AECOM

2021 Annual CCR Rule Groundwater Monitoring Report North Rail Loop Landfill

Gallatin Fossil Plant
Gallatin, Tennessee

January 2022 - Rev 0

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	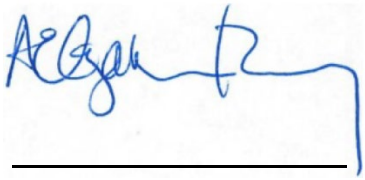	
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Revision History

Revision	Revision Date	Details
Rev 0	01/28/2022	Initial Issue

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Tables

Appendices

1. Overview of Groundwater Monitoring Program Status

In accordance with regulations for management of coal combustion residuals (CCR), 40 CFR 257.90 of the CCR Rule requires "A section at the beginning of the annual report that provides an overview of the current status of groundwater monitoring and corrective action programs for the CCR unit." The specific regulatory requirements of that summary are provided here:

- 257.90(e)(6)(i): At the beginning of the 2021 annual reporting period the North Rail Loop (NRL) Landfill was operating under the detection monitoring program in 257.94.
- 257.90(e)(6)(ii): At the end of the 2021 annual reporting period the NRL Landfill was operating under the detection monitoring program in 257.94.
- 257.90(e)(6)(iii): During the 2021 annual reporting period, statistically significant increases (SSIs) over background were found for one or more constituents listed in Appendix III pursuant to 257.94(e). However, the SSIs were successfully shown to originate from an Alternate Source in accordance with 257.94(e)(2). Thus, the NRL Landfill remains in detection monitoring. For additional details on the SSIs identified in 2021, please refer to the table in the Statistical Evaluation Section of this report.
- 257.90(e)(6)(iv): Not applicable to the NRL Landfill.
- 257.90(e)(6)(v): Not applicable to the NRL Landfill.
- 257.90(e)(6)(vi): Not applicable to the NRL Landfill.

2. Introduction

This report documents groundwater compliance monitoring activities performed at the Tennessee Valley Authority (TVA) Gallatin Fossil Plant (GAF) North Rail Loop (NRL) Landfill as required under the United States Environmental Protection Agency (USEPA) coal combustion residuals (CCR) Rule (40 Code of Federal Regulations [CFR] 257.90(e)). The groundwater monitoring system at the NRL Landfill is shown on **Figure 1**. This report covers the compliance activities performed at the NRL Landfill in 2021 and presents the monitoring activities planned for 2022.

Throughout the 2021 annual reporting period, the NRL Landfill has been in the Detection monitoring phase pursuant to 257.94. As explained in further detail below, statistically significant increases above background were found during the 2021 Detection monitoring events. However, the SSIs were successfully shown to originate from an Alternate Source. Thus, the NRL Landfill remains in detection monitoring.

To comply with the CCR Rule, the following actions were taken in 2021:

- The 2020 Annual Groundwater Monitoring Report (AECOM, 2021) was completed in January 2021 and posted on TVA's publicly accessible CCR Rule website as required by 257.90(e) and 257.107(h)(1).
- Two semi-annual Detection monitoring events took place in March and September 2021.
- Verification (confirmation) sampling was performed in November 2021.
- Detection monitoring results were evaluated in accordance with the CCR Rule (257.94).

- An Alternate Source Demonstration (**Appendix A**) was completed which included evaluation of previous SSIs in addition to the SSIs encountered in 2021.
- TVA's third-party Quality Assurance contractor completed training for field sampling personnel, conducted field audits, and performed data verification/validation.
- Construction of NRL Landfill Cell 2 was completed in 2021, and TVA began placing CCR in Cell 2 in September 2021. Based on CCR Rule definitions (40 CFR 257.53), Cell 2 is a lateral expansion of an existing CCR landfill (NRL Landfill Cell 1). The NRL Landfill groundwater monitoring system was designed as a multi-unit monitoring system covering all three of the constructed/proposed landfill cells (existing Cells 1 and 2, and proposed Cell 3). Thus, no modifications to the current monitoring system are needed due to the landfill expansion.
- In 2021, TVA conducted downhole well and pump maintenance activities at many wells. As a result of these activities, well construction information was updated (for example, based on measured total well depths) where appropriate. These changes reflect record-keeping only; there were no changes in the actual wells themselves due to this maintenance activity. **Table 1** reflects the most up-to-date well construction details and pump intake settings (as applicable to the 2021 monitoring).
- TVA upgraded the surface completions at most of the monitoring wells in November-December 2021 (after completion of the 2021 monitoring). During this upgrade, the top of casing elevations were changed. The re-survey of the wells was not completed in 2021.

Problems encountered and resolution:

- Groundwater monitoring data from the NRL Landfill continues to regularly have false-positive SSIs that do not appear to be associated with a release from the landfill. The on-going occurrence of SSIs indicates that the background (pre-waste) data set used as the basis of the statistical calculations does not sufficiently capture the full range of groundwater variability. To address this and reduce the occurrence of false positive SSIs, TVA will evaluate updating the statistical calculations, considering both the background data set and the statistical methods.

The following activities are planned for 2022 to comply with CCR Rule groundwater monitoring requirements:

- This 2021 Annual Groundwater Monitoring Report will be posted on TVA's publicly accessible CCR Rule website, as required by 257.90(e) and 257.107(h)(1).
- The re-survey of the wells following upgraded surface completions will be completed in 2022, and the new survey data will be reported in the 2022 Annual Report.
- Detection monitoring will continue with two semi-annual monitoring events in 2022, in accordance with 40 CFR 257.94.
- Detection monitoring results will be evaluated in accordance with the CCR Rule (257.94).
- The groundwater analytical data obtained in 2022 will be evaluated using appropriate statistical methods. Changes to the monitoring program will be implemented, as needed, to maintain compliance with 40 CFR 257.90 through 257.98. As noted above, to reduce the occurrence of false positive SSIs, in 2022, TVA anticipates re-evaluating the statistical calculations, considering both the background data set and the statistical methods.
- Alternate source(s), including natural variability, will continue to be evaluated where applicable in accordance with 40 CFR 257.94(e)(2).

