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Ms. Lauren Linehan
Division of Waste Management
Kentucky Department for Environmental Protection
625 Hospital Drive
Madisonville, Kentucky 42431

PPPO-02-10010362-21B

Ms. April Webb
Hazardous Waste Branch Manager
Division of Waste Management
Kentucky Department for Environmental Protection
300 Sower Boulevard, 2nd Floor
Frankfort, Kentucky 40601

Dear Ms. Linehan and Ms. Webb:

C-404 HAZARDOUS WASTE LANDFILL MAY 2021 SEMIANNUAL GROUNDWATER REPORT (OCTOBER 2020–MARCH 2021), PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY, FRNP-RPT-0190/V1, HAZARDOUS WASTE MANAGEMENT FACILITY PERMIT NO. KY8-890-008-982, AGENCY INTEREST ID NO. 3059
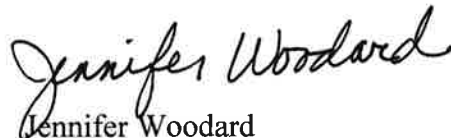
Enclosed is the subject report for the first reporting period fiscal year 2021. This report is required in accordance with Part II, Specific Condition II.K.6.d, of Hazardous Waste Management Facility Permit No. KY8-890-008-982 (Permit).

Results of the statistical analyses indicate that compliance well concentrations of permit-required parameters are not statistically different from those concentrations in background wells, except for technetium-99 (Tc-99) in monitoring well MW84A. The plume discussed in the 2007 *C-404 Landfill Source Demonstration, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PRS-ENM-0031/R2 (ASD), demonstrated that the C-404 Landfill was not the source of the historical, statistically significant background exceedance of trichloroethene in MW84. Concentration trend and spatial distribution data for Tc-99 was evaluated for contaminant distribution and trends presented in the ASD. Application of the ASD rationale to the Tc-99 statistically significant exceedance cannot be made at this time.

Notification of the statistically significant exceedance for Tc-99 in MW84A was submitted, pursuant to Part II, Specific Condition II.K.6.a, to your department under separate correspondence.

If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,

Jennifer Woodard

Jennifer Woodard
Paducah Site Lead
Portsmouth/Paducah Project Office

Enclosures:
1. Certification Page
2. *C-404 Hazardous Waste Landfill May 2021 Semiannual Groundwater Report (October 2020–March 2021), Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* FRNP-RPT-0190/V1

cc w/enclosures:
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CERTIFICATION

Document Identification: *C-404 Hazardous Waste Landfill May 2021 Semiannual Groundwater Report (October 2020–March 2021), Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, **FRNP-RPT-0190/V1, Permit No. KY8-890-008-982, Agency Interest ID No. 3059, dated May 2021**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Four Rivers Nuclear Partnership, LLC

Myrna E. Redfield, Program Manager Four Rivers Nuclear Partnership, LLC	5/19/2021 Date Signed
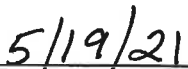
I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.
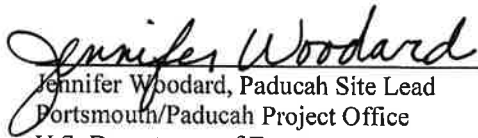
U.S. Department of Energy

Jennifer Woodard, Paducah Site Lead Portsmouth/Paducah Project Office U.S. Department of Energy	5/19/21 Date Signed

C-404 Hazardous Waste Landfill
May 2021 Semiannual
Groundwater Report
(October 2020–March 2021),
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky

FOUR RIVERS
NUCLEAR PARTNERSHIP, LLC

This document is approved for public release per review by:

David Hayden   _05/18/2021_
FRNP Classification Support   Date

C-404 Hazardous Waste Landfill
May 2021 Semiannual
Groundwater Report
(October 2020–March 2021),
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky

Date Issued—May 2021

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC,
managing the
Deactivation and Remediation Project at the
Paducah Gaseous Diffusion Plant
under Contract DE-EM0004895

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CONTENTS

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TABLES

FIGURE

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ACRONYMS

AKGWA	Assembled Kentucky Groundwater
ASD	alternate source demonstration
KDWM	Kentucky Division of Waste Management
MW	monitoring well
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
UCRS	Upper Continental Recharge System
URGA	Upper Regional Gravel Aquifer

EXECUTIVE SUMMARY

This report, *C-404 Hazardous Waste Landfill May 2021 Semiannual Groundwater Report (October 2020–March 2021), Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* FRNP-RPT-0190/V1, is being submitted by the U.S. Department of Energy in accordance with requirements in Kentucky Division of Waste Management Hazardous Waste Management Facility Permit, KY8-890-008-982 (Permit). This first reporting period 2021 covers October 2020 through March 2021 and includes analytical data from the January 2021 sampling of monitoring wells located in the vicinity of the closed C-404 Hazardous Waste Landfill (C-404 Landfill).

The groundwater monitoring analytical data were subjected to statistical analyses. The analyses were conducted in accordance with the Hazardous Waste Management Facility Permit. The technetium-99 (Tc-99) concentration in downgradient compliance monitoring well (MW) MW84A was statistically different from concentrations in the background wells. The statistical tests on all other parameters showed no statistical difference between concentrations in the compliance versus background wells.

The leachate in the C-404 Landfill leachate collection system is monitored at least monthly and at a minimum, is removed and sampled when the level exceeds 3 ft in depth. During this reporting period of October 2020 through March 2021, the maximum depth of the leachate was 40 inches, as measured on February 18, 2021. Subsequently, 1,000 gal of leachate was removed and sampled. The depth of the leachate has not exceeded 3 ft during any of the other monthly monitoring events within the reporting period of October 2020 through March 2021.

1. INTRODUCTION

This report contains the statistical evaluation of data from groundwater sampling and analysis for the closed C-404 Hazardous Waste Landfill (C-404 Landfill) at the U.S. Department of Energy Paducah Site (Paducah Site), Paducah, Kentucky. This semiannual report is required by the Kentucky Division of Waste Management Hazardous Waste Management Facility Permit, KY8-890-008-982 (Permit) (KDWM 2020), Specific Condition II.K.6.d—Recordkeeping, Reporting, and Response. The period covered by this report is October 2020 through March 2021.

Groundwater analytical results are provided in Appendix A. The statistical analyses and qualification statement are provided in Appendix B. Landfill leachate analytical results are provided in Appendix C.

1.1 BACKGROUND

The closed C-404 Landfill is located in the west-central portion of the Paducah Site secured area. The 1.2-acre facility operated as a surface impoundment from approximately 1952 until early 1957. During this time, influents to the impoundment originated from the C-400 Cleaning Building. In 1957, the impoundment was converted to a solid waste disposal facility for uranium-contaminated solid waste. When the impoundment was converted into a disposal facility, a sump was installed at the former weir to collect the leachate from the facility. Leachate is pumped from the sump, as needed, into a mobile tank. The leachate then is transferred to a permitted hazardous waste storage facility on-site prior to characterization and transferred off-site for treatment.

In 1986, the disposal of waste at the C-404 Landfill was halted, and a portion of the disposed-of waste was found to be Resource Conservation and Recovery Act (RCRA)-hazardous. The landfill was covered with a RCRA multilayered cap and certified closed in 1987. It currently is regulated under RCRA as a land disposal unit and compliance is monitored under the current Hazardous Waste Management Facility Permit (KDWM 2020).

Previous groundwater monitoring documented that concentrations in compliance wells were statistically different from background wells for trichloroethene (TCE). The *C-404 Landfill Source Demonstration, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* (PRS 2007a) documented that the source of the TCE in compliance wells is not from the C-404 Landfill, but rather, the source is located upgradient/crossgradient of the C-404 Landfill.

Regional Gravel Aquifer (RGA) compliance monitoring well (MW) 90 was abandoned and replaced by MW90A in 2001. RGA compliance well MW420 was installed in 2007 to better assess groundwater quality at the C-404 Landfill (PRS 2007b). The Burial Grounds Operable Unit evaluated the MW network at the C-404 Landfill relative to the prevailing groundwater flow direction and concluded that the additional RGA well was needed to assess upgradient groundwater quality.

Previous groundwater monitoring of RGA compliance well MW87 documented that concentrations in the compliance well were statistically different from background wells for lead and uranium (FRNP 2018). The *C-404 Hazardous Waste Landfill Alternate Source Demonstration—Source of Lead and Uranium in MW87 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, (FRNP 2019) concluded that the statistical differences were a result of infiltration of Upper Continental Recharge System (UCRS) groundwater into the RGA well due to compromised integrity of the well. The integrity of the well had deteriorated to a point that it no longer was suitable for its intended purpose. RGA compliance wells MW84, MW87, and background well MW93 were abandoned and replaced with MW84A, MW87A, and MW93A in 2019. RGA wells MW84 and MW93 were abandoned and replaced because they were the same age (installed in

1988) as MW87. MW84A and MW87A were placed 10 ft north of MW84 and MW87, respectively, and screened at the same depth intervals. MW93A was placed 6 ft west of MW93 and screened at the same depth interval.

1.2 MONITORING PERIOD ACTIVITIES

1.2.1 Groundwater Monitoring

There are nine MWs sampled under the Permit for the C-404 Landfill: four UCRS wells and five Upper Regional Gravel Aquifer (URGA) wells. A map of the MW locations is provided in Figure 1.

Table 1 presents the well number for URGA wells located upgradient and downgradient of the C-404 Landfill. Table 1 also presents the well numbers for the UCRS wells located in proximity to the URGA wells. This table refers to the UCRS wells as being adjacent to an upgradient or downgradient URGA well location and are identified relative to URGA groundwater flow direction. The conceptual model for the C-404 Landfill indicates that groundwater in the UCRS wells flows primarily vertically downward until it reaches the URGA; therefore, UCRS wells are not considered "upgradient" or "downgradient" of other UCRS wells in the area.

Table 1. Monitoring Well Locations

UCRS	
Located south of C-404 Landfill, adjacent to upgradient URGA background well MW93A	MW94
Located north of C-404 Landfill, adjacent to downgradient URGA compliance wells	MW85, MW88, MW91A*
URGA	
Upgradient background wells	MW93A*, MW420
Downgradient compliance wells	MW84A*, MW87A*, MW90A*

*MW90 was abandoned in 2001 and replaced with MW90A. MW91 was abandoned in 2017 and replaced with MW91A. MW84, MW87, and MW93 were abandoned in 2019 and replaced with MW84A, MW87A, and MW93A.

Table 2 presents the Assembled Kentucky Groundwater (AKGWA) numbers for each MW.

Table 2. Assembled Kentucky Groundwater Numbers

Paducah Site Well Number	AKGWA Number
MW84A	8007-4849
MW85	8000-5234
MW87A	8007-4850
MW88	8000-5237
MW90A	8004-0357
MW91A	8007-2917
MW93A	8007-4851
MW94	8000-5103
MW420	8005-3263

Figure 1. Monitoring Wells

Map Source Information

Map Creation Date and Location:20210421 G\GIS\ARCVIEWS\PROJECTS\C-404\Monitoring Wells_20210421.mxd
Monitoring Wells:G:\GIS\iPEGASIS.gdb\Locations
Roads: G:\GIS\iPEGASIS.gdb\roadrow
Surface Water: G:\GIS\iPEGASIS.gdb\streams
Surface Contour: G:\GIS\Lidar\Paducah_2009_Base_07.gdb\CONTOUR
Figure Location Source Information: G:\GIS\iPEGASIS.gdb\Facilities and G:\GIS\iPEGASIS.gdb\limited_area

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT
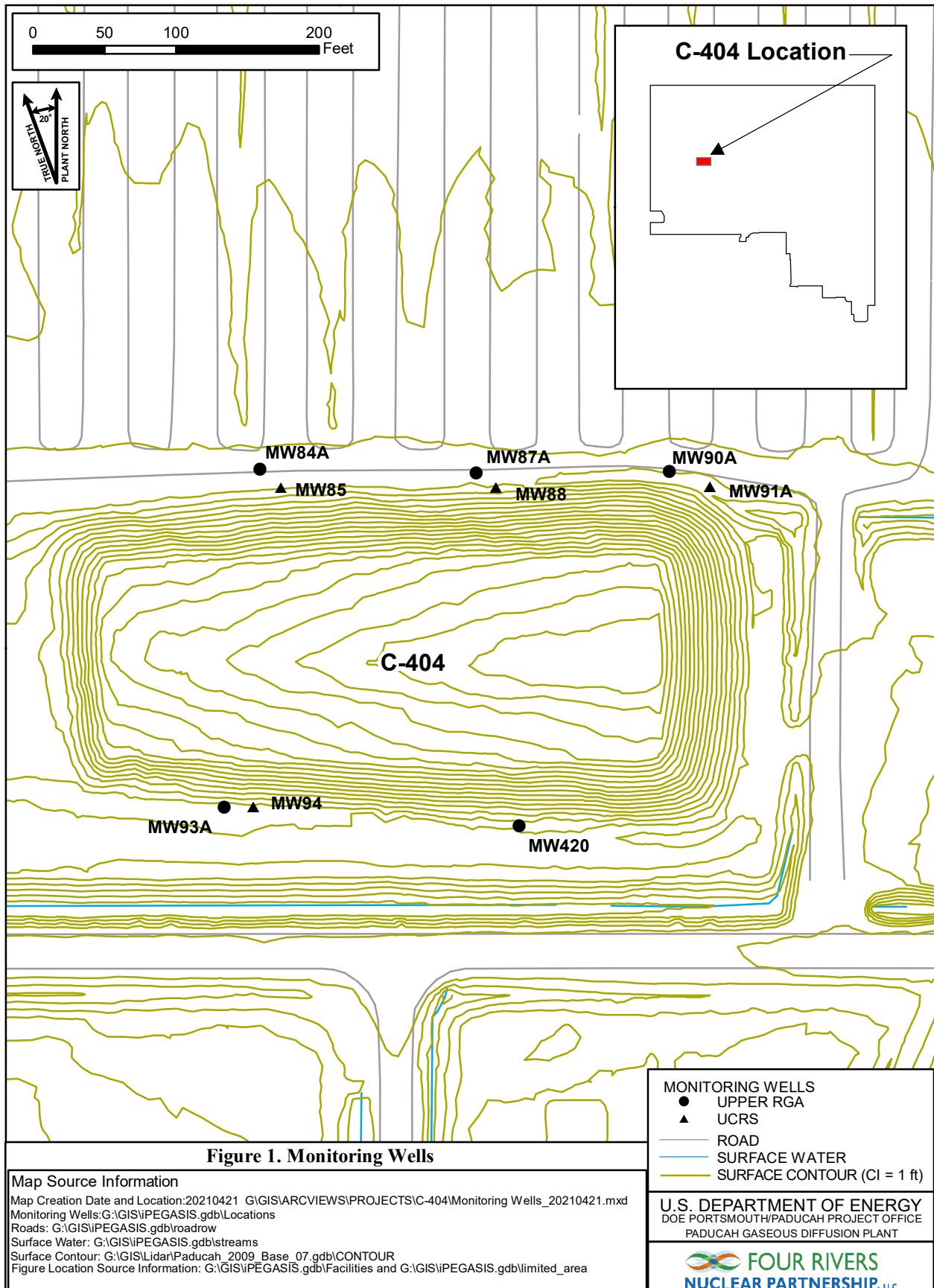
Figure 1. Monitoring Wells

All nine MWs were sampled in January 2021 during this reporting period, and the samples were analyzed for parameters required by Part VIII.E of the Permit. Groundwater sampling was conducted using procedure CP4-ES-2101, *Groundwater Sampling*. Appropriate sample containers and preservatives were used. The laboratory that performed the analyses used U.S. Environmental Protection Agency-approved methods, as applicable. Appendix A of this report contains the analytical results. Appendix B of this report contains the statistical analyses.

1.2.2 Landfill Leachate

In accordance with Appendix I2, C-404 Landfill Closure Plan, Section 1.2 of the Permit, the quantity of liquid in the leachate collection system is monitored (at least monthly) and, at a minimum, will be "removed when the quantity exceeds 3 ft in depth." Once the leachate depth reaches 3 ft, the leachate is pumped into a mobile tank. The leachate then is transferred to a permitted hazardous waste storage facility on-site prior to characterization and transferred off-site for treatment. During this reporting period of October 2020 through March 2021, the maximum depth of the leachate was 40 inches, as measured on February 18, 2021. Subsequently, a total of 1,000 gal of leachate was removed and sampled. The depth of the leachate did not exceeded 3 ft during any of the other monthly monitoring events within the reporting period. Results of the leachate analysis have been included in Appendix C of this report.

