL Landfill is located on land currently owned by TVA at GAF. GAF is located at 1499 Steam Plant Road in Sumner County, on the north bank of the Cumberland River, approximately four miles southeast of the juncture of U.S. Route 31E and Tennessee State Route 109 in Gallatin. The NRL site for the disposal facility (**Figure 1**) is located within the GAF reservation, just north of the GAF plant and west of Steam Plant Road. Existing ground surface elevation across the disposal site ranges from approximately 470 ft to 580 ft National Geodetic Vertical Datum of 1929 (NGVD29).

2.0 REGIONAL GEOLOGY

Middle Tennessee, where GAF is located, is occupied by the Nashville Dome, which is a large anticlinal structure with a northeast-southwest trending axis that occurs on the south end of the Cincinnati Arch. Bedrock of the Nashville Dome nearest the surface generally consists of Ordovician limestones, dolomites, and shales, while the surrounding Highland Rim region



generally consists of younger (less eroded) Silurian, Devonian, and Mississippian limestones, cherts, shales, and sandstones. These sedimentary rocks are underlain by approximately 2,500 ft of Cambrian sedimentary rocks and a Precambrian igneous and metamorphic basement complex (Wilson, 1991). Regional dips for bedrock surrounding the study area are approximately 15-ft to 25-ft per mile (less than one degree) to the northwest (Wilson, 1991). The bedrock stratigraphy in the area of study is, from youngest to oldest and in the order that the units are encountered from the surface:

Nashville Group	<u>Bigby-Cannon Limestone</u> – comprises the <i>Bigby</i> facies (0 to 10 ft thick), the <i>Cannon</i> facies (40 to 80 ft thick), and the <i>dove-colored</i> facies (10 to 20 ft thick).
	<u>Hermitage Formation</u> – comprises the <i>silty nodular</i> facies (0 to 5 ft thick), the <i>granular phosphatic</i> facies (10 to 20 ft thick), and the <i>laminated argillaceous</i> facies (40 to 60 ft thick).
Stones River Group	<u>Carters Limestone</u> – comprises the <i>Upper Carters</i> (10 to 20 ft thick), the <i>T-3 bentonite</i> deposit (6 to 12 inches), and the <i>Lower Carters</i> (60 to 70 ft thick).
	<u>Lebanon Limestone</u> – consists of a single facies, approximately 80 to 120 ft thick.

These strata are separated by erosional unconformities. The most recognizable geologic contacts occurring in this sequence are the Hermitage/Carters contact and the Upper/Lower Carters contact. The published regional geologic map for the Odom’s Bend area is provided in **Figure 2**. A detailed discussion of the regional geology can be found in the NRL Landfill Hydrogeologic Evaluation Report (HER) (URS, 2013).

3.0 REGIONAL HYDROGEOLOGY

GAF is located within the Central Basin Aquifer system of Middle Tennessee. This aquifer system is formed in Devonian to Ordovician age carbonates and shales through the erosion of the Nashville Dome. The base of the Central Basin Aquifer is defined by the top of the Knox Group. This aquifer system is an important source of drinking water for Middle Tennessee, as it supplies most of the rural domestic wells and many public drinking wells in the Central Basin and surrounding region. (Brahana and Bradley, 1986)

Groundwater in the Central Basin aquifer system occurs primarily in a relatively shallow flow system of solution-enhanced fracture zones. These water-bearing zones are highly irregular in their distribution throughout the solid rock mass and generally occur within 300 ft of the land surface. They consist of fractures or openings along joints and bedding planes that have been enlarged by dissolution of the limestones. These water-bearing zones represent zones of secondary porosity and permeability in an otherwise nonporous and impermeable rock mass. Bedding planes are thought to be the major control in the formation of water-bearing zones, which have typically been found to be horizontally elongated (Brahana and Bradley, 1986). As observed by Newcome (1958): “Practically all ground water in the Central Basin of Tennessee is confined under artesian pressure in solution channels in the limestone.”



