PAD-ENM-0084/V1

C-404 Hazardous Waste Landfill May 2013 Semiannual Groundwater Report (October 2012–March 2013), Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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C-404 Hazardous Waste Landfill May 2013 Semiannual Groundwater Report, (October 2012–March 2013) Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Prepared by
LATA ENVIRONMENTAL SERVICES OF KENTUCKY, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
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ACRONYMS

AKGWA	Assembled Kentucky Groundwater Database
ANOVA	Analysis of Variance
KDWM	Kentucky Division of Waste Management
LOD	level of detection
MCL	maximum contaminant level
MW	monitoring well
PGDP	Paducah Gaseous Diffusion Plant
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
UCRS	Upper Continental Recharge System
URGA	Upper Regional Gravel Aquifer

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EXECUTIVE SUMMARY

This report, *C-404 Hazardous Waste Landfill May 2013 Semiannual Groundwater Report (October 2012— March 2013), Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* PAD-ENM-0084/V1, is being submitted by the U.S. Department of Energy (DOE) in accordance with requirements in the Kentucky Division of Waste Management Hazardous Waste Facility Permit, KY8-890-008-982. The reporting period covers October 2012 through March 2013 and includes analytical data from the January 2013 sampling of monitoring wells (MWs) located in the vicinity of the closed C-404 Hazardous Waste Landfill (C-404 Landfill). This unit was closed as a landfill in May 1986.

The groundwater monitoring results were subjected to statistical analyses to fulfill the requirements of the Hazardous Waste Facility Permit. Only the nonparametric analysis of variance test (Statistical Test 3 of the permit-required statistics) for dissolved arsenic indicated that concentrations in the downgradient compliance wells (compliance wells) were different from concentrations in the upgradient background wells (background wells). Otherwise, the statistical analyses indicated that concentrations in the compliance wells were not different from the concentrations in background wells to the required statistical level for the sampling period including events conducted in July 2010, January 2011, July 2011, January 2012, July 2012, and January 2013.

The indication of above-background dissolved arsenic concentration in compliance well MW84 using Statistical Test 3 is not considered evidence of contamination from the C-404 Landfill for these reasons:

- The dissolved arsenic concentration in westernmost downgradient well MW84 is comparable to the dissolved arsenic concentration in westernmost upgradient well MW93; this condition is similar to the pattern of trichloroethene (TCE) concentrations seen in these same wells and attributed to a source upgradient of C-404 in the Alternate Source Demonstration (PRS 2007).

- The dissolved arsenic concentration in downgradient wells MW84 and MW87 is lower for this reporting period than the average concentration levels measured during the previous three semiannual events.

- The maximum concentration of dissolved arsenic is relatively low (less than the drinking water standard maximum contaminant level for arsenic).

- There is no significant difference in arsenic (total) concentrations between background well MW93 and compliance well MW84.

- No arsenic was detected in the C-404 leachate.

- This is the first reporting period where there was statistically significant evidence that dissolved arsenic is higher in compliance well MW84 than in background wells. This also is the first reporting period where dissolved arsenic was evaluated using Statistical Test 3[1] because, in earlier events, 50% or more of the data were censored (i.e., dissolved arsenic was not detected in more than 50% of the samples). Thus, in parallel with the permit requirements, Statistical Test 3 was not performed previously.

For this monitored period, there was no statistically significant difference in TCE concentrations between compliance wells and background wells; however, there have been historical issues with TCE

[1] Recent analyses yielded lower reporting limits, which led to fewer censored data and the required use of Statistical Test 3.

concentrations at a statistically-significant level. The results of the *C-404 Landfill Source Demonstration, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (alternate source demonstration), conducted in 2007, indicate that persistent observations of TCE in downgradient compliance MWs are not the result of the C-404 Landfill and are the result of TCE source(s) located upgradient of the C-404 Landfill. The analytical results and the results of the statistical analysis performed over this period support the conclusions of the alternate source demonstration.

1. INTRODUCTION

This report contains the statistical evaluation of data from groundwater sampling and analysis for the C-404 Hazardous Waste Landfill (C-404 Landfill) at the Paducah Gaseous Diffusion Plant (PGDP), Paducah, Kentucky. This semiannual report is required by the Kentucky Division of Waste Management (KDWM) Hazardous Waste Facility Permit, KY8-890-008-982 (the permit), GSTR2 Part II, Condition T-47—Detection Monitoring Program–Recordkeeping, Reporting, and Response. The period covered by this report is October 2012 through March 2013.

Groundwater analytical results are provided in Appendix A. The statistical analyses and qualification statement are provided in Appendix B. Landfill leachate information and analytical data are provided in Appendix C. The groundwater flow direction determination is provided in Appendix D.

1.1 BACKGROUND

The C-404 Landfill is located in the west-central portion of the PGDP 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 solid uranium-contaminated wastes. 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 and treated as needed at the C-752 Waste Treatment and Storage Facility.

A partial clay cap was installed on the eastern end of the landfill in 1982. In 1986, the disposal of waste in the C-404 Landfill was halted and the landfill was covered with a Resource Conservation and Recovery Act (RCRA)-equivalent multilayered cap. This unit was closed as a landfill in May 1986. A RCRA postclosure permit was issued in 1992. This permit requires the semiannual monitoring of constituents in background and compliance wells in the vicinity of the C-404 Landfill.

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*, documented that the source of the differences from background concentrations in compliance wells is not from the C-404 Landfill, but rather, the source is located upgradient/cross-gradient of the C-404 Landfill.

1.2 MONITORING PERIOD ACTIVITIES

1.2.1 Groundwater Monitoring

Groundwater sampling was conducted in January 2013 using LATA Environmental Services of Kentucky, LLC, procedure PAD-ENM-2101, *Groundwater Sampling*. Appropriate sample containers and preservatives were used. The laboratories that performed analyses used U.S. Environmental Protection Agency (EPA)-approved methods, as applicable. There are nine monitoring wells (MWs) sampled under this permit for the C-404 Landfill: four Upper Continental Recharge System (UCRS) wells and five Upper Regional Gravel Aquifer (URGA) wells. Table 1 presents the well numbers for URGA wells located upgradient and downgradient of the C-404 Landfill. Table 1 also presents the well numbers for

Table 1. Monitoring Well Locations

UCRS	
Located south of C-404, adjacent to upgradient RGA background well MW93	MW94
Located north of C-404, adjacent to downgradient RGA compliance wells	MW85, MW88, MW91
URGA	
Upgradient background wells	MW93, MW420
Downgradient compliance wells	MW84, MW87, MW90A*

* MW90 was abandoned in 2001 and replaced with MW90A.

the UCRS wells located in proximity to the URGA wells. This table refers to these UCRS wells as being adjacent to an "upgradient" or "downgradient" URGA well location, identified relative to the URGA groundwater flow direction (see Figure 1).

The conceptual model for the site demonstrates that groundwater in the UCRS wells flows vertically until it reaches the URGA; therefore, UCRS wells are not considered "upgradient" or "downgradient" of other wells in the area.

Table 2 presents the Assembled Kentucky Groundwater Database (AKGWA) numbers for each MW. A map of the MW locations is provided in Figure 1. All of the MWs listed in Tables 1 and 2 were sampled during this reporting period, and the samples were analyzed for the required parameters.

Appendix A of this report contains the analytical results from the nine wells that were sampled during the January 2013 semiannual event. The parameters specified in Hazardous Waste Facility Permit, Attachment E, Groundwater Monitoring, were analyzed for all locations sampled. Appendix B of this report contains the statistical analyses.

Table 2. Assembled Kentucky Groundwater Database Numbers

PGDP Well Number	AKGWA Number
MW84	8000-5233
MW85	8000-5234
MW87	8000-5236
MW88	8000-5237
MW90A	8004-0357
MW91	8000-5240
MW93	8000-5102
MW94	8000-5103
MW420	8005-3263

Per Permit Condition GSTR2, T-37, the groundwater flow rate and direction is evaluated annually and reported in the November report. For this report, a potentiometric map has been included using data from sampling performed in January as supplemental information, which is provided in Appendix D. Depth-to-water was measured on January 3, 2013, from several wells at the perimeter of the C-404 Landfill (see Table D.1). Water level measurements in 11 vicinity well locations define the potentiometric surface for the URGA. Groundwater flow direction beneath the C-404 Landfill generally trends northward, but commonly varies from northeast to northwest (see Figure 1).

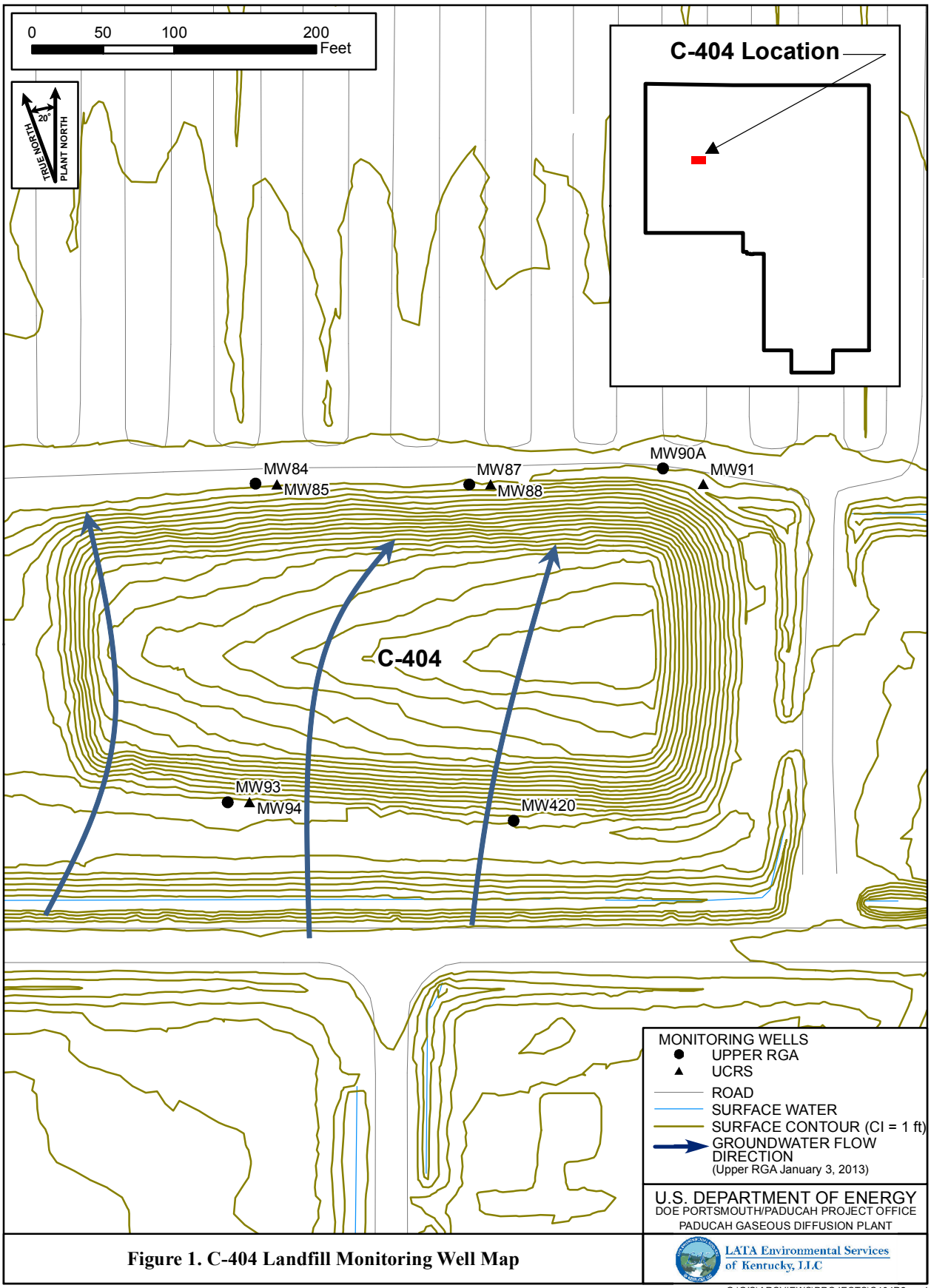

Figure 1. C-404 Landfill Monitoring Well Map

1.2.2 Landfill Leachate

The C-404 General Inspection Records and the Quarterly Landfill Inspection Results are included in Appendix C. In accordance with the Hazardous Waste Facility 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 three ft in depth." The monthly leachate depths in the C-404 sump recorded for this reporting period are included in Appendix C.

The volume of leachate removed from the sump during this reporting period was 1,050 gal. Analytical results from leachate sampling conducted for this removal event (February 2013) are included in Appendix C.