2. STATISTICAL SYNOPSIS

The statistical analyses conducted on the data collected from the C-404 Landfill were performed in accordance with procedures in the Permit, Part VIII.E, reissued in February 2020. Appendix B of this report contains the statistical analyses performed for this reporting period. Statistical analyses utilized data from the URGA background wells, MW93A and MW420, and URGA compliance wells, MW84A, MW87A, and MW90A. For these statistical analyses, the reporting period data set includes data from January 2019, July 2019, January 2020, July 2020, and January 2021.

The technetium-99 (Tc-99) concentration in compliance well MW84A was statistically different from concentrations in the background wells. Appendix B provides a summary of the statistical analyses performed. The statistical tests on all other parameters showed no statistical difference between concentrations in the compliance and background wells. Notification of the statistically significant difference for Tc-99 in MW84A was submitted, pursuant to Part II, Specific Condition II.K.6.a, to the Kentucky Department of Waste Management (KDWM) under separate correspondence.

STATISTICALLY SIGNIFICANT EXCEEDANCE OF TC-99 BACKGROUND IN MW84A

Statistical analysis of Tc-99 detections in downgradient compliance well MW84A indicate a statistically significant exceedance over background concentrations. Mann-Kendall trend analysis on the most recent eight semiannual sampling events has indicated an increasing concentration trend for Tc-99.

An alternate source demonstration previously was conducted for TCE in MW84. The 2007 *C-404 Landfill Source Demonstration, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PRS-ENM-0031/R2, (PRS 2007a) (ASD) demonstrated that the C-404 Landfill was not the source of the historical, statistically significant background exceedance of TCE in MW84.

Concentration trend and spatial distribution data for Tc-99 was evaluated with regard to the contaminant distribution and trends presented in the ASD. Application of the ASD rationale to the Tc-99 statistically significant exceedance cannot be made at this time.

In accordance with Permit Specific Condition II.K.6.d, development and submittal of an engineering feasibility plan for a corrective action program is not required when a statistically significant exceedance has been confirmed for Tc-99.

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3. DATA VALIDATION AND QA/QC SUMMARY

The data and the data validation qualifiers for the January 2021 data set are provided in Appendix A. All data for this data set were considered useable as reported. Data validation was performed on the analytical data by an independent, third-party validator.

Field quality control samples are collected during each semiannual sampling event. Equipment rinseate blanks, field blanks, field duplicates, and trip blanks are obtained to ensure quality control and are reported in the analytical results in Appendix A. Laboratory quality control samples, such as matrix spikes, matrix spike duplicates, and method blanks, are performed by the laboratory and reported in the laboratory report. Both field and laboratory quality control sample results are reviewed as part of the data validation process.

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4. PROFESSIONAL GEOLOGIST AUTHORIZATION

DOCUMENT IDENTIFICATION: *C-404 Hazardous Waste Landfill*
May 2021 Semiannual Groundwater Report
(October 2020–March 2021),
Paducah Gaseous Diffusion Plant, Paducah, Kentucky
(FRNP-RPT-0190/V1)

Stamped and signed pursuant to my authority as a duly registered geologist under the provisions of *KRS* Chapter 322A.

PG 113927
K. Davis
05-18-2021

_____   _____   _____
Kenneth R. Davis   PG113927   Date *May 18, 2021*

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5. REFERENCES

FRNP (Four Rivers Nuclear Partnership, LLC) 2018. *C-404 Hazardous Waste Landfill November 2018 Semiannual Groundwater Report (April 2018—September 2018), Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FRNP-RPT-0026/V2, U.S. Department of Energy, Paducah, KY, November.

FRNP 2019. *C-404 Hazardous Waste Landfill Alternate Source Demonstration—Source of Lead and Uranium in MW87 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FRNP-RPT-0078, Four Rivers Nuclear Partnership, LLC, Kevil, KY.

KDWM (Kentucky Division of Waste Management) 2020. Hazardous Waste Management Facility Permit for the U.S. Department of Energy, Paducah Gaseous Diffusion Plant, KY8-890-008-982, effective February 21.

PRS (Paducah Remediation Services, LLC) 2007a. *C-404 Landfill Source Demonstration, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PRS-ENM-0031/R2, Paducah Remediation Services, LLC, Kevil, KY.

PRS 2007b. *Well Plan for Addition of Wells for C-404 Monitoring Well Network, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PRS/PROJ/0028, Paducah Remediation Services, LLC, Kevil, KY, July.

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APPENDIX A

**C-404 HAZARDOUS WASTE LANDFILL
GROUNDWATER ANALYTICAL RESULTS**

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Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW84A REG Downgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8007-4849

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-	TPU	Method	Validation
Arsenic		0.0204	mg/L	0.005	1/12/2021			SW846-6020	=
Arsenic, Dissolved		0.0118	mg/L	0.005	1/12/2021			SW846-6020	=
Barometric Pressure Reading		30.32	Inches/Hg		1/12/2021				X
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Conductivity		437	umho/cm		1/12/2021				X
Depth to Water		50.24	ft		1/12/2021				X
Dissolved Oxygen		3.17	mg/L		1/12/2021				X
Lead	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
pH		5.87	Std Unit		1/12/2021				X
Redox		436	mV		1/12/2021				X
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Sulfate	W	37.2	mg/L	2	1/12/2021			SW846-9056	J
Technetium-99		353	pCi/L	17.7	1/12/2021	17.3	42.9	HASL 300, Tc-02-RC M	=
Temperature		57.8	deg F		1/12/2021				X
Trichloroethene		2610	ug/L	50	1/12/2021			SW846-8260B	=
Turbidity		10.3	NTU		1/12/2021				X
Uranium	J	0.000156	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	-0.292	pCi/L	1.28	1/12/2021	0.371	0.372	HASL 300, U-02-RC M	=
Uranium-235	U	0.16	pCi/L	1.01	1/12/2021	0.602	0.602	HASL 300, U-02-RC M	=
Uranium-238	U	-0.205	pCi/L	1.2	1/12/2021	0.388	0.389	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Sampling Point: MW84A FR   Downgradient   URGA   **Period:** Semiannual Report

AKGWA Well Tag #: 8007-4849

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-	TPU	Method	Validation
Arsenic		0.0212	mg/L	0.005	1/12/2021			SW846-6020	=
Arsenic, Dissolved		0.0129	mg/L	0.005	1/12/2021			SW846-6020	=
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Lead	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Sulfate	W	37.2	mg/L	2	1/12/2021			SW846-9056	J
Technetium-99		341	pCi/L	18.1	1/12/2021	17.3	41.6	HASL 300, Tc-02-RC M	=
Trichloroethene		2630	ug/L	50	1/12/2021			SW846-8260B	=
Uranium	J	0.000154	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	-0.577	pCi/L	2.06	1/12/2021	0.574	0.575	HASL 300, U-02-RC M	=
Uranium-235	U	0.156	pCi/L	1.66	1/12/2021	0.865	0.867	HASL 300, U-02-RC M	=
Uranium-238	U	0.252	pCi/L	1.6	1/12/2021	0.861	0.862	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Sampling Point: MW85 REG   Downgradient   UCRS   **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5234

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0078	mg/L	0.005	1/12/2021			SW846-6020	=
Arsenic, Dissolved		0.0054	mg/L	0.005	1/12/2021			SW846-6020	=
Barometric Pressure Reading		30.32	Inches/Hg		1/12/2021				X
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	J	0.00415	mg/L	0.01	1/12/2021			SW846-6020	=
Chromium, Dissolved	J	0.00324	mg/L	0.01	1/12/2021			SW846-6020	=
Conductivity		360	umho/cm		1/12/2021				X
Depth to Water		8.57	ft		1/12/2021				X
Dissolved Oxygen		1.55	mg/L		1/12/2021				X
Lead	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
pH		6.06	Std Unit		1/12/2021				X
Redox		443	mV		1/12/2021				X
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Sulfate	W	11.5	mg/L	0.4	1/12/2021			SW846-9056	J
Technetium-99		57.4	pCi/L	18.6	1/12/2021	12.2	13.8	HASL 300, Tc-02-RC M	=
Temperature		57.2	deg F		1/12/2021				X
Trichloroethene		4.11	ug/L	1	1/12/2021			SW846-8260B	=
Turbidity		49	NTU		1/12/2021				X
Uranium		0.00098	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	0.22	pCi/L	1.28	1/12/2021	0.689	0.691	HASL 300, U-02-RC M	=
Uranium-235	U	0.211	pCi/L	0.634	1/12/2021	0.594	0.595	HASL 300, U-02-RC M	=
Uranium-238	U	0.267	pCi/L	1.26	1/12/2021	0.703	0.704	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Sampling Point: MW87A REG   Downgradient   URGA   **Period:** Semiannual Report

AKGWA Well Tag #: 8007-4850

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-	TPU	Method	Validation
Arsenic		0.00939	mg/L	0.005	1/12/2021			SW846-6020	=
Arsenic, Dissolved		0.00589	mg/L	0.005	1/12/2021			SW846-6020	=
Barometric Pressure Reading		30.34	Inches/Hg		1/12/2021				X
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Conductivity		359	umho/cm		1/12/2021				X
Depth to Water		50.67	ft		1/12/2021				X
Dissolved Oxygen		1.94	mg/L		1/12/2021				X
Lead	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
pH		5.77	Std Unit		1/12/2021				X
Redox		445	mV		1/12/2021				X
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Sulfate	W	6.9	mg/L	0.4	1/12/2021			SW846-9056	=
Technetium-99	U	5.14	pCi/L	19.1	1/12/2021	11.2	11.2	HASL 300, Tc-02-RC M	=
Temperature		58.3	deg F		1/12/2021				X
Trichloroethene		2570	ug/L	50	1/12/2021			SW846-8260B	=
Turbidity		63	NTU		1/12/2021				X
Uranium	U	0.0002	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	0.211	pCi/L	1.26	1/12/2021	0.673	0.675	HASL 300, U-02-RC M	=
Uranium-235	U	0.363	pCi/L	0.99	1/12/2021	0.714	0.716	HASL 300, U-02-RC M	=
Uranium-238	U	-0.0401	pCi/L	0.801	1/12/2021	0.346	0.346	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Sampling Point: MW88 REG   Downgradient   UCRS   **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5237

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-	TPU	Method	Validation
Arsenic		0.00857	mg/L	0.005	1/12/2021			SW846-6020	=
Arsenic, Dissolved		0.00535	mg/L	0.005	1/12/2021			SW846-6020	=
Barometric Pressure Reading		30.34	Inches/Hg		1/12/2021				X
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	J	0.00332	mg/L	0.01	1/12/2021			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Conductivity		653	umho/cm		1/12/2021				X
Depth to Water		7.97	ft		1/12/2021				X
Dissolved Oxygen		2.2	mg/L		1/12/2021				X
Lead		0.00249	mg/L	0.002	1/12/2021			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury		0.000394	mg/L	0.0002	1/12/2021			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
pH		5.77	Std Unit		1/12/2021				X
Redox		432	mV		1/12/2021				X
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Sulfate		123	mg/L	4	1/12/2021			SW846-9056	=
Technetium-99		23	pCi/L	18.2	1/12/2021	11.1	11.4	HASL 300, Tc-02-RC M	=
Temperature		54.9	deg F		1/12/2021				X
Trichloroethene		4.1	ug/L	1	1/12/2021			SW846-8260B	=
Turbidity		110.1	NTU		1/12/2021				X
Uranium		0.000311	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	0.0549	pCi/L	1.31	1/12/2021	0.631	0.632	HASL 300, U-02-RC M	=
Uranium-235	U	0.355	pCi/L	1.69	1/12/2021	0.977	0.979	HASL 300, U-02-RC M	=
Uranium-238	U	0	pCi/L	0.673	1/12/2021	0.452	0.454	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Sampling Point: MW90A REG   Downgradient   URGA   **Period:** Semiannual Report

AKGWA Well Tag #:   8004-0357

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-	TPU	Method	Validation
Arsenic	J	0.00211	mg/L	0.005	1/12/2021			SW846-6020	=
Arsenic, Dissolved	J	0.00217	mg/L	0.005	1/12/2021			SW846-6020	=
Barometric Pressure Reading		30.35	Inches/Hg		1/12/2021				X
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Conductivity		219	umho/cm		1/12/2021				X
Depth to Water		49.49	ft		1/12/2021				X
Dissolved Oxygen		5.05	mg/L		1/12/2021				X
Lead	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
pH		5.8	Std Unit		1/12/2021				X
Redox		450	mV		1/12/2021				X
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Sulfate		4.05	mg/L	0.4	1/12/2021			SW846-9056	=
Technetium-99	U	11.5	pCi/L	17.6	1/12/2021	10.5	10.6	HASL 300, Tc-02-RC M	=
Temperature		56	deg F		1/12/2021				X
Trichloroethene		99.6	ug/L	1	1/12/2021			SW846-8260B	=
Turbidity		10.1	NTU		1/12/2021				X
Uranium	U	0.0002	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	-0.117	pCi/L	1.4	1/12/2021	0.553	0.554	HASL 300, U-02-RC M	=
Uranium-235	U	-0.0561	pCi/L	1.12	1/12/2021	0.483	0.485	HASL 300, U-02-RC M	=
Uranium-238	U	0.0529	pCi/L	1.15	1/12/2021	0.553	0.554	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Sampling Point: MW91A REG   Downgradient   UCRS   **Period:** Semiannual Report

AKGWA Well Tag #: 8007-2917

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-	TPU	Method	Validation
Arsenic		0.0137	mg/L	0.005	1/12/2021			SW846-6020	=
Arsenic, Dissolved		0.00959	mg/L	0.005	1/12/2021			SW846-6020	=
Barometric Pressure Reading		30.35	Inches/Hg		1/12/2021				X
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Conductivity		967	umho/cm		1/12/2021				X
Depth to Water		12.5	ft		1/12/2021				X
Dissolved Oxygen		0.8	mg/L		1/12/2021				X
Lead	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
pH		6.09	Std Unit		1/12/2021				X
Redox		237	mV		1/12/2021				X
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Sulfate		96.4	mg/L	4	1/12/2021			SW846-9056	=
Technetium-99		24.2	pCi/L	16.7	1/12/2021	10.3	10.7	HASL 300, Tc-02-RC M	=
Temperature		60.8	deg F		1/12/2021				X
Trichloroethene		28.9	ug/L	1	1/12/2021			SW846-8260B	=
Turbidity		38.1	NTU		1/12/2021				X
Uranium	J	0.000069	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	-0.163	pCi/L	1.21	1/12/2021	0.446	0.447	HASL 300, U-02-RC M	=
Uranium-235	U	0.186	pCi/L	0.558	1/12/2021	0.523	0.524	HASL 300, U-02-RC M	=
Uranium-238	U	-0.108	pCi/L	0.92	1/12/2021	0.327	0.328	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Sampling Point: MW93A REG   Upgradient   URGA   **Period:** Semiannual Report

AKGWA Well Tag #: 8007-4851

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-	TPU	Method	Validation
Arsenic		0.0154	mg/L	0.005	1/12/2021			SW846-6020	=
Arsenic, Dissolved		0.00909	mg/L	0.005	1/12/2021			SW846-6020	=
Barometric Pressure Reading		30.32	Inches/Hg		1/12/2021				X
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	J	0.00338	mg/L	0.01	1/12/2021			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Conductivity		385	umho/cm		1/12/2021				X
Depth to Water		37	ft		1/12/2021				X
Dissolved Oxygen		1.99	mg/L		1/12/2021				X
Lead	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
pH		5.82	Std Unit		1/12/2021				X
Redox		397	mV		1/12/2021				X
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Sulfate		7.21	mg/L	0.4	1/12/2021			SW846-9056	=
Technetium-99	U	11.8	pCi/L	18.3	1/12/2021	10.9	11	HASL 300, Tc-02-RC M	=
Temperature		57.1	deg F		1/12/2021				X
Trichloroethene		3120	ug/L	50	1/12/2021			SW846-8260B	=
Turbidity		12.8	NTU		1/12/2021				X
Uranium	J	0.0001	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	-0.0339	pCi/L	1.19	1/12/2021	0.509	0.509	HASL 300, U-02-RC M	=
Uranium-235	U	-0.0529	pCi/L	1.06	1/12/2021	0.456	0.457	HASL 300, U-02-RC M	=
Uranium-238	U	0.0928	pCi/L	0.988	1/12/2021	0.515	0.516	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Sampling Point: MW94 REG   Upgradient   UCRS   **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5103