At GAF, the Devonian and Silurian formations have eroded, leaving the Ordovician formations present, as described above. The water-bearing characteristics of these formation are as follows:

Hermitage Formation – The high clay/shale content of the Hermitage limits the development of water-bearing zones. It functions as a confining unit and restricts downward movement of groundwater to underlying formations (Brahana and Bradley, 1986; Newcome, 1958).

Carters Limestone – The Carters is a relatively pure limestone and is subject to solution and karst development where water has access to the rock. However, development of water-bearing zones is hindered by the overlying Hermitage, where present. The presence of the Hermitage restricts the downward seepage of water to the Carters Limestone, forming an almost impervious cap (Newcome, 1958). Bentonite zones in the Carters Limestone also play a significant role in the hydrology. In areas where the bentonite layers are laterally continuous, the downward movement of groundwater is restricted. Where the bentonite zones are breached by open joints or intersecting stream valleys, solution openings can form in the underlying limestone. The Carters Limestone forms an important aquifer where it is exposed (where the Hermitage Formation has been eroded) and where the T-3 bentonite is weathered (Brahana and Bradley, 1986; Newcome, 1958).

Lebanon Limestone - The thin bedding and shale beds in the Lebanon Limestone limit the development of water-bearing zones, but not to same extent as the Hermitage (Brahana and Bradley, 1986; Newcome, 1958).

The most prominent surface drainage feature in the region is the westward-flowing Cumberland River, which has cut an open valley profile and deposited a floodplain averaging approximately 3,000 ft in width. The Cumberland River is characterized by its pronounced meanders. The regions bordering the river are maturely dissected by a complex system of tributaries. Due to the presence of the Cumberland River on the east, south, and western boundaries of GAF, groundwater at GAF is expected to ultimately discharge to the River.

4.0 UPPERMOST AQUIFER

As described in the Hydrogeologic Evaluation (URS, 2013) and shown in the site conceptual hydrogeologic model (**Figure 3**), the uppermost aquifer at the site occurs in a specific fracture zone within the Lebanon Limestone, about 30 to 40 ft below the Carters/Lebanon contact, and approximately 95 ft below the T-3 bentonite marker bed. The hydraulic behavior at individual wells behaves as a confined aquifer, with groundwater elevation rising approximately 76 to 116 ft above the water-bearing fracture zone and no water in the rock between the water-bearing fracture zone and the potentiometric head level. This Lebanon facture zone appears to have very low permeability on the east side of landfill Cell 1, but is otherwise water-bearing and interconnected beneath the site.

As shown in **Figure 4**, the potentiometric surface within the uppermost aquifer varies across the site from approximately elevation 458 ft to 450 ft NGVD29. The hydraulic gradient in the uppermost aquifer beneath the NRL Landfill is from a high in the northwest to a low in the east

and southeast toward the Cumberland River. The hydraulic gradient varies from 0.006 to 0.011 in April 2019 to 0.005 to 0.006 ft/ft in September 2019 (AECOM, 2020).

A detailed discussion regarding identification of the uppermost aquifer, site investigation, and interpretation and analysis of the site investigation results can be found in the HER (URS, 2013).

5.0 PLACEMENT ABOVE THE UPPERMOST AQUIFER

40 CFR § 257.60(a) states that the “base” of the landfill must be located at least 5 ft above the upper limit of the uppermost aquifer. The base of the NRL Landfill is defined as the bottom of the lowest layer of the liner system, i.e., the bottom of the compacted clay liner. As shown in the NRL Landfill Cell 2 Issued for Construction (IFC) Drawings (AECOM, 2018), the lowest area within Cell 2 occurs at the sump at approximately elevation 486 ft NGVD29. The approximate closest potentiometric contour is at approximately elevation 458 ft NGVD29. This contour also happens to be the highest within the NRL Landfill footprint. Therefore, this combination of lowest point within NRL Landfill Cell 2 and highest potentiometric contour represent the smallest anticipated separation. Therefore, the smallest separation between the NRL Landfill Cell 2 compacted clay liner and the potentiometric surface of the uppermost aquifer is approximately 28 ft.

