# Appendix A

# Supplemental Groundwater Information

This page intentionally left blank

# Contents

This page intentionally left blank

# Acronyms

| | |
|---|---|
| amsl | above mean sea level |
| bgs | below ground surface |
| CAWWT | Converted Advanced Wastewater Treatment Facility |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CUSUM | Shewhart-cumulative sum |
| EPA | U.S. Environmental Protection Agency |
| EW | extraction well |
| FRL | final remediation level |
| GMA | Great Miami Aquifer |
| GMA-D | Great Miami Aquifer-downgradient |
| GMA-SE | Great Miami Aquifer-southeast |
| GMA-SW | Great Miami Aquifer-southwest |
| GMA-U | Great Miami Aquifer-upgradient |
| GWLMP | Groundwater/Leak Detection and Leachate Monitoring Plan |
| HTW | horizontal till well |
| IEMP | Integrated Environmental Monitoring Plan |
| LCS | leachate collection system |
| LDS | leak detection system |
| LM | DOE Office of Legacy Management |
| LMICP | *Comprehensive Legacy Management and Institutional Controls Plan* |
| NA | not applicable |
| ND | not detected |
| NTU | Nephelometric Turbidity Units |
| ODH | Ohio Department of Health |
| OMMP | Operations and Maintenance Master Plan |
| OSDF | on-site disposal facility |
| OU | Operable Unit |
| PCB | polychlorinated biphenyls |
| P/PB | Property/Plume Boundary |
| PRRS | Paddys Run Road Site |
| PQL | practical quantitation limit |
| RCRA | Resource Conservation and Recovery Act |
| RDL | required detection limit |
| ROD | Record of Decision |
| RW | recovery well |
| SCL | Shewhart control limit |

| | |
|---|---|
| SD | standard deviation |
| SSOD | Storm Sewer Outfall Ditch |
| SU | standard unit |
| TDS | total dissolved solids |
| TOC | total organic carbon |
| TOX | total organic halogens |
| UCL | upper confidence level |
| VAM 3D | Variable Saturated Analysis Model in 3 Dimensions |
| WSA | Waste Storage Area |

# Measurement Abbreviations

| | |
|---|---|
| ft | feet |
| gpad | gallons per acre per day |
| gpm | gallons per minute |
| lb | pound |
| m | meter |
| M gal | million gallons |
| mg/L | milligrams per liter |
| pCi/L | picocuries per liter |
| µg/L | micrograms per liter |
| $yd^3$ | cubic yards |

This page intentionally left blank

Appendix A presents groundwater data and analysis in support of Chapter 3. This appendix consists of the following five attachments:

- Attachment A.1 provides operational data for the South Field Module, the South Plume Module, and the Waste Storage Area Module.
- Attachment A.2 provides total uranium data (including summary statistics) and plume maps for the first and second halves.
- Attachment A.3 provides groundwater elevation data and quarterly water level maps.
- Attachment A.4 provides an analysis of the non-uranium final remediation level (FRL) exceedances both inside and outside the Waste Storage Area (Phase II) design remediation footprint.
- Attachment A.5 presents leak detection and leachate monitoring results associated with the On-Site Disposal Facility (OSDF) monitoring program.

Groundwater analytical data are available through the Department of Energy Office of Legacy Management's Geospatial Environmental Mapping System (http://www.lm.doe.gov/Fernald/Sites.aspx).

# References


DOE (U.S. Department of Energy), 1993. *South Plume Groundwater Recovery System Design, Monitoring, and Evaluation Program Plan,* Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, April.

DOE (U.S. Department of Energy), 1995. *Remedial Investigation Report for Operable Unit 5*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, March.

DOE (U.S. Department of Energy), 1996. *Record of Decision for Remedial Actions at Operable Unit 5*, 7478 U 007 501.4, Final, Fluor Fernald, Cincinnati, Ohio, January.

DOE (U.S. Department of Energy), 1997a. *Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration*, 2505-RP-0003, Revision 0, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 1997b. *Restoration Area Verification Sampling Program Project-Specific Plan*, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1997c. *On-site Disposal Facility Final Design Calculation Package*, Volume 2 of 4, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1998. *Restoration Area Verification Sampling Program Summary Report*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2001a. *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas*, Draft Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2001b. *2000 Integrated Site Environmental Report,* Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2004a. *Groundwater Remedy Evaluation and Field Verification*, 52460-PL-0001, Revision 0, Fluor Fernald, Fernald Area Office, Cincinnati, Ohio, October.

DOE (U.S. Department of Energy), 2004b. *2003 Site Environmental Report*, 51350-RP-0024, Fluor Fernald, Fernald Area Office, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 2005a. *Waste Storage Area Phase II Design Report*, 52424-RP-0004, Revision A, Draft Final, Fluor Fernald, Fernald Area Office, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 2005b. *Storm Sewer Outfall Ditch Infiltration Test Report,* 52460-RP-0001, Revision 0, Final, Fluor Fernald, Fernald Area Office, Cincinnati, Ohio, December.

DOE (U.S. Department of Energy), 2006. *Fernald Preserve 2005 Site Environmental Report*, DOE-LM/1607-2006, S.M. Stoller Corporation for DOE, Fernald Area Office, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 2008. *Fernald Preserve 2007 Site Environmental Report*, DOE-LM/1607-2008, S.M. Stoller Corporation for DOE, Fernald Area Office, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 2009. *Fernald Preserve 2008 Site Environmental Report*, Fernald Area Office, Cincinnati, Ohio, May.

DOE (U.S. Department of Energy), 2010a. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496-4.0, Revision 4, prepared by S.M. Stoller Corporation for DOE, Fernald Area Office, Cincinnati, Ohio, April.

DOE (U.S. Department of Energy), 2010b. *Fernald Preserve 2009 Site Environmental Report*, Fernald Area Office, Cincinnati, Ohio, May.

DOE (U.S. Department of Energy), 2011a. *Fernald Preserve 2010 Site Environmental Report*, Fernald Area Office, Cincinnati, Ohio, May.

DOE (U.S. Department of Energy), 2011b. *Third Five-Year Review Report for the Fernald Preserve*, LMS/FER/S07045, Final, prepared by S.M. Stoller Corporation for DOE, Fernald Area Office, Cincinnati, Ohio, September.

EPA (U.S. Environmental Protection Agency), 1992a. *General Methods for Remedial Operation Performance Evaluations*, Environmental Research Laboratory, Ada, Oklahoma, January.

EPA (U.S. Environmental Protection Agency), 1992b. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities – Addendum to Interim Final Guidance*, July.

EPA (U.S. Environmental Protection Agency), 1996. *Report on the 1995 Workshop on Geosynthetic Clay Liners*, EPA/600/R-96/149, Washington, D.C., June.

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

ERM Midwest, Inc., 1994. "Remedial Investigation and Risk Assessment, Paddys Run Road Site," Revision 1, Volumes 1 through 5, Crosby Township, Hamilton, Ohio.

U.S. Navy, 1999. *Handbook for Statistical Analysis of Environmental Background Data*, prepared by SWDIB and EFA West of Naval Facilities Engineering Command, July.

This page intentionally left blank

**Attachment A.1**

This page intentionally left blank

# A.1.0 Operational Assessment

This attachment presents operational data for each extraction well pumping in 2011, and estimates on when uranium concentrations at each extraction well will reach the aquifer cleanup standard for uranium of 30 micrograms per liter (μg/L). During 2011, 23 extraction wells were operational. Figure A.1−1 depicts the locations of extraction and former re-injection wells and identifies surrounding monitoring wells. Table A.1−1 provides summaries of gallons pumped, total uranium removed, and uranium removal indices for 2011 and for August 1993 through December 2011.

Information in this attachment is organized into the following subsections:

- South Field Module (Section A.1.1)
- South Plume Module (Section A.1.2)
- Waste Storage Area Module (Section A.1.3)
- Total Uranium Data (Section A.1.4)
- Pumping Rates (Section A.1.5).

## A.1.1 South Field Module

Thirteen extraction wells were operational in the South Field Module in 2011. The 13 active extraction wells (EW) are 31550 (EW-18), 31560 (EW-19), 31561 (EW-20), 33326 (EW-17a), 32276 (EW-22), 32446 (EW-24), 32447 (EW-23), 33061 (EW-25), 33262 (EW-15a), 33264 (EW-30), 33265 (EW-31), 33266 (EW-32), and 33298 (EW-21a).

The target combined pumping rate for the South Field Module wells in 2011 was 2,575 gallons per minute (gpm). The combined performance data for the South Field Module are presented in Table A.1−1. This target rate is consistent with pumping rates defined for the Waste Storage Area (Phase II) Model Design. Tables A.1−2 through A.1−14 provide individual extraction well performance data for 2011. The footnotes explain individual extraction well outages of greater than 24 hours.

During 2011, 1,290.96 million gallons (M gal) of groundwater were pumped by the active extraction wells in the South Field Module, resulting in the removal of 337.71 pounds (lbs) of uranium from the Great Miami Aquifer (GMA). Since startup of the South Field Module in July 1998, the module has removed 14.87 billion gallons of water and 6,504.87 lbs of uranium from the GMA.

## A.1.2 South Plume Module

Six extraction wells were operational in the South Plume Module in 2011. The six active recovery wells (RW) are 3924 (RW-1), 3925 (RW-2), 3926 (RW-3), 3927 (RW-4), 32308 (RW-6), and 32309 (RW-7). These wells are located south of Willey Road and north of New Haven Road.

The target combined pumping rate for the South Plume Module in 2011 was 1,200 gpm. Tables A.1−15 through A.1−20 provide individual extraction well performance data for the

South Plume Module extraction wells in 2011. The footnotes explain individual extraction well outages of greater than 24 hours. The combined performance data for the South Plume Module are presented in Table A.1−1.

During 2011, 620.53 M gal of groundwater were pumped by the six wells in the South Plume Module, resulting in the removal of 107.94 lbs of uranium from the GMA. Since startup of the South Plume Module in August 1993, the module has removed 13.05 billion gallons of groundwater and 2,685.66 lbs of uranium from the GMA.

During 2011, the South Plume Module continued to meet the primary objectives of:

- Preventing further southward movement of the total uranium plume while capturing the main lobe of the South Plume without adversely affecting the Paddys Run Road Site (PRRS) plume (3924 [RW-1], 3925 [RW-2], 3926 [RW-3], and 3927 [RW-4]).
- Actively remediating the higher concentration region of the off-property plume (32308 [RW-6] and 32309 [RW-7]).

Attachment A.3 presents additional details concerning capture, along with supporting data.

In 2011, as in previous years, PRRS constituents of concern (arsenic, phosphorus, potassium, sodium, and volatile organic compounds) were monitored at 11 monitoring well locations immediately south of the South Plume Module to ensure that the operation of the system does not adversely impact the PRRS plume. The 11 wells monitored were 2128, 2625, 2636, 2898, 2899, 2900, 3128, 3636, 3898, 3899, and 3900 (refer to Figure A.1−1).

The Mann-Kendall test for trend was run on PRRS data collected from these wells. As indicated in Table A.1−21, three parameters at five different wells monitored for PRRS constituents of concern had "up, significant" trends:

- Arsenic in monitoring wells 2898, 2899, 3636, 3898, and 3899
- Potassium in monitoring wells 2898, 2899, 3898, and 3899
- Sodium in monitoring wells 3898 and 3899

Concentration versus time plots for these constituents and wells are provided in Figures A.1−2 through A.1−12. As reported in Attachment A.3, with the exception of well 3636, the groundwater flow direction at these wells was from the northeast to southwest. This indicates that the increasing concentrations at these locations were moving toward the PRRS plume, not away from it. Well 3636 is south of the south plume extraction wells. Water table maps provided in Attachment A.3 indicate that the flow direction at Well 3636 is to the south, away from the south plume wells.

The monitoring activity for PRRS constituents of concern also included sampling for volatile organic compounds. These compounds are monitored because they were present in the PRRS plume, which is not of Fernald origin (ERM Midwest, Inc. 1994).

In 2011, toluene was detected in five different monitoring wells (well 2900, well 3636, well 3898, well 3899, and well 3900). All results were assigned a qualifier of "J", which indicates the results are estimated values. The "J" qualifier was assigned, because the results were above the method detection limit but below contract required detection limit of 10 μg/L.

Toluene was detected last year in wells 3636 and 3900, again qualified as “J” for the same reason. Toluene is a common lab contaminant. Given the low estimated values of these detections, continued monitoring is the recommended action at this time.

### A.1.3 Waste Storage Area Module

Four extraction wells were operational in the former Waste Storage Area in 2011. The four extraction wells are 32761 (EW-26), 33062 (EW-27), 33334 (EW-28a), and 33347 (EW-33a).

The target combined pumping rate for the Waste Storage Area Module wells in 2011 was 1,000 gpm. This target pumping rate is consistent with the Waste Storage Area (Phase II) Model Design. Tables A.1−22 through A.1−25 provide individual extraction well performance data for the Waste Storage Area Module wells. The combined performance data for the Waste Storage Area Module are presented in Table A.1−1.

During 2011, 519.93 M gal of groundwater were pumped from extraction wells in the Waste Storage Area Module, resulting in the removal of 98.07 lbs of uranium from the GMA. Since startup of the Waste Storage Area Module in May 2002, 4.264 billion gallons of water and 1,690.642 lbs of uranium have been removed from the GMA.

### A.1.4 Total Uranium Data

Water samples were collected monthly in 2011 from the extraction wells and analyzed for total uranium. The total uranium concentrations are used to calculate the mass of uranium removed by the well, support the statistical trend analysis presented in Attachment A.2, and determine if a well is routed to treatment or to bypass treatment. Figure A.1−13 provides a graph of the monthly gallons of groundwater extracted versus the monthly gallons of groundwater treated for 2011. Since 2005, the percentage of treatment needed to achieve uranium discharge limits has been decreasing. Data collected since 2010 indicates that the aquifer remedy can now achieve the uranium discharge limits (i.e., average monthly concentration of less than 30 µg/L, and 600 lbs annually) established in the Operable Unit 5 (OU5) Record of Decision (ROD) without groundwater treatment.

Uranium concentration data collected from the extraction wells are also being tracked graphically to predict when the extraction-well-specific uranium concentrations will reach the groundwater remediation goal of 30 µg/L and to help determine how long groundwater treatment will be necessary. The data are tracked by plotting uranium concentrations over time and then fitting a regression line to the data set.

Figures A.1−14 through A.1−36 are uranium concentration versus time plots for each extraction well. Each graph displays three different data sets (operational data, 95 percent upper confidence level [UCL] of the operational data, and model predictions). Trend lines for the operational data set and the 95 percent UCL of the operational data set were fitted using the regression analysis function in Microsoft Excel software.

As pumping continues, the uranium concentration of the pumped groundwater will decrease. The slope of a fitted regression curve through the uranium concentration data set collected at each extraction well provides a prediction of when pumping concentrations will decrease below 30 µg/L at each well. However, the slope of a fitted regression curve through the pumped uranium concentration data set is an insufficient statistical measure by itself because future measured concentrations could vary about the trend curve. U.S. Environmental Protection Agency (EPA) guidelines in *General Methods for Remedial Operation Performance Evaluations* (EPA 1992a) suggest that a 95 percent UCL of the measured uranium concentration data set can be used to help evaluate the uncertainty of the predicted data trend. From this perspective, the concentration trend of the measured data set presents a less conservative prediction of when pumping concentrations will decrease below 30 µg/L, and the 95 percent UCL data trend presents a more conservative trend prediction (i.e., longer predicted cleanup times).

The graphs in Figures A.1−14 through A.1−36 predict for each extraction well when the actual measured concentrations and the 95 percent UCL calculated concentrations will reach the 30 µg/L FRL for total uranium. For example, the concentration trend of pumped water from extraction well 31550 (refer to Figure A.1−18) reaches 30 µg/L in approximately 2010 (trend for the measured data set) or beyond 2025 (trend for the 95 percent UCL data).

Figures A.1−14 through A.1−36 also show how modeled uranium concentration predictions relate to the measured and 95 percent UCL data trends. The Variable Saturated Model in 3 Dimensions (VAM 3D) groundwater model uranium concentration predictions are taken from modeling results for the Waste Storage Area (Phase II) Design (DOE 2005a). Groundwater model predictions are based on the assumption that an equilibrium linear isotherm adequately describes the partitioning of total uranium between the sorbed and dissolved phases.

The Fernald groundwater model predicts the future average pounds of uranium that will be removed from the aquifer for each year of the modeled remedy. The average annual pounds of uranium actually removed from the aquifer are compared to the model predictions to assess remedy progress. Concentration regression equations based on measured concentration data collected at the extraction wells are also used to provide a prediction of the number of pounds of uranium that will be removed from the aquifer in future years. Regression equations based on uranium concentration data collected at extraction wells through December 31, 2011, are summarized in Table A.1−26.

At the end of December 2011, approximately 10,805 net lbs of uranium had been removed from the GMA by the pump-and-treat remedy. Model predictions indicate that through 2024 an additional 3,219 lbs of uranium will be removed from the GMA by operating the system according to the Waste Storage Area (Phase II) Design. The concentration data set indicates that an additional 3,313 lbs of uranium will be removed from the GMA based on regression analyses of the individual well data. The 95 percent UCL measured concentration data set indicates that an additional 13,250 lbs of uranium will be removed from the GMA based on regression analyses of the individual well data. A summary of the predictions are provided below.

| | **Data** | **Model** | **95% UCL[a]** |
|---|---|---|---|
| Net pounds of uranium extracted through December 2011 | 10,805 | | |
| Predicted pounds of uranium to be extracted between 2012 and the end of the pump and treat stage of the aquifer remedy | 3,313 | 3,219 | 13,250 |
| **Total predicted pounds of uranium to be removed** | **14,118** | **13,930** | **24,055** |
| | | | |
| **Estimated Percent Complete (based on pounds of uranium to be removed)** | **76%** | **77%** | **45%** |

[a] UCL = Upper Confidence Limit

Table A.1−27 provides a yearly breakdown for the three predictions. Figure A.1−37 illustrates the relationship between the three estimates.

Results indicate that as of January 1, 2011, the extraction well concentration trend-based estimated percent complete for the pump and treat stage of the aquifer remedy is approximately 76 percent (based on the uranium concentration data set) or 77 percent (based on the model predictions). The pump and treat stage of the aquifer remedy is approximately 45 percent complete based on the 95 percent UCL data set. The regression trend predictions based on the measured concentration data are very close to the modeled predictions.

As shown in Table A.1-27, 2011 marks the first year that the percent complete based on concentration data is smaller than the percent complete based on model predictions (76 percent compared to 77 percent respectively). This switch indicates that the modeled cleanup predictions are becoming more optimistic than the actual measured concentration data indicates. The uranium decreases plotted at each extraction well illustrate that the concentration curves are trending asymptotic. Actual uranium decreases measured in the field are decreasing each year. This trend is a characteristic of pump-and-treat remediations in general. DOE will continue to track this trend and may recommend operational changes in efforts to improve uranium removal efficiencies as the remedy continues.

## A.1.5 Pumping Rates

Daily pumping rate data for each extraction well are presented on the U.S. Department of Energy Office of Legacy Management's (LM) website under the Fernald Preserve (http://www.lm.doe.gov/fernald/Sites.aspx); therefore, those data are not repeated here. The footnotes in the well-specific operational tables explain individual well outages of greater than 24 hours.

Target extraction well pumping rates for 2011 are provided in Table A.1−28. The total target pumping rate of 4,775 gpm is consistent with the rate defined by the Waste Storage Area (Phase II) Model Design. As additional operational experience is gained, pumping rates may change as efforts are made to maximize the effectiveness of each module.