- TVA's third-party Quality Assurance Program to evaluate groundwater analytical data will be continued and improved using best practices concerning field methods and validation techniques, as well as the application of the most appropriate statistical methods.
- TVA will comply with recordkeeping requirements as specified in 40 CFR 257.105(h), notification requirements specified in 40 CFR 257.106(h), and internet requirements as specified in 40 CFR 257.107(h).
- The next annual groundwater monitoring report, which will address groundwater monitoring activities undertaken in 2022, will be completed in January 2023.

3. Groundwater Monitoring System

GAF is located in north-central Tennessee, just south of Gallatin, Tennessee. The GAF property consists of approximately 1,950 acres of land encompassing the majority of Odoms Bend peninsula. GAF is surrounded by the Cumberland River between approximate river miles 240.5 and 246.

GAF is a coal-fired steam plant that operates four turbo-generating units. Prior to 2016, TVA managed its CCR by sluicing to surface impoundments. In the early 2010s, TVA started transitioning to dry ash handling. In 2016, in compliance with a permit issued by the Tennessee Department of Environment and Conservation (TDEC), TVA began trucking the combined dry fly ash and dry flue gas desulphurization (FGD) product from the newly constructed FGD 'scrubber' units to the newly constructed NRL Landfill. In 2019, the Flow Management System began operation, and dry-handled bottom ash is also disposed in the NRL Landfill. The NRL Landfill is a lined landfill that meets RCRA subtitle D and CCR Rule requirements. Additional information about the NRL Landfill can be found on TVA's publicly accessible CCR Rule website at the following link: https://www.tva.com/environment/environmental-stewardship/coal-combustion-residuals/gallatin.

GAF is located within the Central Basin Aquifer area of Middle Tennessee. This aquifer system is formed in Devonian to Ordovician-aged carbonates and shales through the erosion of the Nashville Dome. 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 shallow flow system of solution channels. These channels are highly irregular in their distribution throughout the solid rock mass and generally occur within 300 feet of the land surface. The solution channels are openings along joints and bedding planes that locally may be enlarged by dissolution of the limestones. These channels 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 solution cavities, which have typically been found to be horizontally elongated (Brahana and Bradley, 1986).

At GAF, the Devonian and Silurian formations have eroded. Leaving the Ordovician formations present, including (from youngest to oldest), the Hermitage Formation, Carters Limestone, and Lebanon Limestone. In the vicinity of the NRL Landfill, water-bearing fracture zones are typically encountered in the Lebanon Limestone and not the overlying formations.

The NRL Landfill groundwater monitoring system contains ten monitoring wells installed in the Lebanon Limestone aquifer, the uppermost aquifer in the area. The monitoring system includes four background monitoring wells, one upgradient monitoring well, and five downgradient monitoring wells. The monitoring well locations are shown on **Figure 1;** monitoring well construction information is provided on **Table 1**.

The background monitoring wells (GAF-412L, GAF-414L, GAF-426L, and GAF-427L) are located in the northern portion of TVA property and represent conditions unaffected by CCR (40 CFR 257.91(a)(1) and (c)(1)). These background wells are not located directly upgradient from the NRL Landfill. Per the CCR Rule 257.91(a)(1), establishing background water quality may include sampling of wells that are not hydraulically upgradient of the CCR management unit. NRL221 is located upgradient of the NRL Landfill and represents groundwater flowing beneath the unit. However, NRL221 is interpreted as being affected by CCR constituents from a different CCR unit, so the well does not meet the requirement of 257.91(a)(1) that background wells not be influenced by CCR. As a result of these conditions, alternate, non-upgradient locations have been selected to represent background.

Monitoring wells located downgradient (NRL015, NRL220, NRL227, NRL230, and NRL301B) of active landfill Cells 1 and 2 (and future Cell 3) monitor groundwater conditions near the waste boundary (40 CFR 257.91(a)(2) and (c)(1)).

In November-December 2021, TVA upgraded the surface completions at most of the NRL Landfill monitoring wells. As a result, the top of casing elevations were changed. The re-survey of the wells was not completed within 2021. **Table 1** reflects top of casing elevations applicable to the 2021 monitoring (i.e., prior to the upgrades). The well re-survey will be completed in 2022 and the revised survey data reported in the 2022 Annual Report.

The current certification of the groundwater monitoring system required under 40 CFR 257.91(f) is included in the facility operating record and on the facility CCR Rule website at the following link: https://www.tva.com/environment/environmental-stewardship/coal-combustion-residuals/gallatin.

4. Groundwater Sampling and Laboratory Analytical Results

The data obtained during the CCR Rule compliance monitoring in 2021 is presented in this section.

4.1 Groundwater Monitoring

Low-flow groundwater sampling and analysis activities were conducted in accordance with the sampling and analysis program developed per 40 CFR 257.93. As shown on **Table 2**, the semi-annual Detection monitoring events took place in March and September 2021, and a verification (confirmation) sampling event took place in November 2021 to evaluate potential SSIs in the September sampling results.

4.2 Groundwater Flow

Groundwater levels were measured in each monitoring well prior to well purging/sampling as required by 40 CFR 257.93(c). The water level gauging dates for each event are presented in **Table 2**, and tabulated water level data and calculated hydraulic heads are presented in **Table 3**. **Figure 2** presents a map for the Lebanon Limestone showing the generalized direction of the hydraulic gradient based on groundwater elevations measured in March 2021.