This approach is conservative, as it underestimates the actual separation distance. As described above in **Section 4.0**, the potentiometric surface is 76 to 116 ft above the actual fracture zones that form the uppermost aquifer itself, resulting in a much greater actual separation distance.

6.0 CONCLUSIONS

Based on the potentiometric surface shown in **Figure 4**, the base of the NRL Landfill Cell 2 is a minimum of 28 ft above the potentiometric surface of the uppermost aquifer. Therefore, the unit meets the 5 ft minimum required separation between the base of the unit and the upper limit of the uppermost aquifer, as specified in 40 CFR § 257.60(a).

7.0 REFERENCES

AECOM (2018), *Tennessee Valley Authority Coal-Combustion Product (CCP) Class II Disposal Facility Gallatin Fossil Plant – North Rail Loop Site, Cell 2 Construction Drawings, TVA Project No. 607603, Issued for Construction – Conformed Documents*, March 2, 2018

AECOM (2020), *2019 Annual CCR Rule Groundwater Monitoring Report, North Rail Loop Landfill, Gallatin Fossil Plant*, January 2020

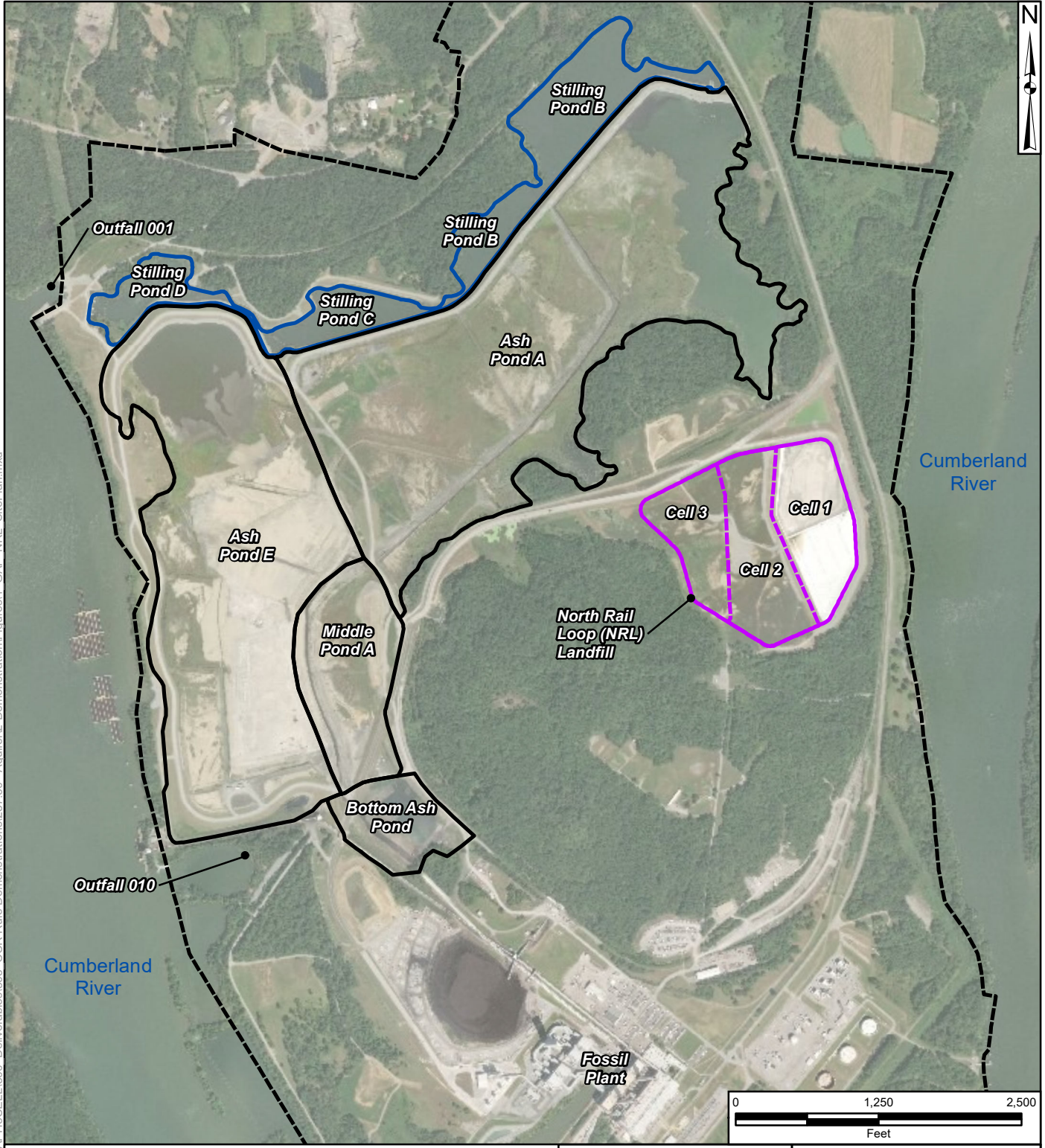
Brahana and Bradley, (1986), *Preliminary Delineation and Description of the Regional Aquifers of Tennessee – The Central Basin Aquifer System*. Prepared by the United States Geological Survey in cooperation with the U.S. Environmental Protection Agency. USGS Water-Resources Investigations Report 82-4002.