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-	TPU	Method	Validation
Arsenic	J	0.00374	mg/L	0.005	1/12/2021			SW846-6020	=
Arsenic, Dissolved	J	0.00286	mg/L	0.005	1/12/2021			SW846-6020	=
Barometric Pressure Reading		30.3	Inches/Hg		1/12/2021				X
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium		0.0161	mg/L	0.01	1/12/2021			SW846-6020	=
Chromium, Dissolved	J	0.00522	mg/L	0.01	1/12/2021			SW846-6020	=
Conductivity		840	umho/cm		1/12/2021				X
Depth to Water		13.04	ft		1/12/2021				X
Dissolved Oxygen		0.78	mg/L		1/12/2021				X
Lead		0.00272	mg/L	0.002	1/12/2021			SW846-6020	=
Lead, Dissolved	J	0.00102	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
pH		6.27	Std Unit		1/12/2021				X
Redox		422	mV		1/12/2021				X
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Sulfate		75.4	mg/L	2	1/12/2021			SW846-9056	=
Technetium-99		1180	pCi/L	17.4	1/12/2021	27.1	133	HASL 300, Tc-02-RC M	=
Temperature		57	deg F		1/12/2021				X
Trichloroethene		2.31	ug/L	1	1/12/2021			SW846-8260B	=
Turbidity		199.1	NTU		1/12/2021				X
Uranium		0.00175	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	0.855	pCi/L	1.33	1/12/2021	0.92	0.929	HASL 300, U-02-RC M	=
Uranium-235	U	0.358	pCi/L	0.536	1/12/2021	0.613	0.615	HASL 300, U-02-RC M	=
Uranium-238	U	0.081	pCi/L	1.07	1/12/2021	0.523	0.523	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Sampling Point: MW420 REG   Upgradient   URGA   **Period:** Semiannual Report

AKGWA Well Tag #: 8005-3263

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.00832	mg/L	0.005	1/12/2021			SW846-6020	=
Arsenic, Dissolved	J	0.00471	mg/L	0.005	1/12/2021			SW846-6020	=
Barometric Pressure Reading		30.3	Inches/Hg		1/12/2021				X
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Conductivity		360	umho/cm		1/12/2021				X
Depth to Water		52.8	ft		1/12/2021				X
Dissolved Oxygen		1.53	mg/L		1/12/2021				X
Lead	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
pH		5.84	Std Unit		1/12/2021				X
Redox		431	mV		1/12/2021				X
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Sulfate	W	6.32	mg/L	0.4	1/12/2021			SW846-9056	J
Technetium-99	U	-4.74	pCi/L	17.6	1/12/2021	10.1	10.1	HASL 300, Tc-02-RC M	=
Temperature		54.5	deg F		1/12/2021				X
Trichloroethene		1690	ug/L	20	1/12/2021			SW846-8260B	=
Turbidity		28.6	NTU		1/12/2021				X
Uranium	U	0.0002	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	0.819	pCi/L	1.14	1/12/2021	0.839	0.848	HASL 300, U-02-RC M	=
Uranium-235	U	0.132	pCi/L	0.833	1/12/2021	0.495	0.495	HASL 300, U-02-RC M	=
Uranium-238	U	0.0393	pCi/L	0.858	1/12/2021	0.411	0.412	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Type of Sample: FB   **Period:** Semiannual Report QC Samples

AKGWA Well Tag #: 0000-0000

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Lead	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Technetium-99	U	-3.74	pCi/L	17.5	1/12/2021	10.1	10.1	HASL 300, Tc-02-RC M	=
Trichloroethene	U	1	ug/L	1	1/12/2021			SW846-8260B	=
Uranium	U	0.0002	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	0.232	pCi/L	2.79	1/12/2021	1.38	1.38	HASL 300, U-02-RC M	=
Uranium-235	U	-0.175	pCi/L	2.02	1/12/2021	0.774	0.777	HASL 300, U-02-RC M	=
Uranium-238	U	0.98	pCi/L	2.29	1/12/2021	1.47	1.48	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Type of Sample: RI **Period:** Semiannual Report QC Samples

AKGWA Well Tag #: 0000-0000

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Cadmium	U	0.001	mg/L	0.001	1/12/2021			SW846-6020	=
Chromium	U	0.01	mg/L	0.01	1/12/2021			SW846-6020	=
Lead	U	0.002	mg/L	0.002	1/12/2021			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/12/2021			SW846-7470A	=
Selenium	U	0.005	mg/L	0.005	1/12/2021			SW846-6020	=
Technetium-99	U	0.455	pCi/L	16.9	1/12/2021	9.83	9.83	HASL 300, Tc-02-RC M	=
Trichloroethene	U	1	ug/L	1	1/12/2021			SW846-8260B	=
Uranium	U	0.0002	mg/L	0.0002	1/12/2021			SW846-6020	=
Uranium-234	U	0.649	pCi/L	2.26	1/12/2021	1.33	1.33	HASL 300, U-02-RC M	=
Uranium-235	U	0.55	pCi/L	2	1/12/2021	1.26	1.27	HASL 300, U-02-RC M	=
Uranium-238	U	0.222	pCi/L	1.4	1/12/2021	0.834	0.835	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill   **County:** McCracken   **Permit #:** KY8-890-008-982

Type of Sample: TB   **Period:** Semiannual Report QC Samples

AKGWA Well Tag #: 0000-0000

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Trichloroethene	U	1	ug/L	1	1/12/2021			SW846-8260B	=

QUALIFIER Codes

U   Analyte analyzed for, but not detected at or below the lowest concentration reported.
J   Estimated quantitation.
W   Post-digestion spike recovery out of control limits.

SAMPLING POINT Codes

UCRS   Upper Continental Recharge System
URGA   Upper Regional Gravel Aquifer

SAMPLE TYPE Codes

FB   Field Blank
FR   Field Duplicate as defined in sampling procedure.
REG Regular
RI   QC Equipment Rinseate/Decon
TB   Trip Blank

VALIDATION Codes

=   Validated result, no qualifier is necessary.
J   The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
X   Not validated.

APPENDIX B

**C-404 HAZARDOUS WASTE LANDFILL
STATISTICAL ANALYSES**

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C-404 HAZARDOUS WASTE LANDFILL
MAY 2021 SEMIANNUAL
Facility: US DOE—Paducah Gaseous Diffusion Plant

Finds/Unit: <u>KY8-980-008-982/1</u>
LAB ID: _____
For Official Use Only

GROUNDWATER
STATISTICAL SUMMARY

INTRODUCTION

The statistical analyses conducted on the data collected from the C-404 Hazardous Waste Landfill (C-404 Landfill) were performed in accordance with procedures provided in Appendix E of the Hazardous Waste Management Facility Permit, reissued by the Kentucky Division of Waste Management (KDWM) in February 2020. The percent of censored (nondetected) data points for individual parameters was calculated for the combined analytical data from the most recent five sampling events. The percent of censored data was used to select the types of statistical analyses to determine whether compliance well concentrations differed from background well concentrations. Data points were used in the statistical analysis for analyte results close to the sample quantitation limit that were judged to be below that limit by the data validator. For the first reporting period 2021 semiannual report, the reporting period data set includes data from January 2019, July 2019, January 2020, July 2020, and January 2021.

STATISTICAL ANALYSIS PROCESS

Utilizing the current data set and four previous data sets, the type of statistical test conducted for each chemical data set is a function of the number of samples and proportion of censored data (nondetects) to uncensored data (detects) in each group. The percent of censored (nondetected) data points for individual parameters was calculated for the combined analytical data. The statistical procedures applied to the data are summarized below.

- Determine the percentage of the censored data using the reporting period data set.

- Group by percentage of censored data where the following apply:

  — If censored data are greater than or equal to 90%, determine the limit of detection (LOD) and half of the LOD (1/2 LOD). This is Statistical Test 1.

  — If censored data are between 50% and 90%, perform a Test of Proportions. If the analysis indicates a significant proportional difference in compliance wells, further analyze through nonparametric Analysis of Variance (ANOVA) Test. This is Statistical Test 2.

  — If censored data are between 15% and 50%, perform nonparametric ANOVA Test. If results exceed the critical value, compute the critical difference used to identify individual well concentrations, which are significantly elevated compared with background. This is Statistical Test 3.

  — If censored data are less than 15%, actual data values are analyzed using parametric ANOVA procedures. If the wells exhibit equal variances, then the data are used as presented. If the wells do not exhibit equal variances, then the log of the data is taken and then used in the calculations. Where statistical testing indicates elevated compliance well concentrations, Bonferroni's Test of Contrasts is performed. This is Statistical Test 4. Statistical Test 4 is found in Section 5.2.1 of EPA guidance

document, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (April 1989).

If the statistical method above indicates no statistical difference between concentrations in downgradient wells and concentrations in background wells, then there are no indications of statistically significant impacts on the groundwater from the C-404 Landfill. If the tiered statistical method above identifies a statistically significant difference between concentrations in downgradient wells and concentrations in background wells, then the data will be evaluated further to determine if the concentrations in downgradient wells are within the statistically developed upper tolerance limit (UTL) for background concentrations or are consistent with the findings of the 2007 Alternate Source Demonstration (ASD), as follows:

(1)   Compare the most recent downgradient sample results to a 95% UTL using the five most recent sets of data for each upgradient well as described below. If downgradient concentrations are lower than the UTL for the paired upgradient concentrations, then there is no confirmed exceedance.

(2)   Evaluate results using paired ANOVA of wells in the same direction relative to the landfill (e.g., compare upgradient westernmost well results to downgradient westernmost well results). If ANOVA does not identify a statistically significant difference between upgradient and downgradient wells, then the results are consistent with the historical ASD.

(3)   If results show downgradient wells have statistically significant higher concentrations than upgradient wells, even when evaluated with respect to the ASD, additional intra-well evaluation of trend will be performed using the Mann-Kendall test for trend. If concentrations do not show an increasing trend, then there is no confirmed exceedance attributable to C-404.

(4)   Review other Regional Gravel Aquifer (RGA) well results in vicinity to determine if they are consistent with ASD.

If the statistical analysis identifies downgradient well concentrations that are increasing, are higher than UTL, are higher than the upgradient well concentrations even when the ASD results are taken into account, this evaluation will identify a confirmed, statistically significant exceedance (in a compliance well) over background.

DATA ANALYSIS

Data from the upgradient background wells in the Upper Regional Gravel Aquifer (URGA) are included for comparison with three downgradient URGA wells. Figure 1 of this C-404 Landfill Groundwater Report provides a map of the well locations associated with the C-404 Landfill. Upper Continental Recharge System (UCRS) wells in Figure 1 are provided for reference only. Data from wells that are in the UCRS are not included in the statistical analyses.

Table B.1 presents the C-404 Landfill upgradient or background wells and downgradient or compliance wells from the URGA. Data from the URGA compliance wells were compared with data from the URGA background wells.

Table B.1. Monitoring Well Locations

URGA	
Upgradient background wells	MW93A*, MW420
Downgradient compliance wells	MW84A*, MW87A*, MW90A*

*MW90 was abandoned in 2001 and replaced with MW90A. MW84, MW87, and MW93 were abandoned in 2019 and replaced with MW84A, MW87A, and MW93A, respectively.

For the first reporting period 2021 semiannual report, the reporting period data set from January 2019 through January 2021 consists of five sets of data.

Table B.2 lists the number of analyses (observations), nondetects (censored observations), detects (uncensored observations), and missing observations by parameter. When field duplicate data are available from a well, the higher of the two readings was retained for further evaluation.

Table B.2. Summary of Missing, Censored, and Uncensored Data Collected

Parameters	Observations	Missing Observations*	Censored Observations (Nondetects)	Uncensored Observations (Detects)
URGA				
Arsenic	25	0	3	22
Cadmium	25	0	21	4
Chromium	25	0	21	4
Lead	25	0	22	3
Mercury	25	0	25	0
Selenium	25	0	25	0
Technetium-99	25	0	20	5
Trichloroethene	25	0	0	25
Uranium (Metals)	25	0	16	9
Uranium-234	25	0	21	4
Uranium-235	25	0	25	0
Uranium-238	25	0	23	2

Censoring Percentage and Statistical Analysis

The type of statistical test set applied to the data is a function of the number of nondetects (censored) versus detects (uncensored) in each of the parameter groups and among the wells. Table B.3 presents the percentage of censored data and type of statistical test chosen for each of the parameters required by Part VIII.E of the Permit.

Table B.3. Percent Censored Report and Statistical Test Set Selected

Parameter	Total Samples (Nonmissing)	Uncensored (Detects)	Censored (Nondetects)	Percent Censored	Statistical Test Set*
URGA					
Arsenic	25	22	3	12	4
Cadmium	25	4	21	84	2
Chromium	25	4	21	84	2
Lead	25	3	22	88	2
Mercury	25	0	25	100	1
Selenium	25	0	25	100	1
Technetium-99	25	5	20	80	2
Trichloroethene	25	25	0	0	4
Uranium (Metals)	25	9	16	64	2
Uranium-234	25	4	21	84	2
Uranium-235	25	0	25	100	1
Uranium-238	25	2	23	92	1

*A list of the constituents with greater than or equal to 90% censored data is included in Table B.4, which summarizes the results of Statistical Test 1.

SUMMARY OF CONCLUSIONS

The results for Statistical Test 1, LOD, are summarized in Table B.4. Table B.5 provides the summary of conclusions for the C-404 Landfill statistical analyses for the first reporting period 2021, including the statistical tests performed, the attachment number, well type, parameter, and results of each statistical test. Results of Statistical Test 2, Statistical Test 3, and Statistical Test 4 are presented in Attachments B1 through B8. The statistician qualification statement is presented in Attachment B9.

Table B.4. Statistical Test 1: Limit of Detection

Parameter	LOD Values	½ LOD Values
URGA		
Mercury (mg/L)	0.0002	0.0001
Selenium (mg/L)	0.005	0.0025
Uranium-235 (pCi/L)	1.12	0.56
Uranium-238 (pCi/L)	1.6	0.8

Table B.5. Summary of Conclusions from the C-404 Hazardous Waste Landfill Statistical Analyses for the First Reporting Period 2021

Attachment	RGA Well Type	Parameter	Applied Statistical Test	Results
B1	URGA	Arsenic	Statistical Test 4, Parametric ANOVA, Statistical Test 3, Nonparametric ANOVA with 95% UTL, paired ANOVA (MW84A vs. MW93A), and Mann-Kendall	Because equality of variance could not be confirmed, Statistical Test 4 was abandoned and Statistical Test 3, Nonparametric ANOVA, was performed. Nonparametric ANOVA indicated a statistically significant difference between concentrations in downgradient wells and concentrations in background wells for compliance well MW84A; a comparison to the 95% UTL, paired ANOVA, and Mann-Kendall trend analysis were performed, as required by the Hazardous Waste Management Facility Permit. Results of the paired ANOVA have identified a significant difference between upgradient and downgradient wells. The Mann-Kendall trend analysis identified no trend in MW84A.
B2	URGA	Cadmium	Statistical Test 2, Test of Proportions	No statistically significant difference between concentrations in downgradient wells and concentrations in background wells.
B3	URGA	Chromium	Statistical Test 2, Test of Proportions	No statistically significant difference between concentrations in downgradient wells and concentrations in background wells.
B4	URGA	Lead	Statistical Test 2, Test of Proportions	No statistically significant difference between concentrations in downgradient wells and concentrations in background wells.
B5	URGA	Technetium-99	Statistical Test 2, Test of Proportions, Statistical Test 3, Nonparametric ANOVA, with 95% UTL, paired (parametric) ANOVA (MW84A vs. MW93A), paired (nonparametric) ANOVA (MW84A vs. MW93A), and Mann-Kendall	Because Test of Proportions indicated statistically significant evidence that the proportion of detects in one group of data exceeds the proportion of detects in the other group, Nonparametric ANOVA was performed. Nonparametric ANOVA indicated a statistically significant difference between concentrations in downgradient wells and concentrations in background wells for compliance well MW84A. A comparison to the 95% UTL identified a statistically significant difference between compliance well MW84A and background wells. The paired (parametric) ANOVA was attempted. Because equality of variance could not be confirmed, the paired (parametric) ANOVA was abandoned and the paired (nonparametric) ANOVA was performed. The paired (nonparametric) ANOVA identified a statistically significant difference between concentrations in the background well and

Attachment	RGA Well Type	Parameter	Applied Statistical Test	Results
B6	URGA	Trichloroethene	Statistical Test 4, Parametric ANOVA, with 95% UTL	compliance well MW84A. The Mann-Kendall trend analysis was performed and identified an increasing trend in MW84A. Because Parametric ANOVA indicated a statistically significant difference between concentrations in downgradient wells and concentrations in background wells for compliance wells MW84A and MW87A, a comparison to the 95% UTL was performed. The 95% UTL indicated no statistically significant difference between concentrations in downgradient wells and concentrations in background wells.
B7	URGA	Uranium	Statistical Test 2, Test of Proportions	No statistically significant difference between concentrations in downgradient wells and concentrations in background wells.
B8	URGA	Uranium-234	Statistical Test 2, Test of Proportions	No statistically significant difference between concentrations in downgradient wells and concentrations in background wells.