Hydraulic gradients were characterized using the data in **Table 3** in addition to water levels measured in other wells at the site beyond those in the NRL Landfill CCR Rule monitoring system. Based on available information, the hydraulic conductivity for the Lebanon Limestone fracture zone measured in the vicinity of the NRL Landfill ranges from 0.86 to 2.9 feet per day (ft/day), with a geometric mean of 1.6 ft/day. A range of average linear groundwater velocities was calculated using the geometric mean hydraulic conductivity, hydraulic gradients of 0.0042 to 0.0142 feet per foot (ft/ft) in March 2021 and 0.0019 to 0.0041 ft/ft in September 2021, and an

effective porosity of 5 percent. The calculated groundwater velocities beneath the NRL Landfill range from 0.10 to 0.28 ft/day.

4.3 Sampling Results

Groundwater samples were submitted to TestAmerica and GEL Laboratories for analysis. The parameters measured in the field and the laboratory analytical results are presented on **Table 4**.

4.4 Statistical Evaluation

Background Upper Prediction Limits (UPLs) for Appendix III constituents at each downgradient well have previously been calculated in accordance with the certified statistical method (AECOM, 2020). The intrawell UPLs are provided on **Table 4**.

The sampling results for the two semi-annual Detection monitoring events and the confirmation (verification) results for 2021 are provided on **Table 4** along with the UPLs for comparison. In 2021, similar to previous years, SSIs continued to be encountered that do not appear to be related to a release from the landfill. Statistically significant increases (SSIs) over statistical background in 2021 are presented below:

Well ID	Boron	Calcium	Chloride	pH
NRL015		X	X	X
NRL227		X	X	
NRL230		X	X	
NRL301B	X			

X - indicates SSI over UPL in 2021, including both original samples and verification samples (where collected); excludes field duplicates.
Specific sample results provided on Table 4.

Many of these SSIs found in 2021 were previously shown to be related to a source other than a release from the NRL Landfill through successful Alternate Source Demonstrations (ASD; see for example, the 2020 Annual Report (AECOM, 2021)). As described in more detail below, in 2021 a new ASD was prepared that provided an integrated evaluation of all SSIs encountered to date during Detection monitoring of the NRL Landfill (2017 to 2021).

4.5 Alternate Source Evaluation

The CCR Rule allows the facility operator to demonstrate that the SSIs are due to a source other than a release from the CCR unit (40 CFR 257.94(e)(2)), specifically: “The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. … If a successful demonstration is completed within the 90-day period, the owner or operator of the CCR unit may continue with a detection monitoring program under this section.”

In 2021, similar to previous years, SSIs continued to be encountered that do not appear to be related to a release from the landfill. An Alternate Source Demonstration (ASD) was prepared that provided an integrated evaluation of all SSIs encountered to date during Detection monitoring (2017 to 2012). The 2021 certification of the integrated ASD by a professional engineer (PE) is presented in **Appendix A**.

The alternate source evaluation (Appendix A) demonstrates that the background (pre-waste) datasets used to calculate the statistical UPLs do not capture the full range of variability in

groundwater in the vicinity for the NRL Landfill. The pre-waste datasets consist of only 8 to 9 samples collected over a one-year period (AECOM, 2020). To obtain a more representative UPL, it may be appropriate at some point for TVA to consider updating the statistics incorporating additional data that has been collected since the landfill has been in operation.

Based on the ASDs, semi-annual Detection monitoring is continuing at the NRL Landfill.

5. Narrative Discussion of Transition between Monitoring Programs

Semi-annual Detection monitoring was conducted in 2021. The Detection monitoring results for 2021 continue to be below the UPLs, and/or attributed to a source other than the NRL Landfill (**Appendix A**). Therefore, the NRL Landfill remains in Detection monitoring.

Two semi-annual Detection monitoring events will take place in 2022. The groundwater analytical data obtained in 2022 will be evaluated using appropriate statistical methods. Changes to the monitoring program will be implemented, as needed, to maintain compliance with 40 CFR 257.90 through 257.98.

6. References

AECOM, 2020. 2019 Annual CCR Rule Groundwater Monitoring Report – North Rail Loop Landfill, Gallatin Fossil Plant, Gallatin, Tennessee. January 2020.

AECOM, 2021. 2020 Annual CCR Rule Groundwater Monitoring Report – North Rail Loop Landfill, Gallatin Fossil Plant, Gallatin, Tennessee. January 2021.

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 USEPA. USGS Water Resources Investigations Report 82-4002.

Figures

GAF-426L
GAF-412L
GAF-427L
GAF-414L
NRL230
NRL221
North Rail
Loop Landfill
NRL301B
NRL015
NRL220
NRL227
Cumberland River/
Old Hickory Lake

LEGEND

- CCR Rule Monitoring System - Downgradient Well
- CCR Rule Monitoring System - Upgradient Well
- CCR Rule Monitoring System - Background Well
- TVA Gallatin Fossil Plant Property Boundary (Approximate)
- North Rail Loop (NRL) Landfill

NOTE: Aerial image dated February 2017

N

0 1,200 2,400
Feet

AECOM

Figure 1

CCR RULE MONITORING SYSTEM
NORTH RAIL LOOP (NRL) LANDFILL

DRAWN BY:	REVIEWED BY:	APPROVED BY:	REVISION NUMBER:
CARRIE.SMITH	C.GARLINGTON	E.PERRY	REV. 1

GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE:	DEPT:
1/14/2022	FOSSIL AND HYDRO ENGINEERING

Document Path: M:\Env\Data\Vol\TVA_GAF\11.0 GIS_CCR_annual_report_figures\CCR_Rule_Monitoring_System_NRL_2021.mxd

GAF-426L
GAF-412L
GAF-427L
GAF-414L
Ash Pond Complex
NRL230
NRL221
NRL301B
North Rail Loop Landfill
NRL015
NRL220
NRL227
Cumberland River/ Old Hickory Lake

LEGEND

- CCR Rule Monitoring System - Downgradient Well
- CCR Rule Monitoring System - Upgradient Well
- CCR Rule Monitoring System - Background Well
- Groundwater Flow Direction
- TVA Gallatin Fossil Plant Property Boundary (Approximate)
- North Rail Loop (NRL) Landfill