TCE was not detected in the leachate during this reporting period; thus, the C-404 Landfill leachate is not an apparent source of statistically quantifiable levels of TCE in URGA wells. Arsenic was not detected in the leachate during this reporting period; thus, the C-404 Landfill leachate is not an apparent source of statistically quantifiable levels of arsenic in URGA wells. Tc-99 was detected in leachate. As noted above, downgradient URGA wells do not have Tc-99 present above the minimum detectable activity; thus, the C-404 Landfill is not an apparent source of statistically quantifiable levels of Tc-99 in the URGA wells.

2. STATISTICAL SYNOPSIS

The statistical analyses conducted on the data collected from C-404 Landfill were performed in accordance with procedures provided in Hazardous Waste Facility Permit, Attachment Part E, and previously approved by KDWM. Appendix B of this report contains the statistical analyses performed for this reporting period. Data utilized for statistical analyses included data from the URGA background wells, MW93 and MW420, and URGA compliance wells, MW84, MW87, and MW90A. For this report, the reporting period data set includes data from the most current sampling event, January 2013, and from July 2010, January 2011, July 2011, January 2012, and July 2012.

The statistical test, level of detection (LOD), was performed for seven of the thirteen parameters (cadmium, mercury, selenium, uranium, uranium-234, uranium-235, and uranium-238). LOD values are presented in Appendix B. Statistical test, Test of Proportions, was performed for four of the thirteen parameters (arsenic, chromium, lead, and Tc-99). Statistical test, Nonparametric Analysis of Variance (ANOVA), was performed for dissolved arsenic and TCE.

Only the nonparametric ANOVA test for dissolved arsenic (Appendix B) indicated that concentrations in the compliance wells were different from concentrations in the background wells. Statistical analysis in Appendix B indicated that no other concentrations in the compliance wells were different from the concentrations in background wells to the required statistical level for the sampling period including events conducted in July 2010, January 2011, July 2011, January 2012, July 2012, and January 2013.

The indication of above-background dissolved arsenic concentrations in compliance well MW84 using Statistical Test 3 is not considered evidence of contamination from the C-404 Landfill for these reasons:

- The dissolved arsenic concentration in westernmost downgradient well MW84 (0.00374 mg/L) is comparable to the dissolved arsenic concentration in westernmost upgradient well MW93 (0.004 mg/L); this condition is similar to the pattern of TCE concentrations seen in these same wells and attributed to a source upgradient of C-404 in the Alternate Source Demonstration (DOE 2007).

- The dissolved arsenic concentration in downgradient wells MW84 and MW87 is lower for this reporting period than the average concentration levels measured during the previous three semiannual events.

- The maximum concentration of dissolved arsenic in MW84 (0.00374 mg/L) is relatively low [less than the drinking water standard maximum contaminant level (MCL) for arsenic (0.010 mg/L), shown in Figure 2].

- There is no significant difference in arsenic (total) concentrations between background well MW93 (0.00652 mg/L) and compliance well MW84 (0.00572 mg/L).

- No arsenic was detected in the C-404 leachate.

- This is the first reporting period where there was statistically significant evidence that dissolved arsenic is higher in compliance well MW84 than in background wells. Note: This also is the first reporting period where dissolved arsenic was evaluated using Statistical Test 3 because, in earlier events, 50% or more of the data were censored (i.e., dissolved arsenic was not detected in more than 50% of the samples). Thus, in parallel with the permit requirements, Statistical Test 3 was not performed previously.

The reporting limits for dissolved arsenic in the July 2010 analysis were higher than those typically achieved. The July 2010 sample was diluted to address sample interferences in accordance with analytical protocols. Thus, the lower reporting limits in the more recent analyses resulted in fewer censored data. The January 2013 event was the first time that more than 50% of the dissolved arsenic data were not censored.

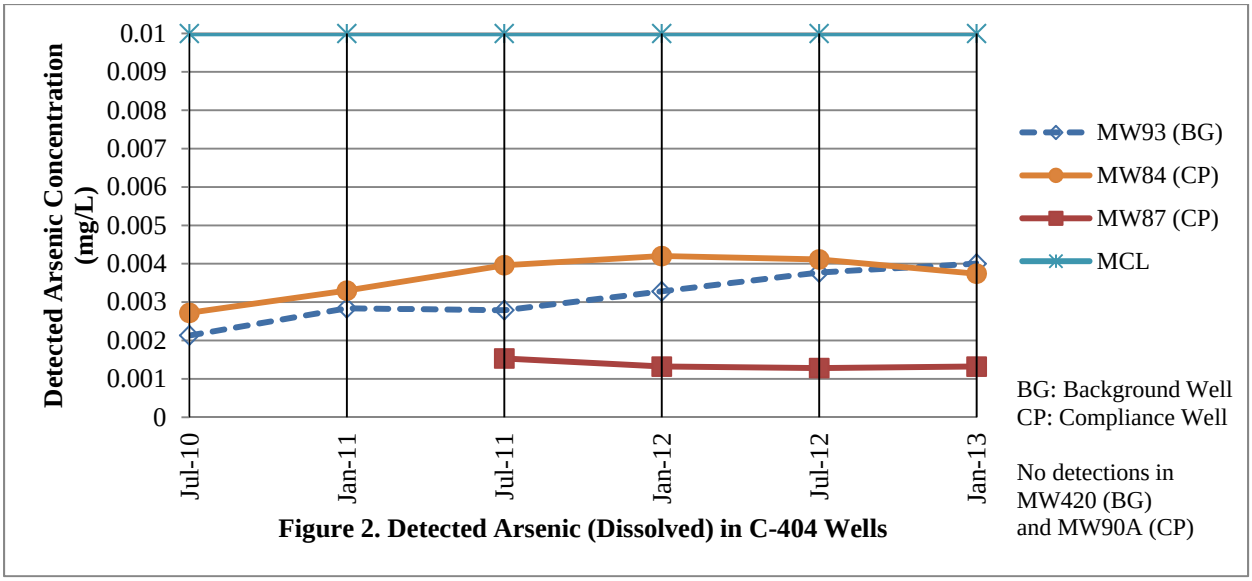

Figure 2. Detected Arsenic (Dissolved) in C-404 Wells

TCE concentrations in background well MW93 continue to increase. Background well MW420 has detectable TCE concentrations, as seen in the past. Similarly, TCE concentrations in compliance wells MW84, MW87, and MW90A are stable to increasing. TCE concentrations in UCRS wells MW85, MW88, and MW91 continue to increase; however, these wells have concentrations that are well below those found in URGA wells located adjacent to them.

By contrast, URGA well MW420 (background) is the only URGA well with technetium-99 (Tc-99) levels above the minimum detectable activity. The absence of Tc-99 in downgradient RGA wells demonstrates that the C-404 Landfill is not a source of statistically quantifiable levels of Tc-99. Note: UCRS wells MW85, MW88, MW91, and MW94 have detectable levels of Tc-99; only MW91 has a Tc-99 level greater than 900 pCi/L, which is derived from the EPA MCL of 4 mrem/yr.

3. DATA VALIDATION AND QA/QC SUMMARY

The data and the data validation qualifiers for the January 2013 data set are provided in Appendix A. All data for this data set were considered useable as reported.

Data validation was performed on the organic, inorganic, and radiochemical analytical data by an independent, third-party validator. Examples of data validation qualifiers, which may be placed on the data during data validation, are "U," "UJ," "J," "=," and "X."

- "U" means that the compound was analyzed for, but was not detected.
- "UJ" means the compound was analyzed for, but was not detected, and the sample quantitation limit is an estimated quantity.
- "J" means the associated numerical value is an estimated quantity.
- "=" means the result was detected and validated, but not qualified.
- "X" means validation was not required or performed for the result.

Field quality control samples are collected semiannually during each sampling event. Equipment rinseate blanks, field blanks, and trip blanks are obtained to ensure quality control and are reported in the Analytical Results in Appendix A. No contamination was detected in these samples. Laboratory quality control samples such as matrix spikes, matrix spike duplicates, and method blanks are performed by the laboratory and reported in the lab report. Both field and laboratory quality control sample results are reviewed as part of the data validation process.

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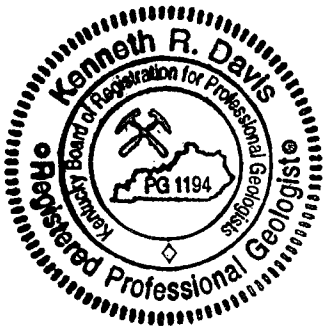
4. PROFESSIONAL GEOLOGIST AUTHORIZATION

DOCUMENT IDENTIFICATION: *C-404 Hazardous Waste Landfill*
May 2013 Semiannual Groundwater Report
(October 2012–March 2013),
Paducah Gaseous Diffusion Plant, Paducah, Kentucky
(PAD-ENM-0084/V1)

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



Kenneth R. Davis — Kenneth R. Davis

PG1194

May 29, 2013
Date

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5. REFERENCES

EPA (U.S. Environmental Protection Agency) 1989. *EPA Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Interim Final Guidance, office of Resource Conservation and recovery, U.S. Environmental Protection Agency, Washington, DC.

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

EPA 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities*, Unified Guidance Document (UGD), EPA/530/R-09/007, U.S. Environmental Protection Agency, Washington, DC.

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APPENDIX A

C-404 HAZARDOUS WASTE LANDFILL ANALYTICAL RESULTS

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Paducah OREIS
GROUNDWATER MONITORING REPORT

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

Sampling Point: MW84 REG Downgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5233

Parameter	Qualifier	Result	Units	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0057	mg/L	1/24/2013			SW846-6020	=
Arsenic, Dissolved		0.0037	mg/L	1/24/2013			SW846-6020	=
Barometric Pressure Reading		30.3	Inches/Hg	1/24/2013				X
Cadmium	U	0.001	mg/L	1/24/2013			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/24/2013			SW846-6020	=
Chromium	X	0.0604	mg/L	1/24/2013			SW846-6020	J
Chromium, Dissolved	UB	0.01	mg/L	1/24/2013			SW846-6020	=
Conductivity		339	umho/cm	1/24/2013				X
Depth to Water		55.39	ft	1/24/2013				X
Dissolved Oxygen		2.24	mg/L	1/24/2013				X
Lead		0.0016	mg/L	1/24/2013			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/24/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/24/2013			SW846-7470A	=
Mercury, Dissolved	UB	0.0002	mg/L	1/24/2013			SW846-7470A	=
pH		5.98	Std Unit	1/24/2013				X
Redox		574	mV	1/24/2013				X
Selenium	U	0.005	mg/L	1/24/2013			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/24/2013			SW846-6020	=
Technetium-99	U	13.4	pCi/L	1/24/2013	10	10	RL-7100	=
Temperature		55	deg F	1/24/2013				X
Trichloroethene	D	1100	ug/L	1/24/2013			SW846-8260B	=
Turbidity		59	NTU	1/24/2013				X
Uranium	U	0.001	mg/L	1/24/2013			SW846-6020	UJ
Uranium-234	U	-0.175	pCi/L	1/24/2013	0.00178	0.964	RL-7128	=
Uranium-235	U	-0.014	pCi/L	1/24/2013	0.0154	0.0822	RL-7128	=
Uranium-238	U	-0.022	pCi/L	1/24/2013	0.0484	0.0484	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0135	mg/L	1/28/2013			SW846-6020	=
Arsenic, Dissolved		0.0135	mg/L	1/28/2013			SW846-6020	=
Barometric Pressure Reading		30.1	Inches/Hg	1/28/2013				X
Cadmium	U	0.001	mg/L	1/28/2013			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/28/2013			SW846-6020	=
Chromium	UX	0.01	mg/L	1/28/2013			SW846-6020	UJ
Chromium, Dissolved	UB	0.01	mg/L	1/28/2013			SW846-6020	=
Conductivity		329	umho/cm	1/28/2013				X
Depth to Water		14.09	ft	1/28/2013				X
Dissolved Oxygen		3.18	mg/L	1/28/2013				X
Lead	U	0.0013	mg/L	1/28/2013			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/28/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/28/2013			SW846-7470A	=
Mercury, Dissolved	UB	0.0002	mg/L	1/28/2013			SW846-7470A	=
pH		6.28	Std Unit	1/28/2013				X
Redox		849	mV	1/28/2013				X
Selenium	U	0.005	mg/L	1/28/2013			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/28/2013			SW846-6020	=
Technetium-99		123	pCi/L	1/28/2013	13.5	13.8	RL-7100	=
Temperature		61.4	deg F	1/28/2013				X
Trichloroethene		1.2	ug/L	1/28/2013			SW846-8260B	=
Turbidity		18.5	NTU	1/28/2013				X
Uranium	U	0.001	mg/L	1/28/2013			SW846-6020	UJ
Uranium-234	U	0.0232	pCi/L	1/28/2013	0.0885	0.968	RL-7128	=
Uranium-235	U	-0.005	pCi/L	1/28/2013	0.0239	0.0842	RL-7128	=
Uranium-238	U	0.202	pCi/L	1/28/2013	0.0874	0.175	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