In summary, Statistical Test 2, Test of Proportions, for cadmium, chromium, lead, uranium, and uranium-234 in the URGA indicated no statistically significant difference between concentrations in downgradient wells and concentrations in background wells.

Statistical Test 2, Test of Proportions, for technetium-99 in the URGA indicated statistically significant evidence that the proportion of detects in one group of data exceeds the proportion of detects in the other group. For technetium-99, downgradient wells had a higher proportion of detects; therefore, the data were evaluated further using Nonparametric ANOVA. Nonparametric ANOVA indicated a statistically significant difference between concentrations in downgradient well MW84A and concentrations in background wells; therefore, the data were evaluated further by comparing results to the UTL. The 95% UTL indicated a statistically significant difference between concentrations in downgradient well MW84A and concentrations in background wells. Based on these results, the data were evaluated using paired (parametric) ANOVA of wells in the same direction relative to the landfill [e.g., performed a comparison of downgradient well (MW84A) results to upgradient westernmost well (MW93A) results]. Because equality of variance could not be confirmed for paired (parametric) ANOVA, paired (nonparametric) ANOVA was performed. Results of the paired (nonparametric) ANOVA identified a statistically significant difference between concentrations in the background well and compliance well MW84A. A Mann-Kendall test was performed to evaluate the data further, and an increasing trend was identified for technetium-99 in MW84A.

Statistical Test 4, Parametric ANOVA, for arsenic in the URGA could not be performed because equality of variance could not be confirmed. Statistical Test 4 was abandoned and Statistical Test 3, Nonparametric ANOVA, was performed. Statistical Test 3, Nonparametric ANOVA, identified a statistically significant difference between concentrations in downgradient wells and concentrations in background wells;

therefore, the data were evaluated further by comparing results to the UTL. The 95% UTL indicated a statistically significant difference between concentrations in downgradient well MW84A and concentrations in background wells. Based on these results, the data were evaluated using paired (parametric) ANOVA of wells in the same direction relative to the landfill [e.g., performed a comparison of downgradient well (MW84A) results to upgradient westernmost well (MW93A) results]. Results of the paired (parametric) ANOVA identified a statistically significant difference between upgradient and downgradient wells. A Mann-Kendall test was performed to evaluate the data further, and no trend was identified for arsenic in MW84A.

Statistical Test 4, Parametric ANOVA, for trichloroethene in the URGA indicated statistically significant difference between concentrations in downgradient wells and concentrations in background wells; therefore, the data were evaluated further by comparing results to the UTL. The 95% UTL indicated no statistically significant difference between concentrations in both downgradient wells MW84A and MW87A and concentrations in background wells.

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ATTACHMENT B1

**ARSENIC
STATISTICAL TEST 4**

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Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Arsenic (As, mg/L)				
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	**0.00462**	**0.00414**	**0.0275**	**0.0116**	0.0025
Jul-19	**0.00602**	**0.00359**	**0.0168**	**0.00723**	0.0025
Jan-20	**0.00817**	**0.00518**	**0.0202**	**0.00928**	**0.00211**
Jul-20	**0.0109**	**0.00534**	**0.0222**	**0.00895**	0.0025
Jan-21	**0.0154**	**0.00832**	**0.0212**	**0.00939**	**0.00211**
n_i	10		5	5	5
Sum	0.0717		0.1079	0.0465	0.0117
(x_i)avg	0.007		0.022	0.009	0.002

mg/L = milligrams per liter
Bolded values indicate a detected result.

Overall mean x.. =	0.01	
N =	25	N = the total number of samples
p =	4	p = the number of n_i groups
x.. =	0.24	x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals

Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	-0.003	-0.003	0.006	0.002	0.000
Jul-19	-0.001	-0.004	-0.005	-0.002	0.000
Jan-20	0.001	-0.002	-0.001	0.000	0.000
Jul-20	0.004	-0.002	0.001	0.000	0.000
Jan-21	0.008	0.001	0.000	0.000	0.000

X: Mean Value =	6.07E-19	
S: Standard Deviation =	0.0	
K* Factor =	2.292	(for n = 25)
CV = S/X =	4.65E+15	> 1, data are not normally distributed

Data are not normally distributed (i.e.,>1)
*K factor [from Table 5, Appendix B of *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

If the coefficient of variation is < 1, the data are normally distributed.
If the coefficient of variation is > or = 1, data are not normally distributed.

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Determine Equality of Variance of Dataset

p = number of well groups

n_i = number of data points per well

N = total sample size

S^2 = the square of the standard deviation

$\ln(S_i^2)$ = natural logarithm of each variance

f = total sample size minus the number of wells (groups)

$f_i = n_i - 1$

x.. = the sum of the total number of samples

$(x_{avg})..$ = the mean of the total number of samples

$x.. = 0.24$

$(x_{avg}).. = 0.01$

$p = 4$

$N = 25$

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_iS_i^2$	$f_i\ln(S_i^2)$
0.004	0.00	-11.216	10	0.0	-100.9
0.004	0.00	-11.102	5	0.000	-44.4
0.002	0.00	-12.929	5	0.000	-51.7
0.000	0.00	-16.903	5	0.000	-67.6

$\sum(S_i^2) =$ 0.00 $\sum f_i\ln(S_i^2) =$ -264.7

Equality of Variance: Bartlett's Test

$f = $ 21

$Sp^2 = $ 0.000

$\ln Sp^2 = $ -11.606

$c^2 = $ 20.952   (If $c^2 \leq c^2_{crit}$, then variances are equal at the given significance level).

$c^2_{crit} * = $ 7.815   at a 5% significance level with   3   degrees of freedom

NOTE: The variances are NOT equal.   **(i.e., $c^2 > c^2_{crit}$)**

Variances are not equal, transform the original data to lognormal (i.e., since $c^2 > c^2_{crit}$).

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Lognormal Data for As

	ln[As (mg/L)]				
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	-5.38	-5.49	-3.59	-4.46	-5.99
Jul-19	-5.11	-5.63	-4.09	-4.93	-5.99
Jan-20	-4.81	-5.26	-3.90	-4.68	-6.16
Jul-20	-4.52	-5.23	-3.81	-4.72	-5.99
Jan-21	-4.17	-4.79	-3.85	-4.67	-6.16
Mean x_i	-4.80	-5.28	-3.85	-4.69	-6.06
Background Mean	-5.04		NA	NA	NA
Grand Mean	-4.94				
x_i^2	28.92	30.11	12.91	19.86	35.90
	26.14	31.69	16.70	24.30	35.90
These values needed for ANOVA	23.11	27.70	15.23	21.90	37.96
	20.42	27.38	14.50	22.24	35.90
	17.42	22.94	14.85	21.79	37.96
Sum x_i^2	624				

mg/L = milligrams per liter

Determine Normality of Dataset

Coefficient of Variability Test

Table of ln[As (mg/L)] Data

Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	-5.38	-5.49	-3.59	-4.46	-5.99
Jul-19	-5.11	-5.63	-4.09	-4.93	-5.99
Jan-20	-4.81	-5.26	-3.90	-4.68	-6.16
Jul-20	-4.52	-5.23	-3.81	-4.72	-5.99
Jan-21	-4.17	-4.79	-3.85	-4.67	-6.16

$$X: \text{Mean Value} = -4.94E+00$$
$$S: \text{Standard Deviation} = 0.79$$
$$K^* \text{ Factor} = 2.292 \quad (\text{for } n = 25)$$
$$CV = S/X = -1.59E-01 \quad <1, \text{ data are normally distributed}$$

Data are normally distributed (i.e.,<1)

*K factor [from Table 5, Appendix B of *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Determine Equality of Variance of Dataset for Lognormal Data

p = number of wells (background wells considered as one group)	$x_{..}$ = -123.38
n_i = number of data points per well	$(x_{avg})_{..}$ = -4.94
N = total sample size	n_i = 5
S^2 = the square of the standard deviation	p = 4
$\ln(S_i^2)$ = natural logarithm of each variance	N = 25
f = total sample size minus the number of wells (groups)	
$f_i = n_i - 1$	
x.. = the sum of the total lognormal dataset	
$(x_{avg})_{..}$ = the mean of the lognormal dataset	

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_i S_i^2$	$f_i \ln(S_i^2)$
0.459	0.210	-1.559	10	1.893	-14.0
0.178	0.032	-3.457	5	0.126	-13.8
0.168	0.028	-3.566	5	0.113	-14.3
0.093	0.009	-4.753	5	0.035	-19.0

$\sum(S_i^2) =$ 0.28 $\sum f_i \ln(S_i^2) =$ -61.1

Equality of Variance: Bartlett's Test

f =	21	
Sp^2 =	0.103	
$\ln Sp^2$ =	-2.271	
c^2 =	13.436	(If $c^2 \leq c^2_{crit}$, then variances are equal at the given significance level).
c^2_{crit} * =	7.815	at a 5% significance level with 3 degrees of freedom

NOTE: The variances are NOT equal.   **(i.e., $c^2 \leq c^2_{crit}$)**

Because variances are not equal, Statistical Test 3, Nonparametric ANOVA is performed.**

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

**Section 5.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

Attachment B1: Arsenic URGA, Statistical Test Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Arsenic (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	**0.00462**	**0.00414**	**0.0275**	**0.0116**	0.0025
Jul-19	**0.00602**	**0.00359**	**0.0168**	**0.00723**	0.0025
Jan-20	**0.00817**	**0.00518**	**0.0202**	**0.00928**	**0.00211**
Jul-20	**0.0109**	**0.00534**	**0.0222**	**0.00895**	0.0025
Jan-21	**0.0154**	**0.00832**	**0.0212**	**0.00939**	**0.00211**
Sum	0.0717		0.10790	0.04645	0.0117
n_i	10		5	5	5
$(x_i)_{avg}$	0.00717		0.02158	0.00929	0.0023

mg/L = milligrams per liter
BG = background
DL = detection limit
All data sets represent 1/2 DL values for nondetects.
Bolded values indicate a detected result.

Overall mean x.. =   0.00951

N =	25	N = the total number of samples
p =	4	p = the number of n_i groups
x.. =	0.24	x.. = the sum of the total number of samples

Attachment B1: Arsenic URGA, Statistical Test Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Nonparametric ANOVA

Ranking of Observations

Sequence	Arsenic (mg/L)	Adjusted Rank	Tie Number
1	0	2	
2	0	2	Tie 1
3	0	2	
4	**0.00211**	4.5	Tie 2
5	**0.00211**	4.5	
6	**0.00359**	6	
7	**0.00414**	7	
8	**0.00462**	8	
9	**0.00518**	9	
10	**0.00534**	10	
11	**0.00602**	11	
12	**0.00723**	12	
13	**0.00817**	13	
14	**0.00832**	14	
15	**0.00895**	15	
16	**0.00928**	16	
17	**0.00939**	17	
18	**0.0109**	18	
19	**0.0116**	19	
20	**0.0154**	20	
21	**0.0168**	21	
22	**0.0202**	22	
23	**0.0212**	23	
24	**0.0222**	24	
25	**0.0275**	25	

mg/L = milligrams per liter
BG = background
DL = detection limit
Bolded values indicate a detected result.
NOTE: For this method, observations below the detection limit that are considered nondetects (i.e., U qualified data) are reported as a concentration of 0.

n_{tie}

3	Tie 1 =	24
2	Tie 2 =	6
	$\sum T_i =$	30

Attachment B1: Arsenic URGA, Statistical Test Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Sums of Ranks and Averages

Arsenic (mg/L)				
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	**0.00462**	**0.00414**	**0.0275**	**0.0116**	0
Jul-19	**0.00602**	**0.00359**	**0.0168**	**0.00723**	0
Jan-20	**0.00817**	**0.00518**	**0.0202**	**0.00928**	**0.00211**
Jul-20	**0.0109**	**0.00534**	**0.0222**	**0.00895**	0
Jan-21	**0.0154**	**0.00832**	**0.0212**	**0.00939**	**0.00211**

Observation Ranks for Arsenic				
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	8	7	25	19	2
Jul-19	11	6	21	12	2
Jan-20	13	9	22	16	4.5
Jul-20	18	10	24	15	2
Jan-21	20	14	23	17	4.5
R_i	116		115	79	15
$(R_i)_{avg}$	11.6		23.0	15.8	3.0
R_i^2/n_i	1345.6		2645.0	1248.2	45.0

$\Sigma R_i^2/n_i =$ 5283.8

mg/L = milligrams per liter   K = the number of n_i groups
BG = background   N = the total number of samples
DL = detection limit
Bolded values indicate a detected result.

$K =$ 4
$N =$ 25

NOTE: For this method, observations below the detection limit that are considered nondetects (i.e., U qualified data) are reported as a concentration of 0.

Calculation of Kruskal-Wallis Statistic

$H =$ 19.547   Kruskal-Wallis Statistic $H = [12/N(N+1)*\Sigma R_i^2/n_i] - 3(N+1)$

$H' =$ 19.585   Corrected Kruskal-Wallis $H' = H/[1-(\Sigma T_i/N^3-N)]$

$\chi^2_{crit} * =$ 7.815   3   degrees of freedom at the 5% significance level

NOTE: $H' > \chi^2_{crit}$

If $H' \leq \chi^2_{crit}$, the data from each well come from the same continuous distribution and hence have the same median concentrations of a specific constituent.

If $H' > \chi^2_{crit}$, reject the null hypothesis and calculate the critical difference for well comparisons to the background.

$K-1 =$ 3 $\alpha/(K-1) =$ 0.01667 $Z(\alpha/(K-1))** =$ 2.1280
$\alpha =$ 0.05 $1-(\alpha/K-1) =$ 0.983

NOTE: *Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).
    **Table 4, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B1: Arsenic URGA, Statistical Test Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Calculate Critical Values

Average Background Ranking = 11.6

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93A			
BG Well	MW420			
	MW84A	8.578	11.4	**evidence of contamination**
	MW87A	8.578	4.2	not contaminated
	MW90A	8.578	-8.6	not contaminated

mg/L = milligrams per liter
BG = background
DL = detection limit

CONCLUSION: If $(R_i)_{avg} - (R_b)_{avg} > C_i$, then there is evidence that the compliance well is contaminated.

If $(R_i)_{avg} - (R_b)_{avg} < C_i$ for wells, there is no evidence of a statistically significant difference between concentrations in downgradient compliance test wells and background wells.

Since $(R_i)_{avg} - (R_b)_{avg} > C_i$ for MW84A, there is a statistically significant difference between downgradient compliance test wells and background wells in MW84A from the C-404 Landfill.

Because nonparametric ANOVA indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance well MW84A, the 95% UTL was performed.

Since $(R_i)_{avg} - (R_b)_{avg} < C_i$ for MW87A and MW90A, there is no statistically significant difference between background wells and these downgradient compliance test wells; however, the negative value indicates that background wells have elevated concentrations.

Section 5.2.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

95% Upper Tolerance Limit (UTL)

Compare the most recent downgradient sample results to a calculated 95% UTL using the five most recent sets of data for each upgradient well, as described below. If downgradient concentration is less than the UTL for the paired upgradient concentrations, then there is no confirmed exceedance.

January 2021 Data, First Reporting Period
Arsenic Observations (mg/L)

Well No.						
MW93A	0.00462	0.00602	0.00817	0.0109	0.0154	**Upgradient Well**[!]
MW420	0.00414	0.00359	0.00518	0.00534	0.00832	**Upgradient Well**[!]
						Current Data
MW84A						0.0212

X: Mean Value =	0.0072	
S: Standard Deviation =	0.0037	
K* factor =	2.911	(for n = 10)
CV = S/X	0.5117	<1, assume normal distribution
Upper Tolerance Interval: TL = X +(KxS) =	**0.0178**	(mg/L)

    ! = Data from previous 5 sampling events.
  CV = coefficient of variation
    * = Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Result: **MW84A exceeded the UTL, which is statistically significant evidence that this compliance well has elevated concentration with respect to background data.**

           Because the 95% UTL indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance well MW84A, the paired ANOVA was performed.