N

0 1,200 2,400
Feet

NOTE: Aerial image dated February 2017

AECOM

Figure 2

GENERALIZED HYDRAULIC GRADIENTS – LEBANON AQUIFER, MARCH 2021

DRAWN BY:	REVIEWED BY:	APPROVED BY:	REVISION NUMBER:
CARRIE.SMITH	C.GARLINGTON	E.PERRY	REV. 1

GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE:	DEPT:
1/14/2022	FOSSIL AND HYDRO ENGINEERING

Document Path: M:\Env\Data\Vol\TVA_GAF\11.0 GIS_Groundwater Contours\F2Generalized Hydraulic Gradients Lebanon March21v1.mxd

Tables

Table 1
Well Construction Information - North Rail Loop Landfill
CCR Rule Groundwater Monitoring
TVA Gallatin Fossil Plant
Gallatin, Tennessee

Well ID	UNID #	Position Relative to CCR Unit	Top of Casing Elevation (ft)	Ground Elevation (ft)	Screened Interval (ft btoc)	Screened Formation	Total Well Depth (ft btoc)	Pump Intake Depth (ft btoc)	Well Diameter (in) / Material	Well Coordinates	
										TN State Plane NAD27 Northing (ft)	TN State Plane NAD27 Easting (ft)
GAF-412L	GAF-00-GW-43-019	Background	477.58	473.7	109.5 - 129.5	Lebanon Limestone	129.8	123.0	4-in PVC	710930.63	1880028.39
GAF-414L	GAF-00-GW-43-021	Background	481.45	478.6	93.2 - 103.2	Lebanon Limestone	103.2	98.0	4-in PVC	710439.64	1880406.18
GAF-426L	GAF-00-GW-43-030	Background	506.83	502.6	176.7 - 186.7	Lebanon Limestone	187.0	181.0	2-in PVC	711283.43	1881641.44
GAF-427L	GAF-00-GW-43-032	Background	488.41	484.2	144.4 - 159.4	Lebanon Limestone	159.9	152.0	4-in PVC	710607.73	1882087.46
NRL015	GAF-00-GW-43-042	Downgradient	546.65	543.7	181.5 - 191.5	Lebanon Limestone	192.0	183.0	2-in PVC	704591.25	1882452.49
NRL220	GAF-00-GW-43-044	Downgradient	502.54	500.0	164.1 - 184.1	Lebanon Limestone	184.5	169.0	2-in PVC	704405.75	1884142.78
NRL221	GAF-00-GW-43-045	Upgradient	478.90	476.0	114.4 - 134.4	Lebanon Limestone	135.0	122.0	2-in PVC	705358.82	1881485.21
NRL227	GAF-00-GW-43-046	Downgradient	560.33	557.2	184.7 - 194.7	Lebanon Limestone	195.2	188.0	2-in PVC	704220.14	1883459.69
NRL230	GAF-00-GW-43-052	Downgradient	511.70	507.8	161.8 - 181.8	Lebanon Limestone	181.8	165.0	4-in PVC	705841.91	1883858.54
NRL301B	GAF-00-GW-43-048	Downgradient	498.15	495.3	140.0 - 170.0	Lebanon Limestone	170.2	168.0	2-in PVC	705245.24	1884140.90

Notes:
Survey information from DDS Survey; elevation in National Geodetic Vertical Datum (NGVD) 1929, coordinates based on North America Datum (NAD) 1927.
ft btoc - feet below top of casing
in - inches (inside diameter)
The information presented here represents the most up-to-date information on well conditions applicable to the 2021 monitoring, which may have changed since the initial well installation (e.g., modified TOC, well construction updates based on video survey, etc.).
Surface completions were upgraded at the end of 2021 (after completion of the 2021 monitoring). This table will be updated with the new survey information for the 2022 Annual Report.

Table 2
Groundwater Sampling Summary - North Rail Loop Landfill, 2021
CCR Rule Groundwater Monitoring
TVA Gallatin Fossil Plant
Gallatin, Tennessee

Sample Dates	Groundwater Gauging Date	Monitoring Program	Constituents Analyzed	Number of Wells Sampled
March 24-30, 2021	March 22, 2021	Detection Monitoring (257.94(a))	Appendix III, major ions and field parameters	Background: 4 Upgradient: 1 Downgradient: 5
September 23-28, 2021	September 20, 2021	Detection Monitoring (257.94(a))	Appendix III, major ions and field parameters	Background: 4 Upgradient: 1 Downgradient: 5
November 15-16, 2021	November 15, 2021	Verification (Confirmation) Sampling (257.94(e)(2))	Boron, Calcium, Chloride, and field parameters	Background: 0 Upgradient: 1 Downgradient: 3

Notes:
Appendix III Constituents: Boron, Calcium, Chloride, Fluoride, pH, Sulfate, Total Dissolved Solids (TDS)
Appendix IV Constituents: Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Fluoride, Lead, Lithium, Mercury, Molybdenum, Radium 226 + 228, Selenium, Thallium

Table 3
Groundwater Elevation Summary - North Rail Loop Landfill, 2021
CCR Rule Groundwater Monitoring
TVA Gallatin Fossil Plant
Gallatin, Tennessee