*Table A.1–1. Aquifer Restoration System Operational Summary Sheet*

| | Reporting Period | | | | | |
|---|---|---|---|---|---|---|
| | January 2011 through December 2011 | | | August 1993 through December 2011 | | |
| | **Gallons Pumped/ Re-injected (M gal)[a]** | **Total Uranium Removed/ Re-injected (lbs)** | **Uranium Removal Index[b] (lbs/M gal)** | **Gallons Pumped/ Re-injected (M gal)** | **Total Uranium Removed/ Re-injected (lbs)** | **Uranium Removal Index[b] (lbs/M gal)** |
| South Field Module | 1,290.96 | 337.71 | 0.26 | 14,867.885 | 6,504.874 | 0.44 |
| Waste Storage Area Module | 519.93 | 98.07 | 0.19 | 4,264.753 | 1,690.642 | 0.40 |
| South Plume Module | 620.53 | 107.94 | 0.17 | 13,050.465 | 2,685.655 | 0.21 |
| Re-injection Module[c] | 0 | 0 | NA | 1,936.478 | 76.27 | NA |
| Aquifer Restoration Systems Totals | | | | | | |
| Extraction Wells | 2,431.42 | 543.72 | 0.22 | 32,183.103 | 10,881.171 | 0.34 |
| (Re-injection Wells[c]) | 0 | 0 | NA | (1,936.478) | (76.27) | NA |
| Net | 2431.42 | 543.72 | NA | 30,246.625 | 10,804.901 | NA |

[a] million gallons
[b] NA = not applicable
[c] Re-injection module was shut down in September 2004

*Table A.1–2. Extraction Well 31550 (EW-18) Operational Summary Sheet For 2011*

Reference Elevation (feet [ft] amsl) – 572.11 (top of well)
Northing Coordinate ('83) – 477,018.5
Easting Coordinate ('83) – 1,348,979.8

Hours in reporting period – 8,760
Hours not pumped – 682

Hours pumped – 8,078
Operational percent – 92.21
Adjusted operational percent[a] – 99.90

Target pumping rate – 100 gpm

**Monthly Measurements at Well Field**

| Month | Monthly Average Pumping Rate[b] (gpm) | M Gal Pumped | Monthly Total Uranium Concentration[c] (µg/L) | Uranium Removal Index (lbs of total uranium removed/M gal pumped) |
|---|---|---|---|---|
| 1/11 | 105.3 | 4.698 | 35.4 | 0.30 |
| 2/11 | 105.5 | 4.255 | 35.4 | 0.30 |
| 3/11 | 105.0 | 4.688 | 36.4 | 0.30 |
| 4/11 | 102.1 | 4.412 | 40.9 | 0.34 |
| 5/11 | 103.3 | 4.612 | 45.0 | 0.38 |
| 6/11 | 42.8 | 1.849 | 43.4 | 0.36 |
| 7/11 | 82.2 | 3.669 | 45.0 | 0.38 |
| 8/11 | 104.7 | 4.675 | 43.0 | 0.36 |
| 9/11 | 100.6 | 4.347 | 41.4 | 0.35 |
| 10/11 | 104.5 | 4.666 | 38.3 | 0.32 |
| 11/11 | 108.5 | 4.687 | 37.7 | 0.31 |
| 12/11 | 105.9 | 4.727 | 38.3 | 0.32 |
| | Average 97.5 | Total 51.286 | Average 40.0 | Average 0.33 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 18 was down from Jun 13 to Jul 11 for annual well field shutdown.
Well 18 was down from Jul 24 to Jul 26 for a blown fuse.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–3. Extraction Well 31560 (EW-19) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 574.93 (top of well)
Northing Coordinate ('83) – 477,403.1
Easting Coordinate ('83) – 1,349,028.9

Hours in reporting period – 8,760
Hours not pumped – 682

Hours pumped – 8,078
Operational percent – 92.21
Adjusted operational percent[a] – 99.89

Target pumping rate – 100 gpm

| Monthly Measurements at Well Field | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Month** | **Monthly Average Pumping Rate[b] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[c] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | 108.3 | | 4.833 | | 16.1 | | 0.65 |
| 2/11 | 106.2 | | 4.280 | | 15.1 | | 0.54 |
| 3/11 | 106.2 | | 4.739 | | 16.9 | | 0.67 |
| 4/11 | 107.2 | | 4.630 | | 21.1 | | 0.82 |
| 5/11 | 108.8 | | 4.857 | | 24.5 | | 0.99 |
| 6/11 | 44.9 | | 1.940 | | 23.2 | | 0.38 |
| 7/11 | 72.8 | | 3.248 | | 30.3 | | 0.82 |
| 8/11 | 106.3 | | 4.744 | | 29.0 | | 1.15 |
| 9/11 | 103.4 | | 4.466 | | 24.7 | | 0.92 |
| 10/11 | 106.0 | | 4.733 | | 22.9 | | 0.90 |
| 11/11 | 108.9 | | 4.706 | | 20.4 | | 0.80 |
| 12/11 | 112.4 | | 5.017 | | 22.4 | | 0.94 |
| Average | 99.3 | Total | 52.193 | Average | 22.2 | Average | 0.19 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 19 was down from Jun 13 to Jul 11 for annual well field shutdown.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–4. Extraction Well 31561 (EW-20) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 578.77 (top of well)
Northing Coordinate ('83) – 477,660.8
Easting Coordinate ('83) – 1,349,254.5

Hours in reporting period – 8,760
Hours not pumped – 774.5

Hours pumped – 7,986
Operational percent – 91.16
Adjusted operational percent[a] – 98.75

Target pumping rate – 100 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | | **Monthly Average Pumping Rate[b] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[c] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | | 111.2 | | 4.966 | | 30.3 | | 0.25 |
| 2/11 | | 108.3 | | 4.368 | | 30.6 | | 0.26 |
| 3/11 | | 112.9 | | 5.038 | | 27.0 | | 0.23 |
| 4/11 | | 108.9 | | 4.705 | | 29.2 | | 0.24 |
| 5/11 | | 106.4 | | 4.751 | | 27.7 | | 0.23 |
| 6/11 | | 43.7 | | 1.886 | | 29.2 | | 0.24 |
| 7/11 | | 73.7 | | 3.289 | | 29.3 | | 0.24 |
| 8/11 | | 108.7 | | 4.854 | | 32.2 | | 0.27 |
| 9/11 | | 110.5 | | 4.774 | | 33.2 | | 0.28 |
| 10/11 | | 110.3 | | 4.923 | | 34.5 | | 0.29 |
| 11/11 | | 113.8 | | 4.915 | | 33.9 | | 0.28 |
| 12/11 | | 115.2 | | 5.140 | | 32.9 | | 0.27 |
| | Average | 102.0 | Total | 53.609 | Average | 30.8 | Average | 0.26 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 20 was down from Feb 16 to Feb 17 for chemical treatment.
Well 20 was down from Jun 13 to Jul 11 for annual well field shutdown.
Well 20 was down from Nov 22 to Nov 23 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–5. Extraction Well 33326 (EW-17a) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 574.84 (top of well)
Northing Coordinate ('83) – 477,905.5
Easting Coordinate ('83) – 1,348,854.1

Hours in reporting period – 8,760
Hours not pumped – 1,091

Hours pumped – 7,669
Operational percent – 87.55
Adjusted operational percent[a] – 94.8

Target pumping rate – 175 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | | **Monthly Average Pumping Rate[b] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[c] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | | 160.3 | | 7.155 | | 16.2 | | 0.14 |
| 2/11 | | 164.6 | | 6.638 | | 16.5 | | 0.14 |
| 3/11 | | 174.2 | | 7.778 | | 17.0 | | 0.14 |
| 4/11 | | 177.0 | | 7.648 | | 20.1 | | 0.17 |
| 5/11 | | 187.6 | | 8.375 | | 20.3 | | 0.17 |
| 6/11 | | 65.8 | | 2.843 | | 18.8 | | 0.16 |
| 7/11 | | 115.9 | | 5.176 | | 22.4 | | 0.19 |
| 8/11 | | 160.2 | | 7.151 | | 22.9 | | 0.19 |
| 9/11 | | 134.6 | | 5.815 | | 22.0 | | 0.18 |
| 10/11 | | 197.0 | | 8.795 | | 19.3 | | 0.16 |
| 11/11 | | 191.5 | | 8.273 | | 19.8 | | 0.17 |
| 12/11 | | 189.7 | | 8.469 | | 20.2 | | 0.17 |
| | Average | 159.9 | Total | 84.116 | Average | 19.6 | Average | 0.16 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 17a was down from Feb 16 to Feb 17 for chemical treatment.
Well 17a was down from Jun 9 to Jun 10 for chemical treatment.
Well 17a was down from Jun 13 to Jul 11 for annual well field shutdown.
Well 17a was down from Aug 23 to Aug 24 for chemical treatment.
Well 17a was down from Aug 28 to Sep 8 due to a ground fault.
Well 17a was down from Sep 7 to Sep 8 to replace variable frequency drive.
Well 17a was down from Sep 19 to Sep 20 for chemical treatment.
Well 17a was down from Dec 19 to Dec 20 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–6. Extraction Well 32276 (EW-22) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 567.14 (top of well)
Northing Coordinate ('83) – 476,447.3
Easting Coordinate ('83) – 1,348,857.3

Hours in reporting period – 8,760
Hours not pumped – 738

Hours pumped – 8,023
Operational percent – 91.58
Adjusted operational percent[a] – 99.21

Target pumping rate – 300 gpm

| Monthly Measurements at Well Field | | | | |
|---|---|---|---|---|
| **Month** | **Monthly Average Pumping Rate[b] (gpm)** | **M Gal Pumped** | **Monthly Total Uranium Concentration[c] (µg/L)** | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | 300.0 | 13.392 | 32.9 | 0.27 |
| 2/11 | 276.0 | 11.128 | 31.9 | 0.27 |
| 3/11 | 316.9 | 14.146 | 30.2 | 0.25 |
| 4/11 | 316.9 | 13.688 | 33.6 | 0.28 |
| 5/11 | 328.8 | 14.678 | 34.0 | 0.28 |
| 6/11 | 132.4 | 5.720 | 37.8 | 0.32 |
| 7/11 | 224.1 | 10.005 | 40.5 | 0.34 |
| 8/11 | 421.0 | 18.792 | 35.3 | 0.29 |
| 9/11 | 327.5 | 14.146 | 33.5 | 0.28 |
| 10/11 | 326.9 | 14.594 | 32.2 | 0.27 |
| 11/11 | 330.7 | 14.288 | 30.6 | 0.26 |
| 12/11 | 298.1 | 13.308 | 29.6 | 0.25 |
| | Average 298.1 | Total 157.877 | Average 33.5 | Average 0.28 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 22 was down from Feb 21 to Feb 22 for chemical treatment.
Well 22 was down from Jun 13 to Jul 11 for annual well field shutdown.
Well 22 was down from Dec 21 to Dec 22 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–7. Extraction Well 32446 (EW-24) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 578.367 (top of well)
Northing Coordinate ('83) – 476,634.53
Easting Coordinate ('83) – 1,349,312.38

Hours in reporting period – 8,760
Hours not pumped – 981

Hours pumped – 7,779
Operational percent – 88.8
Adjusted operational percent[a] – 96.19

Target pumping rate – 300 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | | **Monthly Average Pumping Rate[b] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[c] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | | 279.1 | | 12.460 | | 42.6 | | 0.36 |
| 2/11 | | 291.1 | | 11.738 | | 31.9 | | 0.25 |
| 3/11 | | 321.4 | | 14.348 | | 40.2 | | 0.34 |
| 4/11 | | 317.4 | | 13.710 | | 43.5 | | 0.36 |
| 5/11 | | 293.5 | | 13.104 | | 42.9 | | 0.36 |
| 6/11 | | 36.8 | | 1.589 | | 39.8 | | 0.33 |
| 7/11 | | 213.2 | | 9.515 | | 40.9 | | 0.34 |
| 8/11 | | 303.9 | | 13.567 | | 41.2 | | 0.34 |
| 9/11 | | 315.6 | | 13.633 | | 42.5 | | 0.35 |
| 10/11 | | 323.8 | | 14.453 | | 41.6 | | 0.35 |
| 11/11 | | 312.0 | | 13.477 | | 40.6 | | 0.34 |
| 12/11 | | 330.6 | | 14.757 | | 40.0 | | 0.33 |
| | Average | 278.2 | Total | 146.352 | Average | 40.6 | Average | 0.34 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 24 was down from Jan 10 to Jan 13 due to a problem with the variable frequency drive.
Well 24 was down from Feb 17 to Feb 18 for chemical treatment.
Well 24 was down from Jun 6 to Jun 9 for chemical treatment and motor repair.
Well 24 was down from Jun 13 to Jul 11 for annual well field shutdown.
Well 24 was down from Aug 22 to Aug 23 for chemical treatment.
Well 24 was down from Aug 30 to Aug 31 for chemical treatment.
Well 24 was down from Nov 21 to Nov 22 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–8. Extraction Well 32447 (EW-23) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 574.528 (top of well)
Northing Coordinate ('83) – 477,150.24
Easting Coordinate ('83) – 1,349,421.19

Hours in reporting period – 8,760
Hours not pumped – 918

Hours pumped – 7,842
Operational percent – 89.5
Adjusted operational percent[a] – 96.97

Target pumping rate – 300 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | | **Monthly Average Pumping Rate[b] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[c] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | | 259.7 | | 11.593 | | 23.7 | | 0.20 |
| 2/11 | | 261.2 | | 10.531 | | 51.5 | | 0.43 |
| 3/11 | | 313.1 | | 13.976 | | 47.6 | | 0.40 |
| 4/11 | | 296.4 | | 12.804 | | 52.4 | | 0.44 |
| 5/11 | | 247.6 | | 11.052 | | 50.4 | | 0.42 |
| 6/11 | | 87.3 | | 3.769 | | 40.58 | | 0.34 |
| 7/11 | | 215.7 | | 9.629 | | 44.98 | | 0.38 |
| 8/11 | | 276.1 | | 12.324 | | 52.3 | | 0.44 |
| 9/11 | | 313.7 | | 13.554 | | 53.4 | | 0.45 |
| 10/11 | | 304.4 | | 13.591 | | 53.4 | | 0.45 |
| 11/11 | | 278.7 | | 12.038 | | 51.3 | | 0.43 |
| 12/11 | | 326.2 | | 14.561 | | 53 | | 0.44 |
| | Average | 265.0 | Total | 139.422 | Average | 47.9 | Average | 0.40 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 23 was down from Feb 17 to Feb 18 for chemical treatment.
Well 23 was down from June 6 to June 7 for chemical treatment.
Well 23 was down from Jun 8 to Jun 9 for chemical treatment.
Well 23 was down from Jun 13 to Jul 11 for annual well field shutdown.
Well 23 was down from Aug 22 to Aug 23 for chemical treatment.
Well 23 was down from Aug 30 to Aug 31 for chemical treatment.
Well 23 was down from Nov 21 to Nov 22 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–9. Extraction Well 33061 (EW-25) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 575.56 (top of well)
Northing Coordinate ('83) – 478,318.82
Easting Coordinate ('83) – 1,349,531.03

Hours in reporting period – 8,760
Hours not pumped – 823

Hours pumped – 7937
Operational percent – 90.6
Adjusted operational percent[a] – 98.15

Target pumping rate – 100 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | | **Monthly Average Pumping Rate[b] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[c] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | | 145.9 | | 6.512 | | 25.20 | | 0.21 |
| 2/11 | | 129.4 | | 5.219 | | 21.20 | | off |
| 3/11 | | 107.8 | | 4.812 | | 22.20 | | off |
| 4/11 | | 103.6 | | 4.476 | | 37.30 | | 0.31 |
| 5/11 | | 109.2 | | 4.873 | | 53.50 | | 0.45 |
| 6/11 | | 28.5 | | 1.233 | | 52.55 | | 0.44 |
| 7/11 | | 71.4 | | 3.187 | | 46.22 | | 0.39 |
| 8/11 | | 104.6 | | 4.669 | | 45.90 | | 0.38 |
| 9/11 | | 99.4 | | 4.293 | | 36.10 | | 0.30 |
| 10/9 | | 105.1 | | 4.691 | | 32.20 | | 0.27 |
| 11/11 | | 106.7 | | 4.609 | | 30.70 | | 0.26 |
| 12/11 | | 104.1 | | 4.649 | | 41.50 | | 0.35 |
| | Average | 101.3 | Total | 53.222 | Average | 37.0 | Average | 0.33 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 25 was down from Feb 15 to Feb 16 for chemical treatment.
Well 25 was down from Jun 9 to Jul 11 for rehab and annual well field shutdown.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–10. Extraction Well 33262 (EW-15a) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 568.368 (top of well)
Northing Coordinate ('83) – 477,799.912
Easting Coordinate ('83) – 1,348,149.97

Hours in reporting period – 8,760
Hours not pumped – 898

Hours pumped – 7,863
Operational percent – 89.8
Adjusted operational percent[a] – 97.23

Target pumping rate – 200 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | | **Monthly Average Pumping Rate[b] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[c] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | | 216.8 | | 9.679 | | 25.0 | | 0.21 |
| 2/11 | | 217.4 | | 8.767 | | 24.9 | | 0.21 |
| 3/11 | | 216.0 | | 9.640 | | 23.5 | | 0.20 |
| 4/11 | | 210.4 | | 9.091 | | 32.8 | | 0.27 |
| 5/11 | | 155.6 | | 6.947 | | 33.8 | | 0.28 |
| 6/11 | | 88.0 | | 3.802 | | 35.5 | | 0.30 |
| 7/11 | | 151.1 | | 6.744 | | 38.4 | | 0.32 |
| 8/11 | | 217.5 | | 9.708 | | 35.1 | | 0.29 |
| 9/11 | | 213.8 | | 9.234 | | 32.7 | | 0.27 |
| 10/11 | | 213.3 | | 9.521 | | 37.5 | | 0.31 |
| 11/11 | | 218.6 | | 9.443 | | 32.5 | | 0.27 |
| 12/11 | | 216.1 | | 9.645 | | 36.0 | | 0.30 |
| | Average | 194.5 | Total | 102.221 | Average | 32.3 | Average | 0.27 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 15a was down from May 14 to May 23 due to lightning strike.
Well 15a was down from Jun 13 to Jul 11 for annual well field shutdown.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–11. Extraction Well 33264 (EW-30) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 573.818 (top of well)
Northing Coordinate ('83) – 477,200.945
Easting Coordinate ('83) – 1,349,751.49

Hours in reporting period – 8,760
Hours not pumped – 850
Hours pumped – 7,910
Operational percent – 90.3
Adjusted operational percent[a] – 97.8
Target pumping rate – 200 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | | **Monthly Average Pumping Rate[b] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[c] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | | 210.0 | | 9.374 | | 39.0 | | 0.33 |
| 2/11 | | 201.9 | | 8.141 | | 39.1 | | 0.33 |
| 3/11 | | 210.1 | | 9.377 | | 42.4 | | 0.35 |
| 4/11 | | 207.8 | | 8.976 | | 46.0 | | 0.38 |
| 5/11 | | 204.1 | | 9.113 | | 43.2 | | 0.36 |
| 6/11 | | 53.7 | | 2.318 | | 37.3 | | 0.31 |
| 7/11 | | 145.0 | | 6.474 | | 25.8 | | 0.22 |
| 8/11 | | 213.0 | | 9.510 | | 41.4 | | 0.35 |
| 9/11 | | 203.7 | | 8.798 | | 40.7 | | 0.34 |
| 10/11 | | 213.5 | | 9.532 | | 42.3 | | 0.35 |
| 11/11 | | 211.4 | | 9.132 | | 40.5 | | 0.34 |
| 12/11 | | 210.0 | | 9.375 | | 40.1 | | 0.33 |
| | Average | 190.3 | Total | 100.12 | Average | 39.8 | Average | 0.33 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 30 was down from Jun 9 to Jul 11 for rehab and annual well field shutdown.
Well 30 was down from Dec 30 to Dec 31 for unknown reasons.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–12. Extraction Well 33265 (EW-31) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 577.474 (top of well)
Northing Coordinate ('83) – 477,598.909
Easting Coordinate ('83) – 1,349,849.01

Hours in reporting period – 8,760
Hours not pumped – 1,049

Hours pumped – 7,711
Operational percent – 88.03
Adjusted operational percent[a] – 95.35