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Paired (Parametric) ANOVA - MW93A and MW84A

Evaluate results using paired ANOVA of wells in the same direction relative to the landfill [e.g., compare upgradient westernmost well results to downgradient westernmost well results]. If ANOVA does not identify a statistically significant difference between upgradient and downgradient wells, then the results are consistent with the historical ASD.

Date	Arsenic (mg/L) Background	Compliance		
	MW93A	MW84A	n_i^2	
Jan-19	**0.00462**	**0.0275**	0.00002	0.00076
Jul-19	**0.00602**	**0.0168**	0.00004	0.00028
Jan-20	**0.00817**	**0.0202**	0.00007	0.00041
Jul-20	**0.0109**	**0.0222**	0.00012	0.00049
Jan-21	**0.0154**	**0.0212**	0.00024	0.00045
Sum (x_i)	0.0451	0.1079	0.15301	Total Sum ($x..$)
n_i	5	5		
$(x_i)_{avg}$	0.0090	0.0216		
$(x_i)^2$	0.0020	0.0116		

mg/L = milligrams per liter
Bolded values indicate a detected result.

Overall mean $x.. =$ 0.0153
$N =$ 10 N = the total number of samples
$p =$ 2 p = the number of n_i groups
$x.. =$ 0.1530 x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals ($x_i - x_{iavg}$)

Date	Background	Compliance
	MW93A	MW84A
Jan-19	-0.0044	0.0059
Jul-19	-0.0030	-0.0048
Jan-20	-0.0009	-0.0014
Jul-20	0.0019	0.0006
Jan-21	0.0064	-0.0004

X: Mean Value = 1.39E-18
S: Standard Deviation = 0.004
K* Factor = 2.911 (for n = 10)
CV = S/X = 2.78E+15 ≥1, data are NOT normally distributed

*Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

If the coefficient of variation is < 1, the data are normally distributed.
If the coefficient of variation is > or = 1, data are not normally distributed.

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Determine Equality of Variance of Dataset

p = number of wells	$x_{..} = 0.1530$
n_i = number of data points per well	$(x_{avg})_{..} = 0.0153$
N = total sample size	$n_i = 5$
S^2 = the square of the standard deviation	p = 2
$\ln(S_i^2)$ = natural logarithm of each variance	N = 10
f = total sample size minus the number of wells (groups)	$f_i = 4$
$f_i = n_i - 1$	

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$†	n_i	$f_iS_i^2$	$f_i\ln(S_i^2)$†
0.0043	0.0000	-10.907	5	0	-43.6
0.0039	0.0000	-11.102	5	0	-44.4

$\sum(S_i^2) =$ 0 $\qquad$ $\sum f_i\ln(S_i^2) =$ -88

Equality of Variance: Bartlett's Test

f = 8

$Sp^2 =$ 0.0000

$\ln Sp^2 =$ -11.000

$\chi^2 =$ 0.038 $\quad$ (If calculated $\chi^2 \leq$ tabulated χ^2_{crit}, then variances are equal at the given significance level).

$\chi^2_{crit} * =$ 3.841 $\quad$ at a 5% significance level with $\quad$ 1 $\quad$ degrees of freedom (p-1)

NOTE: The variances are equal. $\qquad$ **(i.e., calculated $\chi^2 \leq \chi^2_{crit}$)**

Since calculated $\chi^2 \leq \chi^2_{crit}$, then the analysis can proceed as normal.

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Between Well Sum of Squares

Source of Variation	Sums of Squares		Degrees of Freedom	Mean Squares	Calculated F	F Statistic**
Between Wells	$SS_{wells} =$	0.0004	1	0.00039	23.60	5.32
Error	$SS_{Error} =$	0.0001	8	0.00002		
Total	$SS_{Total} =$	0.0005	9			

If calculated F > F statistic, then reject the hypothesis of equal well means. If calculated F is less than or equal to F statistic, it can be concluded that there is no significant difference between concentrations; therefore, there is no evidence of well contamination.

CONCLUSION: **Calculated F > F statistic; therefore, ANOVA has identified a significant difference between upgradient and downgradient wells.**

Because the paired ANOVA for the two wells indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance well MW84A, a Mann-Kendall statistical analysis was performed.

**Table 2, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989). F statistic taken at the 5% significance level.

Mann-Kendall Statistical Analysis for Arsenic in MW84A

Mann-Kendall Trend Test Analysis

Input Data

Date Collected	Result (µg/L)
Jul-17	**19.1**
Jan-18	**18.5**
Aug-18	**28.9**
Jan-19	**27.5**
Jul-19	**16.8**
Jan-20	**20.2**
Jul-20	**22.2**
Jan-21	**21.2**

Bolded values indicated a detected result.

User Selected Options

Date/Time of Computation	ProUCL 5.13/30/2021 11:46:09 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

MW84A_As_Jan2021
General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	8
Number Values Reported (n)	8
Minimum	16.8
Maximum	28.9
Mean	21.8
Geometric Mean	21.45
Median	20.7
Standard Deviation	4.296
Coefficient of Variation	0.197

Mann-Kendall Test

M-K Test Value (S)	2
Tabulated p-value	0.452
Standard Deviation of S	8.083
Standardized Value of S	0.124
Approximate p-value	0.451

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Statistical Analysis for Arsenic in MW84A
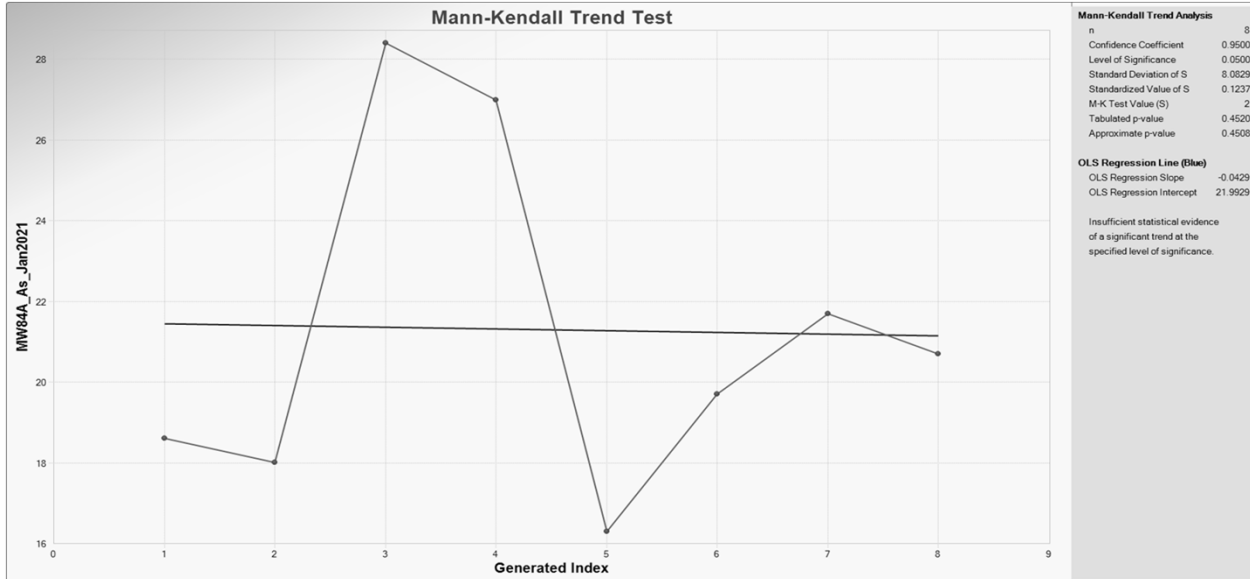
ATTACHMENT B2

CADMIUM
STATISTICAL TEST 2

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Attachment B2: Cadmium URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

	Cadmium (mg/L)				
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	0.0005	0.0005	**0.000415**	**0.000481**	0.0005
Jul-19	0.0005	0.0005	0.0005	0.0005	0.0005
Jan-20	0.0005	0.0005	**0.000385**	**0.000503**	0.0005
Jul-20	0.0005	0.0005	0.0005	0.0005	0.0005
Jan-21	0.0005	0.0005	0.0005	0.0005	0.0005

mg/L = milligrams per liter
BG = background
DL = detection limit
All data sets represent 1/2 DL values for nondetects.
Bolded values indicate a detected result.

[!]**Test of Proportions**

Calculate the number of detections in background wells vs. compliance wells.

X =   0 X = number of samples above DL in background wells
Y =   4 Y = number of samples above DL in compliance wells
n_b =   10 n_b = count of background well results/samples analyzed
n_c =   15 n_c = count of compliance well results/samples analyzed
n =   25 n = total number of samples

P =   0.160 $P = (x+y)/n$
nP =   4 $n = n_b + n_c$
$n(1-P)$ =   21

NOTE: If nP and n(1-P) are both >= 5, then the normal approximation may be used; however, because nP < 5 and/or n(1-P) < 5, the test was continued to determine if the conclusion, along with a simple evaluation of the data would be similar.

P_b =   0.000 P_b = proportion of detects in background wells
P_c =   0.267 P_c = proportion of detects in compliance wells
S_D =   0.150 S_D = standard error of difference in proportions
Z =   -1.782 $Z = (P_b - P_c)/S_D$
absolute value of Z =   1.782

If the absolute value of Z exceeds the 97.5th percentile value of 1.96 from the standard normal distribution, this provides statistically significant evidence at the 5% significance level that the proportion of detects in one group of data exceeds the proportion of detects in the other group.

CONCLUSION: **Because the absolute value of Z is less than 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.**

[!] Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA 1989).

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ATTACHMENT B3

**CHROMIUM
STATISTICAL TEST 2**

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Attachment B3: Chromium URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

	Chromium (mg/L)				
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	**0.0561**	0.005	**0.0251**	**0.0424**	0.005
Jul-19	0.005	0.005	0.005	0.005	0.005
Jan-20	0.005	0.005	0.005	0.005	0.005
Jul-20	0.005	0.005	0.005	0.005	0.005
Jan-21	**0.00338**	0.005	0.005	0.005	0.005

mg/L = milligrams per liter
BG = background
DL = detection limit
Nondetect values are 1/2 DL.
Bolded values indicate a detected result.

[!]**Test of Proportions**

Calculate the number of detections in background wells vs. compliance wells.

$X =$ 2   X = number of samples above DL in background wells
$Y =$ 2   Y = number of samples above DL in compliance wells
$n_b =$ 10 n_b = count of background well results/samples analyzed
$n_c =$ 15 n_c = count of compliance well results/samples analyzed
$n =$ 25   n = total number of samples

$P =$ 0.160 $P=(x+y)/n$
$nP =$ 4 $n=n_b+n_c$
$n(1-P) =$ 21

NOTE: If nP and n(1-P) are both >= 5, then the normal approximation may be used; however, because nP < 5 and/or n(1-P) < 5, the test was continued to determine if the conclusion, along with a simple evaluation of the data would be similar.

$P_b =$ 0.200 P_b = proportion of detects in background wells
$P_c =$ 0.133 P_c = proportion of detects in compliance wells
$S_D =$ 0.150 S_D = standard error of difference in proportions
$Z =$ 0.445 $Z = (P_b-P_c)/S_D$
absolute value of Z = 0.445

If the absolute value of Z exceeds the 97.5th percentile value of 1.96 from the standard normal distribution, this provides statistically significant evidence at the 5% significance level that the proportion of detects in one group of data exceeds the proportion of detects in the other group.

CONCLUSION: **Because the absolute value of Z is less than 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.**

[!]Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA 1989).

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ATTACHMENT B4

LEAD
STATISTICAL TEST 2

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Attachment B4: Lead URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Date	Lead (mg/L)				
	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	0.001	0.001	**0.00204**	**0.00502**	0.001
Jul-19	**0.00051**	0.001	0.001	0.001	0.001
Jan-20	0.001	0.001	0.001	0.001	0.001
Jul-20	0.001	0.001	0.001	0.001	0.001
Jan-21	0.001	0.001	0.001	0.001	0.001

mg/L = milligrams per liter
BG = background
DL = detection limit
Nondetect values are 1/2 DL.
Bolded values indicate a detected result.

[!]**Test of Proportions**

Calculate the number of detections in background wells vs. compliance wells.

$X =$ 1 X = number of samples above DL in background wells
$Y =$ 2 Y = number of samples above DL in compliance wells
$n_b =$ 10 n_b = count of background well results/samples analyzed
$n_c =$ 15 n_c = count of compliance well results/samples analyzed
$n =$ 25 n = total number of samples

$P =$ 0.120 $P = (x+y)/n$
$nP =$ 3 $n = n_b + n_c$
$n(1-P) =$ 22

NOTE: If nP and $n(1-P)$ are both $>= 5$, then the normal approximation may be used; however, because $nP < 5$ and/or $n(1-P) < 5$, the test was continued to determine if the conclusion, along with a simple evaluation of the data would be similar.

$P_b =$ 0.100 P_b = proportion of detects in background wells
$P_c =$ 0.133 P_c = proportion of detects in compliance wells
$S_D =$ 0.133 S_D = standard error of difference in proportions
$Z =$ -0.251 $Z = (P_b - P_c)/S_D$
absolute value of $Z =$ 0.251

If the absolute value of Z exceeds the 97.5th percentile value of 1.96 from the standard normal distribution, this provides statistically significant evidence at the 5% significance level that the proportion of detects in one group of data exceeds the proportion of detects in the other group.

CONCLUSION: **Because the absolute value of Z is less than 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.**

[!]Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA 1989).

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ATTACHMENT B5

TECHNETIUM-99
STATISTICAL TEST 2

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Attachment B5: Technetium-99 URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Technetium-99 (pCi/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	11.05	9.5	**28.8**	9.5	7.9
Jul-19	10.1	10.25	**126**	9.95	9.7
Jan-20	10.25	10.6	**297**	10.5	11.7
Jul-20	10.35	10.7	**332**	9.85	10.25
Jan-21	9.15	8.8	**353**	9.55	8.8

pCi/L = picocuries per liter
BG = background
DL = detection limit
Nondetect values are 1/2 DL.
Bolded values indicate a detected result.

[!]**Test of Proportions**

Calculate the number of detections in background wells vs. compliance wells.

$X =$	0	$X =$ number of samples above DL in background wells
$Y =$	5	$Y =$ number of samples above DL in compliance wells
$n_b =$	10	$n_b =$ count of background well results/samples analyzed
$n_c =$	15	$n_c =$ count of compliance well results/samples analyzed
$n =$	25	$n =$ total number of samples

$P =$	0.200	$P = (x+y)/n$
$nP =$	5	$n = n_b + n_c$
$n(1-P) =$	20	

NOTE: **If nP and n(1-P) are both >= 5, then the normal approximation may be used.**

$P_b =$	0.000	$P_b =$ proportion of detects in background wells
$P_c =$	0.333	$P_c =$ proportion of detects in compliance wells
$S_D =$	0.163	$S_D =$ standard error of difference in proportions
$Z =$	-2.041	$Z = (P_b - P_c)/S_D$
absolute value of $Z =$	2.041	

If the absolute value of Z exceeds the 97.5th percentile value of 1.96 from the standard normal distribution, this provides statistically significant evidence at the 5% significance level that the proportion of detects in one group of data exceeds the proportion of detects in the other group.

CONCLUSION: **Because the absolute value of Z is greater than 1.96, Nonparameteric ANOVA was performed.**

[!]Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA 1989).

Attachment B5: Technetium-99 URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Technetium-99 (pCi/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	11.05	9.5	**28.8**	9.5	7.9
Jul-19	10.1	10.25	**126**	9.95	9.7
Jan-20	10.25	10.6	**297**	10.5	11.7
Jul-20	10.35	10.7	**332**	9.85	10.25
Jan-21	9.15	8.8	**353**	9.55	8.8
Sum	100.7500		1136.80000	49.35000	48.3500
n_i	10		5	5	5
$(x_i)_{avg}$	10.07500		227.36000	9.87000	9.6700

pCi/L = picocuries per liter
BG = background
DL = detection limit
All data sets represent 1/2 DL values for nondetects.
Bolded values indicate a detected result.