Newcome, Roy, Jr, (1958), *Ground Water in the Central Basin of Tennessee*, Tennessee Division of Geology, Report of Investigations No. 4.

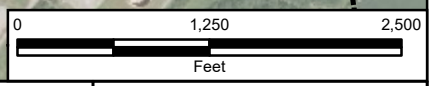


- URS (2013), *TVA Gallatin Fossil Plant, Part II Permit Application, CCP Disposal Facility – North Rail Loop, Hydrogeologic Evaluation*, January 2013
- Wilson Jr., C.W., (1991). *The Geology of Nashville, Tennessee. TDEC, Division of Geology, Bulletin 52, Second Edition.*

FIGURES



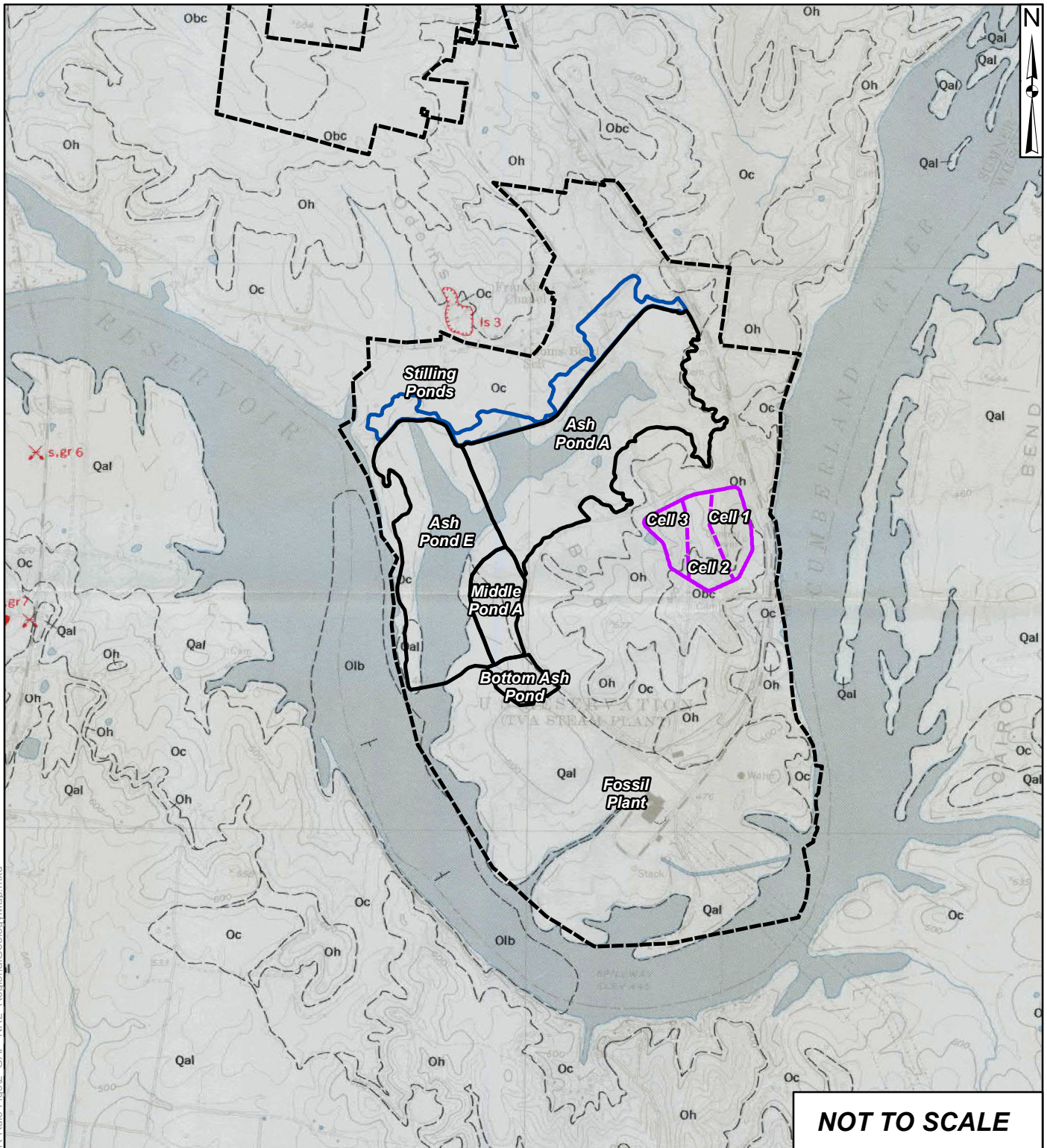
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- LEGEND**
- CCR Management Units
 - North Rail Loop (NRL) Landfill
 - Stilling Ponds
 - TVA Gallatin Fossil Plant Property Boundary (Approximate)

AECOM		Figure 1	
SITE LOCATION MAP			
<small>DRAWN BY:</small> J.COLLEY	<small>REVIEWED BY:</small> D.SKEGGS	<small>APPROVED BY:</small> -	<small>REVISION NUMBER:</small> REV. 0
GALLATIN FOSSIL PLANT TENNESSEE VALLEY AUTHORITY			
<small>DATE:</small> MAR 2020	<small>DEPT:</small> FOSSIL AND HYDRO ENGINEERING		

NOTE: Aerial image dated February 2017



NOT TO SCALE

LEGEND

- CCR Management Units
- North Rail Loop (NRL) Landfill
- Stilling Ponds
- TVA Gallatin Fossil Plant Property Boundary (Approximate)

- Contact, dashed where approximate
- Strike and dip of beds
- Active quarry or pit
- Abandoned quarry
- Abandoned pit
- Map numbers refer to descriptions in Mineral Resources Summary
- Gravel
- Limestone
- Sand

- Alluvial Deposits
- Catheys Formation
- Bigby-Cannon Limestone
- Hermitage Formation
- Carters Limestone
- Lebanon Limestone



Figure 2

REGIONAL GEOLOGIC MAP

DRAWN BY: J.COLLEY	REVIEWED BY: D.SKEGGS	APPROVED BY: -	REVISION NUMBER: REV. 0
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**GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY**