Target pumping rate – 300 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Month | | Monthly Average Pumping Rate[b] (gpm) | | M Gal Pumped | | Monthly Total Uranium Concentration[c] (µg/L) | | Uranium Removal Index (lbs of total uranium removed/M gal pumped) |
| 1/11 | | 326.7 | | 14.583 | | 12.4 | | 0.10 |
| 2/11 | | 318.3 | | 12.833 | | 11.8 | | 0.10 |
| 3/11 | | 322.3 | | 14.388 | | 13.4 | | 0.11 |
| 4/11 | | 313.2 | | 13.531 | | 14.0 | | 0.12 |
| 5/11 | | 244.2 | | 10.899 | | 16.0 | | 0.13 |
| 6/11 | | 130.2 | | 5.623 | | 15.5 | | 0.13 |
| 7/11 | | 214.0 | | 9.555 | | 21.3 | | 0.18 |
| 8/11 | | 311.2 | | 13.891 | | 18.4 | | 0.15 |
| 9/11 | | 313.7 | | 13.551 | | 14.2 | | 0.12 |
| 10/11 | | 280.3 | | 12.514 | | 12.5 | | 0.10 |
| 11/11 | | 319.9 | | 13.819 | | 14.4 | | 0.12 |
| 12/11 | | 306.2 | | 13.669 | | 13.8 | | 0.12 |
| | Average | 283.3 | Total | 148.858 | Average | 14.8 | Average | 0.12 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 31 was down from May 5 to May 12 due to hole in pipe in valve house.
Well 31 was down from Jun 13 to Jul 11 for annual well field shutdown.
Well 31 was down from Aug 25 to Aug 26 for chemical treatment.
Well 31 was down from Oct 14 to Oct 18 for chemical treatment.
Well 31 was down from Dec 30 to Dec 31 for unknown reasons.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–13. Extraction Well 33266 (EW-32) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 579.625 (top of well)
Northing Coordinate ('83) – 476,997.576
Easting Coordinate ('83) – 1,350,046.97

Hours in reporting period – 8,760
Hours not pumped – 752

Hours pumped – 8,008
Operational percent – 91.42
Adjusted operational percent[a] – 99.02

Target pumping rate – 200 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | | **Monthly Average Pumping Rate[b] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[c] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | | 213.9 | | 9.547 | | 5.6 | | 0.05 |
| 2/11 | | 211.6 | | 8.532 | | 5.7 | | 0.05 |
| 3/11 | | 214.8 | | 9.590 | | 5.4 | | 0.05 |
| 4/11 | | 210.4 | | 9.089 | | 5.8 | | 0.05 |
| 5/11 | | 216.4 | | 9.662 | | 5.1 | | 0.04 |
| 6/11 | | 86.0 | | 3.715 | | 5.8 | | 0.05 |
| 7/11 | | 144.0 | | 6.428 | | 6.9 | | 0.06 |
| 8/11 | | 281.0 | | 12.546 | | 5.6 | | 0.05 |
| 9/11 | | 215.9 | | 9.325 | | 5.2 | | 0.04 |
| 10/11 | | 223.9 | | 9.997 | | 5.3 | | 0.04 |
| 11/11 | | 222.9 | | 9.629 | | 4.5 | | 0.04 |
| 12/11 | | 218.6 | | 9.758 | | 4.9 | | 0.04 |
| | Average | 205.0 | Total | 107.818 | Average | 5.5 | Average | 0.05 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 32 was down from Jun 13 to Jul 11 for annual well field shutdown.
Well 32 was down from Dec 19 to Dec 20 for chemical treatment.
Well 32 was down from Dec 30 to Dec 31 for unknown reasons.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–14. Extraction Well 33298 (EW-21a) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 576.21 (top of well)
Northing Coordinate ('83) – 477,953.1
Easting Coordinate ('83) – 1,349,499.9

Hours in reporting period – 8,760
Hours not pumped – 1,456

Hours pumped – 7,304
Operational percent – 83.4
Adjusted operational percent[a] – 90.32

Target pumping rate – 200 gpm

| Monthly Measurements at Well Field | | | | |
|---|---|---|---|---|
| **Month** | **Monthly Average Pumping Rate[b] (gpm)** | **M Gal Pumped** | **Monthly Total Uranium Concentration[c] (µg/L)** | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | 217.1 | 9.689 | 37.1 | 0.31 |
| 2/11 | 214.7 | 8.657 | 35.7 | 0.30 |
| 3/11 | 215.2 | 9.607 | 35.5 | 0.30 |
| 4/11 | 212.8 | 9.191 | 41.5 | 0.35 |
| 5/11 | 207.6 | 9.266 | 48.8 | 0.41 |
| 6/11 | 86.5 | 3.738 | 45.7 | 0.38 |
| 7/11 | 144.8 | 6.462 | 54.9 | 0.46 |
| 8/11 | 212.6 | 9.491 | 47.2 | 0.39 |
| 9/11 | 207.1 | 8.948 | 42.0 | 0.35 |
| 10/11 | 214.3 | 9.567 | 41.3 | 0.34 |
| 11/11 | 213.8 | 9.236 | 38.4 | 0.32 |
| 12/11 | 0.0 | 0.000 | 0.0 | 0.00 |
| | Average 178.9 | Total 93.854 | Average 32.9 | Average 0.33 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 21a was down from Jun 13 to Jul 11 for rehab annual well field shutdown.
Well 21a was down from Dec 1 to Dec 31 for pump and motor and to investigate possible hole in screen.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–15. Extraction Well 3924 (RW-1) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 533.51 (top of well)
Northing Coordinate ('83) – 474,219.7
Easting Coordinate ('83) – 1,348,314.3

Hours in reporting period – 8,760 Hours pumped – 8608.5 Target pumping rate – 200 gpm
Hours not pumped – 151.5 Operational percent – 98.27

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | | **Monthly Average Pumping Rate[a] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[b] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | | 218.6 | | 9.756 | | 20.8 | | 0.17 |
| 2/11 | | 213.5 | | 8.608 | | 19.7 | | 0.16 |
| 3/11 | | 216.6 | | 9.670 | | 19.7 | | 0.16 |
| 4/11 | | 293.6 | | 12.684 | | 19.2 | | 0.16 |
| 5/11 | | 297.5 | | 13.279 | | 16.5 | | 0.14 |
| 6/11 | | 238.1 | | 10.285 | | 14.8 | | 0.12 |
| 7/11 | | 208.5 | | 9.306 | | 14.1 | | 0.12 |
| 8/11 | | 212.2 | | 9.473 | | 15.0 | | 0.13 |
| 9/11 | | 258.2 | | 11.153 | | 14.6 | | 0.12 |
| 10/11 | | 243.8 | | 10.884 | | 14.7 | | 0.12 |
| 11/11 | | 219.2 | | 9.469 | | 14.5 | | 0.12 |
| 12/11 | | 218.5 | | 9.756 | | 15.2 | | 0.13 |
| | Average | 236.5 | Total | 124.324 | Average | 16.6 | Average | 0.14 |

[a] Well 1 was down from Mar 1 to Mar 2 for chemical treatment.
Well 1 was down from Jun 28 to Jun 29 for annual Cla-Val maintenance.
Well 1 was down from Aug 18 to Aug 19 for chemical treatment.
[b] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–16. Extraction Well 3925 (RW-2) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 542.01 (top of well)
Northing Coordinate ('83) – 474,319.7
Easting Coordinate ('83) – 1,348,565.4

Hours in reporting period – 8,760
Hours not pumped – 150.5
Hours pumped – 8,609.5
Operational percent – 98.3
Target pumping rate – 200 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Month | | Monthly Average Pumping Rate[a] (gpm) | | M Gal Pumped | | Monthly Total Uranium Concentration[b] (µg/L) | | Uranium Removal Index (lbs of total uranium removed/M gal pumped) |
| 1/11 | | 219.2 | | 9.784 | | 16.6 | | 0.14 |
| 2/11 | | 206.8 | | 8.339 | | 16.5 | | 0.14 |
| 3/11 | | 216.7 | | 9.674 | | 15.9 | | 0.13 |
| 4/11 | | 293.1 | | 12.663 | | 16.9 | | 0.14 |
| 5/11 | | 298.2 | | 13.310 | | 15.8 | | 0.13 |
| 6/11 | | 237.3 | | 10.252 | | 17.6 | | 0.15 |
| 7/11 | | 212.2 | | 9.472 | | 18.2 | | 0.15 |
| 8/11 | | 210.5 | | 9.395 | | 18.9 | | 0.16 |
| 9/11 | | 247.5 | | 10.692 | | 16.9 | | 0.14 |
| 10/11 | | 230.8 | | 10.303 | | 16.7 | | 0.14 |
| 11/11 | | 200.3 | | 8.654 | | 15.8 | | 0.13 |
| 12/11 | | 160.4 | | 7.160 | | 16.3 | | 0.14 |
| | Average | 227.8 | Total | 119.7 | Average | 16.8 | Average | 0.14 |

[a] Well 2 was down from Mar 1 to Mar 2 for chemical treatment.
Well 2 was down from Jun 28 to Jun 29 for annual Cla-Val maintenance.
Well 2 was down from Aug 18 to Aug 19 for chemical treatment.
[b] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–17. Extraction Well 3926 (RW-3) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 586.73 (top of well)
Northing Coordinate ('83) – 474,428.6
Easting Coordinate ('83) – 1,348,837.5

Hours in reporting period – 8,760 | Hours pumped – 8,559 | Target pumping rate – 200 gpm
Hours not pumped – 201 | Operational percent – 97.71

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | | **Monthly Average Pumping Rate[a] (gpm)** | | **M Gal Pumped** | | **Monthly Total Uranium Concentration[b] (µg/L)** | | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | | 185.0 | | 8.261 | | 22.2 | | 0.19 |
| 2/11 | | 162.6 | | 6.556 | | 22.0 | | 0.18 |
| 3/11 | | 208.0 | | 9.286 | | 21.5 | | 0.18 |
| 4/11 | | 207.5 | | 8.965 | | 27.9 | | 0.23 |
| 5/11 | | 205.7 | | 9.183 | | 21.4 | | 0.18 |
| 6/11 | | 196.5 | | 8.490 | | 22.2 | | 0.19 |
| 7/11 | | 197.2 | | 8.805 | | 23.9 | | 0.20 |
| 8/11 | | 190.9 | | 8.520 | | 24.4 | | 0.20 |
| 9/11 | | 206.0 | | 8.900 | | 24.0 | | 0.20 |
| 10/11 | | 215.6 | | 9.623 | | 24.2 | | 0.20 |
| 11/11 | | 193.6 | | 8.365 | | 25.9 | | 0.22 |
| 12/11 | | 175.7 | | 7.843 | | 25.9 | | 0.22 |
| | Average | 195.4 | Total | 102.797 | Average | 23.8 | Average | 0.20 |

[a] Well 3 was down from Mar 3 to Mar 4 for chemical treatment.
Well 3 was down from Jun 8 to Jun 9 for chemical treatment.
Well 3 was down from Jun 28 to Jun 29 for annual Cla-Val maintenance.
Well 3 was down from Aug 17 to Aug 18 for chemical treatment.
Well 3 was down from Sep13 to Sep 14 for chemical treatment.
[b] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–18. Extraction Well 3927 (RW-4) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 591.84 (top of well)
Northing Coordinate ('83) – 474,541.8
Easting Coordinate ('83) – 1,349,127.3

Hours in reporting period – 8,760 | Hours pumped – 6,583.75 | Target pumping rate – 200 gpm
Hours not pumped – 2,176.3 | Operational percent – 75.16

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Month | | Monthly Average Pumping Rate[a] (gpm) | | M Gal Pumped | | Monthly Total Uranium Concentration[b] (µg/L) | | Uranium Removal Index (lbs of total uranium removed/M gal pumped) |
| 1/11 | | 218.1 | | 9.738 | | 2.4 | | 0.02 |
| 2/11 | | 211.8 | | 8.540 | | 5.0 | | 0.04 |
| 3/11 | | 167.8 | | 7.492 | | 3.0 | | 0.03 |
| 4/11 | | 0.0 | | 0.000 | | 3.0 | | 0.00 |
| 5/11 | | 152.2 | | 6.795 | | 3.5 | | 0.03 |
| 6/11 | | 145.5 | | 6.287 | | 3.8 | | 0.03 |
| 7/11 | | 211.4 | | 9.435 | | 3.4 | | 0.03 |
| 8/11 | | 223.7 | | 9.986 | | 3.1 | | 0.03 |
| 9/11 | | 114.0 | | 4.925 | | 2.6 | | 0.02 |
| 10/11 | | 146.7 | | 6.550 | | 2.4 | | 0.02 |
| 11/11 | | 215.8 | | 9.323 | | 2.6 | | 0.02 |
| 12/11 | | 213.3 | | 9.520 | | 3.0 | | 0.03 |
| | Average | 168.4 | Total | 88.591 | Average | 3.2 | Average | 0.03 |

[a] Well 4 was down from Mar 24 to May 16 due to suspected hole in screen.
Well 4 was down from Jun 13 to Jun 21 due to an electrical problem.
Well 4 was down from Jun 28 to Jun 29 for annual Cla-Val maintenance.
Well 4 was down from Aug 17 to Aug 18 for chemical treatment.
Well 4 was down from Sep 16 Oct 10 for VFD installation.
[b] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–19. Extraction Well 32308 (RW-6) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 582.05 (top of casing)
Northing Coordinate ('83) – 475,078.83
Easting Coordinate ('83) – 1,348,693.9

Hours in reporting period – 8,760
Hours not pumped – 884.3

Hours pumped – 7,875
Operational percent – 89.91
Adjusted operational percent[a] – 97.38

Target pumping rate – 200 gpm

| Monthly Measurements at Well Field | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Month | | Monthly Average Pumping Rate[b] (gpm) | | M Gal Pumped | | Monthly Total Uranium Concentration[c] (μg/L) | | Uranium Removal Index (lbs of total uranium removed/M gal pumped) |
| 1/11 | | 123.4 | | 5.511 | | 33.4 | | 0.28 |
| 2/11 | | 103.6 | | 4.175 | | 32.4 | | 0.27 |
| 3/11 | | 100.8 | | 4.497 | | 33.6 | | 0.28 |
| 4/11 | | 216.0 | | 9.331 | | 34.0 | | 0.28 |
| 5/11 | | 218.5 | | 9.754 | | 34.3 | | 0.29 |
| 6/11 | | 88.4 | | 3.817 | | 31.4 | | 0.26 |
| 7/11 | | 97.0 | | 4.331 | | 31.8 | | 0.27 |
| 8/11 | | 211.8 | | 9.455 | | 32.9 | | 0.27 |
| 9/11 | | 215.6 | | 9.315 | | 34.5 | | 0.29 |
| 10/11 | | 208.2 | | 9.293 | | 35.1 | | 0.29 |
| 11/11 | | 219.5 | | 9.484 | | 37.7 | | 0.31 |
| 12/11 | | 218.0 | | 9.730 | | 37.0 | | 0.31 |
| | Average | 168.4 | Total | 88.693 | Average | 34.0 | Average | 0.28 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 6 was down from Mar 30 to Mar 31 for pump replacement.
Well 6 was down from Jun 11 to Jul 18 for rehab annual well field shutdown.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–20. Extraction Well 32309 (RW-7) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 582.05 (top of casing)
Northing Coordinate ('83) – 475,109.60
Easting Coordinate ('83) – 1,348,366.34

Hours in reporting period – 8,760
Hours not pumped – 780.5

Hours re-injected – 7,980
Operational percent – 91.09
Adjusted operational percent[a] – 98.68

Target pumping rate – 200 gpm

| Monthly Measurements at Well Field | | | | |
|---|---|---|---|---|
| Month | Monthly Average Pumping Rate[b] (gpm) | M Gal Pumped | Monthly Total Uranium Concentration[c] (µg/L) | Uranium Removal Index (lbs of total uranium removed/M gal pumped) |
| 1/11 | 177.0 | 7.903 | 30.3 | 0.25 |
| 2/11 | 152.4 | 6.144 | 31.3 | 0.26 |
| 3/11 | 152.9 | 6.825 | 31.5 | 0.26 |
| 4/11 | 203.3 | 8.783 | 34.5 | 0.29 |
| 5/11 | 218.9 | 9.770 | 38.1 | 0.32 |
| 6/11 | 88.3 | 3.814 | 32.5 | 0.27 |
| 7/11 | 147.3 | 6.574 | 34.5 | 0.29 |
| 8/11 | 211.3 | 9.434 | 33.2 | 0.28 |
| 9/11 | 207.8 | 8.975 | 32.4 | 0.27 |
| 10/11 | 201.3 | 8.987 | 31.1 | 0.26 |
| 11/11 | 218.8 | 9.451 | 28.4 | 0.24 |
| 12/11 | 218.7 | 9.764 | 26.4 | 0.22 |
| | Average 183.2 | Total 96.426 | Average 32.0 | Average 0.27 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 7 was down from Jun 13 to Jul 11 for annual well field shutdown.
Well 7 was down from Sep 13 to Sep 14 for chemical treatment.
Well 7 was down from Oct 29 to Oct 31 due to an electrical problem.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–21. PRRS Groundwater Summary Statistics and Trend Analysis*

| Analyte | Monitoring Well | Number of Samples[a,b,c] | Min.[a,b,c,d] (mg/L) | Max.[a,b,c,d] (mg/L) | Avg.[a,b,c,d] (mg/L) | SD[a,b,c,d,e] | Trend[a,b,c,d,e,f] |
|---|---|---|---|---|---|---|---|
| Arsenic | 2128 | 238 | 0.000195 | 0.188 | 0.0114 | 0.0206 | Down, Significant |
| | 2625 | 211 | 0.00110 | 0.0706 | 0.0118 | 0.0095 | Down, Significant |
| | 2636 | 181 | 0.01 | 0.0939 | 0.0443 | 0.0185 | Down, Significant |
| | 2898 | 55 | 0.000147 | 0.0820 | 0.0043 | 0.0117 | **Up, Significant** |
| | 2899 | 48 | 0.00032 | 0.0283 | 0.0023 | 0.0043 | **Up, Significant** |
| | 2900 | 237 | 0.00032 | 0.0609 | 0.0050 | 0.0054 | Down, Significant |
| | 3128 | 58 | 0.0004 | 0.234 | 0.0075 | 0.0307 | No Significant Trend |
| | 3636 | 57 | 0.0005 | 0.0233 | 0.0028 | 0.0039 | **Up, Significant** |
| | 3898 | 55 | 0.0005 | 0.0434 | 0.0043 | 0.0068 | **Up, Significant** |
| | 3899 | 56 | 0.000147 | 0.0307 | 0.0026 | 0.0048 | **Up, Significant** |
| | 3900 | 56 | 0.000375 | 0.0208 | 0.0029 | 0.0034 | No Significant Trend |
| Phosphorus | 2128 | 64 | 0.025 | 16.2 | 1.47 | 2.44 | Down, Significant |
| | 2625 | 35 | 0.307 | 12.3 | 3.09 | 2.75 | No Significant Trend |
| | 2636 | 33 | 9.6 | 170 | 87.1 | 44.3 | No Significant Trend |
| | 2898 | 56 | 0.005 | 9.95 | 0.274 | 1.34 | No Significant Trend |
| | 2899 | 47 | 0.005 | 0.831 | 0.0600 | 0.122 | No Significant Trend |
| | 2900 | 54 | 0.05 | 4.74 | 0.492 | 0.682 | Down, Significant |
| | 3128 | 65 | 0.005 | 13.0 | 0.252 | 1.61 | No Significant Trend |
| | 3636 | 56 | 0.00955 | 1.10 | 0.073 | 0.148 | No Significant Trend |
| | 3898 | 54 | 0.0075 | 1.24 | 0.107 | 0.178 | No Significant Trend |
| | 3899 | 55 | 0.005 | 0.830 | 0.0940 | 0.152 | Down, Significant |
| | 3900 | 56 | 0.005 | 1.38 | 0.0930 | 0.244 | Down, Significant |
| Potassium | 2128 | 56 | 0.83 | 18.0 | 3.47 | 3.42 | No Significant Trend |
| | 2625 | 36 | 0.64 | 9.49 | 3.22 | 1.92 | No Significant Trend |
| | 2636 | 33 | 4.6 | 218 | 67.1 | 52.8 | Down, Significant |
| | 2898 | 56 | 1.11 | 9.64 | 4.36 | 1.27 | **Up, Significant** |
| | 2899 | 48 | 1.36 | 8.85 | 4.04 | 1.02 | **Up, Significant** |
| | 2900 | 55 | 0.0095 | 6.00 | 2.01 | 1.08 | No Significant Trend |
| | 3128 | 58 | 1.09 | 3.70 | 1.97 | 0.65 | Down, Significant |
| | 3636 | 56 | 1.09 | 4.24 | 2.22 | 0.55 | Down, Significant |
| | 3898 | 55 | 0.61 | 3.93 | 2.47 | 0.61 | **Up, Significant** |
| | 3899 | 56 | 0.875 | 4.24 | 2.51 | 0.45 | **Up, Significant** |
| | 3900 | 56 | 0.975 | 3.19 | 1.73 | 0.40 | Down, Significant |
| Sodium | 2128 | 56 | 12.3 | 75.2 | 34.8 | 11.6 | Down, Significant |
| | 2625 | 36 | 13.1 | 50.7 | 31.4 | 8.15 | Down, Significant |
| | 2636 | 33 | 23.0 | 148 | 54.6 | 26.9 | No Significant Trend |
| | 2898 | 56 | 4.95 | 29.2 | 18.7 | 4.3 | No Significant Trend |
| | 2899 | 48 | 11.2 | 24.5 | 17.0 | 2.8 | No Significant Trend |
| | 2900 | 55 | 0.0136 | 43.3 | 27.2 | 7.3 | No Significant Trend |
| | 3128 | 58 | 3.52 | 13.4 | 5.63 | 2.64 | Down, Significant |
| | 3636 | 56 | 3.14 | 13.0 | 5.93 | 2.83 | Down, Significant |
| | 3898 | 55 | 7.29 | 24.9 | 10.8 | 3.8 | **Up, Significant** |
| | 3899 | 56 | 6.24 | 29.5 | 9.45 | 3.37 | **Up, Significant** |
| | 3900 | 56 | 3.13 | 10.8 | 4.90 | 1.84 | Down, Significant |