Overall mean x.. =   53.41000

N =   25   N = the total number of samples
p =   4   p = the number of n_i groups
x.. =   1335.25   x.. = the sum of the total number of samples

Nonparametric ANOVA

Ranking of Observations

Sequence	Technetium-99 (pCi/L)	Adjusted Rank	Tie Number
1	**0**	10.5	
2	**0**	10.5	
3	**0**	10.5	
4	**0**	10.5	
5	**0**	10.5	
6	**0**	10.5	
7	**0**	10.5	
8	**0**	10.5	
9	**0**	10.5	
10	**0**	10.5	Tie 1
11	**0**	10.5	
12	**0**	10.5	
13	**0**	10.5	
14	**0**	10.5	
15	**0**	10.5	
16	**0**	10.5	
17	**0**	10.5	
18	**0**	10.5	
19	**0**	10.5	
20	**0**	10.5	
21	**28.8**	21	
22	**126**	22	
23	**297**	23	
24	**332**	24	
25	**353**	25	

pCi/L = picocuries per liter
BG = background
DL = detection limit
Bolded values indicate a detected result.
NOTE: For this method, observations below the detection limit that are considered nondetects (i.e., U qualified data) are reported as a concentration of 0.

n_{tie}
20   Tie 1 =   7980

            $\sum T_i =$ 7980

Attachment B5: Technetium-99 URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Sums of Ranks and Averages

Technetium-99 (pCi/L)				
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	0	0	**28.8**	0	0
Jul-19	0	0	**126**	0	0
Jan-20	0	0	**297**	0	0
Jul-20	0	0	**332**	0	0
Jan-21	0	0	**353**	0	0

Observation Ranks for Technetium-99				
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	10.5	10.5	21	10.5	10.5
Jul-19	10.5	10.5	22	10.5	10.5
Jan-20	10.5	10.5	23	10.5	10.5
Jul-20	10.5	10.5	24	10.5	10.5
Jan-21	10.5	10.5	25	10.5	10.5
R_i	105		115	52.5	52.5
$(R_i)_{avg}$	10.5		23.0	10.5	10.5
R_i^2/n_i	1102.5		2645.0	551.3	551.3

$\Sigma R_i^2/n_i =$ 4850.0

pCi/L = picocuries per liter   K = the number of n_i groups

BG = background   N = the total number of samples

DL = detection limit

Bolded values indicate a detected result.

K =   4   NOTE: For this method, observations below the detection limit

N =   25   that are considered nondetects (i.e., U qualified data) are reported as a concentration of 0.

Calculation of Kruskal-Wallis Statistic

H =   11.538   Kruskal-Wallis Statistic $H = [12/N(N+1)*\Sigma R_i^2/n_i] - 3(N+1)$

H' =   23.622   Corrected Kruskal-Wallis $H' = H/[1-(\Sigma T_i/N^3-N)]$

$\chi^2_{crit}* =$ 7.815   3   degrees of freedom at the 5% significance level

NOTE: $H' > \chi^2_{crit}$

If $H' \leq \chi^2_{crit}$, the data from each well come from the same continuous distribution and hence have the same median concentrations of a specific constituent.

If $H' > \chi^2_{crit}$, reject the null hypothesis and calculate the critical difference for well comparisons to the background.

K-1 =   3 $\alpha/(K-1) =$ 0.01667 $Z(\alpha/(K-1))** =$ 2.1280

$\alpha =$ 0.05 $1-(\alpha/K-1) =$ 0.983

NOTE: *Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

    **Table 4, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B5: Technetium-99 URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Calculate Critical Values

Average Background Ranking = 10.5

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93A			
BG Well	MW420			
	MW84A	8.578	12.5	**evidence of contamination**
	MW87A	8.578	0.0	not contaminated
	MW90A	8.578	0.0	not contaminated

pCi/L = picocuries per liter
BG = background
DL = detection limit

CONCLUSION: If $(R_i)_{avg} - (R_b)_{avg} > C_i$, then there is evidence that the compliance well is contaminated.

If $(R_i)_{avg} - (R_b)_{avg} < C_i$ for wells, there is no evidence of a statistically significant difference between concentrations in downgradient compliance test wells and background wells.

Since $(R_i)_{avg} - (R_b)_{avg} > C_i$ for MW84A, there is a statistically significant difference between downgradient compliance test wells and background wells in MW84A from the C-404 Landfill.

Because nonparametric ANOVA indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance well MW84A, the 95% UTL was performed.

Since $(R_i)_{avg} - (R_b)_{avg} < C_i$ for MW87A and MW90A, there is no statistically significant difference between background wells and these downgradient compliance test wells.

Section 5.2.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B5: Techetium-99 URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

95% Upper Tolerance Limit (UTL)

Compare the most recent downgradient sample results to a calculated 95% UTL using the five most recent sets of data for each upgradient well, as described below. If downgradient concentration is less than the UTL for the paired upgradient concentrations, then there is no confirmed exceedance.

January 2021 Data, First Reporting Period
Technetium-99 Observations (pCi/L)

Well No.						
MW93A	11.05	10.1	10.25	10.35	9.15	Upgradient Well[!]
MW420	9.5	10.25	10.6	10.7	8.8	Upgradient Well[!]
						Current Data
MW84A						353

X: Mean Value =	10	
S: Standard Deviation =	1	
K* factor =	2.911	(for n = 10)
CV = S/X	0.0707	<1, assume normal distribution
Upper Tolerance Interval: TL = X +(KxS) =	**12**	(pCi/L)

```
        ! = Data from previous 5 sampling events.
       CV = coefficient of variation
        * = Table 5, Appendix B, Statistical Analysis of Ground-Water Monitoring Data at RCRA
            Facilities, Interim Guidance (EPA 1989).
```

Result: **MW84A exceeded the UTL, which is statistically significant evidence that this compliance well has elevated concentration with respect to background data.**

Because the 95% UTL indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance wells MW84A, the paired (parametric) ANOVA was performed.

Attachment B5: Techetium-99 URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Paired (Parametric) ANOVA

Evaluate results using paired ANOVA of wells in the same direction relative to the landfill [e.g., compare upgradient westernmost well results to downgradient westernmost well results]. If ANOVA does not identify a statistically significant difference between upgradient and downgradient wells, then the results are consistent with the historical ASD.

Technetium-99 (Tc-99, pCi/L)				
Date	Background	Compliance		n_i^2
	MW93A	MW84A		
Jan-19	11.05	**28.8**	122.10	829.44
Jul-19	10.1	**126**	102.01	15876.00
Jan-20	10.25	**297**	105.06	88209.00
Jul-20	10.35	**332**	107.12	110224.00
Jan-21	9.15	**353**	83.72	124609.00
Sum (x_i)	50.9000	1136.80000	1187.70	Total Sum $(x_{..})$
n_i	5	5		
$(x_i)_{avg}$	10.18000	227.36000		
$(x_i)^2$	2590.81000	1292314.24000		

pCi/L = picocuries per liter
Bolded values indicate a detected result.

Overall mean $x_{..}$ =	118.77000	
N =	10	N = the total number of samples
p =	2	p = the number of n_i groups
$x_{..}$ =	1187.7000	$x_{..}$ = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals $(x_i–x_{iavg})$

Date	Background	Compliance
	MW93A	MW84A
Jan-19	0.87000	-198.56000
Jul-19	-0.08000	-101.36000
Jan-20	0.07000	69.64000
Jul-20	0.17000	104.64000
Jan-21	-1.03000	125.64000

X: Mean Value =	0.00E+00	
S: Standard Deviation =	95.03593	
K* Factor =	2.911	(for n = 10)
CV = S/X =	#ΔIç/0!	#DIV/0!

The Coefficient of Variability Test was not performed due to mean = 0 (i.e., division by 0 not possible).

*Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

If the coefficient of variation (CV) is < 1, the data are normally distributed.
If the coefficient of variation (CV) is > or = 1, data are not normally distributed.

Determine Equality of Variance of Dataset

p = number of wells

n_i = number of data points per well

N = total sample size

S^2 = the square of the standard deviation

$\ln(S_i^2)$ = natural logarithm of each variance

f = total sample size minus the number of wells (groups)

$f_i = n_i - 1$

$x_{..} = 1187.70$

$(x_{avg})_{..} = 118.77$

$n_{i} = 5$

$p = 2$

$N = 10$

$f_i = 4$

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_iS_i^2$	$f_i\ln(S_i^2)$
0.68154	0.4645	-0.767	5	1.8580	-3.1
142.55226	20321.1480	9.919	5	81284.5920	39.7

$\sum(S_i^2) = \quad 20{,}321.61250$ $\qquad \sum f_i\ln(S_i^2) = \quad 36.61049$

Equality of Variance: Bartlett's Test

$f = \quad 8$

$Sp^2 = \quad 10160.80625$

$\ln Sp^2 = \quad 9.226$

$\chi^2 = \quad 37.200$ $\qquad$ (If calculated $\chi^2 \leq$ tabulated χ^2_{crit}, then variances are equal at the given significance level).

$\chi^2_{crit} * = \quad 3.841$ $\qquad$ at a 5% significance level with $\quad 1 \quad$ degrees of freedom (p-1)

NOTE: The variances are NOT equal. $\qquad$ **(i.e., calculated $\chi^2 > \chi^2_{crit}$)**

Equality of variance cannot be calculated, transform the original data to lognormal

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B5: Techetium-99 URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Paired (Parametric) ANOVA—Lognormal Data

Date	ln[Tc-99 (pCi/L)] Background	Compliance		
	MW93A	MW84A	n_i^2	
Jan-19	**2.40**	**3.36**	5.77	11.29
Jul-19	**2.31**	**4.84**	5.35	23.39
Jan-20	**2.33**	**5.69**	5.42	32.42
Jul-20	**2.34**	**5.81**	5.46	33.70
Jan-21	**2.21**	**5.87**	4.90	34.42
Sum (x_i)	11.59	25.56	37.15	Total Sum (x..)
n_i	5	5		
$(x_i)_{avg}$	2.32	5.11		
$(x_i)^2$	134.40	653.42		

pCi/L = picocuries per liter   **Bolded values indicate a detected result.**

Overall mean x.. =	3.72	
N =	10	N = the total number of samples
p =	2	p = the number of n_i groups
x.. =	37.15	x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test—Lognormal Data

Table of Residuals (x_i-$x_i$avg) for Lognormal Data

Date	Background	Compliance
	MW93A	MW87A
Jan-19	0.08	-1.75
Jul-19	-0.01	-0.28
Jan-20	0.01	0.58
Jul-20	0.02	0.69
Jan-21	-0.10	0.75

X: Mean Value =	0.00E+00	
S: Standard Deviation =	0.71	
K* Factor =	2.911	(for n = 10)
CV = S/X =	#ΔIç/0!	#DIV/0!

The Coefficient of Variability Test was not performed due to mean = 0 (i.e., division by 0 not possible).

*Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

If the coefficient of variation is < 1, the residuals are normally distributed.
If the coefficient of variation is > or = 1, the residuals are not normally distributed.

Determine Equality of Variance—Lognormal Data

p = number of wells

n_i = number of data points per well

N = total sample size

S^2 = the square of the standard deviation

$\ln(S_i^2)$ = natural logarithm of each variance

f = total sample size minus the number of wells (groups)

$f_i = n_i - 1$

$x_{..} = 37.15$

$(x_{avg})_{..} = 3.72$

$n_i = 5$

$p = 2$

$N = 10$

$f_i = 4$

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_i S_i^2$	$f_i \ln(S_i^2)$
0.07	0.00	-5.38	5	0.02	-21.5
1.06	1.13	0.12	5	4.53	0.5

$\sum(S_i^2) =$ 1.14

$\sum f_i \ln(S_i^2) =$ -21.01

Equality of Variance: Bartlett's Test

f = 8

$Sp^2 =$ 0.57

$\ln Sp^2 =$ -0.56

$\chi^2 =$ 16.50   (If calculated $\chi^2 \leq$ tabulated χ^2_{crit}, then variances are equal at the given significance level).

χ^2_{crit} * = 3.841   at a 5% significance level with   1   degrees of freedom (p-1)

NOTE: The variances are NOT equal.   **(i.e., calculated $\chi^2 \leq \chi^2_{crit}$)**

Because equality of variance could not be determined, a paired (nonparametric) ANOVA was performed.

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

**Section 5.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

Attachment B5: Techetium-99 URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Paired Nonparametric ANOVA

Technetium-99 (pCi/L)		
Date	Background	Compliance
	MW93A	MW84A
Jan-19	11.05	**28.8**
Jul-19	10.1	**126**
Jan-20	10.25	**297**
Jul-20	10.35	**332**
Jan-21	9.15	**353**
Sum	50.9000	1136.80000
n_i	5	5
$(x_i)_{avg}$	10.18000	227.36000

pCi/L = picocuries per liter
BG = background
DL = detection limit
All data sets represent 1/2 DL values for nondetects.
Bolded values indicate a detected result.

Overall mean x.. =   118.77000
N =   10
p =   2
x.. = 1187.70000

Ranking of Observations

Sequence	Tc-99 (pCi/L)	Adjusted Rank	Tie Number
1	0	3	
2	0	3	
3	0	3	Tie-1
4	0	3	
5	0	3	
6	**28.8**	6	
7	**126**	7	
8	**297**	8	
9	**332**	9	
10	**353**	10	

pCi/L = picocuries per liter

Bolded values indicate a detected result.

Note: for this method, observations below the detection that are considered non-detects (i.e., U qualified data) are reported as a concentration 0.

Adjustment for Ties: $(n_{tie}^3 - n_{tie})$

n_{tie}		
5	Tie 1 =	120
	$\sum T_i$ =	120

Sums of Ranks and Averages

Observation Ranks for Tc-99		
Date	Background	Compliance
	MW93A	MW84A
Jan-19	3	6
Jul-19	3	7
Jan-20	3	8
Jul-20	3	9
Jan-21	3	10
R_i	15	40
$(R_i)_{avg}$	3.0	8
R_i^2/n_i	45.0	320.0

$\sum R_i^2/n_i$ =   365
K =   2
N =   10

Attachment B5: Techetium-99 URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Calculation of Kruskal-Wallis Statistic

$H =$	6.818	Kruskal-Wallis Statistic	$H = [12/N(N+1)*\Sigma R_i^2/n_i] - 3(N+1)$
$H' =$	7.759	Corrected Kruskal-Wallis	$H' = H/[1-(\sum T_i/N^3-N)]$
$\chi^2_{crit} * =$	3.841	1	degrees of freedom at the 5% significance level

NOTE: $H' > \chi^2_{crit}$

If $H' \leq \chi^2_{crit}$, the data from each well comes from the same continuous distribution and hence have the same median concentrations of a specific constituent.

If $H' > \chi^2_{crit}$, reject the null hypothesis and calculate the critical difference for well comparisons to the background.

$K-1 =$	1	$\alpha/(K-1) =$	0.05000	$Z(\alpha/(K-1))** =$		1.6449
$\alpha =$	0.05	$1-(\alpha/K-1) =$	0.950			

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).
**Table 4, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Calculate Critical Values

Average Background Ranking =   3.000

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
	MW93A			
BG Well	MW84A	3.150	5.000	**evidence of contamination**

pCi/L = picocuries per liter
BG = background
DL = detection limit

If $(R_i)_{avg} - (R_b)_{avg} > C_i$, then there is evidence that the compliance well is contaminated.

CONCLUSION:

If $(R_i)_{avg} - (R_b)_{avg} < C_i$ for wells, there is no evidence of a statistically significant difference between concentrations in downgradient compliance test wells and background wells.

Since (Ri)avg - (Rb)avg > Ci for MW84A, there is a statistically significant difference in this downgradient compliance test well.

Because the nonparametric ANOVA for the two wells indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance well MW84A, a Mann Kendall statistical analysis was performed.

Section 5.2.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Mann-Kendall Statistical Analysis for Technetium-99 in MW84A

Input Data

Date Collected	Result (pCi/L)
Jul-17	9.98
Jan-18	**34.4**
Aug-18	11.8
Jan-19	**28.8**
Jul-19	**126**
Jan-20	**297**
Jul-20	**332**
Jan-21	**353**

Bolded values indicated a detected result.

Mann-Kendall Trend Test Analysis

User Selected Options

Date/Time of Computation	ProUCL 5.14/12/2021 9:38:16 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

MW84A_Tc-99

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	8
Number Values Reported (n)	8
Minimum	9.98
Maximum	353
Mean	149.1
Geometric Mean	68.96
Median	80.2
Standard Deviation	152.7
Coefficient of Variation	1.024

Mann-Kendall Test

M-K Test Value (S)	24
Tabulated p-value	0.001
Standard Deviation of S	8.083
Standardized Value of S	2.846
Approximate p-value	0.00222

Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Statistical Analysis for Technetium-99 in MW84A

Mann-Kendall Trend Test

Mann-Kendall Trend Analysis	
n	8
Confidence Coefficient	0.9500
Level of Significance	0.0500
Standard Deviation of S	8.0829
Standardized Value of S	2.8455
M-K Test Value (S)	24
Tabulated p-value	0.0010
Approximate p-value	0.0022

OLS Regression Line (Blue)	
OLS Regression Slope	57.6421
OLS Regression Intercept	-110.2671

Statistically significant evidence of an increasing trend at the specified level of significance.