Paducah OREIS
GROUNDWATER MONITORING REPORT

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

Sampling Point: MW87 REG Downgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5236

Parameter	Qualifier	Result	Units	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0018	mg/L	1/22/2013			SW846-6020	=
Arsenic, Dissolved		0.0013	mg/L	1/22/2013			SW846-6020	=
Barometric Pressure Reading		30.41	Inches/Hg	1/22/2013				X
Cadmium		0.0011	mg/L	1/22/2013			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/22/2013			SW846-6020	=
Chromium	X	0.177	mg/L	1/22/2013			SW846-6020	J
Chromium, Dissolved	UB	0.01	mg/L	1/22/2013			SW846-6020	=
Conductivity		283	umho/cm	1/22/2013				X
Depth to Water		55.26	ft	1/22/2013				X
Dissolved Oxygen		3.38	mg/L	1/22/2013				X
Lead		0.0117	mg/L	1/22/2013			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/22/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
pH		6.2	Std Unit	1/22/2013				X
Redox		665	mV	1/22/2013				X
Selenium	U	0.005	mg/L	1/22/2013			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/22/2013			SW846-6020	=
Technetium-99	U	3.66	pCi/L	1/22/2013	9.68	9.68	RL-7100	=
Temperature		57.2	deg F	1/22/2013				X
Trichloroethene	D	470	ug/L	1/22/2013			SW846-8260B	=
Turbidity		34.1	NTU	1/22/2013				X
Uranium	U	0.001	mg/L	1/22/2013			SW846-6020	UJ
Uranium-234	U	-0.147	pCi/L	1/22/2013	0.0574	0.965	RL-7128	=
Uranium-235	U	0.0093	pCi/L	1/22/2013	0.031	0.0866	RL-7128	=
Uranium-238	U	0.0054	pCi/L	1/22/2013	0.0423	0.0423	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0051	mg/L	1/23/2013			SW846-6020	=
Arsenic, Dissolved		0.0036	mg/L	1/23/2013			SW846-6020	=
Barometric Pressure Reading		30.33	Inches/Hg	1/23/2013				X
Cadmium	U	0.001	mg/L	1/23/2013			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/23/2013			SW846-6020	=
Chromium	X	0.0176	mg/L	1/23/2013			SW846-6020	J
Chromium, Dissolved	UB	0.01	mg/L	1/23/2013			SW846-6020	=
Conductivity		573	umho/cm	1/23/2013				X
Depth to Water		13.49	ft	1/23/2013				X
Dissolved Oxygen		1.65	mg/L	1/23/2013				X
Lead		0.0028	mg/L	1/23/2013			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/23/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/23/2013			SW846-7470A	=
Mercury, Dissolved	UB	0.0002	mg/L	1/23/2013			SW846-7470A	=
pH		5.96	Std Unit	1/23/2013				X
Redox		796	mV	1/23/2013				X
Selenium	U	0.005	mg/L	1/23/2013			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/23/2013			SW846-6020	=
Technetium-99		27.1	pCi/L	1/23/2013	10.5	10.5	RL-7100	=
Temperature		57.7	deg F	1/23/2013				X
Trichloroethene		26	ug/L	1/23/2013			SW846-8260B	=
Turbidity		143	NTU	1/23/2013				X
Uranium	U	0.001	mg/L	1/23/2013			SW846-6020	UJ
Uranium-234	U	-0.051	pCi/L	1/23/2013	0.0656	0.966	RL-7128	=
Uranium-235	U	-0.043	pCi/L	1/23/2013	0.0249	0.0846	RL-7128	=
Uranium-238	U	0.0697	pCi/L	1/23/2013	0.0587	0.121	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	U	0.001	mg/L	1/23/2013			SW846-6020	=
Arsenic, Dissolved	U	0.001	mg/L	1/23/2013			SW846-6020	=
Barometric Pressure Reading		30.33	Inches/Hg	1/23/2013				X
Cadmium	U	0.001	mg/L	1/23/2013			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/23/2013			SW846-6020	=
Chromium	UX	0.01	mg/L	1/23/2013			SW846-6020	UJ
Chromium, Dissolved	UB	0.01	mg/L	1/23/2013			SW846-6020	=
Conductivity		202	umho/cm	1/23/2013				X
Depth to Water		53.51	ft	1/23/2013				X
Dissolved Oxygen		4.54	mg/L	1/23/2013				X
Lead	U	0.0013	mg/L	1/23/2013			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/23/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/23/2013			SW846-7470A	=
Mercury, Dissolved	UB	0.0002	mg/L	1/23/2013			SW846-7470A	=
pH		6.06	Std Unit	1/23/2013				X
Redox		684	mV	1/23/2013				X
Selenium	U	0.005	mg/L	1/23/2013			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/23/2013			SW846-6020	=
Technetium-99	U	6.15	pCi/L	1/23/2013	9.73	9.73	RL-7100	=
Temperature		53	deg F	1/23/2013				X
Trichloroethene		17	ug/L	1/23/2013			SW846-8260B	=
Turbidity		8.6	NTU	1/23/2013				X
Uranium	U	0.001	mg/L	1/23/2013			SW846-6020	UJ
Uranium-234	U	-0.166	pCi/L	1/23/2013	0.0197	0.965	RL-7128	=
Uranium-235	U	-0.022	pCi/L	1/23/2013	0	0.114	RL-7128	=
Uranium-238	U	-0.038	pCi/L	1/23/2013	0.0177	0.0752	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

Paducah OREIS
GROUNDWATER MONITORING REPORT

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

Sampling Point: MW91 REG Downgradient UCRS **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5240

Parameter	Qualifier	Result	Units	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0044	mg/L	1/28/2013			SW846-6020	=
Arsenic, Dissolved		0.0023	mg/L	1/28/2013			SW846-6020	=
Barometric Pressure Reading		30.1	Inches/Hg	1/28/2013				X
Cadmium	U	0.001	mg/L	1/28/2013			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/28/2013			SW846-6020	=
Chromium	X	0.709	mg/L	1/28/2013			SW846-6020	J
Chromium, Dissolved	B	0.0162	mg/L	1/28/2013			SW846-6020	=
Conductivity		521	umho/cm	1/28/2013				X
Depth to Water		13.19	ft	1/28/2013				X
Dissolved Oxygen		3.65	mg/L	1/28/2013				X
Lead		0.0037	mg/L	1/28/2013			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/28/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/28/2013			SW846-7470A	=
Mercury, Dissolved	UB	0.0002	mg/L	1/28/2013			SW846-7470A	=
pH		5.63	Std Unit	1/28/2013				X
Redox		582	mV	1/28/2013				X
Selenium		0.0101	mg/L	1/28/2013			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/28/2013			SW846-6020	=
Technetium-99		2200	pCi/L	1/28/2013	41.5	68.5	RL-7100	=
Temperature		61.5	deg F	1/28/2013				X
Trichloroethene		68	ug/L	1/28/2013			SW846-8260B	=
Turbidity		462	NTU	1/28/2013				X
Uranium	U	0.001	mg/L	1/28/2013			SW846-6020	UJ
Uranium-234	U	0.148	pCi/L	1/28/2013	0.0954	0.969	RL-7128	=
Uranium-235	U	-0.022	pCi/L	1/28/2013	0	0.114	RL-7128	=
Uranium-238	U	0.165	pCi/L	1/28/2013	0.0734	0.163	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

Paducah OREIS
GROUNDWATER MONITORING REPORT

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

Sampling Point: MW93 REG Upgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5102

Parameter	Qualifier	Result	Units	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0065	mg/L	1/22/2013			SW846-6020	=
Arsenic, Dissolved		0.004	mg/L	1/22/2013			SW846-6020	=
Barometric Pressure Reading		30.41	Inches/Hg	1/22/2013				X
Cadmium	U	0.001	mg/L	1/22/2013			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/22/2013			SW846-6020	=
Chromium	X	0.224	mg/L	1/22/2013			SW846-6020	J
Chromium, Dissolved	UB	0.01	mg/L	1/22/2013			SW846-6020	=
Conductivity		434	umho/cm	1/22/2013				X
Depth to Water		46.73	ft	1/22/2013				X
Dissolved Oxygen		1.74	mg/L	1/22/2013				X
Lead		0.0026	mg/L	1/22/2013			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/22/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
Mercury, Dissolved	UB	0.0002	mg/L	1/22/2013			SW846-7470A	=
pH		6.74	Std Unit	1/22/2013				X
Redox		482	mV	1/22/2013				X
Selenium	U	0.005	mg/L	1/22/2013			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/22/2013			SW846-6020	=
Technetium-99	U	-1.17	pCi/L	1/22/2013	9.38	9.38	RL-7100	=
Temperature		51.2	deg F	1/22/2013				X
Trichloroethene	D	1900	ug/L	1/22/2013			SW846-8260B	=
Turbidity		110	NTU	1/22/2013				X
Uranium	U	0.001	mg/L	1/22/2013			SW846-6020	UJ
Uranium-234	U	-0.11	pCi/L	1/22/2013	0.0514	0.965	RL-7128	=
Uranium-235	U	-0.014	pCi/L	1/22/2013	0.0154	0.0822	RL-7128	=
Uranium-238	U	0.0362	pCi/L	1/22/2013	0.0505	0.0872	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0019	mg/L	1/22/2013			SW846-6020	=
Arsenic, Dissolved	U	0.001	mg/L	1/22/2013			SW846-6020	=
Barometric Pressure Reading		30.41	Inches/Hg	1/22/2013				X
Cadmium	U	0.001	mg/L	1/22/2013			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/22/2013			SW846-6020	=
Chromium	X	0.0316	mg/L	1/22/2013			SW846-6020	J
Chromium, Dissolved	UB	0.01	mg/L	1/22/2013			SW846-6020	=
Conductivity		900	umho/cm	1/22/2013				X
Depth to Water		17.23	ft	1/22/2013				X
Dissolved Oxygen		1.44	mg/L	1/22/2013				X
Lead		0.0027	mg/L	1/22/2013			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/22/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
pH		6.8	Std Unit	1/22/2013				X
Redox		572	mV	1/22/2013				X
Selenium	U	0.005	mg/L	1/22/2013			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/22/2013			SW846-6020	=
Technetium-99		700	pCi/L	1/22/2013	24.7	30.2	RL-7100	=
Temperature		54.3	deg F	1/22/2013				X
Trichloroethene		2.7	ug/L	1/22/2013			SW846-8260B	=
Turbidity		118	NTU	1/22/2013				X
Uranium		0.0031	mg/L	1/22/2013			SW846-6020	J
Uranium-234	U	0.877	pCi/L	1/22/2013	0.17	0.994	RL-7128	=
Uranium-235	U	0.0038	pCi/L	1/22/2013	0.0395	0.09	RL-7128	=
Uranium-238		1.01	pCi/L	1/22/2013	0.164	0.294	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	U	0.001	mg/L	1/22/2013			SW846-6020	=
Arsenic, Dissolved	U	0.001	mg/L	1/22/2013			SW846-6020	=
Barometric Pressure Reading		30.41	Inches/Hg	1/22/2013				X
Cadmium	U	0.001	mg/L	1/22/2013			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/22/2013			SW846-6020	=
Chromium	UX	0.01	mg/L	1/22/2013			SW846-6020	UJ
Chromium, Dissolved	UB	0.01	mg/L	1/22/2013			SW846-6020	=
Conductivity		285	umho/cm	1/22/2013				X
Depth to Water		56.77	ft	1/22/2013				X
Dissolved Oxygen		2.87	mg/L	1/22/2013				X
Lead	U	0.0013	mg/L	1/22/2013			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/22/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
pH		6.81	Std Unit	1/22/2013				X
Redox		785	mV	1/22/2013				X
Selenium	U	0.005	mg/L	1/22/2013			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/22/2013			SW846-6020	=
Technetium-99		49.1	pCi/L	1/22/2013	11.3	11.3	RL-7100	=
Temperature		54	deg F	1/22/2013				X
Trichloroethene	D	190	ug/L	1/22/2013			SW846-8260B	=
Turbidity		0	NTU	1/22/2013				X
Uranium	U	0.001	mg/L	1/22/2013			SW846-6020	UJ
Uranium-234	U	-0.11	pCi/L	1/22/2013	0.0535	0.965	RL-7128	=
Uranium-235	U	-0.026	pCi/L	1/22/2013	0.00873	0.0866	RL-7128	=
Uranium-238	U	-0.032	pCi/L	1/22/2013	0.0282	0.0646	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