*Table A.1–21 (continued). PRRS Groundwater Summary Statistics and Trend Analysis*

[a] The data are based on unfiltered samples from the Operable Unit 5 Remedial Investigation/Feasibility Study data set (1988 through 1993) and 1994 through 2011 groundwater data (unfiltered and filtered for 2001 through 2011).
[b] If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum concentration is used to determine the summary statistics (minimum, maximum, average, standard deviation, and Mann-Kendall test for trend).
[c] Rejected data qualified with an R were not included in this count or the summary statistics.
[d] Where concentrations are below the detection limit each result used in the summary statistics is set at half the detection limit.
[e] SD = standard deviation.
[f] Trend starts on August 27, 1993, and is based on the start-up of the South Plume extraction wells (DOE 1993).

*Table A.1–22. Extraction Well 32761 (EW-26) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 570.88 (top of casing)
Northing Coordinate ('83) – 479,892.36
Easting Coordinate ('83) – 1,347,364.02

Hours in reporting period – 8,760
Hours not pumped – 720

Hours pumped – 8,040
Operational percent – 91.78
Adjusted operational percent[a] – 99.42

Target pumping rate – 300 gpm

| Monthly Measurements at Well Field | | | | |
|---|---|---|---|---|
| **Month** | **Monthly Average Pumping Rate[b] (gpm)** | **M Gal Pumped** | **Monthly Total Uranium Concentration[c] (μg/L)** | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | 312.0 | 13.926 | 25.2 | 0.21 |
| 2/11 | 325.6 | 13.128 | 26.0 | 0.22 |
| 3/11 | 328.9 | 14.684 | 27.1 | 0.23 |
| 4/11 | 314.8 | 13.600 | 30.3 | 0.25 |
| 5/11 | 325.6 | 14.534 | 32.8 | 0.27 |
| 6/11 | 129.0 | 5.573 | 27.1 | 0.23 |
| 7/11 | 215.6 | 9.623 | 30.6 | 0.26 |
| 8/11 | 323.8 | 14.454 | 30.7 | 0.26 |
| 9/11 | 318.6 | 13.762 | 27.3 | 0.23 |
| 10/11 | 325.5 | 14.532 | 26.7 | 0.22 |
| 11/11 | 327.0 | 14.128 | 25.9 | 0.22 |
| 12/11 | 327.1 | 14.600 | 26.8 | 0.22 |
| | Average 297.8 | Total 156.544 | Average 28.0 | Average 0.23 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 26 was down from Jun 13 to Jul 11 for annual well field shutdown.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–23. Extraction Well 33062 (EW-27) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 575.1 (top of casing)
Northing Coordinate ('83) – 480,013.01
Easting Coordinate ('83) – 1,348,037.2

Hours in reporting period – 8,760
Hours not pumped – 932

Hours pumped – 7,828
Operational percent – 89.36
Adjusted operational percent[a] – 96.80

Target pumping rate – 200 gpm

| Monthly Measurements at Well Field | | | | |
|---|---|---|---|---|
| **Month** | **Monthly Average Pumping Rate[b] (gpm)** | **M Gal Pumped** | **Monthly Total Uranium Concentration[c] (µg/L)** | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | 219.8 | 9.814 | 28.3 | 0.24 |
| 2/11 | 217.6 | 8.775 | 28.8 | 0.24 |
| 3/11 | 221.4 | 9.885 | 27.7 | 0.23 |
| 4/11 | 216.3 | 9.346 | 31.4 | 0.26 |
| 5/11 | 220.6 | 9.846 | 33.5 | 0.28 |
| 6/11 | 84.5 | 3.649 | 30.2 | 0.25 |
| 7/11 | 95.1 | 4.245 | 32.2 | 0.27 |
| 8/11 | 205.5 | 9.173 | 34.2 | 0.29 |
| 9/11 | 216.5 | 9.353 | 31.3 | 0.26 |
| 10/11 | 219.5 | 9.798 | 33.7 | 0.28 |
| 11/11 | 217.0 | 9.375 | 31.9 | 0.27 |
| 12/11 | 221.4 | 9.883 | 30.9 | 0.26 |
| | Average 196.3 | Total 103.141 | Average 31.2 | Average 0.26 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 27 was down from Jun 13 to Jul 11 for annual well field shutdown.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–24. Extraction Well 33334 (EW-28a) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 570.441 (top of casing)
Northing Coordinate ('83) – 479,918.959
Easting Coordinate ('83) – 1,348,686.378

Hours in reporting period – 8,760
Hours not pumped – 745.5

Hours pumped – 8,015
Operational percent – 91.49
Adjusted operational percent[a] – 99.11

Target pumping rate – 200 gpm

| Monthly Measurements at Well Field | | | | |
|---|---|---|---|---|
| Month | Monthly Average Pumping Rate[b] (gpm) | M Gal Pumped | Monthly Total Uranium Concentration[c] (µg/L) | Uranium Removal Index (lbs of total uranium removed/M gal pumped) |
| 1/11 | 208.7 | 9.316 | 20.10 | 0.17 |
| 2/11 | 216.0 | 8.709 | 9.90 | 0.08 |
| 3/11 | 217.6 | 9.712 | 9.80 | 0.08 |
| 4/11 | 213.6 | 9.226 | 10.80 | 0.09 |
| 5/11 | 216.4 | 9.660 | 9.90 | 0.08 |
| 6/11 | 85.0 | 3.672 | 10.05 | 0.08 |
| 7/11 | 140.4 | 6.266 | 8.75 | 0.07 |
| 8/11 | 219.9 | 9.817 | 9.80 | 0.08 |
| 9/11 | 208.1 | 8.989 | 10.10 | 0.08 |
| 10/11 | 217.3 | 9.702 | 10.50 | 0.09 |
| 11/11 | 216.6 | 9.358 | 9.80 | 0.08 |
| 12/11 | 214.9 | 9.593 | 10.20 | 0.09 |
| | Average 197.9 | Total 104.019 | Average 10.8 | Average 0.09 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 28a was down from Jun 13 to Jul 12 for rehab annual well field shutdown.
Well 28a was down from Aug 23 to Aug 24 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–25. Extraction Well 33347 (EW-33a) Operational Summary Sheet For 2011*

Reference Elevation (ft amsl) – 574.86 (top of casing)
Northing Coordinate ('83) – 481,031.762
Easting Coordinate ('83) – 1,346,715.817

Hours in reporting period – 8,760
Hours not pumped – 726

Hours pumped – 8034
Operational percent – 91.7
Adjusted operational percent[a] – 99.34

Target pumping rate – 300 gpm

| Monthly Measurements at Well Field | | | | |
|---|---|---|---|---|
| **Month** | **Monthly Average Pumping Rate[b] (gpm)** | **M Gal Pumped** | **Monthly Total Uranium Concentration[c] (µg/L)** | **Uranium Removal Index (lbs of total uranium removed/M gal pumped)** |
| 1/11 | 319.4 | 14.258 | 9.1 | 0.08 |
| 2/11 | 328.3 | 13.237 | 15.60 | 0.13 |
| 3/11 | 328.1 | 14.647 | 15.40 | 0.13 |
| 4/11 | 308.7 | 13.336 | 19.1 | 0.16 |
| 5/11 | 326.1 | 14.557 | 20.4 | 0.17 |
| 6/11 | 130.8 | 5.650 | 17.2 | 0.14 |
| 7/11 | 202.3 | 9.029 | 22.1 | 0.18 |
| 8/11 | 327.1 | 14.604 | 26.9 | 0.22 |
| 9/11 | 326.2 | 14.094 | 23.6 | 0.20 |
| 10/11 | 328.3 | 14.656 | 20.7 | 0.17 |
| 11/11 | 329.0 | 14.211 | 19.2 | 0.16 |
| 12/11 | 312.5 | 13.952 | 21.9 | 0.18 |
| | Average 297.2 | Total 156.231 | Average 19.3 | Average 0.16 |

[a] Adjusted for planned annual well field shutdown.
[b] Well 33a was down from Apr 18 to Apr 19 for sampling.
Well 33a was down from Jun 13 to Jul 11 for annual well field shutdown.
[c] Average is used if more than one concentration measurement is available for a particular month.

*Table A.1–26. Regression Equations for Uranium Concentration Data Collected at Extraction Wells—Data Collected Through December 31, 2011*

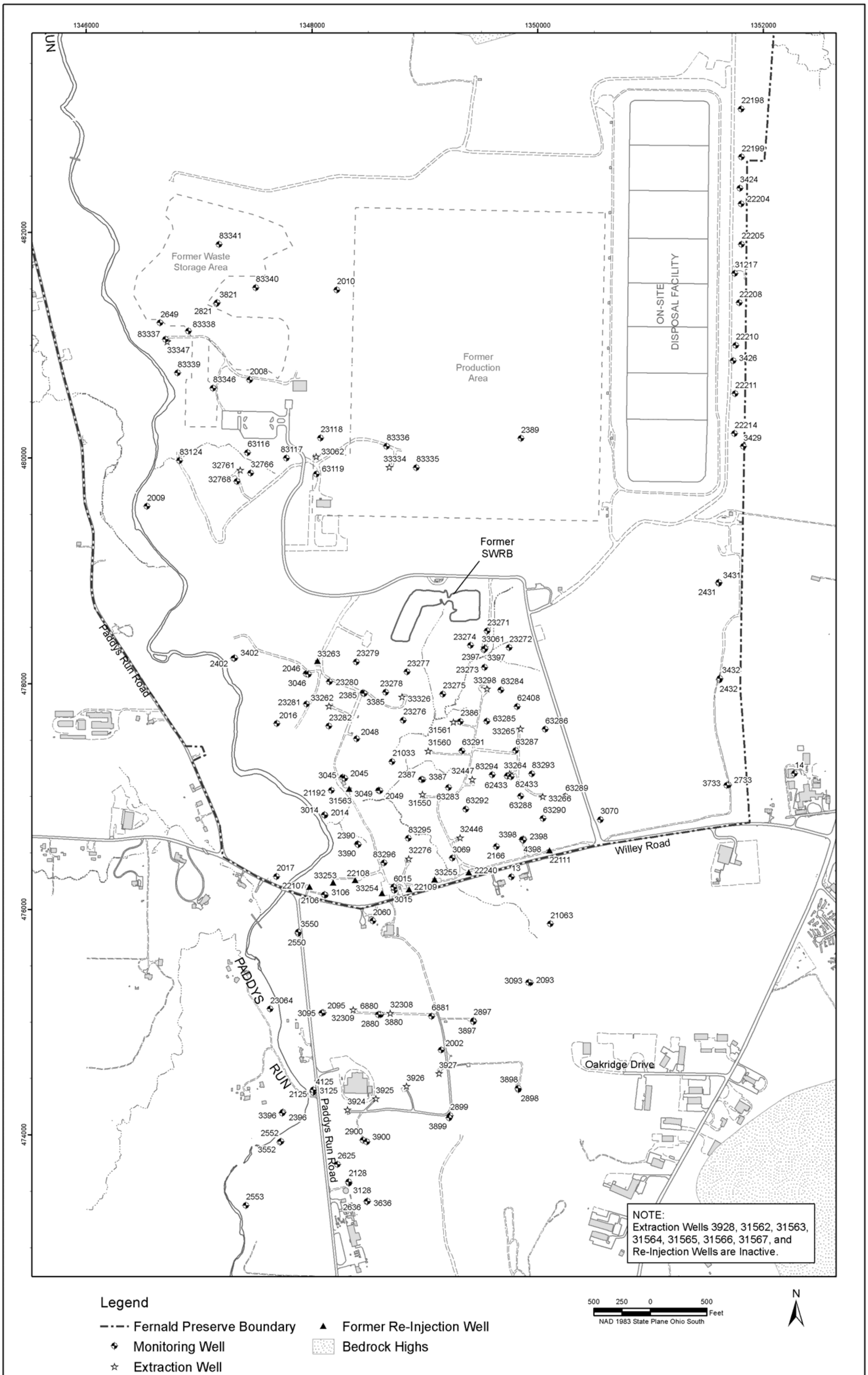
| Well ID | Location ID | Data Trend | $R^2$ | 95% UCL | $R^2$ | Function Type |
|---|---|---|---|---|---|---|
| RW-1 | 3924 | $y=1.10E+05e^{-2.19E-04x}$ | 0.78 | $y = 4.39E+03e^{-1.14E-04x}$ | 0.72 | Exponential Function |
| RW-2 | 3925 | $y = 1.090E-06x^2 - 8.772E-02x + 1.782E+03$ | 0.69 | $y = 1.09E-06x^2 - 8.77E-02x + 1.80E+03$ | 0.69 | Polynomial |
| RW-3 | 3926 | $y = -2.03E-06x^2 + 1.56E-01x - 2.96E+03$ | 0.76 | $y = -2.03E-06x^2 + 1.56E-01x - 2.94E+03$ | 0.76 | Polynomial |
| RW-4 | 3927 | $y = 7.39E-03e^{1.53E-04x}$ | 0.31 | $y = 3.43E-01e^{6.95E-05x}$ | 0.25 | Exponential Function |
| RW-6 | 32308 | $y = 7.82E+04e^{-1.931E-04x}$ | 0.83 | $y = 8.71E+03e^{-1.23E-04x}$ | 0.83 | Exponential Function |
| RW-7 | 32309 | $y = 2.73E+05e^{-2.26E-04x}$ | 0.87 | $y = 1.42E+04e^{-1.34E-04x}$ | 0.85 | Exponential Function |
| EW-15a | 33262 | $y = 2.27E+54x^{-1.15E+01}$ | 0.74 | $y = 1.29E+35x^{-7.24E+00}$ | 0.74 | Power Function |
| EW-17a | 33326 | $y = 6.70E+03e^{-1.431E-04x}$ | 0.51 | $y = 1.54E+03e^{-9.20E-05x}$ | 0.50 | Exponential Function |
| EW-18 | 31550 | $y = 3.06E+04e^{-1.70E-04x}$ | 0.48 | $y = 4.05E+03e^{-1.01E-04x}$ | 0.46 | Exponential Function |
| EW-19 | 31560 | $y = 2.71E+08e^{-4.09E-04x}$ | 0.87 | $y = 9.77E+04e^{-1.75E-04x}$ | 0.78 | Exponential Function |
| EW-20 | 31561 | $y = 3.99E+03e^{-1.21E-04x}$ | 0.46 | $y = 1.32E+03e^{-8.16E-05x}$ | 0.48 | Exponential Function |
| EW-21a | 33298 | $y = 1.97E+06e^{-2.70E-04x}$ | 0.77 | $y = 3.35E+04e^{-1.45E-04x}$ | 0.75 | Exponential Function |
| EW-22 | 32276 | $y = 2.52E+09e^{-4.54E-04x}$ | 0.94 | $y = 3.18E+05e^{-1.92E-04x}$ | 0.89 | Exponential Function |
| EW-23 | 32447 | $y = 2.88E+08e^{-3.88E-04x}$ | 0.89 | $y = 3.50E+05e^{-1.94E-04x}$ | 0.85 | Exponential Function |
| EW-24 | 32446 | $y = 1.97E+05e^{-2.12E-04x}$ | 0.73 | $y = 1.41E+04e^{-1.29E-04x}$ | 0.69 | Exponential Function |
| EW-25 | 33061 | $y = 3.09E+04e^{-1.70E-04x}$ | 0.36 | $y = 3.78E+03e^{-1.05E-04x}$ | 0.33 | Exponential Function |
| EW-30 | 33264 | $y = 5.06E+09e^{-4.60E-04x}$ | 0.88 | $y = 1.76E+06e^{-2.40E-04x}$ | 0.85 | Exponential Function |
| EW-31 | 33265 | $y = 5.45+06e^{-3.19E-04x}$ | 0.71 | $y = 4.01E+04e^{-1.793E-04x}$ | 0.66 | Exponential Function |
| EW-32 | 33266 | $y = 3.95E+11e^{-6.16E-04x}$ | 0.91 | $y = 1.20E+06e^{-2.69E-04x}$ | 0.81 | Exponential Function |
| EW-26 | 32761 | $y = 4.76E+09e^{-4.71E-04x}$ | 0.88 | $y=6.38E+05e^{-2.20E-04x}$ | 0.81 | Exponential Function |
| EW-27 | 33062 | $y = 2.23E+10e^{-5.08E-04x}$ | 0.83 | $y=7.69E+05e^{-2.18E-04x}$ | 0.71 | Exponential Function |
| EW-28a | 33334 | $y = 8.28E+13e^{-7.36E-04x}$ | 0.88 | $y=4.78E+05e^{-2.10E-04x}$ | 0.67 | Exponential Function |
| EW-33a | 33347 | $y = 2.63E+13e^{-6.97E-04x}$ | 0.45 | $y=5.13E+06e^{-2.78E-04x}$ | 0.42 | Exponential Function |

*Table A.1–27. Estimated Percent Complete Based on Pounds of Uranium Removed from the Aquifer*

| **Year** | **Annual Uranium To Be Extracted From GMA (pounds) Based on Conc. Data** | **Annual Uranium To Be Extracted From GMA (pounds) Based on Model** | **Annual Uranium To Be Extracted From GMA (pounds) Based on 95% UCL** |
|---|---|---|---|
| 2012 | 456 | 404 | 1,448 |
| 2013 | 404 | 366 | 1,355 |
| 2014 | 360 | 335 | 1,267 |
| 2015 | 320 | 307 | 1,186 |
| 2016 | 291 | 276 | 1,137 |
| 2017 | 260 | 247 | 1,064 |
| 2018 | 233 | 225 | 997 |
| 2019 | 209 | 208 | 934 |
| 2020 | 189 | 193 | 875 |
| 2021 | 170 | 180 | 820 |
| 2022 | 154 | 169 | 769 |
| 2023 | 140 | 159 | 722 |
| 2024 | 127 | 150 | 677 |
| Total To Be Extracted | 3,313 | 3,219 | 13,250 |
| Pounds Already Extracted Through 12-31-2010 | 10,805 | 10,805 | 10,805 |
| Total | 14,118 | 13,930 | 24,055 |
| % Complete Based on Pounds (2011) | **76** | **77** | 45 |
| % Complete Based on Pounds (2010) | 75 | 74 | 43 |
| % Complete Based on Pounds (2009) | 72 | 70 | 41 |
| % Complete Based on Pounds (2008) | 69 | 66 | 39 |
| % Complete Based on Pounds (2007) | 66 | 61 | 37 |
| % Complete Based on Pounds (2006) | 59 | 55 | 33 |