Gauging Date:	3/22/2021			9/20/2021			11/15/2021		
Well ID	**Reference Elevation (ft AMSL)**	**Water Level Measurement (ft)**	**Hydraulic Head (ft AMSL)**	**Reference Elevation (ft AMSL)**	**Water Level Measurement (ft)**	**Hydraulic Head (ft AMSL)**	**Reference Elevation (ft AMSL)**	**Water Level Measurement (ft)**	**Hydraulic Head (ft AMSL)**
GAF-412L	477.58	25.72	451.86	477.58	25.95	451.63	477.58	NA	NA
GAF-414L	481.45	33.31	448.14	481.45	33.45	448.00	481.45	NA	NA
GAF-426L	506.83	44.31	462.52	506.83	51.45	455.38	506.83	NA	NA
GAF-427L	488.41	32.31	456.10	488.41	37.48	450.93	488.41	NA	NA
NRL015	546.65	86.92	459.73	546.65	94.68	451.97	546.65	92.39	454.26
NRL220	502.54	54.95	447.59	502.54	55.83	446.71	502.54	55.08	447.46
NRL221	478.90	18.97	459.93	478.90	26.74	452.16	478.90	24.36	454.54
NRL227	560.33	109.85	450.48	560.33	112.98	447.35	560.33	112.08	448.25
NRL230	511.70	52.22	459.48	511.70	59.75	451.95	511.70	57.35	454.35
NRL301B	498.15	70.63	427.52	498.15	69.20	428.95	498.15	86.34	411.81
Surface Water ID									
CUMBERLAND RIVER (a)	NA	NA	444.95	NA	NA	444.37	NA	NA	444.88

Notes:
AMSL - above mean sea level
ft - feet
NA - not applicable
(a) Data downloaded from TVA's iSite Central Database

Table 4
Detection Monitoring Groundwater Analytical Results - North Rail Landfill
CCR Rule Groundwater Monitoring
TVA Gallatin Fossil Plant
Gallatin, Tennessee

Monitoring Well			GAF-412L	GAF-412L	GAF-414L	GAF-414L	GAF-426L	GAF-426L
Sample Date			3/26/2021	9/23/2021	3/26/2021	9/27/2021	3/26/2021	9/24/2021
Well Location Designation			Background	Background	Background	Background	Background	Background
Sample ID			GAF-GW-GAF-412L-03262021	GAF-GW-GAF-412L-09232021	GAF-GW-GAF-414L-03262021	GAF-GW-GAF-414L-09272021	GAF-GW-GAF-426L-03262021	GAF-GW-GAF-426L-09242021
Sample_type			N	N	N	N	N	N
Analyte	**CAS**	**Units**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Field								
Dissolved oxygen	DO	mg/L	0.09	0	0.35	1.90	1.15	0.15
ORP	ORP	mV	-327.2	-331.7	-184.2	179.2 J	-44.6	105.4
pH, Field	PH-FIELD	pH Units	7.85	7.67	7.54	7.20	6.98	6.97
Specific Cond. (Field)	COND	umhos/cm	621	908	832	847	783	964
Temperature	TEMPW	DEG_C	14.8	16.8	13.9	15.2	15.0	15.5
Turbidity, field	TURB-FIELD	NTU	2.23	2.45	1.31	0.45	1.32	3.35
General Chemistry								
Alkalinity as CaCO3	ALK	mg/L	269 J	325	322	298	325	325
Bicarbonate as CaCO3	ALKB	mg/L	269 J	325	322	298	325	325
Carbonate as CaCO3	ALKC	mg/L	5.00 UJ	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
Chloride	16887-00-6	mg/L	40.0	86.1	99.7	105	12.5	49.3
Fluoride	16984-48-8	mg/L	1.36	1.92	0.764	0.494	0.355	0.456
Sulfate	14808-79-8	mg/L	7.26	9.34	8.78	12.2	113	133
Total Dissolved Solids	TDS	mg/L	352	524	454	764	507	623
Metals								
Boron	7440-42-8	mg/L	0.288	0.397	0.171 U*	0.149 U*	0.0784 U*	0.0916 U*
Calcium	7440-70-2	mg/L	33.5	33.0	66.9	65.5	142	128
Magnesium	7439-95-4	mg/L	18.8	18.8	27.9	26.4	21.2	17.0
Potassium	7440-09-7	mg/L	5.52	6.17	2.25	2.11	3.10	12.9
Sodium	7440-23-5	mg/L	91.9	157	94.1	78.1	15.1	54.4
Metals, Dissolved								
Boron	7440-42-8	mg/L	--	--	--	--	--	--
Calcium	7440-70-2	mg/L	--	--	--	--	--	--

Table 4
Detection Monitoring Groundwater Analytical Results - North Rail Landfill
CCR Rule Groundwater Monitoring
TVA Gallatin Fossil Plant
Gallatin, Tennessee

Monitoring Well			GAF-427L	GAF-427L	NRL015	NRL015	NRL015	NRL015 Background UPL
Sample Date			3/29/2021	9/24/2021	3/29/2021	9/27/2021	11/15/2021	
Well Location Designation			Background	Background	Downgradient	Downgradient	Downgradient	
Sample ID			GAF-GW-GAF-427L-03292021	GAF-GW-GAF-427L-09242021	GAF-GW-NRL015-03292021	GAF-GW-NRL015-09272021	GAF-GW-NRL015-11152021	
Sample_type			N	N	N	N	N	
Analyte	**CAS**	**Units**	**Result**	**Result**	**Result**	**Result**	**Result**	
Field								
Dissolved oxygen	DO	mg/L	0.46	2.02	0.31	0.02	0.28	--
ORP	ORP	mV	-52.6	184.6	-292.4	-286.3	-160.7	--
PH-FIELD	PH-FIELD	pH Units	7.11	7.11	7.26	**6.05**	**6.03**	*6.35 - 7.75
Specific Cond. (Field)	COND	umhos/cm	670	660	913	1064	1131	--
Temperature	TEMPW	DEG_C	13.9	15.8	14.7	15.3	14.7	--
Turbidity, field	TURB-FIELD	NTU	1.81	0.22	0.21	0.41	1.16	--
General Chemistry								
Alkalinity as CaCO3	ALK	mg/L	306	326	410	452	--	--
Bicarbonate as CaCO3	ALKB	mg/L	306	326	410	452	--	--
Carbonate as CaCO3	ALKC	mg/L	5.00 U	5.00 U	5.00 U	5.00 U	--	--
Chloride	16887-00-6	mg/L	9.49	9.89	5.45	**6.37**	5.49	6.08
Fluoride	16984-48-8	mg/L	0.268	0.340	0.792	0.990	--	1.05
Sulfate	14808-79-8	mg/L	41.5	43.9	144	166	--	293
Total Dissolved Solids	TDS	mg/L	342	373	618	660	--	855
Metals								
Boron	7440-42-8	mg/L	0.106 U*	0.0581 U*	0.261	0.300	0.282 U*	0.353
Calcium	7440-70-2	mg/L	99.8	94.4	128	122	**143**	129
Magnesium	7439-95-4	mg/L	28.6	28.2	53.6	57.8	--	--
Potassium	7440-09-7	mg/L	1.70	1.67	8.53	9.62	--	--
Sodium	7440-23-5	mg/L	8.79	8.82	38.9	49.0	--	--
Metals, Dissolved								
Boron	7440-42-8	mg/L	--	--	--	--	0.274 U*	--
Calcium	7440-70-2	mg/L	--	--	--	--	155	--