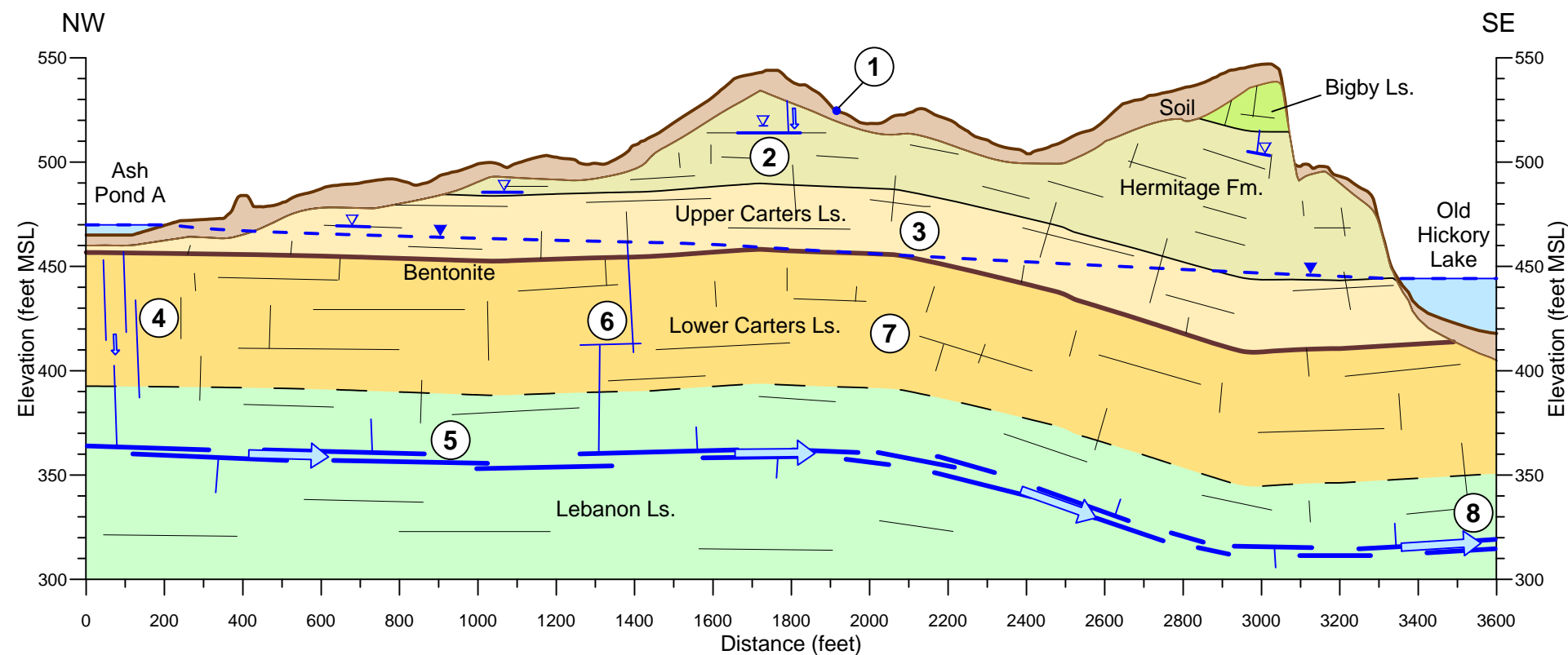
DATE: JULY 2020	DEPT: FOSSIL AND HYDRO ENGINEERING
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NOTE: Laguado Quadrangle Geologic Map from the State of Tennessee Department of Conservation Division of Geology dated 1964.