Paducah OREIS
GROUNDWATER MONITORING REPORT

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

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

AKGWA Well Tag #: 8005-3263

Parameter	Qualifier	Result	Units	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	U	0.001	mg/L	1/22/2013			SW846-6020	=
Arsenic, Dissolved	U	0.001	mg/L	1/22/2013			SW846-6020	=
Barometric Pressure Reading		30.41	Inches/Hg	1/22/2013				X
Cadmium	U	0.001	mg/L	1/22/2013			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/22/2013			SW846-6020	=
Chromium	UX	0.01	mg/L	1/22/2013			SW846-6020	UJ
Chromium, Dissolved	UB	0.01	mg/L	1/22/2013			SW846-6020	=
Conductivity		285	umho/cm	1/22/2013				X
Depth to Water		56.77	ft	1/22/2013				X
Dissolved Oxygen		2.87	mg/L	1/22/2013				X
Lead	U	0.0013	mg/L	1/22/2013			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/22/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
pH		6.81	Std Unit	1/22/2013				X
Redox		785	mV	1/22/2013				X
Selenium	U	0.005	mg/L	1/22/2013			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/22/2013			SW846-6020	=
Technetium-99		46.3	pCi/L	1/22/2013	11.2	11.2	RL-7100	=
Temperature		54	deg F	1/22/2013				X
Trichloroethene	D	190	ug/L	1/22/2013			SW846-8260B	=
Turbidity		0	NTU	1/22/2013				X
Uranium	U	0.001	mg/L	1/22/2013			SW846-6020	UJ
Uranium-234	U	-0.149	pCi/L	1/22/2013	0.0404	0.964	RL-7128	=
Uranium-235	U	-0.022	pCi/L	1/22/2013	0	0.114	RL-7128	=
Uranium-238	U	-0.050	pCi/L	1/22/2013	0.00806	0.101	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	U	0.001	mg/L	1/22/2013			SW846-6020	=
Cadmium	U	0.001	mg/L	1/22/2013			SW846-6020	=
Chromium	UX	0.01	mg/L	1/22/2013			SW846-6020	UJ
Lead	U	0.0013	mg/L	1/22/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
Selenium	U	0.005	mg/L	1/22/2013			SW846-6020	=
Technetium-99	U	9.7	pCi/L	1/22/2013	9.86	9.86	RL-7100	=
Trichloroethene	U	1	ug/L	1/22/2013			SW846-8260B	=
Uranium	U	0.001	mg/L	1/22/2013			SW846-6020	UJ
Uranium-234	U	-0.168	pCi/L	1/22/2013	0.0165	0.964	RL-7128	=
Uranium-235	U	-0.027	pCi/L	1/22/2013	0.0102	0.0838	RL-7128	=
Uranium-238	U	-0.028	pCi/L	1/22/2013	0.0293	0.055	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	U	0.001	mg/L	1/22/2013			SW846-6020	=
Cadmium	U	0.001	mg/L	1/22/2013			SW846-6020	=
Chromium	UX	0.01	mg/L	1/22/2013			SW846-6020	UJ
Lead	U	0.0013	mg/L	1/22/2013			SW846-6020	=
Mercury	U	0.0002	mg/L	1/22/2013			SW846-7470A	=
Selenium	U	0.005	mg/L	1/22/2013			SW846-6020	=
Technetium-99	U	11.1	pCi/L	1/22/2013	9.92	9.92	RL-7100	=
Trichloroethene	U	1	ug/L	1/22/2013			SW846-8260B	=
Uranium	U	0.001	mg/L	1/22/2013			SW846-6020	UJ
Uranium-234	U	-0.164	pCi/L	1/22/2013	0.0243	0.964	RL-7128	=
Uranium-235	U	-0.034	pCi/L	1/22/2013	0.0254	0.0858	RL-7128	=
Uranium-238	U	-0.024	pCi/L	1/22/2013	0.0374	0.0481	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Trichloroethene	U	1	ug/L	1/22/2013			SW846-8260B	=
	U	1	ug/L	1/28/2013			SW846-8260B	=
	U	1	ug/L	1/24/2013			SW846-8260B	=
	U	1	ug/L	1/22/2013			SW846-8260B	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

MEDIA Codes

WG Groundwater

QUALIFIER Codes

B Applies when the analyte is found in the associated blank.
D Compounds identified in an analysis at a secondary dilution factor.
U Analyte analyzed for, but not detected at or below the lowest concentration reported.
X Other specific flags and footnotes may be required to properly define the results.

SAMPLE METHOD Codes

GR Grab

SAMPLING POINT Codes

UCRS Upper Continental Recharge System
URGA Upper Regional Gravel Aquifer

SAMPLE TYPE Codes

FB Field Blank
FR Field Replicate (Code used for Field Duplicate)
REG Regular
RI QC Equipment Rinseate/Decon
TB Trip Blank

VALIDATION Code

= Validated result, which is detected and unqualified.
J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
X Not validated.

APPENDIX B

C-404 HAZARDOUS WASTE LANDFILL STATISTICAL ANALYSES

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GROUNDWATER STATISTICAL SUMMARY

Introduction

The statistical analyses conducted on the data collected from C-404 Hazardous Waste Landfill (C-404 Landfill) were performed in accordance with procedures provided in Attachment VIII, Appendix C, of the C-404 Hazardous Waste Management Permit and previously approved by the Kentucky Division of Waste Management (KDWM). The percent of censored (nondetected) data points for individual parameters was calculated for the combined analytical data. The percent of censored data was used to select the types of statistical analyses to determine if compliance well concentrations differed from background well concentrations. For this report, the reporting period data set includes data from July 2010, January 2011, July 2011, January 2012, July 2012, and January 2013.

Statistical Analysis Process

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 non-parametric 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.

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.

For this report, the reporting period data set is from July 2010 through January 2013, which consists of six sets of data.

Table B.1. Monitoring Well Locations

UCRS	
Located South of C-404; adjacent to upgradient Regional Gravel Aquifer (RGA) background well MW93	MW94
Located north of C-404, adjacent to downgradient RGA compliance wells	MW85, MW88, MW91
URGA	
Upgradient background wells	MW93, MW420
Downgradient compliance wells	MW84, MW87, MW90A*

* MW90 was abandoned in 2001 and replaced with MW90A.

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	Uncensored Observations
URGA				
Arsenic	30	0	15	15
Arsenic, Dissolved	30	0	14	16
Cadmium	30	0	29	1
Cadmium, Dissolved	30	0	30	0
Chromium	30	0	20	10
Chromium, Dissolved	30	0	30	0
Lead	30	0	24	6
Lead, Dissolved	30	0	30	0
Mercury	30	0	30	0
Mercury, Dissolved	30	0	30	0
Selenium	30	0	27	3
Selenium, Dissolved	30	0	30	0
Technetium-99	30	0	21	9
Trichloroethene	30	0	0	30
Uranium (Metals)	30	0	30	0
Uranium, Dissolved	30	0	30	0
Uranium-234	30	0	30	0
Uranium-235	20	0	20	0
Uranium-238	30	0	30	0

Missing parameters that were dissolved metals were not analyzed when the parent total metals were not detected.

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 and uncensored data and type of statistical test chosen for each of the parameters.

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

Parameter	Total Samples (Nonmissing)	Detects	Nondetects	Percent Censored	Statistical Test Set
URGA					
Arsenic	30	15	15	50 %	2
Arsenic, Dissolved	30	16	14	47 %	3
Cadmium	30	1	29	97 %	1
Chromium	30	10	20	67 %	2
Lead	30	6	24	80 %	2
Mercury	30	0	30	100 %	1
Selenium	30	3	27	90 %	1
Technetium-99	30	9	21	70 %	2
Trichloroethene	30	30	0	0%	4 [a]
Uranium	30	0	30	100 %	1
Uranium-234	30	0	30	100 %	1
Uranium-235	20	0	20	100 %	1
Uranium-238	30	0	30	100 %	1

[a] Because variances were found to be unequal even for log-transformed concentrations, Statistical Test 4 was abandoned and Statistical Test 3 was used to compare compliance wells with background wells.

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 Test 1, LOD, are summarized in Table B.4. Table B.5 provides the summary of conclusions for the statistical analyses for the C-404 Landfill, the statistical test performed, including the attachment number, well type, parameter, and results of the statistical test. Results of Statistical Test 2, Statistical Test 3, and Statistical Test 4 are presented in Attachments 1 through 6.

In summary, Statistical Test 2, Test of Proportions, for arsenic, chromium, lead, and Tc-99 in the URGA indicated no statistical evidence of contamination. Statistical Test 3, Nonparametric ANOVA, for dissolved arsenic in the URGA, indicated concentrations were elevated relative to background in MW84; however no statistical evidence of elevated dissolved arsenic in the other two compliance wells (MW87 and MW90A) was found. Dissolved arsenic in background wells ranged from nondetect (DL = 0.001 mg/L) to 0.004 mg/L, whereas concentrations were the same order of magnitude and ranged from 0.00272 to 0.0042 mg/L in MW84 (see Figure B.1 for graph). Statistical Test 4, Parametric ANOVA, for TCE in the URGA indicated that there was no evidence of equality of variance and thus, Statistical Test 4 was abandoned and Statistical Test 3, Non-parametric ANOVA was performed. Statistical Test 3 showed there was no evidence of contamination of TCE in any compliance well.

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

Parameter	LOD Values	½ LOD Values
URGA		
Cadmium (mg/L)	0.001	0.0005
Mercury (mg/L)	0.0002	0.0001
Selenium (mg/L)	0.005	0.0025
Uranium (mg/L)	0.001	0.0005
Uranium-234 (pCi/L)	2.26	1.13
Uranium-235 (pCi/L)	0.214	0.107
Uranium-238 (pCi/L)	0.468	0.234

LOD = Limit of Detection
mg/L = milligrams per liter
pCi/L = picocuries per liter

Table B.5. Summary of Conclusions from the Statistical Analyses for the C-404 Hazardous Waste Landfill for the January 2013 Data Set

Attachment	RGA Well Type	Parameter	Applied Statistical Test	Results
1	URGA	Arsenic	Statistical Test 2, Test of Proportions	No statistically significant evidence of contamination in compliance wells.
2	URGA	Arsenic, Dissolved	Statistical Test 3, Nonparametric ANOVA	There is statistically significant evidence that dissolved arsenic is higher in MW84 when compared to background wells. There is no statistically significant evidence of contamination in other compliance wells (MW85 and MW90A). (See Figure B.1 for graph of detected arsenic concentrations in monitoring wells versus time).
3	URGA	Chromium	Statistical Test 2, Test of Proportions	No statistically significant evidence of contamination in compliance wells.
4	URGA	Lead	Statistical Test 2, Test of Proportions	No statistically significant evidence of contamination in compliance wells.
5	URGA	Technitium-99	Statistical Test 2 Test of Proportions	No statistically significant evidence of contamination in compliance wells.
6	URGA	Trichloroethene	Statistical Test 4 Parametric ANOVA	Because equality of variance could not be confirmed, Statistical Test 4 was abandoned and Statistical Test 3, Non-parametric ANOVA, was performed. No statistically significant evidence of contamination in compliance wells.

RGA = Regional Gravel Aquifer
URGA = Upper Regional Gravel Aquifer

The concentrations of dissolved arsenic in the URGA wells were graphed. As shown in Figure B.1, the dissolved arsenic concentration in MW84 was lower in the most recent monitoring when compared to the three previous semiannual events. None of the concentrations exceeded the U.S. Environmental Protection Agency drinking water standard maximum contaminant level MCL for arsenic (0.010 mg/L). The dissolved arsenic concentration in the upgradient well MW93 was comparable and exceeded the concentration in MW84 for the most recent event. As illustrated in Figure B.1, the detection limit for dissolved arsenic concentrations in C-44 monitoring wells was 0.001 mg/L, except for sampled collected in July 2010 (detection limit was 0.01 mg/L) from MW87 and MW90A.

As a result of this analysis, it does not appear that the C-404 Landfill is a source of dissolved arsenic contamination of the URGA.