Table 4
Detection Monitoring Groundwater Analytical Results - North Rail Landfill
CCR Rule Groundwater Monitoring
TVA Gallatin Fossil Plant
Gallatin, Tennessee

Monitoring Well			NRL220	NRL220	NRL 220 Background UPL
Sample Date			3/29/2021	9/27/2021	
Well Location Designation			Downgradient	Downgradient	
Sample ID			GAF-GW-NRL220-03292021	GAF-GW-NRL220-09272021	
Sample_type			N	N	
Analyte	**CAS**	**Units**	**Result**	**Result**	
Field					
Dissolved oxygen	DO	mg/L	0.38	1.00	--
ORP	ORP	mV	-340.0	-349.7	--
PH-FIELD	PH-FIELD	pH Units	7.63	8.42	*7.50 - 9.51
Specific Cond. (Field)	COND	umhos/cm	1280	1265	--
Temperature	TEMPW	DEG_C	15.7	16.9	--
Turbidity, field	TURB-FIELD	NTU	1.83	0.88	--
General Chemistry					
Alkalinity as CaCO3	ALK	mg/L	394	417	--
Bicarbonate as CaCO3	ALKB	mg/L	394	417	--
Carbonate as CaCO3	ALKC	mg/L	5.00 U	5.00 U	--
Chloride	16887-00-6	mg/L	82.7	87.6	97.5
Fluoride	16984-48-8	mg/L	1.59	1.85	1.88
Sulfate	14808-79-8	mg/L	108	131	212
Total Dissolved Solids	TDS	mg/L	766	906	1020
Metals					
Boron	7440-42-8	mg/L	0.525	0.562	0.624
Calcium	7440-70-2	mg/L	5.30	4.63	5.58
Magnesium	7439-95-4	mg/L	2.13	2.18	--
Potassium	7440-09-7	mg/L	8.91	8.75	--
Sodium	7440-23-5	mg/L	281	281	--
Metals, Dissolved					
Boron	7440-42-8	mg/L	--	--	--
Calcium	7440-70-2	mg/L	--	--	--

Table 4
Detection Monitoring Groundwater Analytical Results - North Rail Landfill
CCR Rule Groundwater Monitoring
TVA Gallatin Fossil Plant
Gallatin, Tennessee

Monitoring Well			NRL221	NRL221	NRL221	NRL221	NRL221	NRL221	NRL221 Background UPL
Sample Date			3/29/2021	3/29/2021	9/28/2021	9/28/2021	11/15/2021	11/15/2021	
Well Location Designation			Upgradient	Upgradient	Upgradient	Upgradient	Upgradient	Upgradient	
Sample ID			GAF-GW-NRL221-03292021	GAF-GW-FD03-03292021	GAF-GW-NRL221-09282021	GAF-GW-FD01-09282021	GAF-GW-NRL221-11152021	GAF-GW-FD-11152021	
Sample_type			N	FD	N	FD	N	FD	
Analyte	**CAS**	**Units**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	
Field									
Dissolved oxygen	DO	mg/L	1.84	--	0.37	--	0.74	--	--
ORP	ORP	mV	-271.3	--	-189.1	--	-152.2	--	--
PH-FIELD	PH-FIELD	pH Units	7.00	--	6.80	--	6.95	--	*6.25 - 7.46
Specific Cond. (Field)	COND	umhos/cm	1093	--	1254	--	1206	--	--
Temperature	TEMPW	DEG_C	15.7	--	19.1	--	17.0	--	--
Turbidity, field	TURB-FIELD	NTU	0.46	--	0.54	--	0.06	--	--
General Chemistry									
Alkalinity as CaCO3	ALK	mg/L	401	418	457	425	--	--	--
Bicarbonate as CaCO3	ALKB	mg/L	401	418	457	425	--	--	--
Carbonate as CaCO3	ALKC	mg/L	5.00 U	5.00 U	5.00 U	5.00 U	--	--	--
Chloride	16887-00-6	mg/L	5.46	5.17	5.68	6.12	5.01	5.63	5.42
Fluoride	16984-48-8	mg/L	0.568	0.538	0.718	0.769	--	--	0.851
Sulfate	14808-79-8	mg/L	307	300	324	341	--	--	330
Total Dissolved Solids	TDS	mg/L	881	885	948	883	--	--	1130
Metals									
Boron	7440-42-8	mg/L	1.77	1.87	1.99	2.02	1.79	1.87	3.14
Calcium	7440-70-2	mg/L	194	198	198	197	189	191	179
Magnesium	7439-95-4	mg/L	60.8	61.2	69.1	69.6	--	--	--
Potassium	7440-09-7	mg/L	6.51	6.62	7.34	7.22	--	--	--
Sodium	7440-23-5	mg/L	19.6	20.2	27.5	27.1	--	--	--
Metals, Dissolved									
Boron	7440-42-8	mg/L	--	--	--	--	1.84	1.91	--
Calcium	7440-70-2	mg/L	--	--	--	--	187	195	--