ATTACHMENT B6
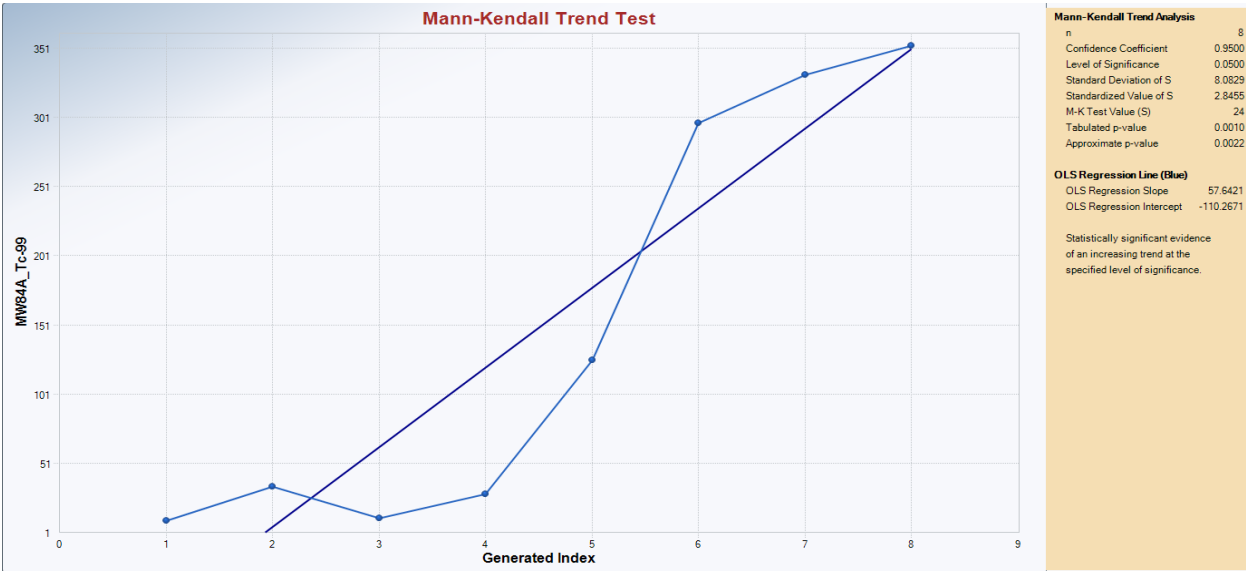
**TRICHLOROETHENE
STATISTICAL TESTS 4**

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Attachment B6: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Trichloroethene (TCE, µg/L)				
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	**1000**	**601**	**5580**	**2380**	**69.9**
Jul-19	**789**	**600**	**2000**	**1850**	**55.7**
Jan-20	**1360**	**1090**	**2930**	**2580**	**92.9**
Jul-20	**2220**	**1340**	**3230**	**3090**	**52**
Jan-21	**3120**	**1690**	**2630**	**2570**	**99.6**
n_i	10		5	5	5
Sum	13810		16370	12470	370.10
(x_i)avg	1381.00		3274.00	2494.00	74.02

µg/L = micrograms per liter
Bolded values indicate a detected result.

Overall mean x.. =　　1720.80

N = 　25　　　 N = the total number of samples

p = 　4　　　 p = the number of n_i groups

x.. = 　43020.10　 x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals

Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	-381.00	-780.00	2306.00	-114.00	-4.12
Jul-19	-592.00	-781.00	-1274.00	-644.00	-18.32
Jan-20	-21.00	-291.00	-344.00	86.00	18.88
Jul-20	839.00	-41.00	-44.00	596.00	-22.02
Jan-21	1739.00	309.00	-644.00	76.00	25.58

X: Mean Value = 　2.27E-15

S: Standard Deviation = 　761.0

K* Factor = 　2.292　　(for n = 25)

CV = S/X = 　3.35E+17　 > 1, data are not normally distributed

Data are not normally distributed (i.e.,>1)

*K factor [from Table 5, Appendix B of *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

If the coefficient of variation is < 1, the data are normally distributed.
If the coefficient of variation is > or = 1, data are not normally distributed.

Attachment B6: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Determine Equality of Variance of Dataset

p = number of well groups

n_i = number of data points per well

N = total sample size

S^2 = the square of the standard deviation

$\ln(S_i^2)$ = natural logarithm of each variance

f = total sample size minus the number of wells (groups)

$f_i = n_i - 1$

x.. = the sum of the total number of samples

$(x_{avg})_{..}$ = the mean of the total number of samples

$x_{..}$ = 43020.10

$(x_{avg})_{..}$ = 1720.80

p = 4

N = 25

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_i S_i^2$	$f_i \ln(S_i^2)$
790.521	624923.56	13.345	10	5624312.0	120.1
1367.088	1868930.00	14.441	5	7475720.000	57.8
446.128	199030.00	12.201	5	796120.000	48.8
21.496	462.07	6.136	5	1848.268	24.5

$\sum(S_i^2) =$ 2693345.62 $\qquad$ $\sum f_i \ln(S_i^2) =$ 251.2

Equality of Variance: Bartlett's Test

$\qquad\qquad f =$ 21

$\qquad\quad Sp^2 =$ 661809.537

$\qquad \ln Sp^2 =$ 13.403

$\qquad\qquad c^2 =$ 30.238 $\qquad$ (If $c^2 \leq c^2_{crit}$, then variances are equal at the given significance level).

$\qquad c^2_{crit} * =$ 7.815 $\qquad$ at a 5% significance level with $\qquad$ 3 $\qquad$ degrees of freedom

NOTE: The variances are NOT equal. $\qquad\qquad$ **(i.e., $c^2 > c^2_{crit}$)**

Variances are not equal, transform the original data to lognormal (i.e., since $c^2 > c^2_{crit}$).

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B6: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Lognormal Data for TCE

	ln[TCE (µg/L)]				
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	6.91	6.40	8.63	7.77	4.25
Jul-19	6.67	6.40	7.60	7.52	4.02
Jan-20	7.22	6.99	7.98	7.86	4.53
Jul-20	7.71	7.20	8.08	8.04	3.95
Jan-21	8.05	7.43	7.87	7.85	4.60
Mean x_i	7.31	6.88	8.03	7.81	4.27
Background Mean	7.10		NA	NA	NA
Grand Mean	6.86				
x_i^2	47.72	40.94	74.42	60.45	18.04
	44.50	40.92	57.77	56.59	16.16
These values needed for ANOVA	52.06	48.92	63.72	61.71	20.53
	59.37	51.85	65.29	64.58	15.61
	64.73	55.24	62.01	61.65	21.17
Sum x_i^2	1226				

µg/L = micrograms per liter

Determine Normality of Dataset

Coefficient of Variability Test

Table of ln[TCE (µg/L)] Data

Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	6.91	6.40	8.63	7.77	4.25
Jul-19	6.67	6.40	7.60	7.52	4.02
Jan-20	7.22	6.99	7.98	7.86	4.53
Jul-20	7.71	7.20	8.08	8.04	3.95
Jan-21	8.05	7.43	7.87	7.85	4.60

X: Mean Value = 6.86E+00
S: Standard Deviation = 1.43

K* Factor = 2.292 (for n = 25)
CV = S/X = 2.09E-01 <1, data are normally distributed

Data are normally distributed (i.e.,<1)

*K factor [from Table 5, Appendix B of *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

Attachment B6: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

Determine Equality of Variance of Dataset for Lognormal Data

p = number of wells (background wells considered as one group) $x_{..} = 171.52$

n_i = number of data points per well $(x_{avg})_{..} = 6.86$

N = total sample size $n_i = 5$

S^2 = the square of the standard deviation $p = 4$

$\ln(S_i^2)$ = natural logarithm of each variance $N = 25$

f = total sample size minus the number of wells (groups)

$f_i = n_i - 1$

x.. = the sum of the total lognormal dataset

$(x_{avg})_{..} = $ the mean of the lognormal dataset

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	ni	$f_i S_i^2$	$f_i \ln(S_i^2)$
0.539	0.290	-1.237	10	2.613	-11.1
0.377	0.142	-1.950	5	0.569	-7.8
0.186	0.035	-3.363	5	0.138	-13.5
0.293	0.086	-2.457	5	0.343	-9.8

$\sum(S_i^2) = $ 0.55 $\sum f_i \ln(S_i^2) = $ -42.2

Equality of Variance: Bartlett's Test

$f = $ 21

$Sp^2 = $ 0.174

$\ln Sp^2 = $ -1.746

$c^2 = $ 5.543   (If $c^2 \leq c^2_{crit}$, then variances are equal at the given significance level).

$c^2_{crit} * = $ 7.815   at a 5% significance level with   3   degrees of freedom

NOTE: The variances are equal.   **(i.e., $c^2 \leq c^2_{crit}$)**

Because variances are equal, the Parametric ANOVA for the lognormal dataset will proceed.

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

**Section 5.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

Parametric ANOVA

Between Well Sum of Squares[1]

Source of Variation	Sums of Squares	df	Mean Squares	$F_{calculated}$
Between Wells (SS wells)	45.47	3	15.157	86.89
Error within wells (SS error)	3.66	21	0.174	
Total (SS total)	49.14	24		

If $F_{calculated} > F_{tabulated}$, then reject the hypothesis of equal well means. If $F_{calculated}$ is less than or equal to

$F_{tabulated}$, it can be concluded that there is no significant difference between concentrations, therefore,

there is no evidence of well contamination.

$F_{tabulated} = 3.07$**

CONCLUSION: $F_{calculated} > F_{tabulated}$; therefore, evidence of well contamination. Additional comparisons must be made.

NOTE: ** Table 2, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* , USEPA, 1989. $F_{tabulated}$ taken at the 5% significance level.

Comparison of Compliance Wells to Background Wells (Bonferroni Test)

$n_b =$	10	$N\text{-}p =$	21	$\alpha =$	0.05
$(x_b)_{avg} =$	7.10	$m =$	3	$1\text{-}\alpha/m =$	0.9833

n_b = total sample size of all background wells

$(x_b)_{avg}$ = average concentration from all background wells

Well No.	Well Mean	Differences of Avg.	Standard Error	Bonferroni's t[2]	D_i	Conclusion
	$(x_b)_{avg}$	$(x_i)_{avg}\text{-}(x_b)_{avg}$	SE_i	$t_{(N\text{-}p),(\alpha/m)}$		
MW93A						
MW420						
MW84A	8.03	0.94	0.23	2.27	0.52	evidence of contamination
MW87A	7.81	0.71	0.23	2.27	0.52	evidence of contamination
MW90A	4.27	-2.83	0.23	2.27	0.52	not contaminated

CONCLUSION: If the "Differences of Averages" is greater than D_i, then the well is contaminated.

After performing Bonferroni's t calculation, the following can be concluded:

MW84A and MW87A show statistically significantly levels of contamination as compared background wells.

MW90A does not show statistically significant levels of contamination.

[1]Section 5.2.1, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* , (EPA, 1989).

[2]Appendix B, Table 3 (EPA, 1989).

A 95% UTL comparison is performed.

Attachment B6: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, First Reporting Period 2021

95% Upper Tolerance Limit (UTL)

Compare the most recent downgradient sample results to a calculated 95% UTL using the five most recent sets of data for each upgradient well, as described below. If downgradient concentration is less than the UTL for the paired upgradient concentrations, then there is no confirmed exceedance.

January 2021 Data, First Reporting Period
TCE Observations (µg/L)

Well No.						
MW93A	1000	789	1360	2220	3120	Upgradient Well[!]
MW420	601	600	1090	1340	1690	Upgradient Well[!]
						Current Data
MW84A						**2630**
MW87A	X: Mean Value =		1381			**2570**
	S: Standard Deviation =		791			
	K* factor =		2.911	(for n = 10)		
	CV = S/X		0.5724	<1, assume normal distribution		
	Upper Tolerance Interval: TL = X +(KxS) =		**3682**	(µg/L)		

     ! = Data from previous 5 sampling events.
   CV = coefficient of variation
     * = Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Result: **Neither MW84A nor MW87A exceeded the UTL, which is statistically significant evidence that these compliance wells do not have elevated TCE concentrations with respect to background data.**

ATTACHMENT B7

**URANIUM
STATISTICAL TEST 2**

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Attachment B7: Uranium URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Date	Uranium (pCi/L)				
	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	0.000100	0.0001	**0.000193**	**0.00042**	0.0001
Jul-19	**0.000560**	0.0001	**0.00089**	0.0001	0.0001
Jan-20	0.000100	0.0001	**0.000305**	0.0001	0.0001
Jul-20	**0.000089**	0.0001	**0.000219**	0.0001	0.0001
Jan-21	**0.000100**	0.0001	**0.000156**	0.0001	0.0001

pCi/L = picocuries per liter
BG = background
DL = detection limit
Nondetect values are 1/2 DL.
Bolded values indicate a detected result.

[!]**Test of Proportions**

Calculate the number of detections in background wells vs. compliance wells.

X =	3	X = number of samples above DL in background wells
Y =	6	Y = number of samples above DL in compliance wells
n_b =	10	n_b = count of background well results/samples analyzed
n_c =	15	n_c = count of compliance well results/samples analyzed
n =	25	n = total number of samples

P =	0.360	$P=(x+y)/n$
nP =	9	$n=n_b+n_c$
$n(1-P)$ =	16	

NOTE: If nP and $n(1-P)$ are both $>= 5$, then the normal approximation may be used.

P_b =	0.300	P_b = proportion of detects in background wells
P_c =	0.400	P_c = proportion of detects in compliance wells
S_D =	0.196	S_D = standard error of difference in proportions
Z =	-0.510	$Z = (P_b-P_c)/S_D$
absolute value of Z =	0.510	

If the absolute value of Z exceeds the 97.5th percentile value of 1.96 from the standard normal distribution, this provides statistically significant evidence at the 5% significance level that the proportion of detects in one group of data exceeds the proportion of detects in the other group.

CONCLUSION: **Because the absolute value of Z is less than 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.**

[!]Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA 1989).

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ATTACHMENT B8

URANIUM-234
STATISTICAL TEST 2

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Attachment B8: Uranium-234 URGA, Statistical Test 2, Test of Proportions, First Reporting Period 2021

Uranium-234 (pCi/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jan-19	0.685	1.115	0.715	1.19	**1.89**
Jul-19	**2.38**	0.71	**1.77**	1.01	**1.67**
Jan-20	0.755	0.56	0.695	0.675	0.655
Jul-20	0.83	0.955	0.94	0.825	0.92
Jan-21	0.595	0.57	0.64	0.63	0.7

pCi/L = picocuries per liter
BG = background
DL = detection limit
Nondetect values are 1/2 DL.
Bolded values indicate a detected result.

[!]**Test of Proportions**

Calculate the number of detections in background wells vs. compliance wells.

$X =$	1	X = number of samples above DL in background wells
$Y =$	3	Y = number of samples above DL in compliance wells
$n_b =$	10	n_b = count of background well results/samples analyzed
$n_c =$	15	n_c = count of compliance well results/samples analyzed
$n =$	25	n = total number of samples

$P =$	0.160	$P = (x+y)/n$
$nP =$	4	$n = n_b + n_c$
$n(1-P) =$	21	

NOTE: If nP and $n(1-P)$ are both $>= 5$, then the normal approximation may be used; however, because $nP < 5$ and/or $n(1-P) < 5$, the test was continued to determine if the conclusion, along with a simple evaluation of the data would be similar.

$P_b =$	0.100	P_b = proportion of detects in background wells
$P_c =$	0.200	P_c = proportion of detects in compliance wells
$S_D =$	0.150	S_D = standard error of difference in proportions
$Z =$	-0.668	$Z = (P_b - P_c)/S_D$
absolute value of $Z =$	0.668	

If the absolute value of Z exceeds the 97.5th percentile value of 1.96 from the standard normal distribution, this provides statistically significant evidence at the 5% significance level that the proportion of detects in one group of data exceeds the proportion of detects in the other group.

CONCLUSION: **Because the absolute value of Z is less than 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.**

[!]Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA 1989).

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ATTACHMENT B9

STATISTICIAN STATEMENT

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May 12, 2021

Mr. Dennis Greene
Four Rivers Nuclear Partnership, LLC
5511 Hobbs Road
Kevil, KY 42053

Dear Mr. Greene:

I am submitting this statement as a supplementary document to the completed statistical analysis I performed on the groundwater data for the C-404 Hazardous Waste Landfill at the Paducah Site.