*Table A.1–28. Extraction Well Target Pumping Rates*

| Module | Extraction Well | January 1 to December 31 (gpm) |
|---|---|---|
| South Plume | 3924 (RW-1) | 200 |
| | 3925 (RW-2) | 200 |
| | 3926 (RW-3) | 200 |
| | 3927 (RW-4) | 200 |
| | 32308 (RW-6) | 200 |
| | 32309 (RW-7) | 200 |
| Subtotal | | 1,200 |
| Waste Storage Area | 32761 (EW-26) | 300 |
| | 33062 (EW-27) | 200 |
| | 33334 (EW-28a) | 200 |
| | 33347 (EW-33a) | 300 |
| Subtotal | | 1,000 |
| South Field Extraction | 31550 (EW-18) | 100 |
| | 31560 (EW-19) | 100 |
| | 31561 (EW-20) | 100 |
| | 33298 (EW-21a) | 200 |
| | 33326 (EW-17a) | 175 |
| | 32276 (EW-22) | 300 |
| | 32446 (EW-24) | 300 |
| | 32447 (EW-23) | 300 |
| | 33061 (EW-25) | 100 |
| | 33264 (EW-30) | 200 |
| | 33265 (EW-31) | 300 |
| | 33266 (EW-32) | 200 |
| | 33262 (EW-15a) | 200 |
| Subtotal | | 2,575 |
| Total Pumping | | 4,775 |




M:\LTS\111\0051\17\006\S08648\S0864800.mxd pawels 05/08/2012 2:41:44 PM

*Figure A.1−1. Well Locations for South Plume, South Field, Waste Storage Area, and PRRS Monitoring Activities*