Table 4
Detection Monitoring Groundwater Analytical Results - North Rail Landfill
CCR Rule Groundwater Monitoring
TVA Gallatin Fossil Plant
Gallatin, Tennessee

Monitoring Well			NRL227	NRL227	NRL227	NRL227 Background UPL	NRL230	NRL230	NRL230	NRL230 Background UPL
Sample Date			3/29/2021	9/27/2021	11/16/2021		3/30/2021	9/28/2021	11/16/2021	
Well Location Designation			Downgradient	Downgradient	Downgradient		Downgradient	Downgradient	Downgradient	
Sample ID			GAF-GW-NRL227-03292021	GAF-GW-NRL227-09272021	GAF-GW-NRL227-11162021		GAF-GW-NRL230-03302021	GAF-GW-NRL230-09282021	GAF-GW-NRL230-11162021	
Sample_type			N	N	N		N	N	N	
Analyte	**CAS**	**Units**	**Result**	**Result**	**Result**		**Result**	**Result**	**Result**	
Field										
Dissolved oxygen	DO	mg/L	1.45	0.35	2.09	--	1.78	2.50	0.42	--
ORP	ORP	mV	-239.8	-243.7	-138.9	--	-253.7	185.0 J	-197.2	--
PH-FIELD	PH-FIELD	pH Units	7.05	6.92	6.66	*6.35 - 7.79	7.42	7.42	7.37	*6.21 - 7.60
Specific Cond. (Field)	COND	umhos/cm	1080	1087	1084	--	1307	1367	1371	--
Temperature	TEMPW	DEG_C	15.1	17.0	15.1	--	17.2	16.7	16.2	--
Turbidity, field	TURB-FIELD	NTU	2.04	1.92	1.11	--	0.28	1.82	1.19	--
General Chemistry										
Alkalinity as CaCO3	ALK	mg/L	408	433	--	--	465 J	533	--	--
Bicarbonate as CaCO3	ALKB	mg/L	408	433	--	--	465 J	533	--	--
Carbonate as CaCO3	ALKC	mg/L	5.00 U	5.00 U	--	--	5.00 UJ	5.00 U	--	--
Chloride	16887-00-6	mg/L	**8.44**	**10.1**	**9.42**	8.02	33.0 J	**51.6**	**52.4**	43.1
Fluoride	16984-48-8	mg/L	0.719	0.951	--	1.05	1.11 J	1.50	--	2.00
Sulfate	14808-79-8	mg/L	169	187	--	205	171 J	147	--	296
Total Dissolved Solids	TDS	mg/L	623 J	688	--	711	800 J	835	--	859
Metals										
Boron	7440-42-8	mg/L	1.11	1.24	1.24	1.79	0.686	0.833	0.728	0.962
Calcium	7440-70-2	mg/L	**129**	**127**	**131**	116	**57.7 J**	40.0	39.1	48.3
Magnesium	7439-95-4	mg/L	55.5	60.6	--	--	29.9	22.8	--	--
Potassium	7440-09-7	mg/L	10.5	10.3	--	--	22.8	17.8	--	--
Sodium	7440-23-5	mg/L	48.1	45.3	--	--	221	277	--	--
Metals, Dissolved										
Boron	7440-42-8	mg/L	--	--	1.27	--	--	--	0.717	--
Calcium	7440-70-2	mg/L	--	--	130	--	--	--	37.7	--

Table 4
Detection Monitoring Groundwater Analytical Results - North Rail Landfill
CCR Rule Groundwater Monitoring
TVA Gallatin Fossil Plant
Gallatin, Tennessee

Monitoring Well			NRL301B	NRL301B	NRL301B Background UPL
Sample Date			3/30/2021	9/28/2021	
Well Location Designation			Downgradient	Downgradient	
Sample ID			GAF-GW-NRL301B-03302021	GAF-GW-NRL301B-09282021	
Sample_type			N	N	
Analyte	**CAS**	**Units**	**Result**	**Result**	
Field					
Dissolved oxygen	DO	mg/L	0.46	2.11	--
ORP	ORP	mV	-310.7	-364.0	--
PH-FIELD	PH-FIELD	pH Units	7.39	7.27	*6.53 - 7.96
Specific Cond. (Field)	COND	umhos/cm	8718	8694	--
Temperature	TEMPW	DEG_C	16.1	16.7	--
Turbidity, field	TURB-FIELD	NTU	0.74	4.55	--
General Chemistry					
Alkalinity as CaCO3	ALK	mg/L	519 J	616	--
Bicarbonate as CaCO3	ALKB	mg/L	519 J	616	--
Carbonate as CaCO3	ALKC	mg/L	5.00 UJ	5.00 U	--
Chloride	16887-00-6	mg/L	2420 J	2470	3920
Fluoride	16984-48-8	mg/L	3.36 J	4.21	5.56
Sulfate	14808-79-8	mg/L	170 J	102	430
Total Dissolved Solids	TDS	mg/L	5000 J	4900	7380
Metals					
Boron	7440-42-8	mg/L	**1.86**	**1.80**	1.68
Calcium	7440-70-2	mg/L	73.3 J	68.5	503
Magnesium	7439-95-4	mg/L	33.3	33.9	--
Potassium	7440-09-7	mg/L	36.7	33.5	--
Sodium	7440-23-5	mg/L	1930	1920	--
Metals, Dissolved					
Boron	7440-42-8	mg/L	--	--	--
Calcium	7440-70-2	mg/L	--	--	--

Table 4
Detection Monitoring Groundwater Analytical Results - North Rail Loop Landfill
CCR Rule Groundwater Monitoring
TVA Gallatin Fossil Plant
Gallatin, Tennessee

Bolded and **Underlined** concentrations indicate a Statistically Significant Increase (SSI) over the Background Upper Prediction Limit (UPL) in downgradient wells
Gray shaded wells are background/upgradient wells