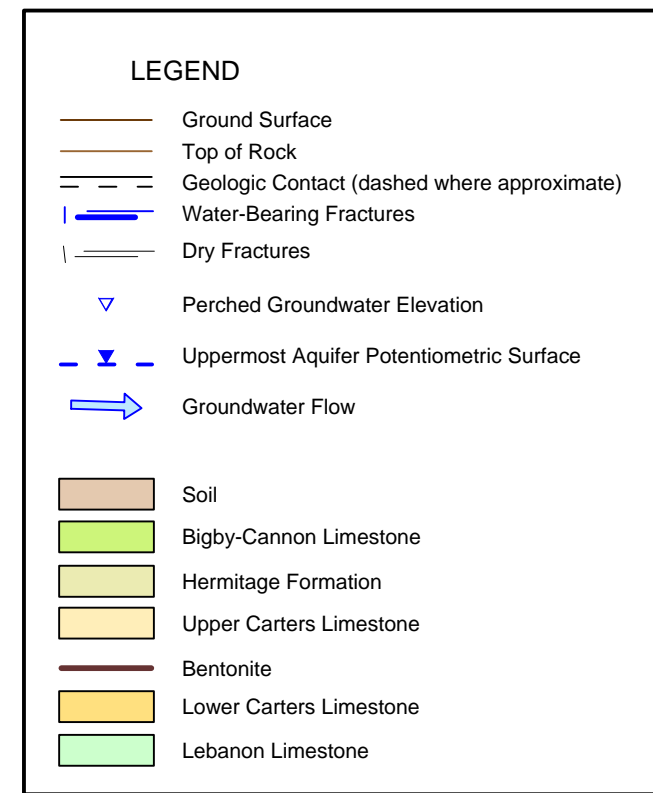
Figure 3

Extracted from the Hydrogeologic Evaluation Report (URS, 2013)