This page intentionally left blank

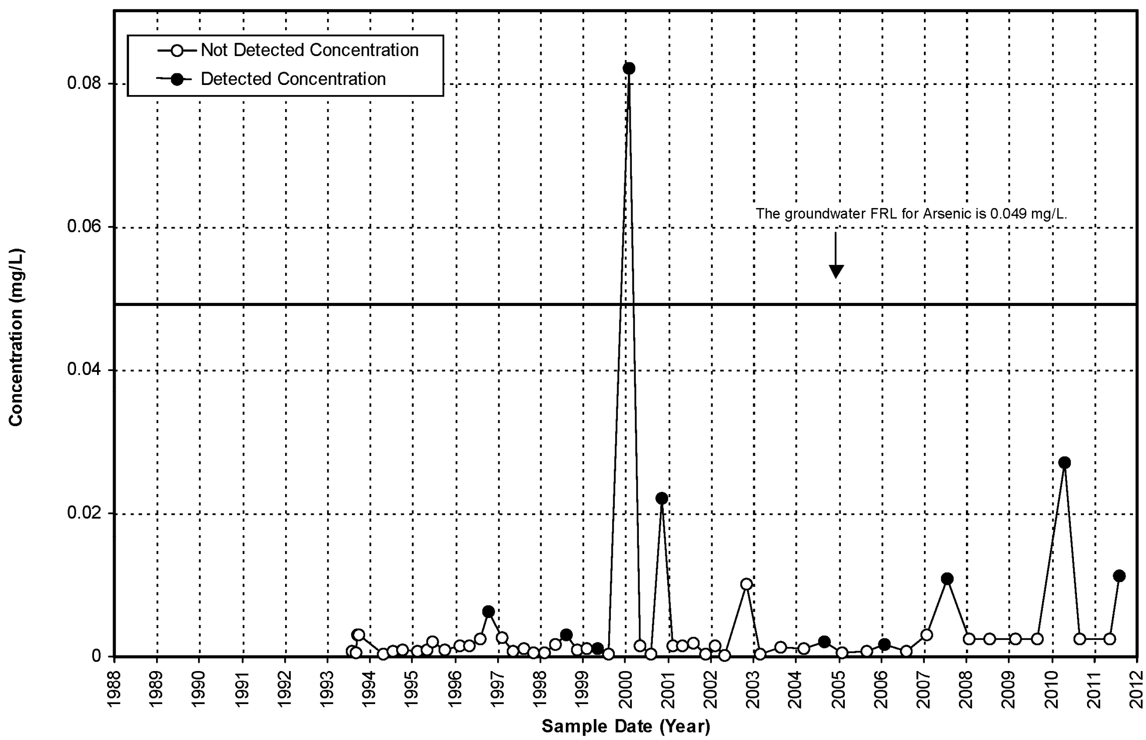



Figure A.1-2. Arsenic Concentration VS. Time Plot for Monitoring Well 2898

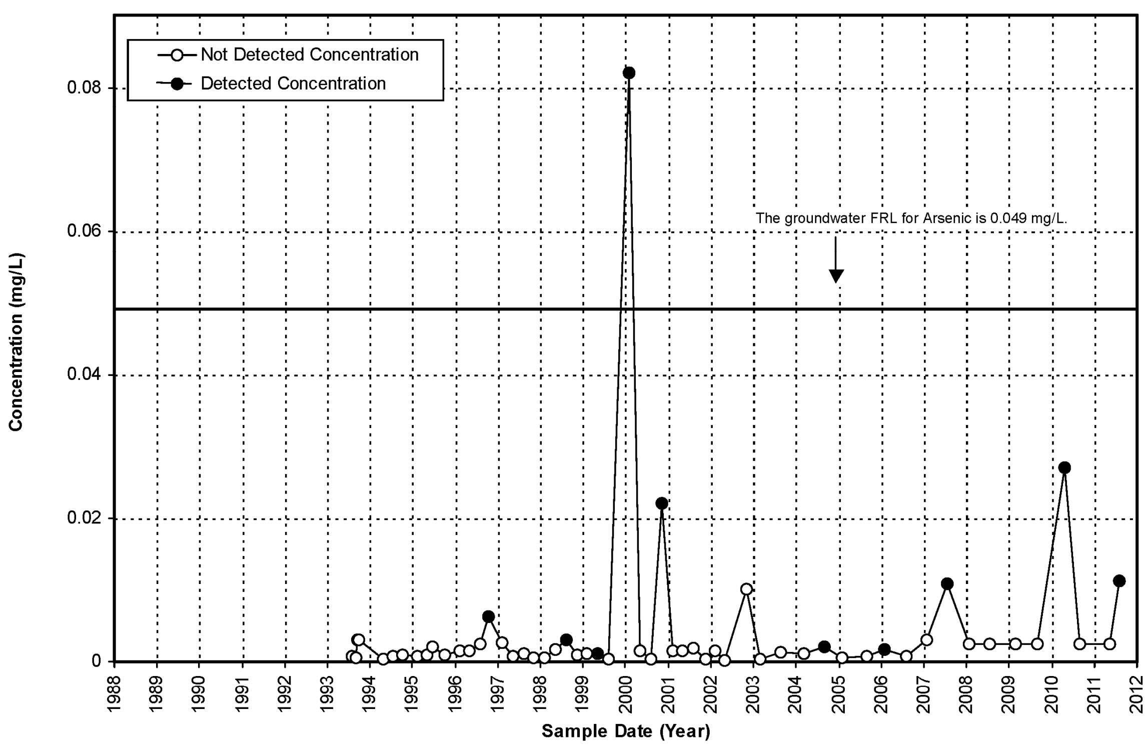



Figure A.1-3. Arsenic Concentration VS. Time Plot for Monitoring Well 2899

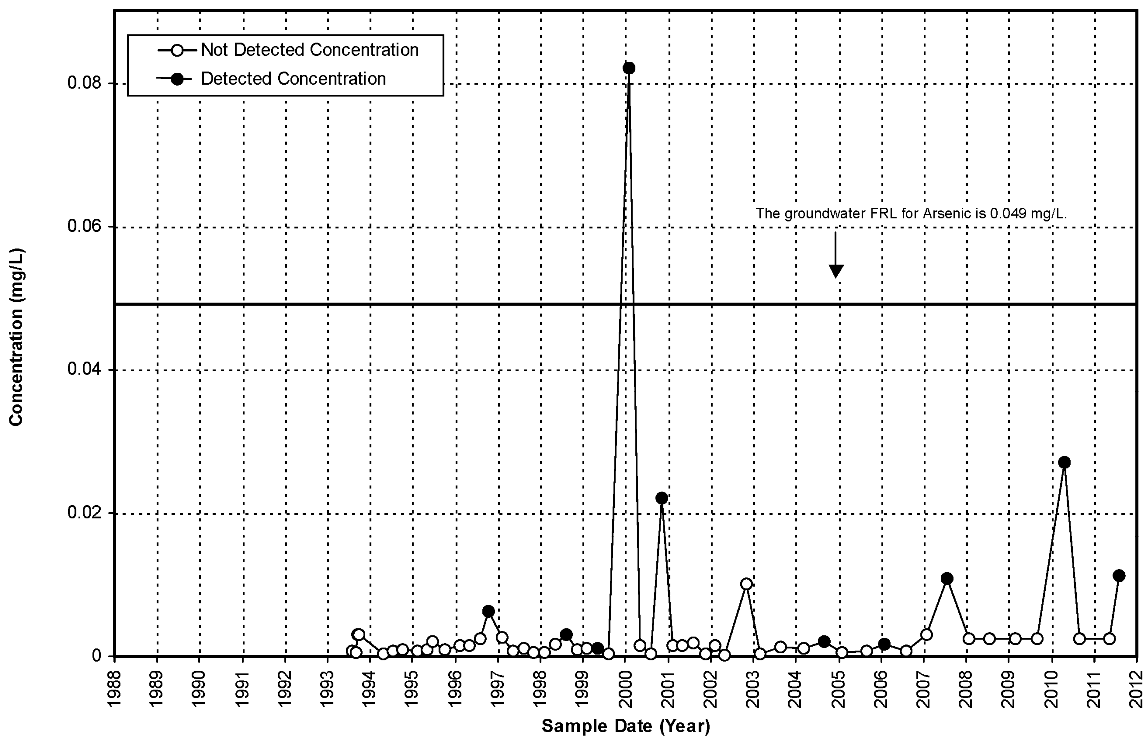



Figure A.1-4. Arsenic Concentration VS. Time Plot for Monitoring Well 3636

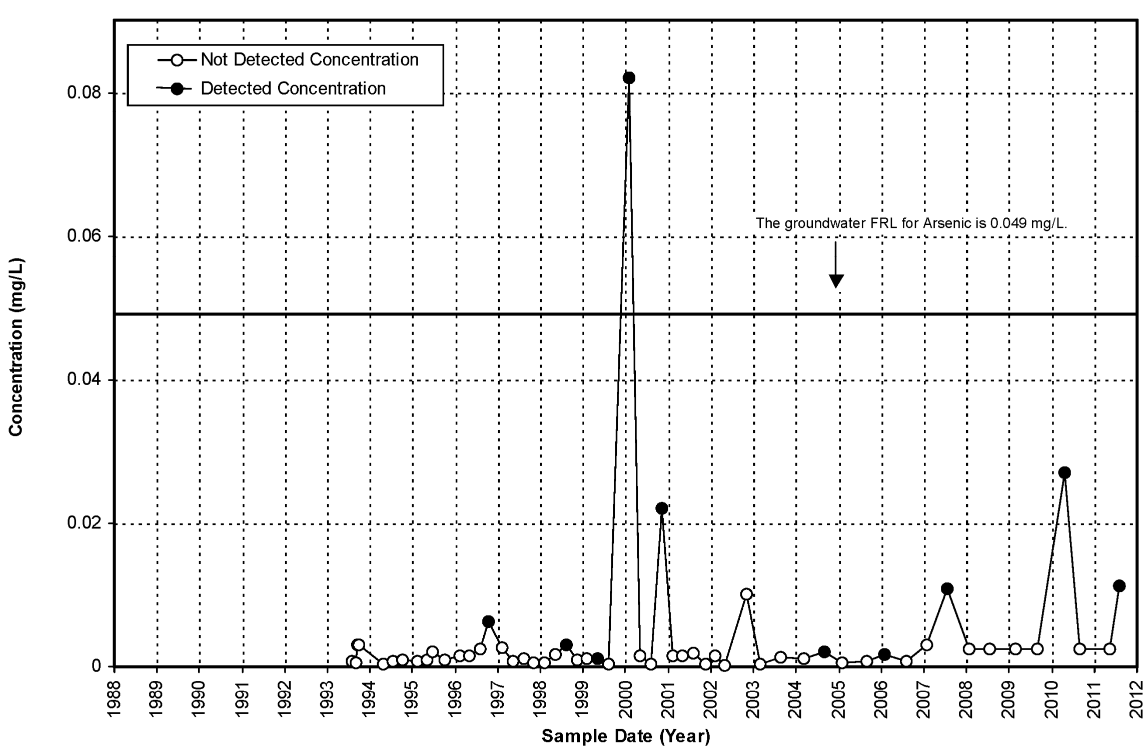



Figure A.1-5. Arsenic Concentration VS. Time Plot for Monitoring Well 3898

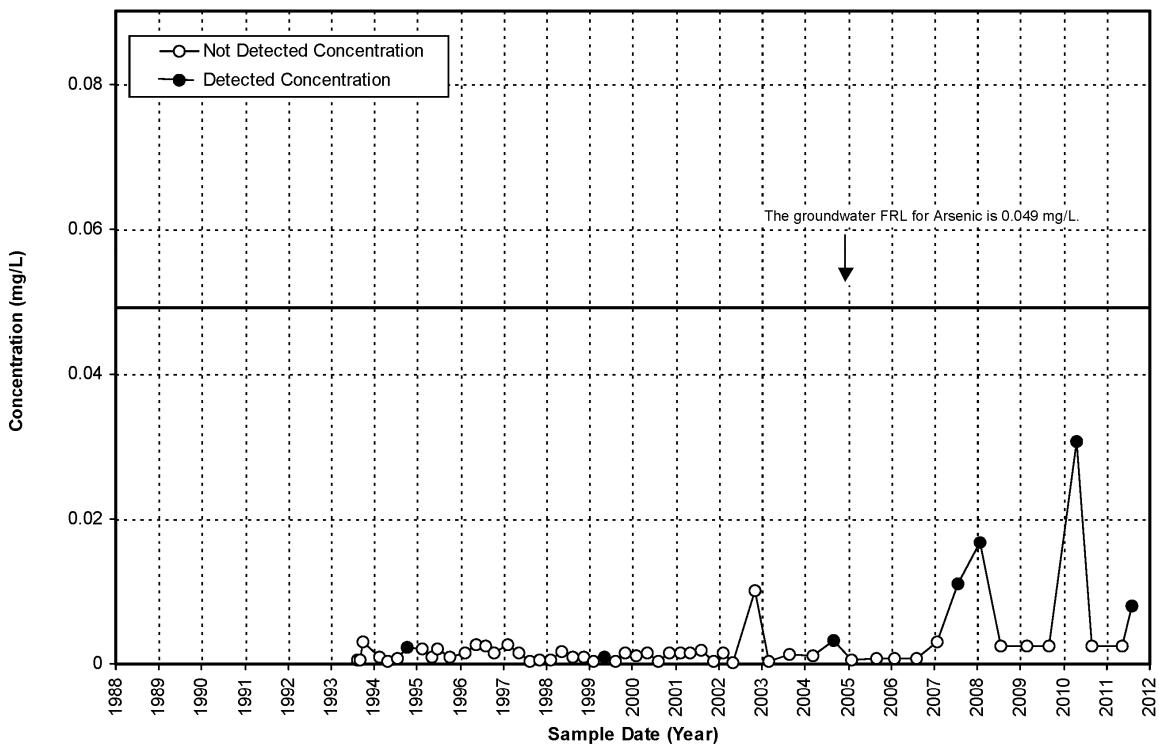



Figure A.1-6. Arsenic Concentration VS. Time Plot for Monitoring Well 3899

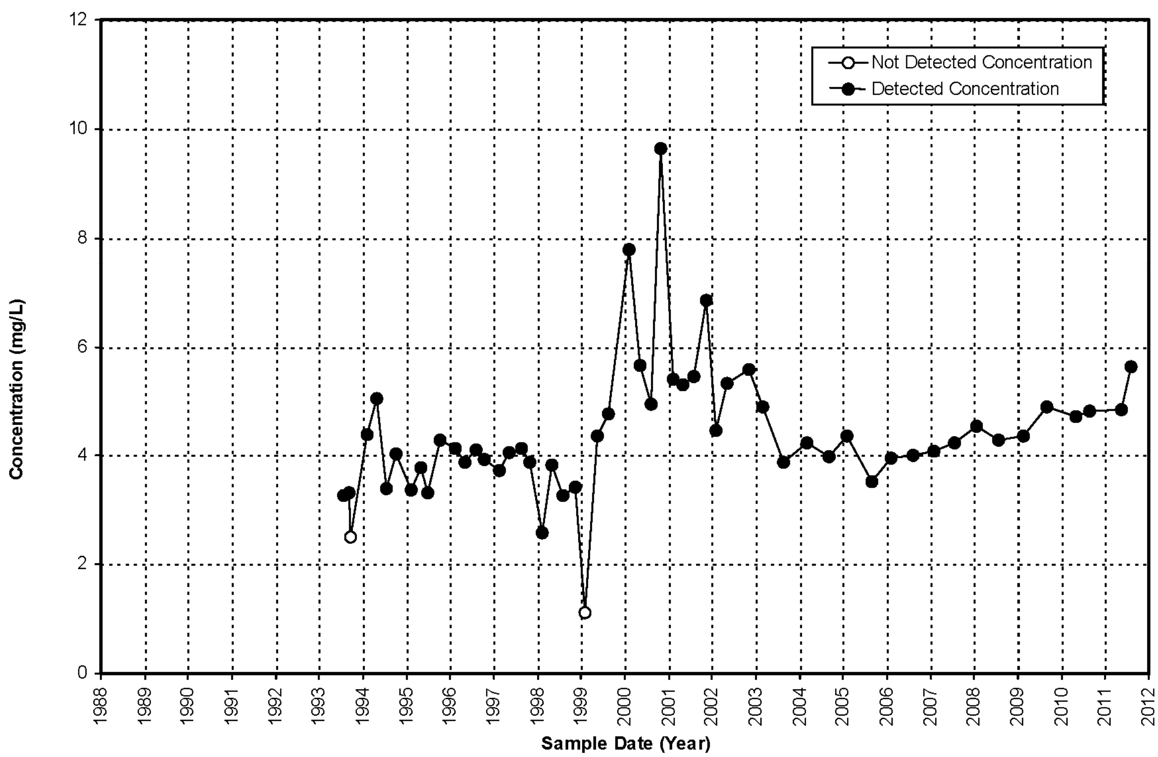



Figure A.1-7. Potassium Concentration VS. Time Plot for Monitoring Well 2898

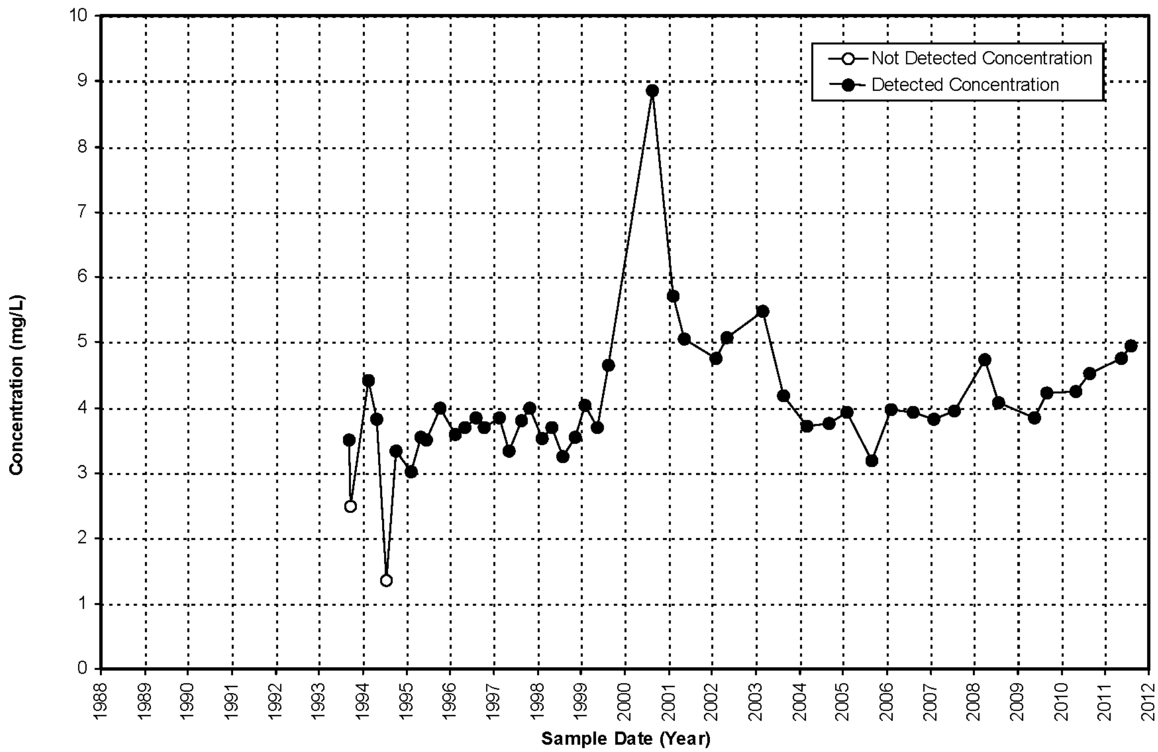



Figure A.1-8. Potassium Concentration VS. Time Plot for Monitoring Well 2899

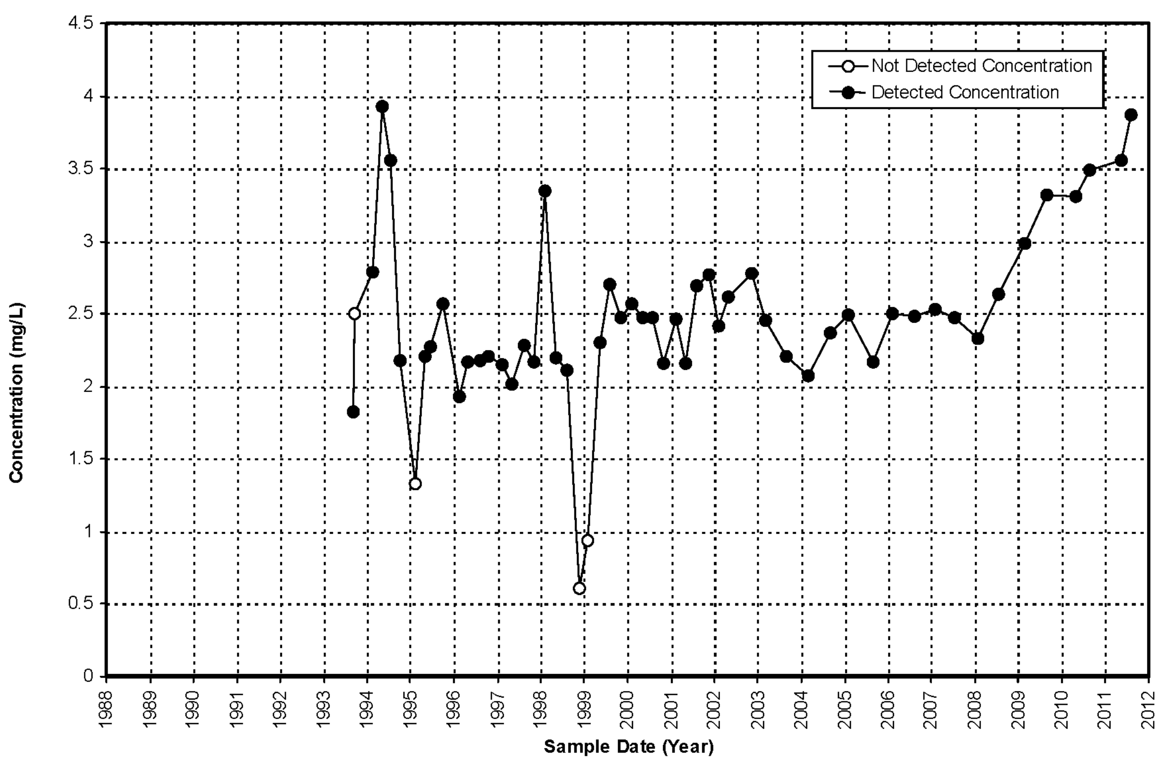



Figure A.1-9. Potassium Concentration VS. Time Plot for Monitoring Well 3898

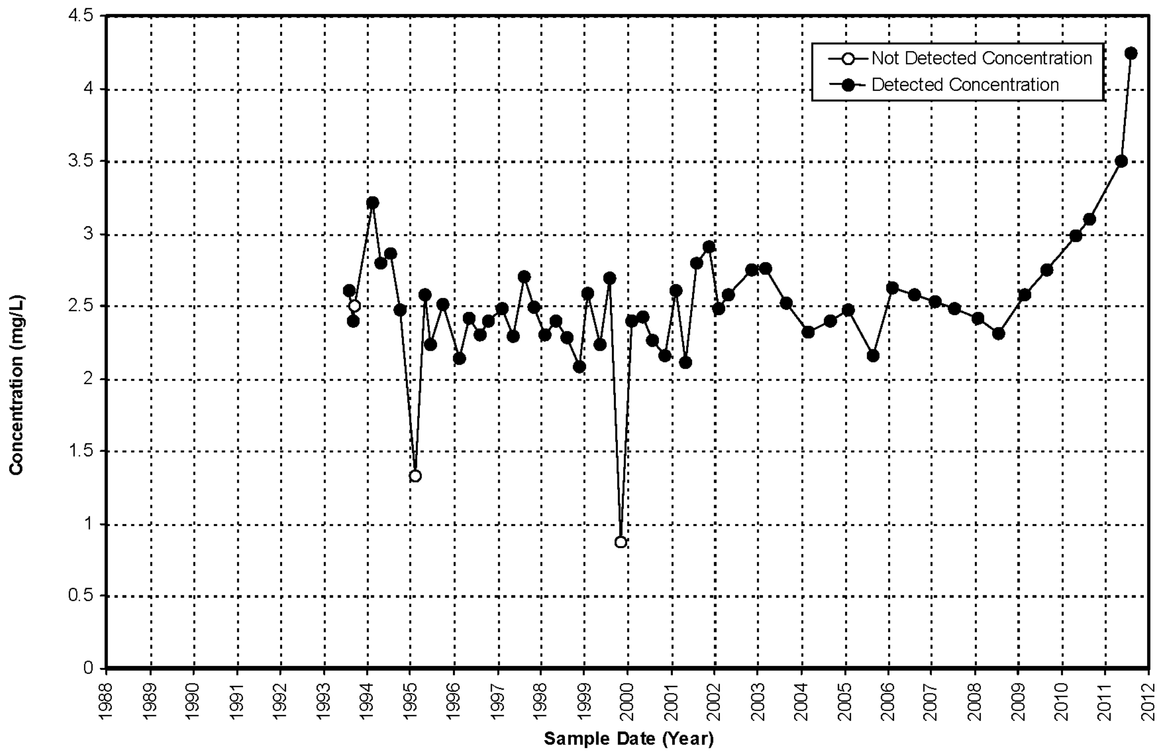



Figure A.1-10. Potassium Concentration VS. Time Plot for Monitoring Well 3899

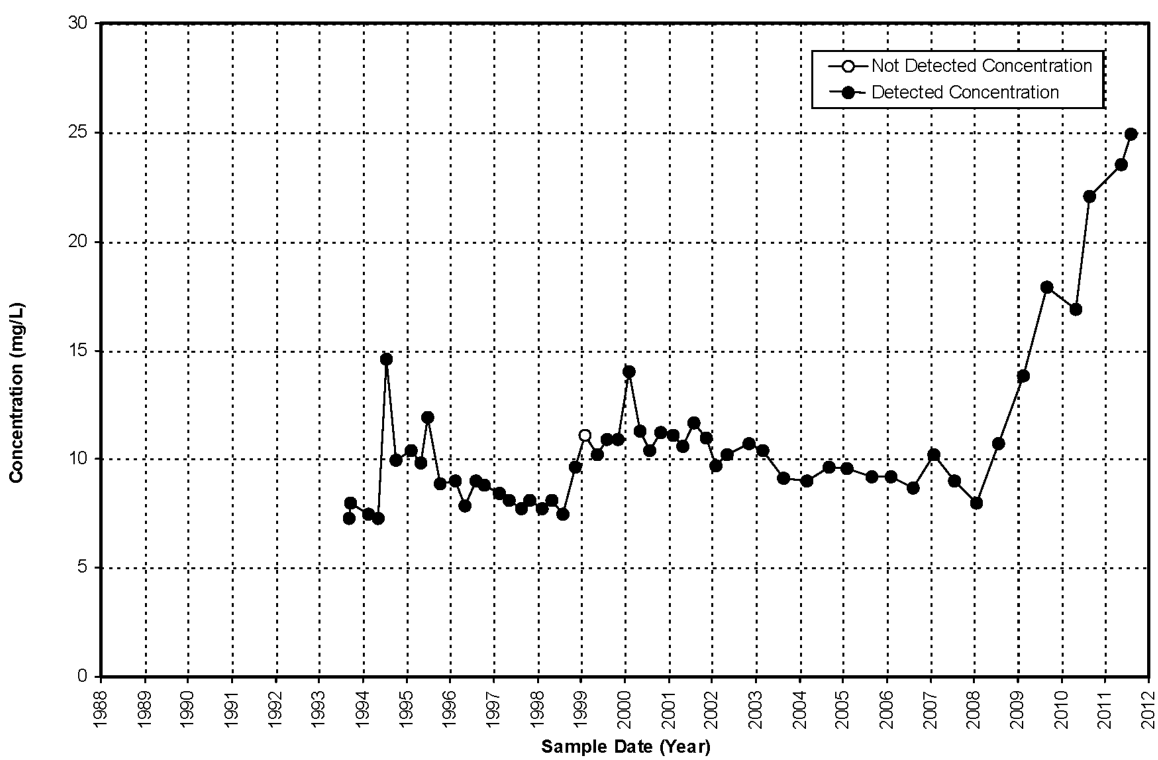



Figure A.1-11. Sodium Concentration VS. Time Plot for Monitoring Well 3898

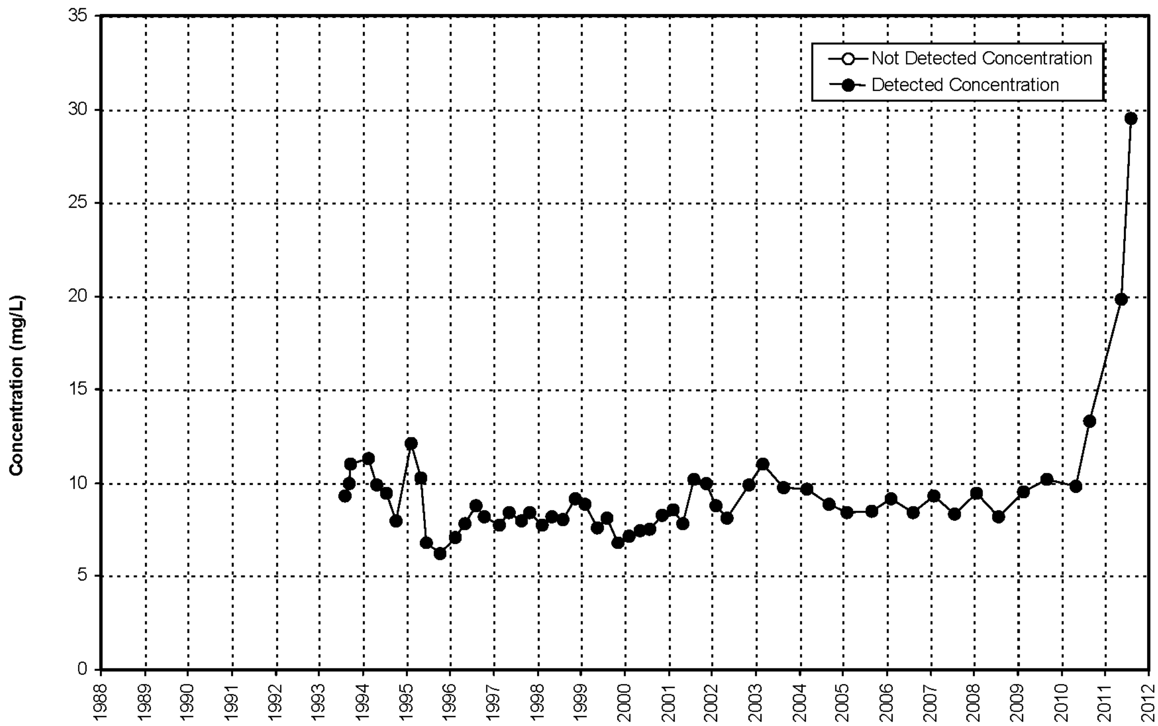



Figure A.1-12. Sodium Concentration VS. Time Plot for Monitoring Well 3899

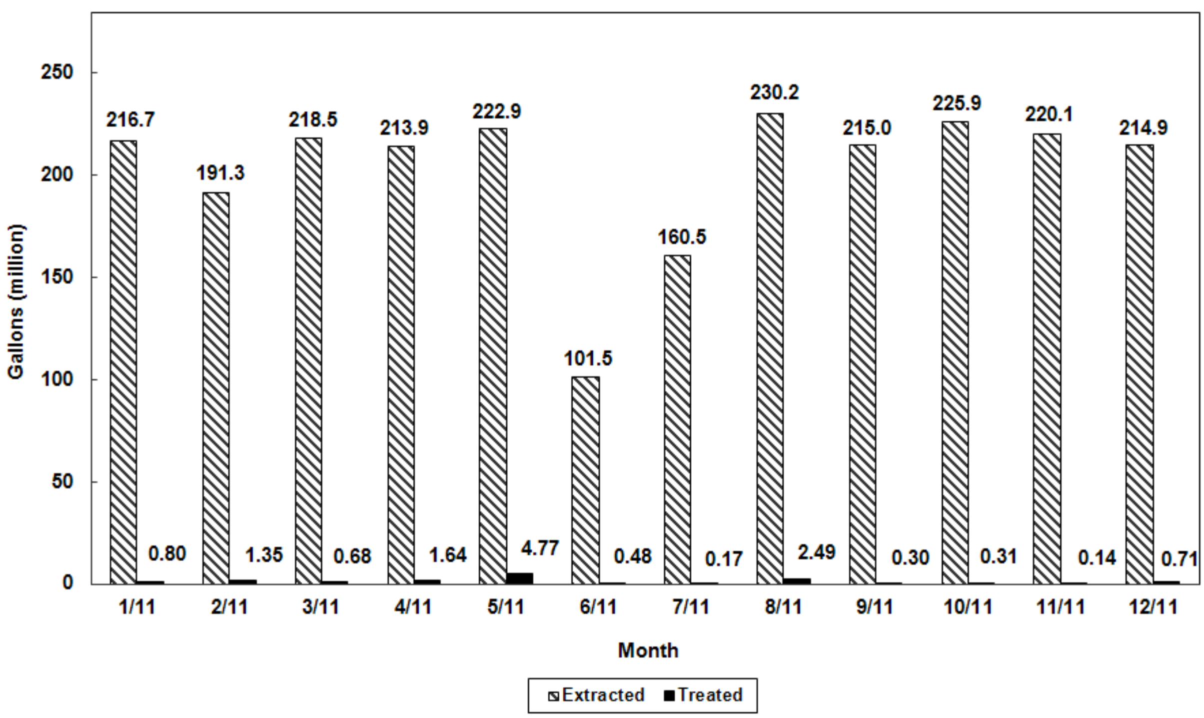



**Figure A.1-13. Total Groundwater Extracted vs. Groundwater Treated for 2011**

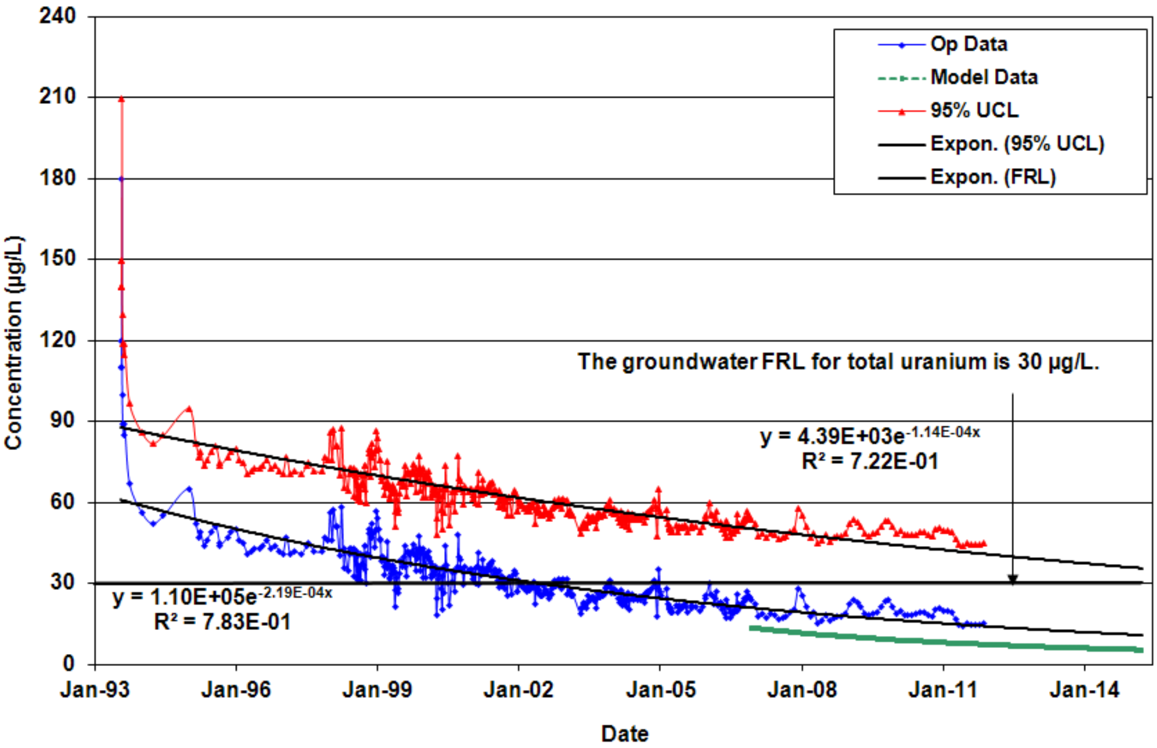



Figure A.1-14. Total Uranium Concentration vs. Time Plot
for Extraction Well 3924 (RW-1) with Regression Analysis