Notes and Acronymns

*****	-	a pH value outside of the Lower Prediction Limit (LPL) - UPL range represents a statistically significant increase
FD	-	field duplicate sample
MG/L	-	milligrams per liter
MV	-	millivolts
N	-	primary sample
NA	-	not analyzed for the specified analysis or not applicable for field duplicate (field parameters)
NTU	-	nephelometric turbidity units
pCi/L	-	picoCuries per liter
umhos/cm	-	microMhos per centimeter
UPL	-	upper prediction limit

Qualifier Definitions

U	-	The analyte was analyzed for but not detected. The associated numerical value is at or below the reporting limit.
U*	-	This result should be considered “not detected” because it was detected in a rinsate blank or laboratory blank at a similar level.
J	-	Quantitation is approximate due to limitations identified during data validation.
UJ	-	This analyte was not detected, but the reporting or detection limit may or may not be higher due to a bias identified during data validation.

Appendix A
Alternate Source Demonstration

NOTICE OF DEMONSTRATION OF ALTERNATE SOURCE(S)
GALLATIN FOSSIL PLANT
NORTH RAIL LOOP LANDFILL

In accordance with the provisions of 40 C.F.R. 257.94(e)(2), Tennessee Valley Authority (TVA) commissioned an Alternate Source Demonstration (ASD) study for the above-named coal combustion residuals (CCR) unit located within the Gallatin Fossil Plant's reservation. The study concluded that the Statistically Significant Increases (SSIs) of the Appendix III constituents measured was due to source(s) other than the CCR unit named above. As required by 40 C.F.R. 257.94(e)(2), TVA will include the demonstration, as certified by the qualified Professional Engineer (PE) named below, in its "Annual Groundwater Monitoring Report" for 2021. TVA will continue its detection monitoring program for the North Rail Loop Landfill.

QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, David E. Skeggs, being a Registered 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 is 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 ASD as described in the attached summary meets the requirements of 40 CFR § 257.94(e)(2). Opinions relating to this ASD, environmental, geologic, and hydrogeologic conditions or other conclusions are based on available data; actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

SIGNATURE: _____

PRINTED NAME: David E. Skeggs, PE

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

TELEPHONE: 919-461-1267

Attachments:

Summary of Alternate Source Demonstration, TVA Gallatin Fossil Plant, North Rail Loop Landfill

DATE: 1/28/2022

SUMMARY OF ALTERNATE SOURCE DEMONSTRATION
TVA GALLATIN FOSSIL PLANT
NORTH RAIL LOOP LANDFILL

This document presents a summary of the Alternate Source Demonstration (ASD) prepared for the Tennessee Valley Authority (TVA) North Rail Loop (NRL) Landfill at the Gallatin Fossil Plant (GAF) located in Gallatin, Tennessee. The ASD was prepared in accordance with the US Environmental Protection Agency coal combustion residuals (CCR) Rule (40 CFR 257.94(e)(2)).

During groundwater monitoring at the NRL Landfill in 2021, sampling results were evaluated using the certified statistical methods in accordance with 40 CFR 257.93(h). The statistical analysis resulted in the identification of Statistically Significant Increases (SSIs) over background in at least one downgradient well. ASDs have previously been completed for other SSIs at the NRL Landfill under the CCR Rule, as described in previous Annual Reports. The summary below addresses both the current and previous SSIs together in one comprehensive evaluation.

The observed SSIs over background concentrations indicated a possible release from the NRL Landfill which required further evaluation. The landfill is fully lined, containing both a composite liner and a leachate collection system. The completed ASD presents the justification of an alternate source for the SSIs identified in downgradient wells, and demonstrates it is not due to a release from the landfill. In summary:

The multiple lines of evidence listed below indicate there has been no release from the landfill, and therefore the SSIs cannot be due to the landfill.

- Many of the SSIs have occurred in wells that were not downgradient from landfill cells that are/were in active use at the time of the SSI. Concentrations above the pre-waste UPL are also present in the upgradient well, which also cannot be affected by the landfill.
- The landfill is constructed with a construction drain located beneath the liner to collect shallow perched water that may be present. If there were a release from the landfill, it could initially be detected in the water in this drain system. Regular sampling of the drain weir box does not indicate any evidence of a release from the landfill.
- SSIs in some wells are sporadic, with only one or two SSIs occurring over the five-year period of landfill operation. Because concentrations have decreased following the SSI, the SSI does not reflect a release. If there were a release, concentrations would consistently exceed the UPL and/or exhibit an increasing trend over time.
- The chemistry of the landfill leachate was used to characterize the chemical signature of a potential release, specifically, to identify what constituents and patterns would be expected in downgradient wells if there were a release from the landfill. The observed SSIs and other

groundwater chemistry are not consistent with the chemical signatures and patterns expected if there were a release from the NRL Landfill.

The alternate sources for the SSIs in the NRL Landfill wells include the Ash Pond Complex, another CCR unit located upgradient, natural groundwater chemistry, and variability of groundwater chemistry.

- Previous interpretations suggest that CCR constituents from the APC have migrated to groundwater and affected the chemistry at wells NRL221 and NRL227. Based on the evaluation of chemical signatures, it is possible that the SSIs for calcium in NRL227 and NRL230 and the calcium concentrations above the UPL in NRL221 (the upgradient wells) could be caused by groundwater migration from beneath the APC. However, if the APC were the source of the calcium SSIs, it is unclear why there are not also SSIs for boron in these wells, or an indication of increasing trends in boron.
- Data from 2012 and concentrations fluctuations over time show that the dataset used to calculate the statistical UPLs does not capture the full range of groundwater variability in the vicinity of the NRL Landfill.
- With the exception of certain wells interpreted as being impacted by CCR constituents from the APC, the concentrations of Appendix III constituents, including the SSIs, are consistent with documented groundwater chemistry in the Central Basin Aquifer system.