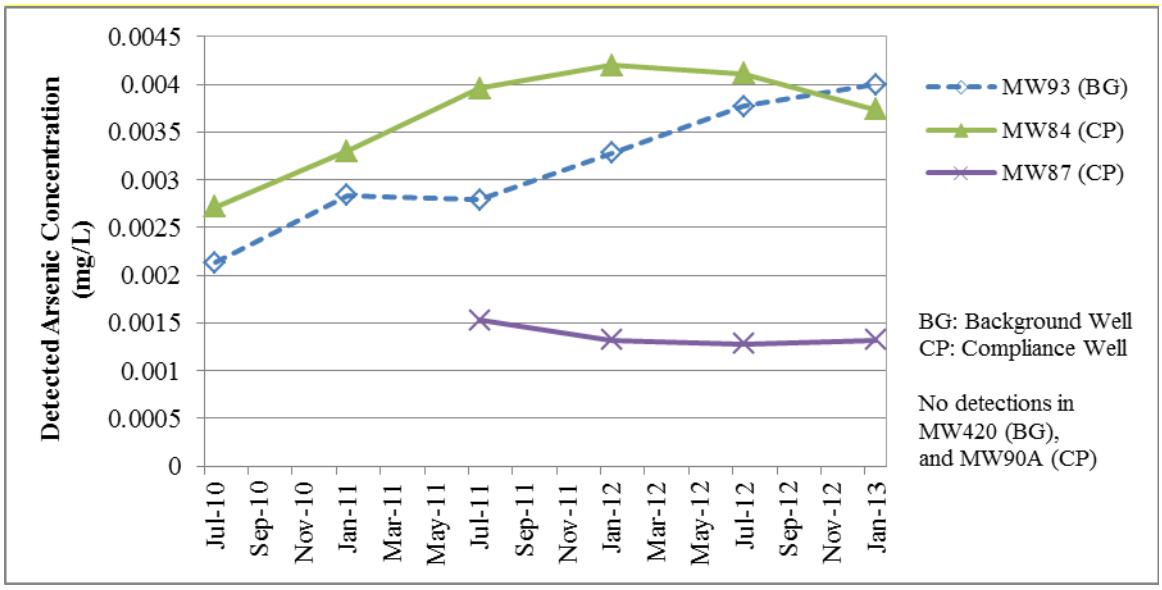

Figure B.1. Detected Dissolved Arsenic Concentrations in C-404 Monitoring Wells

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GEO Consultants, LLC

A Geological Engineering and Environmental Services Company

325 Kentucky Avenue • Kevil, KY 42053 • (270) 462-3882 • Fax (270) 462-3887

April 15, 2013
LKYBA1036-13-0008

Mr. Mark Legier
LATA Kentucky
175 Freedom Blvd,
Kevil, KY 42053

Subject: Statistical Analysis of Groundwater Data for C-404 Landfill

Dear Mr. Legier:

I am submitting this statement in response to your request that it be included with the completed statistical analysis I performed on the groundwater data for the C-404 Landfill at the Paducah Gaseous Diffusion Plant.

As a Senior Environmental Engineer, with a doctorate in Civil Engineering and Professional Engineer license with the State of Tennessee, I have twenty-one years of experience in the analysis and interpretation of environmental data.

For this project, the statistical analyses on groundwater data from July 2010 through January 2013 were performed in accordance with the C-404 Hazardous Waste Landfill Permit, Appendix C using Microsoft Excel 2010. The Excel files were saved in a format compatible with Microsoft Excel 1997-2003. I used the Excel files from the previous reporting period (November 2012) and modified these as appropriate for this reporting period. This approach was used so that the format for the spreadsheets would be familiar to you and would facilitate your review. The spreadsheets include the results for the following statistical tests:

- Test of Proportions
- Parametric Analysis of Variance (ANOVA)
- Nonparametric ANOVA

The statistical analysis procedures were based on the U.S. Environmental Protection Agency's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance* (1989).

With respect to the statistical analyses for dissolved arsenic, I used Statistical Test 3 (Nonparametric ANOVA) because 47% of the data were censored (non-detects), thereby falling slightly below the 50% threshold for performing Statistical Test 2 (Test of Proportions). Application of nonparametric ANOVA resulted in a statistically significant difference between dissolved arsenic in URGA compliance well MW84 and the background wells, with the concentrations in MW84 being higher. I have included time-trend graphs both in the Excel file (Attachment 2, provided on April 10, 2013) and the body of the report. In the latest sampling event (January 2013), the dissolved arsenic concentration in MW84 was lower than

the concentration measured in one of the background wells (MW93). However, the time-trend graphs show that dissolved arsenic concentrations were consistently higher in MW84 when compared to the background wells from July 2010 through November 2012. Thus, the result of Statistical Test 3 for this data set is consistent with the trends observed in the temporal graphs. In the previous reporting period, no difference in dissolved arsenic concentrations between compliance and background wells was detected by Statistical Test 2 (Test of Proportions), which was used because the percentage of censored data was 50%. The Test of Proportions compares the number of detects versus non-detects in background and compliance wells and would not have been sensitive to the concentration differences in the data.

Please feel free to contact me at (865) 671-4401, Jeff Douthitt, or Vanessa Pineda at (270) 462-3882 if you have any questions.

Sincerely,

Olivia R. West

Olivia R. West, Ph.D., P.E.

OW:vp

cc: GEO Kevil DMC

ATTACHMENT 1

STATISTICAL TEST 2, TEST OF PROPORTIONS
JANUARY 2013 ARSENIC URGA

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Attachment 1: Statistical Test 2, Test of Proportions, January 2013 Arsenic URGA

Arsenic (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	0.005	0.0005	**0.00310**	0.0005	0.005
Jan-11	**0.00345**	0.0005	**0.00493**	0.005	0.0005
Jul-11	**0.00255**	0.0005	**0.00422**	**0.00103**	0.0005
Jan-12	**0.00535**	0.0005	**0.00434**	**0.00187**	0.0005
Jul-12	**0.00412**	0.0005	**0.00425**	**0.00133**	0.0005
Jan-13	**0.00652**	0.0005	**0.00572**	**0.00183**	0.0005

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

[!] **Test of Proportions**

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

X=	5	X=number of samples above DL in background wells
Y=	10	Y=number of samples above DL in compliance wells
n_b=	12	n_b=count of background well results/samples analyzed
n_c=	18	n_c=count of compliance well results/samples analyzed
n=	30	n=total number of samples

P =	0.500	P=(x+y)/n
nP =	15	$n=n_b+n_c$
n(1-P) =	15	

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

P_b =	0.417	P_b =proportion of detects in background wells
P_c =	0.556	P_c =proportion of detects in compliance wells
S_D =	0.186	S_D=standard error of difference in proportions
Z =	-0.745	$Z = (P_b-P_c)/S_D$
absolute value of Z =	0.745	

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 2

STATISTICAL TEST 3, NONPARAMETRIC ANOVA, JANUARY 2013 ARSENIC (DISSOLVED) URGA

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Attachment 2: Statistical Test 3, Nonparametric ANOVA, January 2013 Arsenic (Dissolved) URGA

Arsenic (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	**0.00213**	0.0005	**0.00272**	0.005	0.005
Jan-11	**0.00284**	0.0005	**0.0033**	0.0005	0.0005
Jul-11	**0.00279**	0.0005	**0.00396**	**0.00153**	0.0005
Jan-12	**0.00328**	0.0005	**0.0042**	**0.00132**	0.0005
Jul-12	**0.00377**	0.0005	**0.00411**	**0.00128**	0.0005
Jan-13	**0.004**	0.0005	**0.00374**	**0.00132**	0.0005
x_i	0.0218		0.02203	0.01095	0.0075
n_i	12		6	6	6
$(x_i)_{avg}$	0.00182		0.00367	0.00183	0.0013

Overall mean x.. = 0.00208

N = 30
p = 4
x..= 0.06

Attachment 2: Statistical Test 3, Nonparametric ANOVA, January 2013 Arsenic (Dissolved) URGA

Statistical Test 3, Non-parametric ANOVA

Ranking of Observations

Sequence	Arsenic (mg/L)	Adjusted Rank	Tie Number
1	0.0005	6.5	
2	0.0005	6.5	
3	0.0005	6.5	
4	0.0005	6.5	
5	0.0005	6.5	
6	0.0005	6.5	
7	0.0005	6.5	Tie 1
8	0.0005	6.5	
9	0.0005	6.5	
10	0.0005	6.5	
11	0.0005	6.5	
12	0.0005	6.5	
13	**0.00128**	13	
14	**0.00132**	14.5	Tie 2
15	**0.00132**	14.5	
16	**0.00153**	16	
17	**0.00213**	17	
18	**0.00272**	18	
19	**0.00279**	19	
20	**0.00284**	20	
21	**0.00328**	21	
22	**0.0033**	22	
23	**0.00374**	23	
24	**0.00377**	24	
25	**0.00396**	25	
26	**0.004**	26	
27	**0.00411**	27	
28	**0.0042**	28	
29	0.005	29.5	Tie 3
30	0.005	29.5	

Adjustment for Ties:

Tie 1 = (12^3-12) = 1716

Tie 2 = (2^3-2) = 6

Tie 3 = (2^3-2) = 6

$\sum T_i$ = 1728

Attachment 2: Statistical Test 3, Nonparametric ANOVA, January 2013 Arsenic (Dissolved) URGA

Sums of Ranks and Averages

Arsenic (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	**0.00213**	0.0005	**0.00272**	0.005	0.005
Jan-11	**0.00284**	0.0005	**0.0033**	0.0005	0.0005
Jul-11	**0.00279**	0.0005	**0.00396**	**0.00153**	0.0005
Jan-12	**0.00328**	0.0005	**0.0042**	**0.00132**	0.0005
Jul-12	**0.00377**	0.0005	**0.00411**	**0.00128**	0.0005
Jan-13	**0.004**	0.0005	**0.00374**	**0.00132**	0.0005

Observation Ranks for Arsenic					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	17	6.5	18	29.5	29.5
Jan-11	20	6.5	22	6.5	6.5
Jul-11	19	6.5	25	16	6.5
Jan-12	21	6.5	28	14.5	6.5
Jul-12	24	6.5	27	13	6.5
Jan-13	26	6.5	23	14.5	6.5
R_i	166		143	94	62
$(R_i)_{avg}$	13.8		23.8	15.7	10.3
R_i^2/n_i	2296.3		3408.2	1472.7	640.7

$\Sigma R_i^2/n_i$ = 7817.8

n_i= 12 (for Group 1, which includes MW93 and MW420)
n_i= 6 (for Groups 2, 3, and 4)
K= 4
N= 30

Calculation of Kruskal-Wallis Statistic

H = 7.875 Kruskal-Wallis Statistic $H = [12/N(N+1)*\Sigma R_i^2/n_i] - 3(N+1)$
H' = 8.414 Corrected Kruskal-Wallis $H' = H/[1-(\sum T_i/N^3-N)]$
χ^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 $Z(\alpha/(K-1))$** = 2.1201
α = 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* , USEPA, 1989.
**Table 4, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* , USEPA, 1989.

Attachment 2: Statistical Test 3, Nonparametric ANOVA, January 2013 Arsenic (Dissolved) URGA

Calculate Critical Values

Average Background Ranking = 13.833

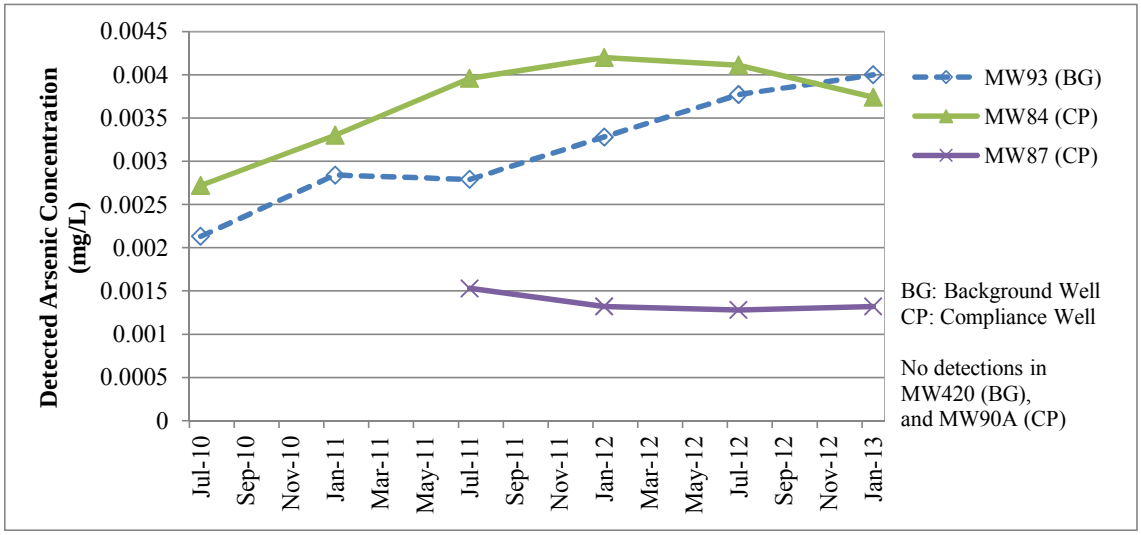
	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93			
BG Well	MW420			
	MW84	9.332	10.00	evidence of contamination
	MW87	9.332	1.83	not contaminated
	MW90A	9.332	-3.50	not contaminated

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

CONCLUSION: Since $(R_i)_{avg} - (R_b)_{avg} < C_i$ for MW87 and MW90A, there is no statistically significant evidence these downgradient compliance test wells are contaminated; however, there is statistically evidence that compliance well MW84 is contaminated.

Section 5.2.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* , USEPA, 1989

Detected Arsenic (Dissolved) in C-404 Wells



*Detection limit was 0.001 mg/L except for samples collected in July 2010 (detection limit was 0.01 mg/L) from MW87 and MW90A.