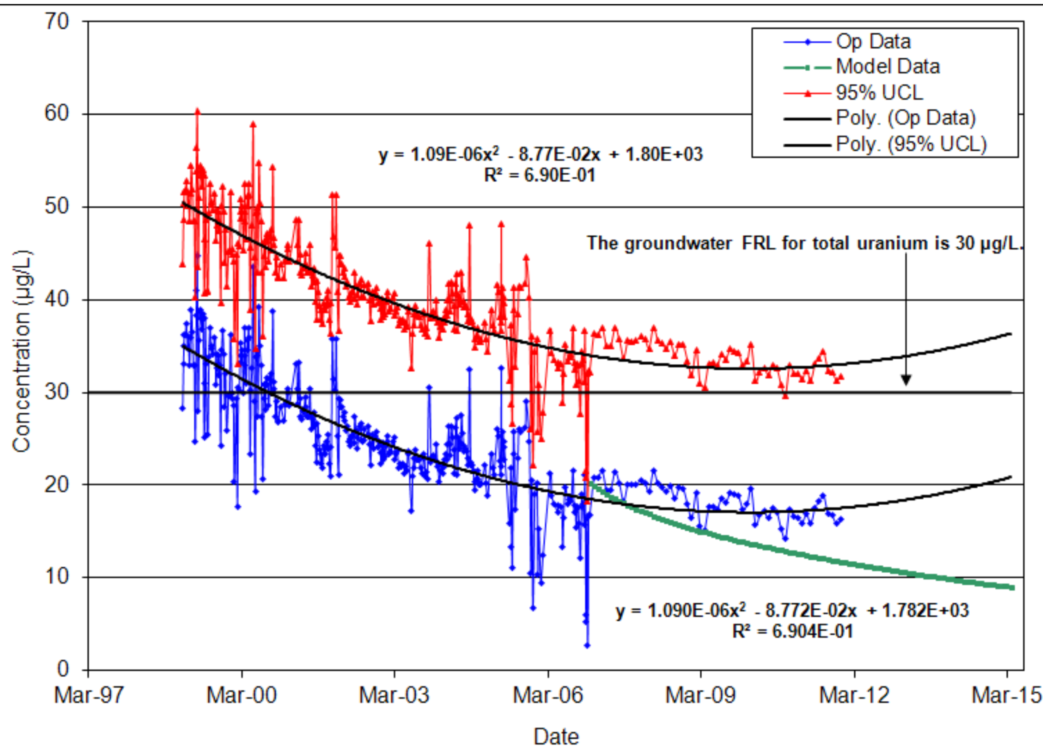



FIGURE A.1-15. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR EXTRACTION WELL 3925 (RW-2) WITH REGRESSION ANALYSIS

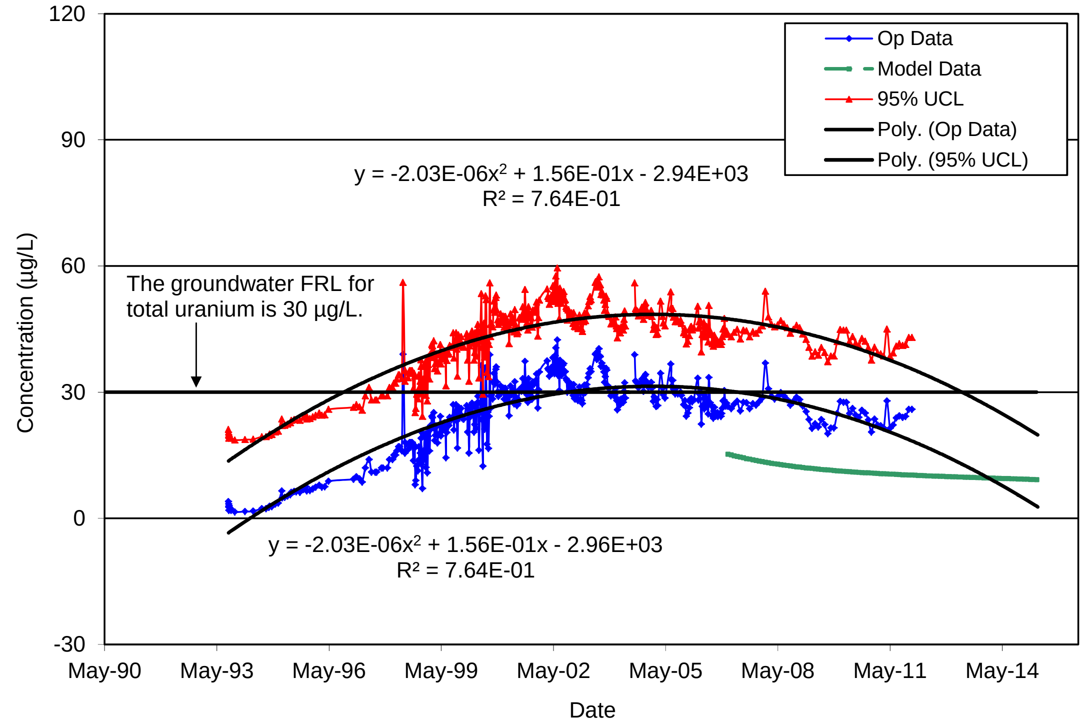



Figure A.1-16. Total Uranium Concentration vs. Time Plot for Extraction Well 3926 (RW-3) with Regression Analysis

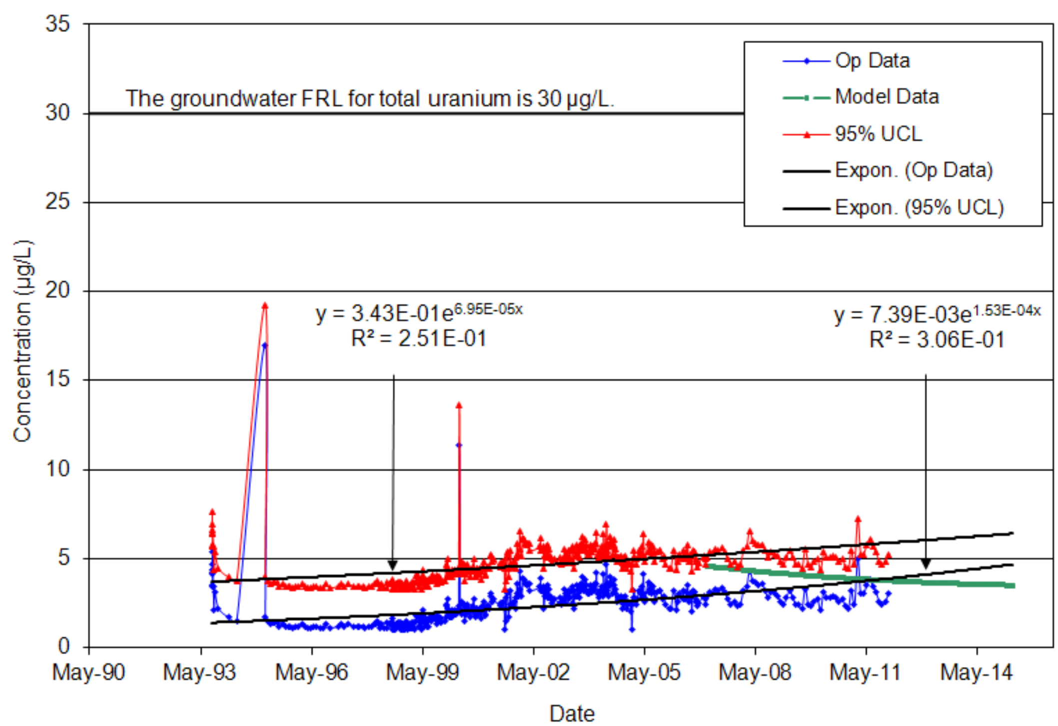



Figure A.1-17. Total Uranium Concentration vs. Time Plot for Extraction Well 3927 (RW-4) with Regression Analysis

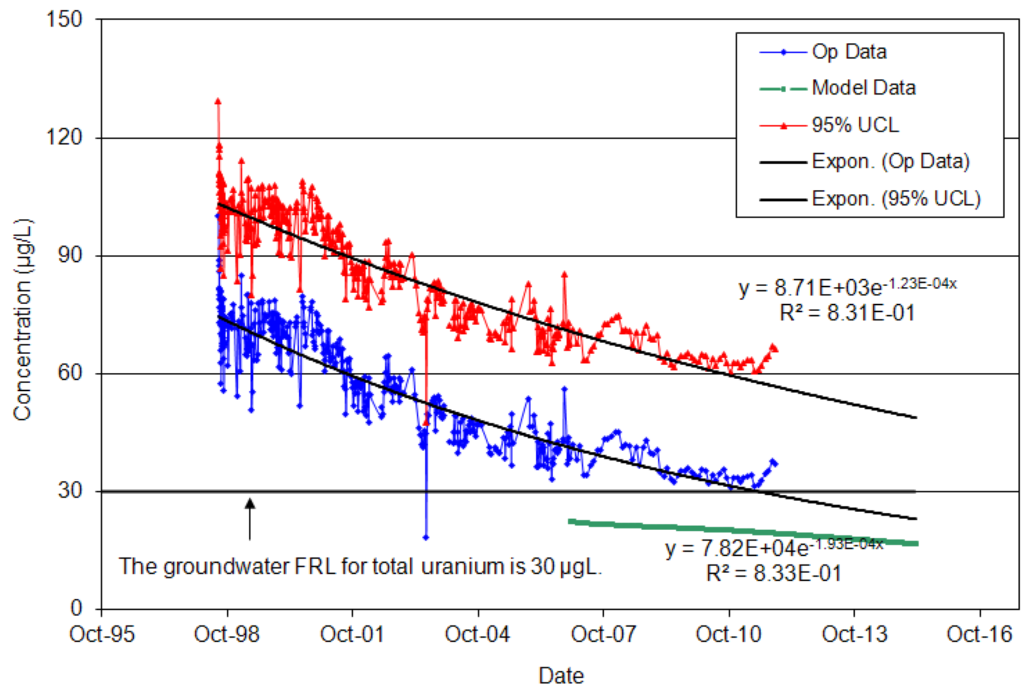



Figure A.1-18. Total Uranium Concentration vs. Time Plot for Extraction Well 32308 (RW-6) with Regression Analysis

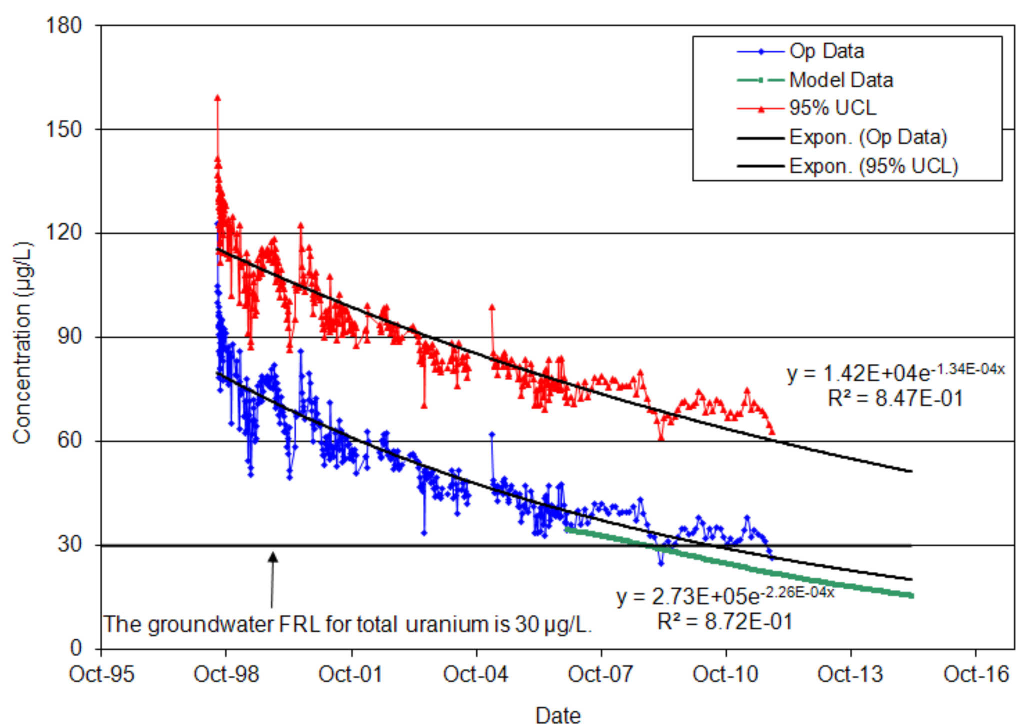



FIGURE A.1-19. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR EXTRACTION WELL 32309 (RW-7) WITH REGRESSION ANALYSIS

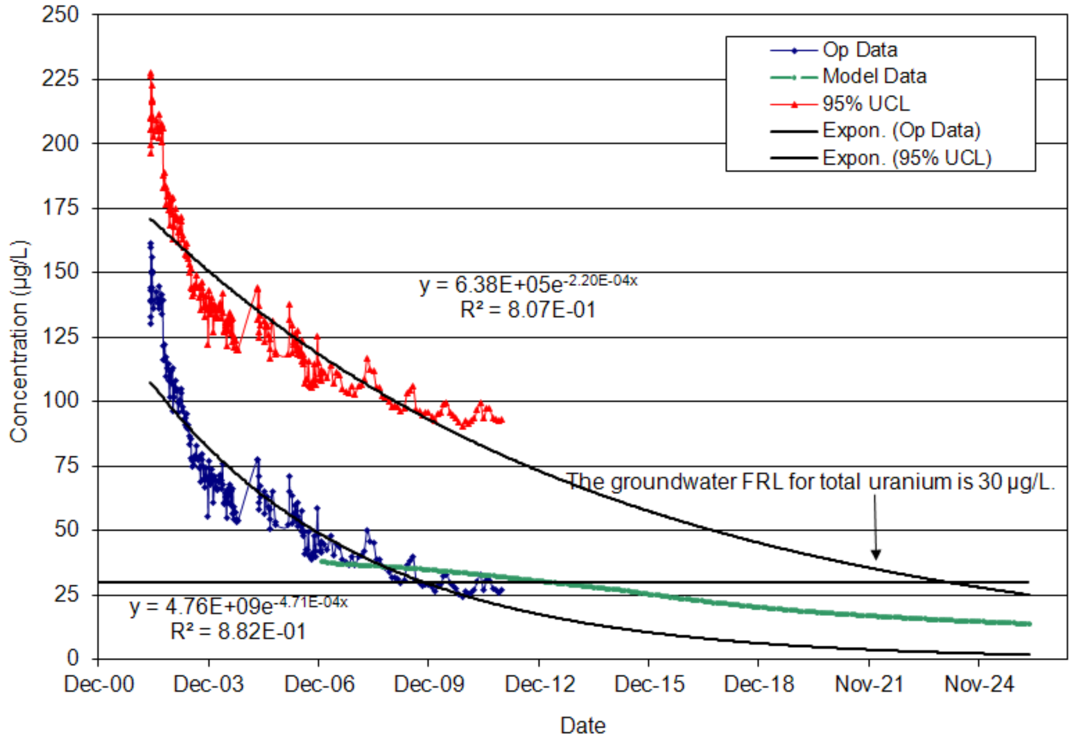



Figure A.1-20. Total Uranium Concentration vs. Time Plot
for Extraction Well 32761 (EW-26) with Regression Analysis

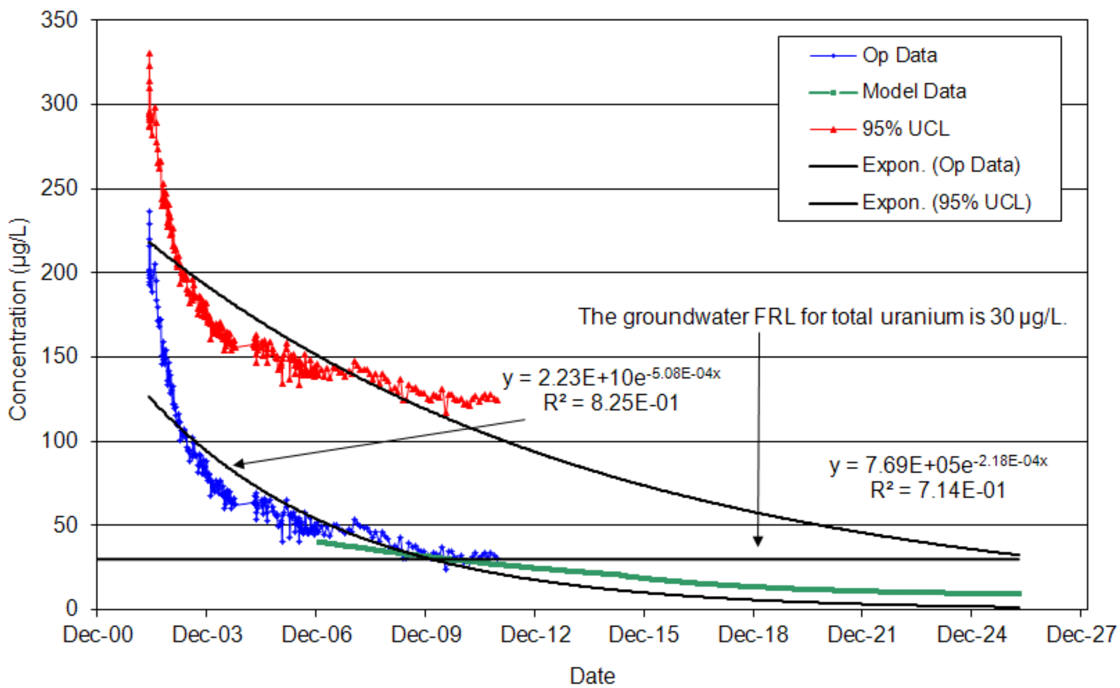



Figure A.1-21. Total Uranium Concentration vs. Time Plot
for Extraction Well 33062 (EW-27) with Regression Analysis

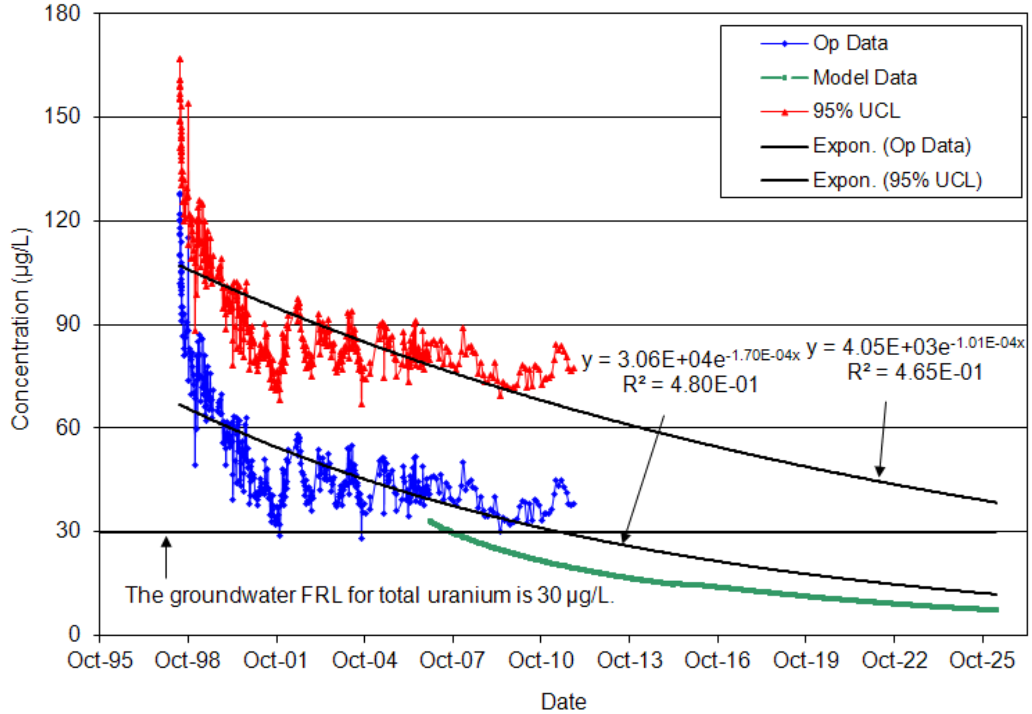



Figure A.1-22. Total Uranium Concentration vs. Time Plot
for Extraction Well 31550 (EW-18) with Regression Analysis