As an Environmental Scientist, with a bachelor's degree in Earth Sciences/Geology, I have over 30 years of experience in reviewing and assessing laboratory analytical results associated with environmental sampling and investigation activities.

For this project, the statistical analyses on groundwater data from January 2019 through January 2021 were performed in accordance with the Hazardous Waste Management Facility Permit, Appendix E using Microsoft Excel 2016 and U.S. Environmental Protection Agency's (EPA's) ProUCL 5.1. The spreadsheets include the results for the following statistical tests:

- Test of Proportions
- Parametric Analysis of Variance (ANOVA)
- Nonparametric ANOVA
- 95% Upper Tolerance Limit
- Paired (parametric) ANOVA
- Paired (nonparametric) ANOVA
- Mann-Kendall

The statistical analyses procedures were based on EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance* (1989).

Sincerely,

Bryan Smith

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APPENDIX C

**C-404 HAZARDOUS WASTE LANDFILL
LEACHATE ANALYTICAL RESULTS**

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Paducah OREIS Report for 404L21-01

L1404L1-21   from: C404L   on 2/22/2021   Media: WW   SmpMethod: GR

Comments: Water level = 4.60 ft from ground surface. SF 2-22-21 Due to a delay by FedEx, samples were not delivered to the lab until 2-24-21. HLN 2-24-21

Analysis	Results	Units	Result Qual	Foot Note	Reporting Limit	Counting Error	TPU**	Method	LabCode	V/V/A*
ANION										
Fluoride	6.87	mg/L			0.2			SW846-9056	GEL	I / X /
FS										
Conductivity	416	umho/cm						FS	FS	/ /
Dissolved Oxygen	10.95	mg/L						FS	FS	/ /
pH	8.08	Std Unit						FS	FS	/ /
Redox	437	mV						FS	FS	/ /
Temperature	46.5	deg F						FS	FS	/ /
METAL										
Arsenic	0.005	mg/L	U		0.005			SW846-6020	GEL	/ X /
Barium	0.0678	mg/L			0.004			SW846-6020	GEL	/ X /
Cadmium	0.001	mg/L	U		0.001			SW846-6020	GEL	/ X /
Chromium	0.01	mg/L	U		0.01			SW846-6020	GEL	/ X /
Copper	0.0141	mg/L			0.002			SW846-6020	GEL	/ X /
Iron	0.172	mg/L			0.1			SW846-6020	GEL	/ X /
Lead	0.002	mg/L	U		0.002			SW846-6020	GEL	/ X /
Mercury	0.0002	mg/L	U		0.0002			SW846-7470A	GEL	/ X /
Nickel	0.00703	mg/L			0.002			SW846-6020	GEL	/ X /
Selenium	0.005	mg/L	U		0.005			SW846-6020	GEL	/ X /
Silver	0.001	mg/L	U		0.001			SW846-6020	GEL	/ X /
Uranium	44.4	mg/L			0.2			SW846-6020	GEL	I / X /
Zinc	0.00376	mg/L	J		0.02			SW846-6020	GEL	S / X /
PPCB										
PCB-1016	0.119	ug/L	U		0.119			SW846-8082	GEL	/ X /
PCB-1221	0.119	ug/L	U		0.119			SW846-8082	GEL	/ X /
PCB-1232	0.119	ug/L	U		0.119			SW846-8082	GEL	/ X /
PCB-1242	0.119	ug/L	U		0.119			SW846-8082	GEL	/ X /
PCB-1248	1.73	ug/L			0.119			SW846-8082	GEL	/ X / FDUP-OUT
PCB-1254	0.119	ug/L	U		0.119			SW846-8082	GEL	/ X /
PCB-1260	0.253	ug/L			0.119			SW846-8082	GEL	/ X /
Polychlorinated biphenyl	1.98	ug/L			0.119			SW846-8082	GEL	I / X / FDUP-OUT
RADS										
Cesium-137	3.32	pCi/L	U		13.2	6.36	6.54	EPA-901.1	GEL	/ X /
Neptunium-237	1.43	pCi/L	U		2.27	1.61	1.61	ASTM-1475-00M	GEL	/ X /
Plutonium-239/240	-0.0372	pCi/L	U		1.31	0.559	0.559	HASL 300, Pu-11-RC M	GEL	/ X /
Technetium-99	298	pCi/L			20.2	18.1	37.7	HASL 300, Tc-02-RC M	GEL	/ X /
Thorium-230	2.85	pCi/L			1.51	1.48	1.53	HASL 300, Th-01-RC M	GEL	/ X /
Uranium-234	1570	pCi/L			154	369	449	HASL 300, U-02-RC M	GEL	/ X /
Uranium-235	183	pCi/L			129	151	154	HASL 300, U-02-RC M	GEL	/ X /
Uranium-238	14800	pCi/L			133	1120	2650	HASL 300, U-02-RC M	GEL	/ X /
VOA										
Trichloroethene	1	ug/L	U		1			SW846-8260B	GEL	/ X /
WETCHEM										
Ammonia as Nitrogen	0.0397	mg/L	J		0.05			EPA-350.1	GEL	S / X /

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*Verification/Validation/Assessment   ** TPUs reported at 1.96 sigma

4/15/2021 Page 1 of 4

C-3

L1404LD1-21									
		from: C404L		on 2/22/2021	Media: WW		SmpMethod: GR		
Comments:		Water level = 4.60 ft from ground surface. SF 2-22-21 Due to a delivery delay by FedEx, samples were not delivered to the lab until 2-24-21. HLN 2-24-21							

Analysis	Results	Units	Result Qual	Foot Note	Reporting Limit	Counting Error	TPU**	Method	LabCode	V/V/A*
ANION										
Fluoride	6.81	mg/L			0.2			SW846-9056	GEL	I / X /
METAL										
Arsenic	0.005	mg/L	U		0.005			SW846-6020	GEL	/ X /
Barium	0.069	mg/L			0.004			SW846-6020	GEL	/ X /
Cadmium	0.001	mg/L	U		0.001			SW846-6020	GEL	/ X /
Chromium	0.01	mg/L	U		0.01			SW846-6020	GEL	/ X /
Copper	0.014	mg/L			0.002			SW846-6020	GEL	/ X /
Iron	0.191	mg/L			0.1			SW846-6020	GEL	/ X /
Lead	0.002	mg/L	U		0.002			SW846-6020	GEL	/ X /
Mercury	0.0002	mg/L	U		0.0002			SW846-7470A	GEL	/ X /
Nickel	0.00699	mg/L			0.002			SW846-6020	GEL	/ X /
Selenium	0.005	mg/L	U		0.005			SW846-6020	GEL	/ X /
Silver	0.001	mg/L	U		0.001			SW846-6020	GEL	/ X /
Uranium	43.5	mg/L			0.2			SW846-6020	GEL	I / X /
Zinc	0.0038	mg/L	J		0.02			SW846-6020	GEL	S / X /
PPCB										
PCB-1016	0.126	ug/L	U		0.126			SW846-8082	GEL	/ X /
PCB-1221	0.126	ug/L	U		0.126			SW846-8082	GEL	/ X /
PCB-1232	0.126	ug/L	U		0.126			SW846-8082	GEL	/ X /
PCB-1242	0.126	ug/L	U		0.126			SW846-8082	GEL	/ X /
PCB-1248	2.36	ug/L			0.126			SW846-8082	GEL	/ X / FDUP-OUT
PCB-1254	0.126	ug/L	U		0.126			SW846-8082	GEL	/ X /
PCB-1260	0.267	ug/L			0.126			SW846-8082	GEL	/ X /
Polychlorinated biphenyl	2.62	ug/L			0.126			SW846-8082	GEL	I / X / FDUP-OUT
RADS										
Cesium-137	6.43	pCi/L	U		10.3	14.8	14.8	EPA-901.1	GEL	/ X /
Neptunium-237	0.904	pCi/L	U		2.11	1.36	1.36	ASTM-1475-00M	GEL	/ X /
Plutonium-239/240	0.391	pCi/L	U		1.05	0.69	0.692	HASL 300, Pu-11-RC M	GEL	/ X /
Technetium-99	210	pCi/L			18.7	15.5	28	HASL 300, Tc-02-RC M	GEL	/ X /
Thorium-230	3.55	pCi/L			1.59	1.67	1.74	HASL 300, Th-01-RC M	GEL	/ X /
Uranium-234	1900	pCi/L			237	437	545	HASL 300, U-02-RC M	GEL	/ X /
Uranium-235	447	pCi/L			145	239	250	HASL 300, U-02-RC M	GEL	/ X /
Uranium-238	16400	pCi/L			172	1250	3050	HASL 300, U-02-RC M	GEL	/ X /
VOA										
Trichloroethene	1	ug/L	U		1			SW846-8260B	GEL	/ X /
WETCHEM										
Ammonia as Nitrogen	0.0934	mg/L			0.05			EPA-350.1	GEL	/ X /

FB404L1-21	from: QC	on 2/22/2021	Media: WQ	SmpMethod:
Comments:				

Analysis	Results	Units	Result Qual	Foot Note	Reporting Limit	Counting Error	TPU**	Method	LabCode	V/V/A*
ANION										
Fluoride	0.1	mg/L	U		0.1			SW846-9056	GEL	/ X /
METAL										
Arsenic	0.005	mg/L	U		0.005			SW846-6020	GEL	/ X /
Barium	0.004	mg/L	U		0.004			SW846-6020	GEL	/ X /
Cadmium	0.001	mg/L	U		0.001			SW846-6020	GEL	/ X /
Chromium	0.01	mg/L	U		0.01			SW846-6020	GEL	/ X /
Copper	0.002	mg/L	U		0.002			SW846-6020	GEL	/ X /
Iron	0.1	mg/L	U		0.1			SW846-6020	GEL	/ X /
Lead	0.002	mg/L	U		0.002			SW846-6020	GEL	/ X /
Mercury	0.0002	mg/L	U		0.0002			SW846-7470A	GEL	/ X /
Nickel	0.002	mg/L	U		0.002			SW846-6020	GEL	/ X /
Selenium	0.005	mg/L	U		0.005			SW846-6020	GEL	/ X /
Silver	0.001	mg/L	U		0.001			SW846-6020	GEL	/ X /
Uranium	0.0002	mg/L	U		0.0002			SW846-6020	GEL	/ X /
Zinc	0.02	mg/L	U		0.02			SW846-6020	GEL	/ X /
PPCB										
PCB-1016	0.0953	ug/L	U		0.0953			SW846-8082	GEL	/ X /
PCB-1221	0.0953	ug/L	U		0.0953			SW846-8082	GEL	/ X /
PCB-1232	0.0953	ug/L	U		0.0953			SW846-8082	GEL	/ X /
PCB-1242	0.0953	ug/L	U		0.0953			SW846-8082	GEL	/ X /
PCB-1248	0.0953	ug/L	U		0.0953			SW846-8082	GEL	/ X /
PCB-1254	0.0953	ug/L	U		0.0953			SW846-8082	GEL	/ X /
PCB-1260	0.0953	ug/L	U		0.0953			SW846-8082	GEL	/ X /
Polychlorinated biphenyl	0.0953	ug/L	U		0.0953			SW846-8082	GEL	/ X /
RADS										
Cesium-137	2.14	pCi/L	U		9.86	4.68	4.78	EPA-901.1	GEL	/ X /
Neptunium-237	0.143	pCi/L	U		1.42	0.712	0.712	ASTM-1475-00M	GEL	/ X /
Plutonium-239/240	-0.0439	pCi/L	U		0.877	0.378	0.379	HASL 300, Pu-11-RC M	GEL	/ X /
Technetium-99	-6.69	pCi/L	U		19.5	11.1	11.1	HASL 300, Tc-02-RC M	GEL	/ X /
Thorium-230	0.926	pCi/L	U		1.9	1.2	1.21	HASL 300, Th-01-RC M	GEL	/ X /
Uranium-234	0.515	pCi/L	U		2.17	1.22	1.22	HASL 300, U-02-RC M	GEL	/ X /
Uranium-235	0	pCi/L	U		0.992	0.666	0.668	HASL 300, U-02-RC M	GEL	/ X /
Uranium-238	0.407	pCi/L	U		1.48	0.934	0.936	HASL 300, U-02-RC M	GEL	/ X /
VOA										
Trichloroethene	1	ug/L	U		1			SW846-8260B	GEL	/ X /
WETCHEM										
Ammonia as Nitrogen	0.05	mg/L	U		0.05			EPA-350.1	GEL	/ X /

Paducah OREIS Report for 404L21-01

RI404L1-21 from: QC on 2/22/2021 Media: WQ SmpMethod:

Comments:

Analysis	Results	Units	Result Qual	Foot Note	Reporting Limit	Counting Error	TPU**	Method	LabCode	V/V/A*
ANION										
Fluoride	0.1	mg/L	U		0.1			SW846-9056	GEL	/ X /
METAL										
Arsenic	0.005	mg/L	U		0.005			SW846-6020	GEL	/ X /
Barium	0.004	mg/L	U		0.004			SW846-6020	GEL	/ X /
Cadmium	0.001	mg/L	U		0.001			SW846-6020	GEL	/ X /
Chromium	0.01	mg/L	U		0.01			SW846-6020	GEL	/ X /
Copper	0.002	mg/L	U		0.002			SW846-6020	GEL	/ X /
Iron	0.1	mg/L	U		0.1			SW846-6020	GEL	/ X /
Lead	0.002	mg/L	U		0.002			SW846-6020	GEL	/ X /
Mercury	0.0002	mg/L	U		0.0002			SW846-7470A	GEL	/ X /
Nickel	0.002	mg/L	U		0.002			SW846-6020	GEL	/ X /
Selenium	0.005	mg/L	U		0.005			SW846-6020	GEL	/ X /
Silver	0.001	mg/L	U		0.001			SW846-6020	GEL	/ X /
Uranium	0.0002	mg/L	U		0.0002			SW846-6020	GEL	/ X /
Zinc	0.02	mg/L	U		0.02			SW846-6020	GEL	/ X /
PPCB										
PCB-1016	0.0958	ug/L	U		0.0958			SW846-8082	GEL	/ X /
PCB-1221	0.0958	ug/L	U		0.0958			SW846-8082	GEL	/ X /
PCB-1232	0.0958	ug/L	U		0.0958			SW846-8082	GEL	/ X /
PCB-1242	0.0958	ug/L	U		0.0958			SW846-8082	GEL	/ X /
PCB-1248	0.0958	ug/L	U		0.0958			SW846-8082	GEL	/ X /
PCB-1254	0.0958	ug/L	U		0.0958			SW846-8082	GEL	/ X /
PCB-1260	0.0958	ug/L	U		0.0958			SW846-8082	GEL	/ X /
Polychlorinated biphenyl	0.0958	ug/L	U		0.0958			SW846-8082	GEL	/ X /
RADS										
Cesium-137	0.414	pCi/L	U		7.75	4	4.01	EPA-901.1	GEL	/ X /
Neptunium-237	-0.331	pCi/L	U		1.83	0.702	0.703	ASTM-1475-00M	GEL	/ X /
Plutonium-239/240	0.318	pCi/L	U		1.16	0.731	0.732	HASL 300, Pu-11-RC M	GEL	/ X /
Technetium-99	-4.06	pCi/L	U		20.8	12	12	HASL 300, Tc-02-RC M	GEL	/ X /
Thorium-230	0.856	pCi/L	U		1.54	1.01	1.02	HASL 300, Th-01-RC M	GEL	/ X /
Uranium-234	-0.148	pCi/L	U		2.34	0.988	0.989	HASL 300, U-02-RC M	GEL	/ X /
Uranium-235	0.585	pCi/L	U		1.59	1.15	1.15	HASL 300, U-02-RC M	GEL	/ X /
Uranium-238	0.204	pCi/L	U		1.29	0.766	0.768	HASL 300, U-02-RC M	GEL	/ X /
VOA										
Trichloroethene	1	ug/L	U		1			SW846-8260B	GEL	/ X /
WETCHEM										
Ammonia as Nitrogen	0.05	mg/L	U		0.05			EPA-350.1	GEL	/ X /

TB404L1-21 from: QC on 2/22/2021 Media: WQ SmpMethod:

Comments:

Analysis	Results	Units	Result Qual	Foot Note	Reporting Limit	Counting Error	TPU**	Method	LabCode	V/V/A*
VOA										
Trichloroethene	1	ug/L	U		1			SW846-8260B	GEL	/ X /

*Verification/Validation/Assessment ** TPUs reported at 1.96 sigma

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