ATTACHMENT 3

STATISTICAL TEST 2, TEST OF PROPORTIONS
JANUARY 2013 CHROMIUM URGA

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Attachment 3: Statistical Test 2, Test of Proportions, January 2013 Chromium URGA

Chromium (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	0.05	0.005	0.005	0.005	0.05
Jan-11	0.005	0.005	**0.0451**	**0.177**	0.005
Jul-11	0.005	0.005	**0.0232**	**0.0357**	0.005
Jan-12	**0.0214**	0.005	0.005	**0.0792**	0.005
Jul-12	0.005	0.005	0.005	**0.0218**	0.005
Jan-13	**0.224**	0.005	**0.0604**	**0.177**	0.005

mg/L = milligrams per liter
BG=background
DL=detection limit
All data sets represent 1/2DL values for nondetects.
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=	8	Y=number of samples above DL in compliance wells
n_b=	12	n_b=count of background well results/samples analyzed
n_c=	18	n_c=count of compliance well results/samples analyzed
n=	30	n=total number of samples

P =	0.333	P=(x+y)/n
nP =	10	$n=n_b+n_c$
n(1-P) =	20	

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

P_b =	0.167	P_b =proportion of detects in background wells
P_c =	0.444	P_c =proportion of detects in compliance wells
S_D =	0.176	S_D=standard error of difference in proportions
Z =	-1.581	$Z = (P_b-P_c)/S_D$
absolute value of Z =	1.581	

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 4

STATISTICAL TEST 2, TEST OF PROPORTIONS
JANUARY 2013 LEAD URGA

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Attachment 4: Statistical Test 2, Test of Proportions, January 2013 Lead URGA

Lead (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	0.00065	0.00065	0.00065	0.00065	0.00065
Jan-11	0.00065	0.00065	0.00065	**0.00309**	0.00065
Jul-11	0.00065	0.00065	0.00065	0.00065	0.00065
Jan-12	**0.00229**	0.00065	0.00065	**0.00279**	0.00065
Jul-12	0.00065	0.00065	0.00065	0.00065	0.00065
Jan-13	**0.00256**	0.00065	**0.00164**	**0.0117**	0.00065

mg/L = milligrams per liter
BG=background
DL=detection limit
Nondetect values are 1/2DL.
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=	4	Y=number of samples above DL in compliance wells
n_b=	12	n_b=count of background well results/samples analyzed
n_c=	18	n_c=count of compliance well results/samples analyzed
n=	30	n=total number of samples

P =	0.200	P=(x+y)/n
nP =	6	$n=n_b+n_c$
n(1-P) =	24	

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 =	0.167	P_b =proportion of detects in background wells
P_c =	0.222	P_c =proportion of detects in compliance wells
S_D =	0.149	S_D=standard error of difference in proportions
Z =	-0.373	$Z = (P_b-P_c)/S_D$
absolute value of Z =	0.373	

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 5

STATISTICAL TEST 2, TEST OF PROPORTIONS
JANUARY 2013 TECHNETIUM-99 URGA

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Attachment 5: Statistical Test 2, Test of Proportions, January 2013 Technetium-99 URGA

Technetium-99 (pCi/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	8.55	**19.8**	8.55	8.55	8.55
Jan-11	8.70	**45.3**	8.70	8.70	8.70
Jul-11	**12.9**	**35.3**	**12.5**	**13.6**	6.20
Jan-12	7.90	**32.6**	7.90	7.90	7.90
Jul-12	9.25	9.25	**22.3**	9.25	9.25
Jan-13	7.4	**49.1**	7.4	7.4	7.4

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

[!] **Test of Proportions**

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

X=	6	X=number of samples above DL in background wells
Y=	3	Y=number of samples above DL in compliance wells
n_b=	12	n_b=count of background well results/samples analyzed
n_c=	18	n_c=count of compliance well results/samples analyzed
n=	30	n=total number of samples

P =	0.300	P=(x+y)/n
nP =	9	$n=n_b+n_c$
n(1-P) =	21	

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

P_b =	0.500	P_b =proportion of detects in background wells
P_c =	0.167	P_c =proportion of detects in compliance wells
S_D =	0.171	S_D=standard error of difference in proportions
Z =	1.952	$Z = (P_b-P_c)/S_D$
absolute value of Z =	1.952	

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 6

STATISTICAL TEST 4, PARAMETRIC ANOVA
JANUARY 2013 TRICHLOROETHENE URGA

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Attachment 6: Statistical Test 4, Parametric ANOVA, January 2013 Trichloroethene URGA

TCE (µg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	1200	220	950	330	11
Jan-11	1200	230	1100	270	20
Jul-11	990	290	1000	420	26
Jan-12	1200	280	1300	540	24
Jul-12	1500	210	1100	450	14
Jan-13	1900	190	1100	470	17
n_i	12		6	6	6
x_i	9410		6550	2480	112.00
(x_i)avg	784.17		1091.67	413.33	18.67

Overall mean x.. = 618.40

N = 30
p = 4
x..= 18552.00

µg/L = micrograms per liter

Determine Normality of Dataset

Coefficient of Varibility Test

Table of Residuals

Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	415.83	-564.17	-141.67	-83.33	-7.67
Jan-11	415.83	-554.17	8.33	-143.33	1.33
Jul-11	205.83	-494.17	-91.67	6.67	7.33
Jan-12	415.83	-504.17	208.33	126.67	5.33
Jul-12	715.83	-574.17	8.33	36.67	-4.67
Jan-13	1115.83	-594.17	8.33	56.67	-1.67

X: Mean Value = 1.58E-14
S: Standard Deviation = 382.6
K* Factor = 2.22 (for n = 30)
CV = S/X = 2.43E+16 >1, residuals not normal

* K factor (From Table 5, Appendix B of *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* , USEPA, 1989).
Because the coefficient of variation is >1, the resdiuals do not appear to be normally distributed.

Attachment 6: Statistical Test 4, Parametric ANOVA, January 2013 Trichloroethene URGA

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)
$f_i = n_i - 1$

$x_{..=}$ 18552.00
$(x_{avg})_{..=}$ 618.40

p= 4
N= 30

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_iS_i^2$	$f_i\ln(S_i^2)$
612.379	375008.333	12.835	12	4125091.667	141.2
120.069	14416.667	9.576	6	72083.333	47.9
98.116	9626.667	9.172	6	48133.333	45.9
5.785	33.467	3.511	6	167.333	17.6

$\sum(S_i^2)$= 399085.13 $\sum f_i\ln(S_i^2)$= 252.5

Equality of Variance: Bartlett's Test

f = 26
Sp^2 = 163287.526
ln Sp^2 = 12.003
χ^2 = 59.608 (If calculated $\chi^2 \leq \chi^2_{crit}$, then variances are equal at the given significance level).
χ^2_{crit} *= 7.815 at a 5% significance level with 3 degrees of freedom

Variances are not equal, transform the original data to lognormal.

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

Attachment 6: Statistical Test 4, Parametric ANOVA, January 2013 Trichloroethene URGA

Lognormal Data for TCE

lnTCE (µg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	7.09	5.39	6.86	5.80	2.40
Jan-11	7.09	5.44	7.00	5.60	3.00
Jul-11	6.90	5.67	6.91	6.04	3.26
Jan-12	7.09	5.63	7.17	6.29	3.18
Jul-12	7.31	5.35	7.00	6.11	2.64
Jan-13	7.55	5.25	7.00	6.15	2.83
x_i	75.76		41.94	35.99	17.30
(x_i)avg	6.31		6.99	6.00	2.88

Determine Normality of Dataset

Coefficient of Varibility Test

Table of residuals

Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	0.78	-0.92	-0.13	-0.20	-0.49
Jan-11	0.78	-0.88	0.01	-0.40	0.11
Jul-11	0.58	-0.64	-0.08	0.04	0.37
Jan-12	0.78	-0.68	0.18	0.29	0.29
Jul-12	1.00	-0.97	0.01	0.11	-0.24
Jan-13	1.24	-1.07	0.01	0.15	-0.05

X: Mean Value = 0.00
S: Standard Deviation = 0.6
K* Factor = 2.22 (for n = 30)
CV = S/X = 1.25E+15 >1, residuals of log-transformed data are not normally distributed

* K factor (From Table 5, Appendix B of *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* , USEPA, 1989)

Determine Equality of Variance of Dataset

p = number of wells (background wells considered as one group)
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)
$f_i = n_i - 1$

$x_{..=}$ 171.00
$(x_{avg})_{..=}$ 5.70
n_i= 6
p= 4
N= 30

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	ni	$f_iS_i^2$	$f_i\ln(S_i^2)$

0.227	0.052	-2.965	12	0.567	-32.6
0.107	0.012	-4.465	6	0.058	-22.3
0.254	0.065	-2.738	6	0.324	-13.7
0.328	0.108	-2.230	6	0.538	-11.1

$\sum(S_i^2)$= 0.24 $\sum f_i \ln(S_i^2)$= -79.8

Equality of Variance: Bartlett's Test

f = 26

Sp^2 = 0.057

ln Sp^2 = -2.862

χ^2 = 5.364 (If calculated $\chi^2 \leq$ tabulated χ^2, then variances are equal at the given significance level).

tabulated χ^2 *= 7.815 at a 5% significance level with 3 degrees of freedom

Variances are not equal.

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

Because log transformed concentrations do not exhibit equality of variance, a non-parametric ANOVA. procedure is performed

Attachment 6: Statistical Test 4, Parametric ANOVA, January 2013 Trichloroethene URGA

Statistical Test 3, Non-parametric ANOVA

Ranking of Observations

Sequence	TCE (µg/L)	Adjusted Rank	Tie Number
1	11	1	
2	14	2	
3	17	3	
4	20	4	
5	24	5	
6	26	6	
7	190	7	
8	210	8	
9	220	9	
10	230	10	
11	270	11	
12	280	12	
13	290	13	
14	330	14	
15	420	15	
16	450	16	
17	470	17	
18	540	18	
19	950	19	
20	990	20	
21	1000	21	
22	1100	23	Tie 1
23	1100	23	
24	1100	23	
25	1200	26	Tie 2
26	1200	26	
27	1200	26	
28	1300	28	
29	1500	29	
30	1900	30	

Adjustment for Ties:

Tie 1 = (3^3-3) = 24

Tie 2 = (3^3-3) = 24

$\sum T_i$ = 48

Attachment 6: Statistical Test 4, Parametric ANOVA, January 2013 Trichloroethene URGA

Sums of Ranks and Averages

TCE (µg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Apr-10	790	200	980	260	8.2
Jul-10	1200	220	950	330	11
Jan-11	1200	230	1100	270	20
Jul-11	990	290	1000	420	26
Jan-12	1200	280	1300	540	24
Jul-12	1500	210	1100	450	14

Observation Ranks for TCE					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	26	9	19	14	1
Jan-11	26	10	23	11	4
Jul-11	20	13	21	15	6
Jan-12	26	12	28	18	5
Jul-12	29	8	23	16	2
Jan-13	30	7	23	17	3
R_i	216		137	91	21
$(R_i)_{avg}$	18.0		22.8	15.2	3.5
R_i^2/n_i	3888.0		3128.2	1380.2	73.5

$\Sigma R_i^2/n_i$ = 8469.8

n_i= 12 (for Group 1, which includes MW93 and MW420)
n_i= 6 (for Groups 2, 3, and 4)
K= 4
N= 30

Calculation of Kruskal-Wallis Statistic

H = 16.288 Kruskal-Wallis Statistic $H = [12/N(N+1)*\Sigma R_i^2/n_i] - 3(N+1)$
H' = 16.317 Corrected Kruskal-Wallis $H' = H/[1-(\sum T_i/N^3-N)]$
χ^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 α/(K-1)= 0.01667 Z(α/(K-1))** = 2.1201
α = 0.05 1-(α/K-1)= 0.983

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

Attachment 6: Statistical Test 4, Parametric ANOVA, January 2013 Trichloroethene URGA

Calculate Critical Values

Average Background Ranking = 18.0

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93			
BG Well	MW420			
	MW84	9.332	4.83	not contaminated
	MW87	9.332	-2.83	not contaminated
	MW90A	9.332	-14.50	not contaminated

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

CONCLUSION: Since $(R_i)_{avg} - (R_b)_{avg} < C_i$, there is no statistically significant evidence that downgradient compliance test wells are contaminated; 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* , USEPA, 1989

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APPENDIX C

C-404 HAZARDOUS WASTE LANDFILL LEACHATE INFORMATION

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PADUCAH GASEOUS DIFFUSION PLANT
C-404 HAZARDOUS WASTE LANDFILL
PERMIT NUMBER KY8-890-008-982

LEACHATE INFORMATION

The leachate information in this document includes the monthly, quarterly, and annual inspections; volumes of leachate removed during this reporting period; and analytical results of leachate sampling.