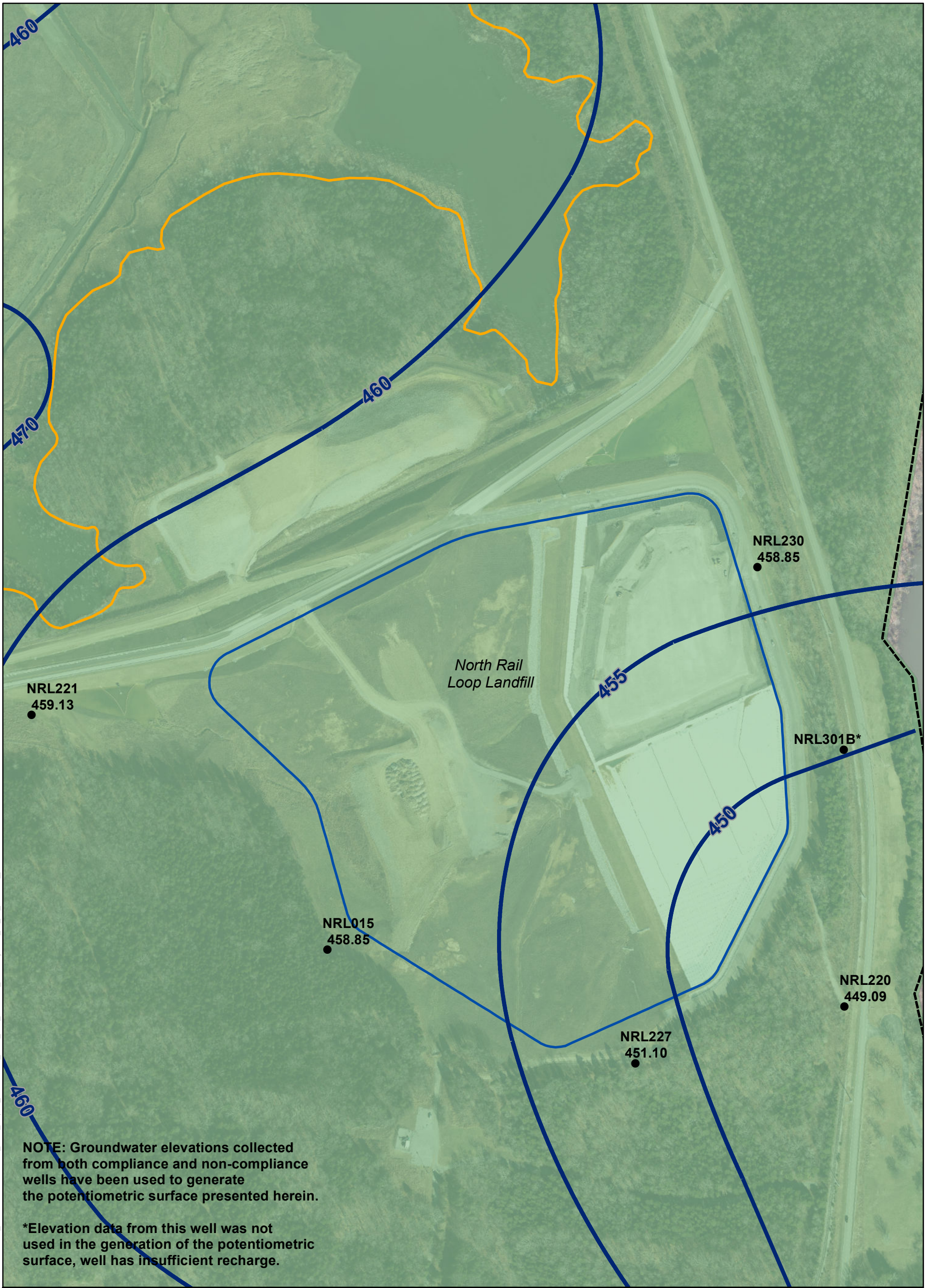
EXPLANATION

- ① Precipitation infiltrates into soil. Minor localized lateral flow. Seeps occur in thin soil on slopes during wet seasons.
- ② Perched groundwater. Horizontal fractures of limited extent receive recharge from surface through vertical fractures. Accumulates locally where there are no deeper transmissive fractures.
- ③ Limited recharge by infiltration through vertical fractures to uppermost aquifer.
- ④ Water from Pond A applies hydraulic head to uppermost aquifer through weakly transmissive vertical fractures.
- ⑤ Uppermost aquifer. Well-connected, transmissive horizontal fractures in Lebanon Limestone behave as semiconfined aquifer.
- ⑥ Slow-responding wells intersect low transmissivity fractures with weak hydraulic connection to uppermost aquifer.
- ⑦ Non-responding wells intersect fractures that are not hydraulically connected to uppermost aquifer.
- ⑧ Discharge from uppermost aquifer to Old Hickory Lake downgradient of Rail Loop area through vertical transmissive fractures.



RAIL LOOP CCP LANDFILL PROJECT						
CONCEPTUAL HYDROGEOLOGIC MODEL						
DESIGNED BY: JRW	DRAWN BY: JRW	CHECKED BY: PFF	SUPERVISED BY: VEK	REVIEWED BY: DPC	ISSUED BY:	APPROVED BY:
GALLATIN FOSSIL PLANT TENNESSEE VALLEY AUTHORITY FOSSIL AND HYDRO ENGINEERING						
Golden Grapher	DATE 1/8/2013					FIGURE 5-1



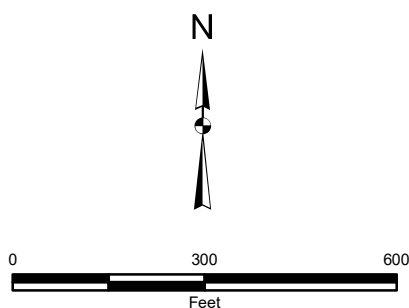


NOTE: Groundwater elevations collected from both compliance and non-compliance wells have been used to generate the potentiometric surface presented herein.

***Elevation data from this well was not used in the generation of the potentiometric surface, well has insufficient recharge.**

LEGEND:

- NRL227** Well ID
- 451.10** Hydraulic head ft. MSL on 4/15/2019
- Well Screened in Lebanon Limestone
- Hydraulic Head Contour in Aquifer
- - - TVA Gallatin Fossil Plant Property Boundary (Approximate)
- ▭ CCR Management Units
- ▭ North Rail Loop (NRL) Landfill



AECOM

Figure 4

**POTENTIOMETRIC SURFACE:
LEBANON LIMESTONE, FEBRUARY 2019**

DRAWN BY: MARK.P.SMITH	REVIEWED BY: C.GARLINGTON	APPROVED BY:	REVISION NUMBER: REV. 0
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GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE: 4/2/2020	DEPT: FOSSIL AND HYDRO ENGINEERING
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NOTE: Aerial image dated February 2017

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