C-404 Monthly Inspection Summary[1, 2, 3, 4]

Period of Inspection: October, November, December

Leachate Level	Date (M/D/YY)	Level (inches deep)*	Inspector(s)
First monthly leachate level determination	10/9/12	15	[signature]
Second monthly leachate level determination	11/6/12	15	[signature]
Third monthly leachate level determination	12/4/12	15	[signature]

* If the leachate level in the sump is at **3 feet (36 inches)**, then contact the appropriate personnel to initial removal and sampling of leachate AND w hen leachate is removed, complete the "**C-404 Inspection Checklist for Leachate Removal.**"

NOTES:

1. If any item is found to be unacceptable and cannot be explained in the space available, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.
2. Third quarter of calendar year inspection includes the annual leachate collection system inspection.
3. The original forms shall be kept on file in the facility operating record.
4. Upon completing the monthly inspections, e-mail Environmental Compliance the leachate level and whether or not the leachate needs to be sampled or removed.

ENM-F-0001 (8/17/10)
PAD-ENM-0022

C-404 Quarterly Inspection Checklist[1, 5]

Item No.	Inspection Item	Item Description	Inspection Results		Comments/Observations
			A	U	
A	Warning Signs	Four signs around landfill	✓		
B	Vegetative Cover[2]	Gully erosion depth > 6 inches	✓		
		Vegetative die-off	✓		
		Varmint intrusion/burrowing from animals	✓		
		Overgrowth	✓		
		Depressions	✓		
C	Ditches[3]	Debris in ditches	✓		
		Excessive sediment	✓		
		Drainage	✓		
		Erosion	✓		
D	Anchor Trench[4]	Washouts or depressions	✓		
		Lack of discharge	✓		
		Unusual volume or color	✓		
		Drainage (4 drains from landfill)	✓		
E	Leachate System	Level	✓		
		Cracks or damage	✓		
Inspector: Ronnie Poynen (Printed Name)			Signature: Ronnie Poynen Date: 10/15/12 Time: 1400		

A=Acceptable
U=Unacceptable

NOTES:

1. If any item is found to be unacceptable, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.
2. For Item No. B, the vegetative cover shall be mowed regularly during the active growing season to discourage the growth of weeds, competitive species, or deep-rooted vegetation. Mowing shall be conducted using a sickle-type mower to prevent airborne contaminants. A radiation work permit will be required. Any erosion damage greater than 6 inches will be repaired by restoring to its original grade and reseeding. Differential settlement will be repaired by restoring site to its original grade and reseeding.
3. For Item No. C, blockage of or damage to the system shall be repaired by removing debris and accumulated sediment and restoring the ditch to its original grade. Ditches shall be reseeded and additional gravel shall be installed as needed.
4. For Item No. D, drainage pipe failures shall be repaired by removing the failed pipe, installing a new section, and replacing the fill material as necessary.
5. The original forms shall be kept on file in the facility operating record.

ENM-F-0002 (8-17-10)
PAD-ENM-0022

C-404 Monthly Inspection Summary[1, 2, 3, 4]

Period of Inspection: January, February, March

Leachate Level	Date (M/D/YY)	Level (inches deep)*	Inspector(s)
First monthly leachate level determination	1/2/13	22"	Lonnie Payne
Second monthly leachate level determination	2/4/13	38"	Lonnie Payne
Third monthly leachate level determination	3/4/13	18"	Lonnie Payne

* If the leachate level in the sump is at **3 feet (36 inches)**, then contact the appropriate personnel to initial removal and sampling of leachate AND when leachate is removed, complete the "**C-404 Inspection Checklist for Leachate Removal.**"

NOTES:

1. If any item is found to be unacceptable and cannot be explained in the space available, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.
2. Third quarter of calendar year inspection includes the annual leachate collection system inspection.
3. The original forms shall be kept on file in the facility operating record.
4. Upon completing the monthly inspections, e-mail Environmental Compliance the leachate level and whether or not the leachate needs to be sampled or removed.

ENM-F-0001 (8/17/10)
PAD-ENM-0022

C-404 Inspection Checklist for Leachate Removal[1,2]

Leachate Removal Inspection	YES	NO	N/A	Date (M/D/YY)	Volume (gallons)
Was any removal necessary during the quarter?	✓			2/6/13	1050
Has any leachate removed during the quarter been sampled?	✓			2/6/13	
Date of superficial inspection upon removal of leachate.	✓			2/6/13	
Date of sampling of leachate after removal.			✓		

Item No.	Inspection Item	Item Description	Inspection Results A	Inspection Results U	Comments
A	Leachate Pit	Interior malformations	✓		
		Exterior malformations	✓		

Inspector: Ronnie Poynor (Printed Name)

Signature: Ronnie Poynor

Date: 2/6/13 Time: 0900

A=Acceptable
U=Unacceptable

Notes:

1. This form is completed if the leachate level in the sump is at 3 feet (36 inches) and is being removed.
2. If any item is found to be unacceptable, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.

C-404 Quarterly Inspection Checklist[1, 5]

Item No.	Inspection Item	Item Description	Inspection Results		Comments/Observations
			A	U	
A	Warning Signs	Four signs around landfill	✓		
B	Vegetative Cover[2]	Gully erosion depth > 6 inches	✓		
		Vegetative die-off	✓		
		Varmint intrusion/burrowing from animals	✓		
		Overgrowth	✓		
		Depressions	✓		
C	Ditches[3]	Debris in ditches	✓		
		Excessive sediment	✓		
		Drainage	✓		
		Erosion	✓		
D	Anchor Trench[4]	Washouts or depressions	✓		
		Lack of discharge	✓		
		Unusual volume or color	✓		
		Drainage (4 drains from landfill)	✓		
E	Leachate System	Level	✓		
		Cracks or damage	✓		
Inspector: Ronnie Poyner (Printed Name)			Signature: Ronnie Poyner Date: 2/7/13 Time: 1330		

A=Acceptable
U=Unacceptable

NOTES:

1. If any item is found to be unacceptable, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.
2. For Item No. B, the vegetative cover shall be mowed regularly during the active growing season to discourage the growth of weeds, competitive species, or deep-rooted vegetation. Mowing shall be conducted using a sickle-type mower to prevent airborne contaminants. A radiation work permit will be required. Any erosion damage greater than 6 inches will be repaired by restoring to its original grade and reseeding. Differential settlement will be repaired by restoring site to its original grade and reseeding.
3. For Item No. C, blockage of or damage to the system shall be repaired by removing debris and accumulated sediment and restoring the ditch to its original grade. Ditches shall be reseeded and additional gravel shall be installed as needed.
4. For Item No. D, drainage pipe failures shall be repaired by removing the failed pipe, installing a new section, and replacing the fill material as necessary.
5. The original forms shall be kept on file in the facility operating record.

ENM-F-0002 (8-17-10)
PAD-ENM-0022

C-404 Inspection Addendum[1, 2, 3]

Date	Item No.	Observation	Repairs Completed
2/6/13	C-404 Leachate Sump	Water level was at 38"	Leachate sump was sampled and pumped out at 0900-1000 hrs. 1050 gals. of water was pumped out.

NOTES:

1. This form can be used if additional space is necessary to document the appropriate information.
2. If the notation is made by someone other than the inspector for the repairs completed, that person should sign the entry.
3. The original forms shall be kept on file in the facility operating record.

ENM-F-0006 (8-17-10)
PAD-ENM-0022

C-404 Annual Inspection Checklist[1, 2, 3]

Item No.	Inspection Item	Item Description	Inspection Results		Comments
			A	U	
A	Wells	14 Wells (attach well inspection form)	✓		
B	Leachate Pit	Interior malformations	✓		
		Exterior malformations	✓		
		Integrity test (attach data)[4]	✓		
Inspector: Ronnie Poyner (Printed Name)			Signature: Ronnie Poyner Date: 10/15/12 Time: 1355		

A=Acceptable
U=Unacceptable

NOTES:

1. If any item is found to be unacceptable, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.
2. The original forms shall be kept on file in the facility operating record.
3. Annual inspection performed during the third quarter of the calendar year.
4. For the integrity test of the leachate pit during the annual inspection, data from the data logger is downloaded electronically and printed annually, and then attached to the annual inspection checklist for maintaining in the file.

Paducah OREIS Report for 404L13-01

L1404L1-13 from: C404L on 2/6/2013 Media: WW SmpMethod: GR

Comments: F039

Analysis	Results	Counting Error	Units	Result Qual	Foot Note	Reporting Limit	TPU	Method	V/V/A*
ANION									
Fluoride	8.4		mg/L			1		SW846-9056	I / X /
FS									
Conductivity	624		umho/cm					FS	/ /
Dissolved Oxygen	10.36		mg/L					FS	/ /
pH	8.73		Std Unit					FS	/ /
Redox	377		mV					FS	/ /
Temperature	50.8		deg F					FS	/ /
METAL									
Arsenic	0.001		mg/L	U		0.001		SW846-6020	/ X /
Barium	0.0871		mg/L			0.005		SW846-6020	/ X /
Cadmium	0.001		mg/L	U		0.001		SW846-6020	/ X /
Chromium	0.01		mg/L	UB		0.01		SW846-6020	/ X /
Copper	0.02		mg/L	U		0.02		SW846-6020	/ X /
Iron	0.1		mg/L	U		0.1		SW846-6010B	/ X /
Lead	0.0013		mg/L	UX		0.0013		SW846-6020	/ X /
Mercury	0.0002		mg/L	U		0.0002		SW846-7470A	/ X /
Nickel	0.00607		mg/L	X		0.005		SW846-6020	/ X /
Selenium	0.005		mg/L	U		0.005		SW846-6020	/ X /
Silver	0.001		mg/L	UB		0.001		SW846-6020	/ X /
Uranium	111		mg/L	B		5		SW846-6020	I / X /
Zinc	0.02		mg/L	UN		0.02		SW846-6020	/ X /
PPCB									
PCB-1016	0.16		ug/L	U		0.16		SW846-8082	/ X /
PCB-1221	0.17		ug/L	U		0.17		SW846-8082	/ X /
PCB-1232	0.13		ug/L	U		0.13		SW846-8082	/ X /
PCB-1242	0.09		ug/L	U		0.09		SW846-8082	/ X /
PCB-1248	1.15		ug/L			0.11		SW846-8082	/ X /
PCB-1254	0.07		ug/L	U		0.07		SW846-8082	/ X /
PCB-1260	0.05		ug/L	U		0.05		SW846-8082	/ X /
PCB-1268	0.08		ug/L	U		0.08		SW846-8082	/ X /
Polychlorinated biphenyl	1.15		ug/L			0.17		SW846-8082	I / X /
RADS									
Cesium-137	3.83	7.67	pCi/L	U		20.8	11	RL-7124	/ X /
Neptunium-237	7.2	1.32	pCi/L			1.58	1.92	RL-7128	/ X /
Plutonium-239/240	0.796	0.431	pCi/L	U		2.37	1.05	RL-7128	/ X /
Technetium-99	303	18	pCi/L			14.7	19.5	RL-7100	/ X /
Thorium-230	4.24	1.14	pCi/L	U		21	9.01	RL-7128	/ X /
Uranium-234	3640	254	pCi/L	T		131	836	RL-7128	S / X /
Uranium-235	609	116	pCi/L	T		36.5	177	RL-7128	S / X /
Uranium-238	39100	824	pCi/L	T		40.5	8580	RL-7128	/ X /
VOA									
Trichloroethene	1		ug/L	U		1		SW846-8260B	/ X /
WETCHEM									
Ammonia as Nitrogen	0.1		mg/L	U		0.1		EPA-350.3	/ X /

*Verification/Validation/Assessment

Paducah OREIS Report for 404L13-01

L1404LD1-13 from: C404L on 2/6/2013 Media: WW SmpMethod: GR

Comments: F039

Analysis	Results	Counting Error	Units	Result Qual	Foot Note	Reporting Limit	TPU	Method	V/V/A*
ANION									
Fluoride	8.5		mg/L			1		SW846-9056	I / X /
FS									
Conductivity	624		umho/cm					FS	/ /
Dissolved Oxygen	10.36		mg/L					FS	/ /
pH	8.73		Std Unit					FS	/ /
Redox	377		mV					FS	/ /
Temperature	50.8		deg F					FS	/ /
METAL									
Arsenic	0.001		mg/L	U		0.001		SW846-6020	/ X /
Barium	0.0878		mg/L			0.005		SW846-6020	S / X /
Cadmium	0.001		mg/L	U		0.001		SW846-6020	/ X /
Chromium	0.01		mg/L	UB		0.01		SW846-6020	/ X /
Copper	0.02		mg/L	U		0.02		SW846-6020	/ X /
Iron	0.1		mg/L	U		0.1		SW846-6010B	/ X /
Lead	0.0013		mg/L	UX		0.0013		SW846-6020	/ X /
Mercury	0.0002		mg/L	U		0.0002		SW846-7470A	/ X /
Nickel	0.00577		mg/L	X		0.005		SW846-6020	/ X /
Selenium	0.005		mg/L	U		0.005		SW846-6020	/ X /
Silver	0.001		mg/L	UB		0.001		SW846-6020	/ X /
Uranium	110		mg/L	B		5		SW846-6020	I / X /
Zinc	0.02		mg/L	UN		0.02		SW846-6020	/ X /
PPCB									
PCB-1016	0.16		ug/L	U		0.16		SW846-8082	/ X /
PCB-1221	0.17		ug/L	U		0.17		SW846-8082	/ X /
PCB-1232	0.13		ug/L	U		0.13		SW846-8082	/ X /
PCB-1242	0.09		ug/L	U		0.09		SW846-8082	/ X /
PCB-1248	1.09		ug/L			0.11		SW846-8082	/ X /
PCB-1254	0.07		ug/L	U		0.07		SW846-8082	/ X /
PCB-1260	0.05		ug/L	U		0.05		SW846-8082	/ X /
PCB-1268	0.08		ug/L	U		0.08		SW846-8082	/ X /
Polychlorinated biphenyl	1.09		ug/L			0.17		SW846-8082	I / X /
RADS									
Cesium-137	0.173	0.346	pCi/L	U		21.3	11.7	RL-7124	/ X /
Neptunium-237	10.3	1.63	pCi/L			1.83	2.51	RL-7128	/ X /
Plutonium-239/240	0.685	0.402	pCi/L	U		2.36	1.04	RL-7128	/ X /
Technetium-99	308	18	pCi/L			14.7	19.6	RL-7100	/ X /
Thorium-230	3.11	1.07	pCi/L	U		20.9	8.99	RL-7128	/ X /
Uranium-234	3540	236	pCi/L	T		132	792	RL-7128	S / X /
Uranium-235	647	112	pCi/L	T		35	177	RL-7128	S / X /
Uranium-238	39700	784	pCi/L	T		44.8	8490	RL-7128	/ X /
VOA									
Trichloroethene	1		ug/L	U		1		SW846-8260B	/ X /
WETCHEM									
Ammonia as Nitrogen	0.1		mg/L	U		0.1		EPA-350.3	/ X /

*Verification/Validation/Assessment

Paducah OREIS Report for 404L13-01

FB404L1-13 from: QC on 2/6/2013 Media: WQ SmpMethod:

Comments:

Analysis	Results	Counting Error	Units	Result Qual	Foot Note	Reporting Limit	TPU	Method	V/V/A*
ANION									
Fluoride	1		mg/L	U		1		SW846-9056	/ X /
METAL									
Arsenic	0.001		mg/L	U		0.001		SW846-6020	/ X /
Barium	0.005		mg/L	U		0.005		SW846-6020	/ X /
Cadmium	0.001		mg/L	U		0.001		SW846-6020	/ X /
Chromium	0.01		mg/L	UB		0.01		SW846-6020	/ X /
Copper	0.02		mg/L	U		0.02		SW846-6020	/ X /
Iron	0.1		mg/L	U		0.1		SW846-6010B	/ X /
Lead	0.0013		mg/L	UX		0.0013		SW846-6020	/ X /
Mercury	0.0002		mg/L	U		0.0002		SW846-7470A	/ X /
Nickel	0.005		mg/L	UX		0.005		SW846-6020	/ X /
Selenium	0.005		mg/L	U		0.005		SW846-6020	/ X /
Silver	0.001		mg/L	UB		0.001		SW846-6020	/ X /
Uranium	0.001		mg/L	U		0.001		SW846-6020	/ X /
Zinc	0.02		mg/L	UN		0.02		SW846-6020	/ X /
PPCB									
PCB-1016	0.17		ug/L	U		0.17		SW846-8082	/ X /
PCB-1221	0.18		ug/L	U		0.18		SW846-8082	/ X /
PCB-1232	0.14		ug/L	U		0.14		SW846-8082	/ X /
PCB-1242	0.1		ug/L	U		0.1		SW846-8082	/ X /
PCB-1248	0.12		ug/L	U		0.12		SW846-8082	/ X /
PCB-1254	0.07		ug/L	U		0.07		SW846-8082	/ X /
PCB-1260	0.05		ug/L	U		0.05		SW846-8082	/ X /
PCB-1268	0.09		ug/L	U		0.09		SW846-8082	/ X /
Polychlorinated biphenyl	0.18		ug/L	U		0.18		SW846-8082	/ X /
RADS									
Cesium-137	0.185	0.371	pCi/L	U		18.5	9.96	RL-7124	/ X /
Neptunium-237	-0.0524	0.0477	pCi/L	U		0.172	0.074	RL-7128	/ X /
Plutonium-239/240	-0.0142	0.00719	pCi/L	U		0.24	0.098	RL-7128	/ X /
Technetium-99	1.52	9.55	pCi/L	U		14.7	9.55	RL-7100	/ X /
Thorium-230	-0.0235	0.0463	pCi/L	U		2.1	0.893	RL-7128	/ X /
Uranium-234	-0.114	0.0596	pCi/L	U		2.26	0.965	RL-7128	/ X /
Uranium-235	-0.0217	0	pCi/L	U		0.21	0.114	RL-7128	/ X /
Uranium-238	-0.0208	0.0327	pCi/L	U		0.464	0.0416	RL-7128	/ X /
VOA									
Trichloroethene	1		ug/L	U		1		SW846-8260B	/ X /
WETCHEM									
Ammonia as Nitrogen	0.1		mg/L	U		0.1		EPA-350.3	/ X /

TB404L1-13 from: QC on 2/6/2013 Media: WQ SmpMethod:

Comments:

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

*Verification/Validation/Assessment

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APPENDIX D

C-404 HAZARDOUS WASTE LANDFILL GROUNDWATER FLOW DIRECTION

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C-404 LANDFILL FLOW DIRECTION

The C-404 Hazardous Waste Landfill (C-404 Landfill) Permit requires annual determination of average hydraulic flow rate and direction of flow in the uppermost aquifer. The uppermost aquifer below C-404 Landfill is the Regional Gravel Aquifer (RGA). Water level measurements currently are taken from several wells at the perimeter of the C-404 Landfill on a semiannual basis. The flow direction information included in this report is supplemental to the permit-required annual flow rate and direction.

The water levels used for this analysis (taken on January 3, 2013) were measured as closely as possible and within a 24-hour period to ensure the comparability of the data. These measurements were used to plot the potentiometric surface of the upper RGA for the January 2013 sampling event. As indicated in previous reports, flow direction beneath the C-404 Landfill generally trends northward, but commonly varies from northeast to northwest.

Contours for each potentiometric surface were drawn after water-level data were corrected for barometric efficiency The potentiometric contours depict the directions of hydraulic flow during each sampling event.

The January potentiometric surface data of the upper RGA are presented in Table D.1, and potentiometric surface maps are presented in Figures D.1.

Table D.1. Barometric Pressure Corrections

C-404 Landfill (January 2013) Water Levels									
						Raw Data		*Corrected Data	
Date	Time	Well	Datum Elev (ft amsl)	BP	Delta BP (in Hg)	DTW (ft H_2O)	Elev (ft amsl)	DTW (ft)	Elev (ft amsl)
1/3/2013	08:38	MW67	374.91	30.33	0.00	54.26	320.65	54.26	320.65
1/3/2013	08:25	MW76	376.86	30.33	0.00	55.91	320.95	55.91	320.95
1/3/2013	12:42	MW84	375.91	30.35	-0.02	55.21	320.70	55.19	320.72
1/3/2013	08:33	MW87	375.79	30.33	0.00	55.12	320.67	55.12	320.67
1/3/2013	08:29	MW90A	374.28	30.33	0.00	53.66	320.62	53.66	320.62
1/3/2013	08:16	MW93	377.59	30.33	0.00	61.66	315.93	61.66	315.93
1/3/2013	08:03	MW95A	376.94	30.33	0.00	56.01	320.93	56.01	320.93
1/3/2013	07:49	MW227	378.74	30.32	0.01	57.41	321.33	57.42	321.32
1/3/2013	08:22	MW333	377.27	30.33	0.00	56.27	321.00	56.27	321.00
1/3/2013	12:48	MW337	374.52	30.35	-0.02	53.77	320.75	53.75	320.77
1/3/2013	12:45	MW338	374.72	30.35	-0.02	54.04	320.68	54.02	320.70
1/3/2013	08:00	MW420	377.59	30.33	0.00	56.86	320.73	56.86	320.73

Initial Barometric Pressure **30.33**
Elev = elevation
amsl = above mean sea level
BP = barometric pressure
DTW = depth to water in feet below datum
*Assumes a barometric efficiency of 1.0

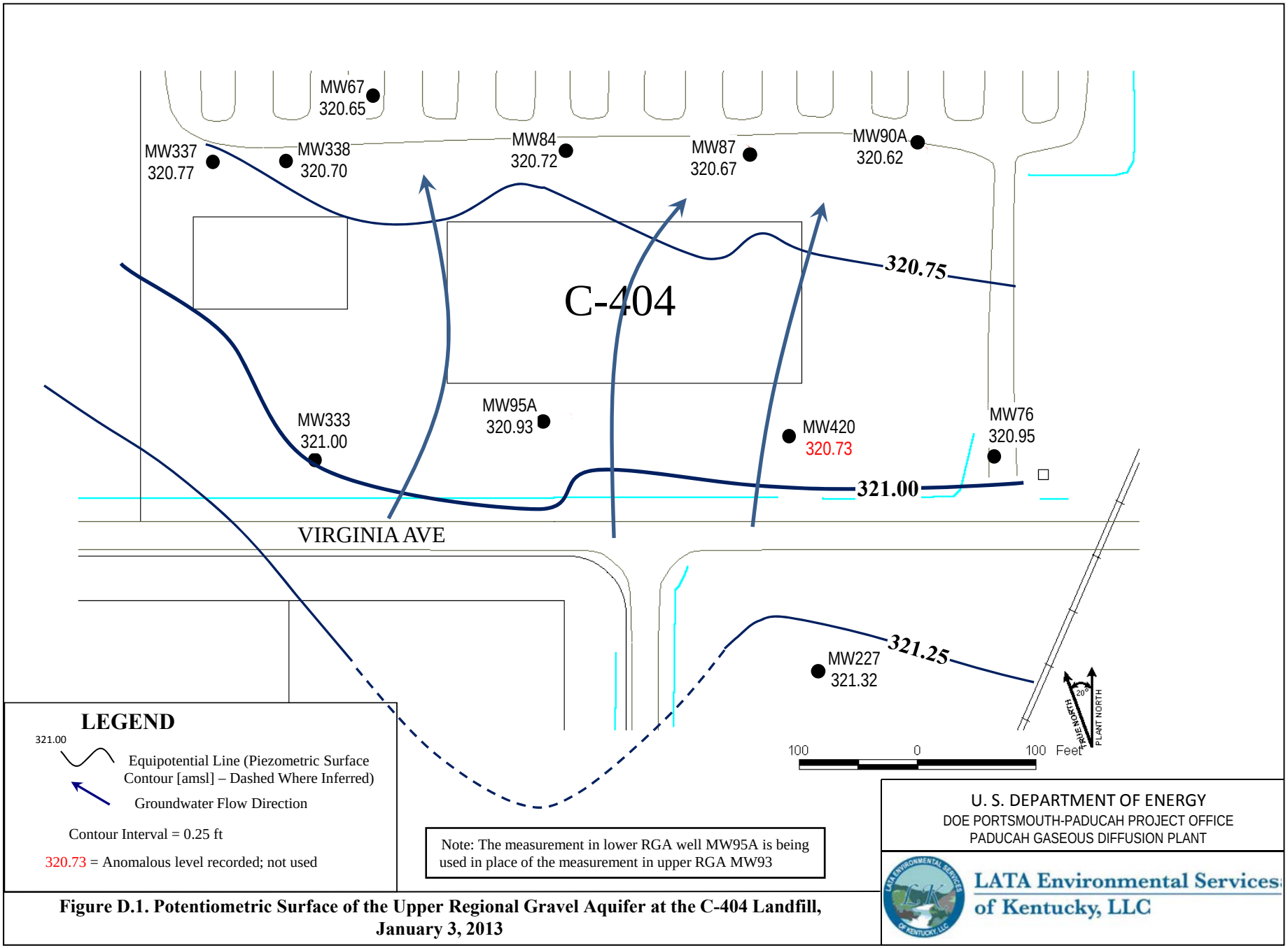

Figure D.1. Potentiometric Surface of the Upper Regional Gravel Aquifer at the C-404 Landfill, January 3, 2013