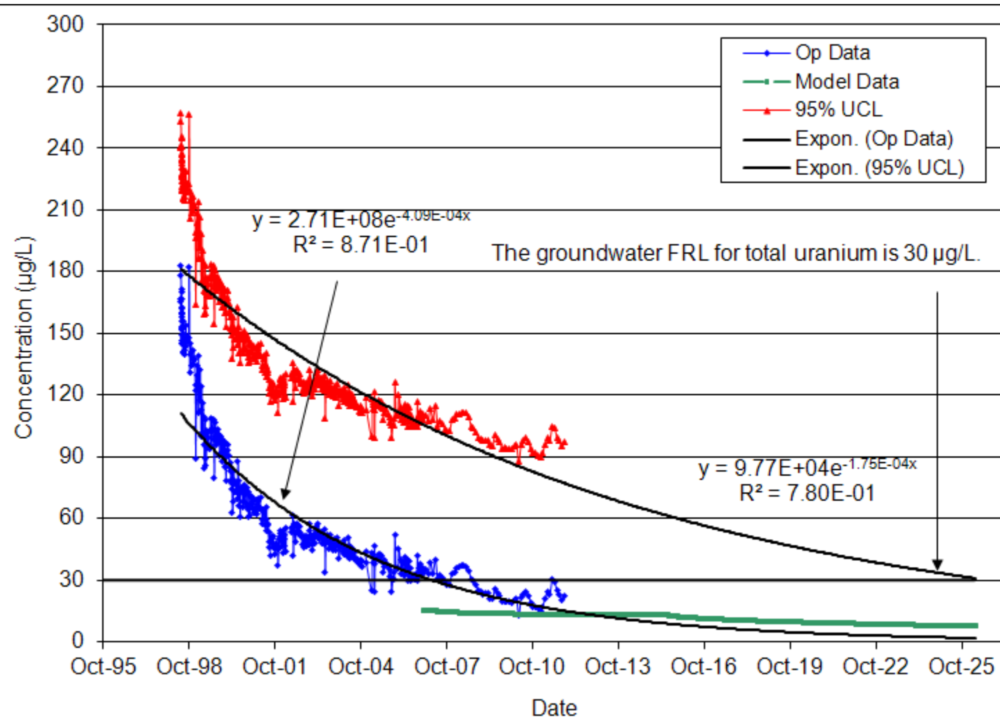



Figure A.1-23. Total Uranium Concentration vs. Time Plot
for Extraction Well 31560 (EW-19) with Regression Analysis

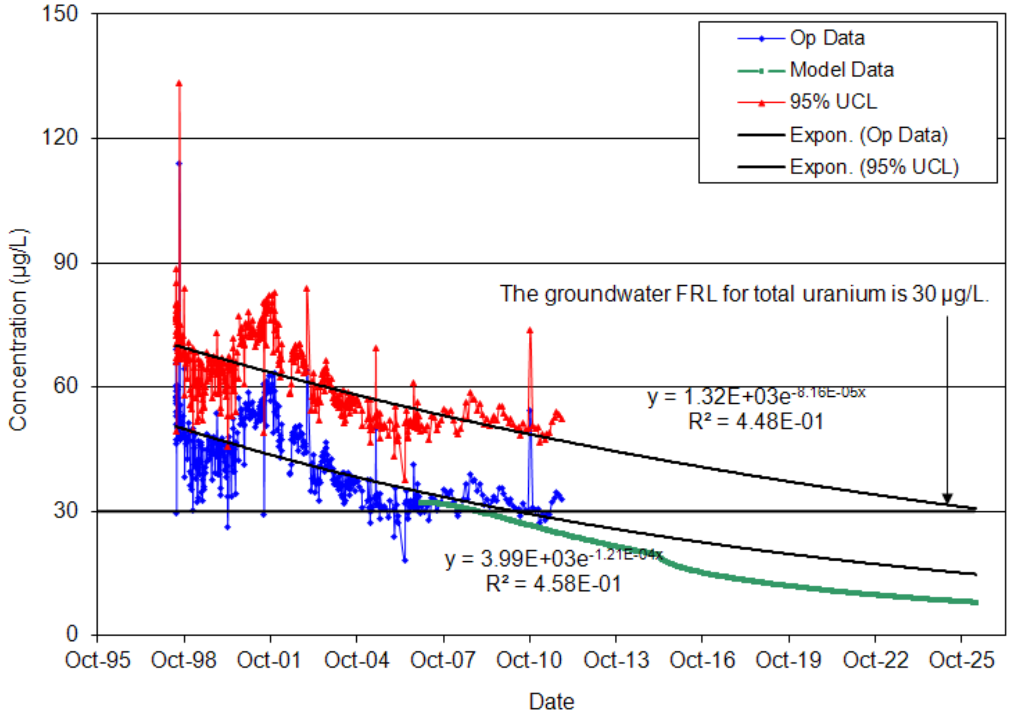



Figure A.1-24. Total Uranium Concentration vs. Time Plot for Extraction Well 31561 (EW-20) with Regression Analysis

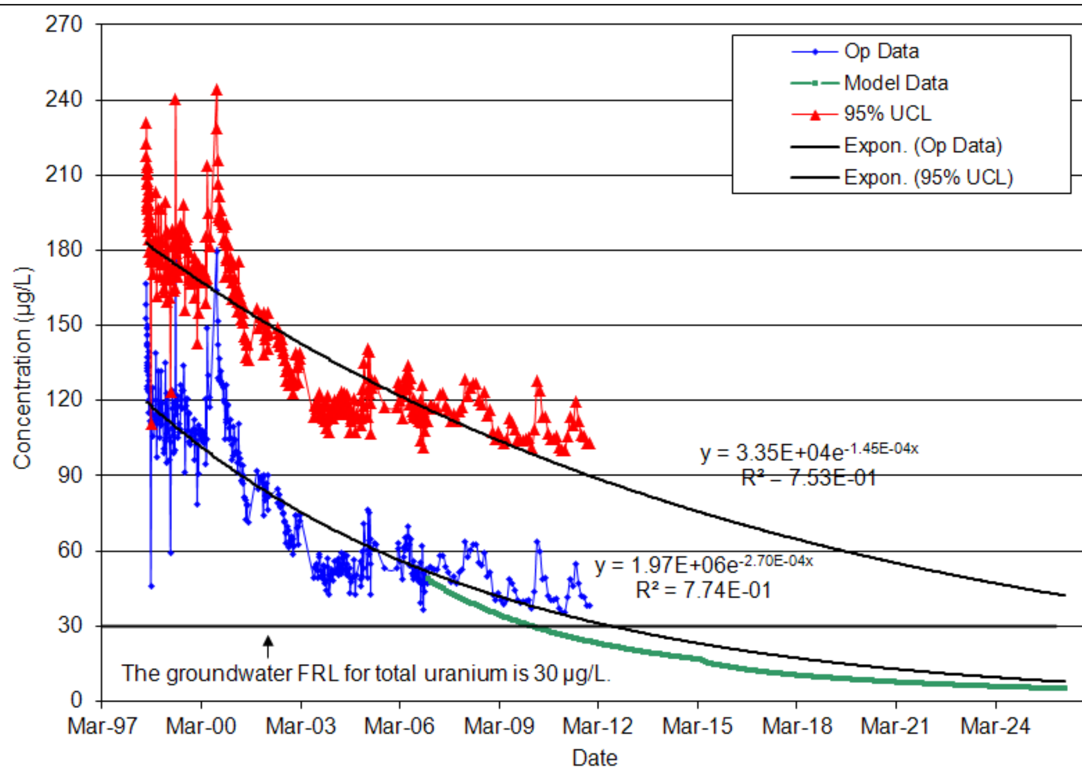



Figure A.1-25. Total Uranium Concentration vs. Time Plot for Extraction Well 31562 (EW-21) / 33298 (EW-21a) with Regression Analysis

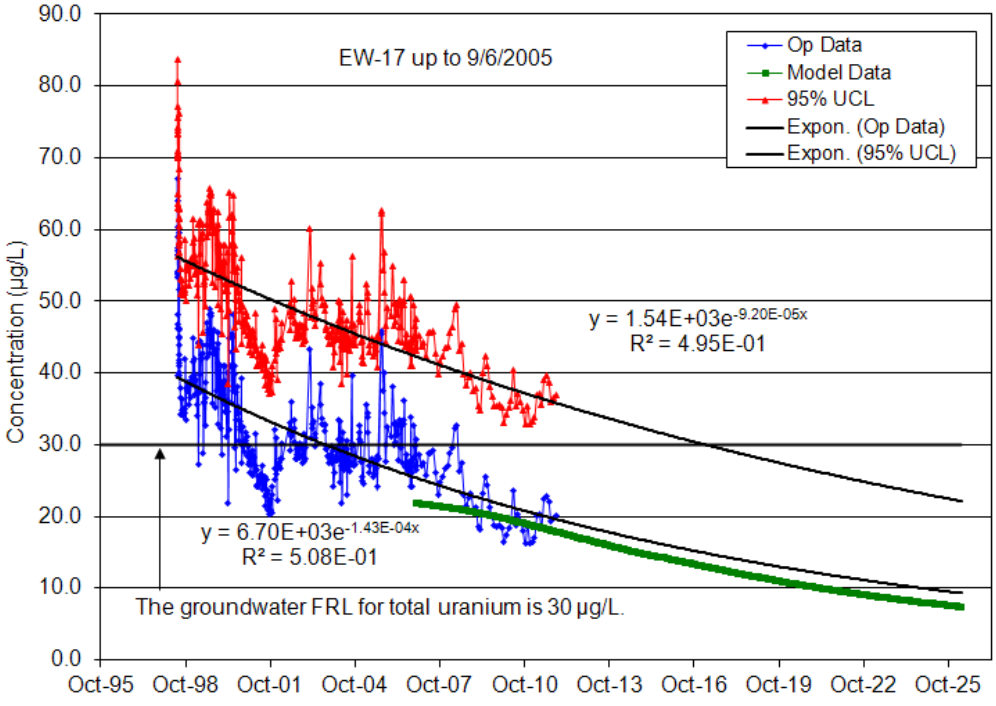



Figure A.1-26. Total Uranium Concentration vs. Time Plot for Extraction Well 31567 (EW-17)/ 33326 (EW-17a) with Regression Analysis

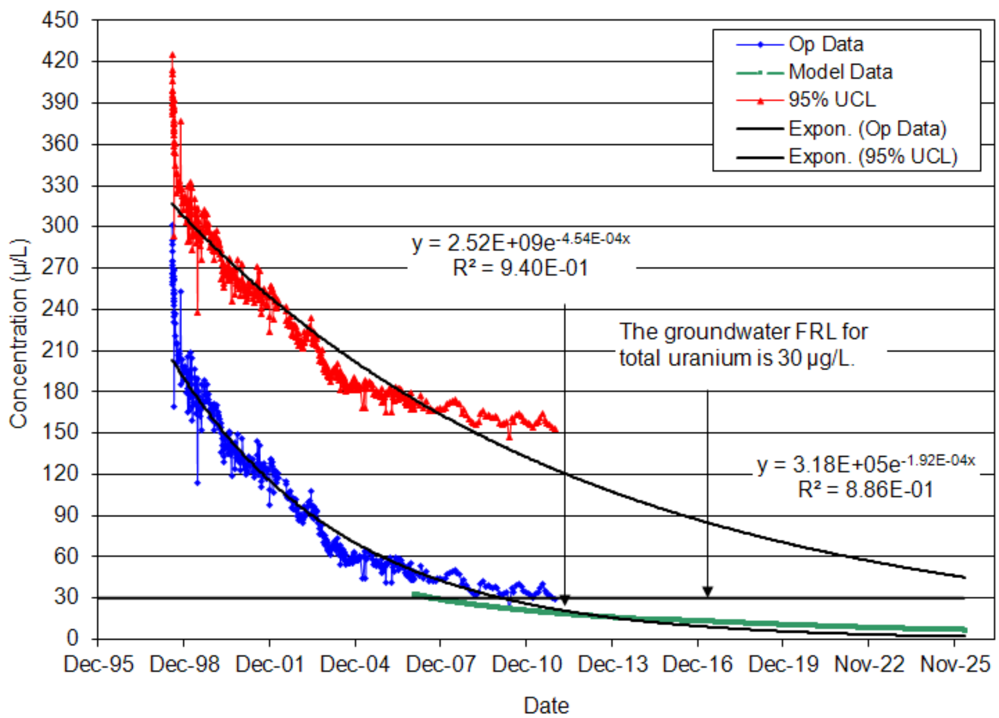



Figure A.1-27. Total Uranium Concentration vs. Time Plot for Extraction Well 32276 (EW-22) with Regression Analysis

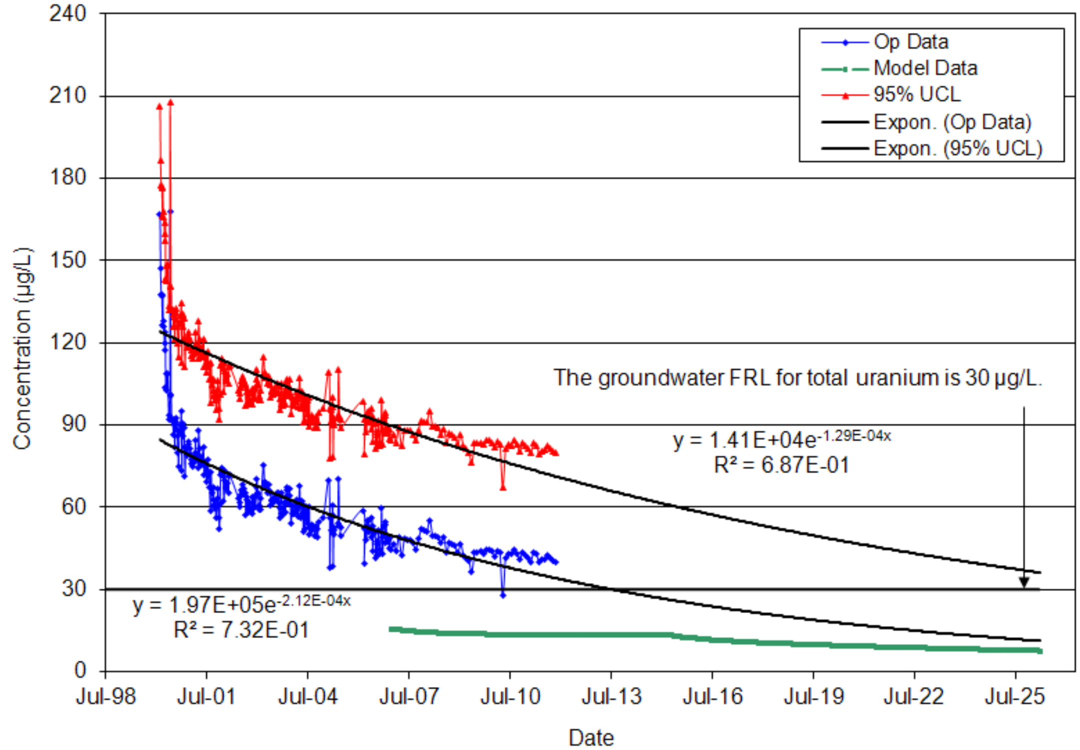



Figure A.1-28. Total Uranium Concentration vs. Time Plot for Extraction Well 32446 (EW-24) with Regression Analysis

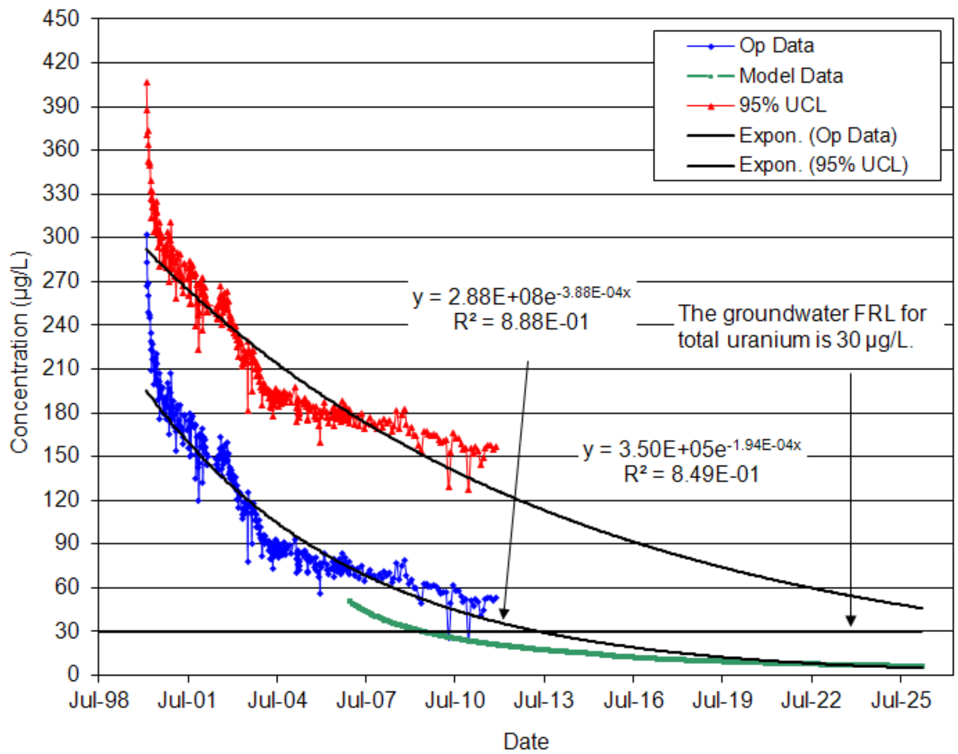



Figure A.1-29. Total Uranium Concentration vs. Time Plot for Extraction Well 32447 (EW-23) with Regression Analysis

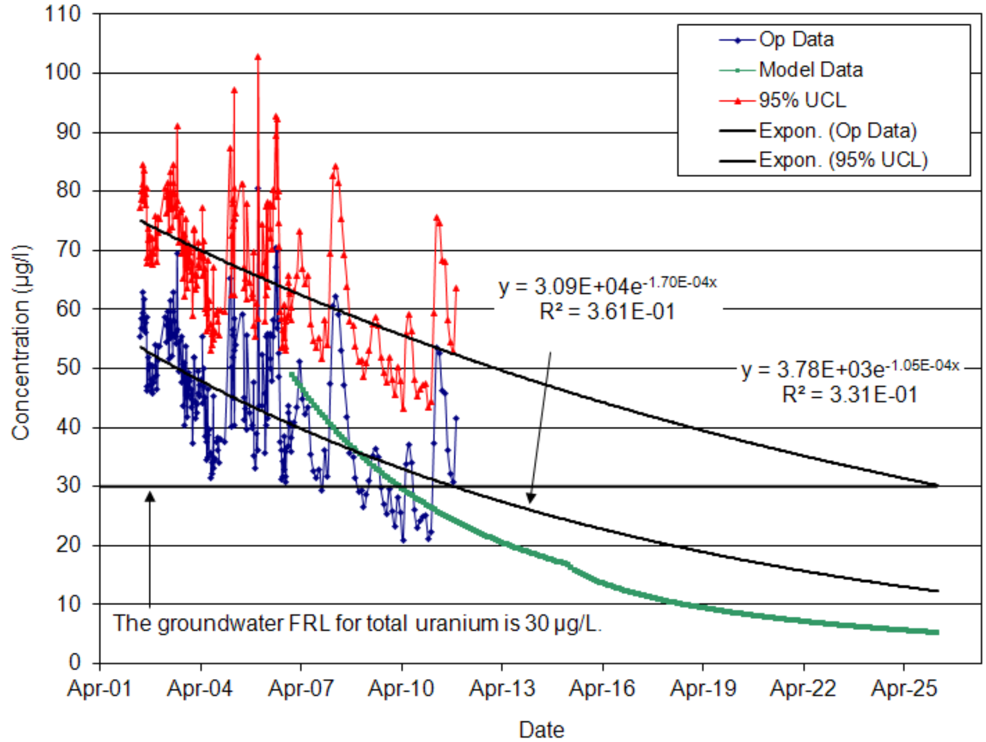



Figure A.1-30. Total Uranium Concentration vs. Time Plot for Extraction Well 33061 (EW-25) with Regression Analysis

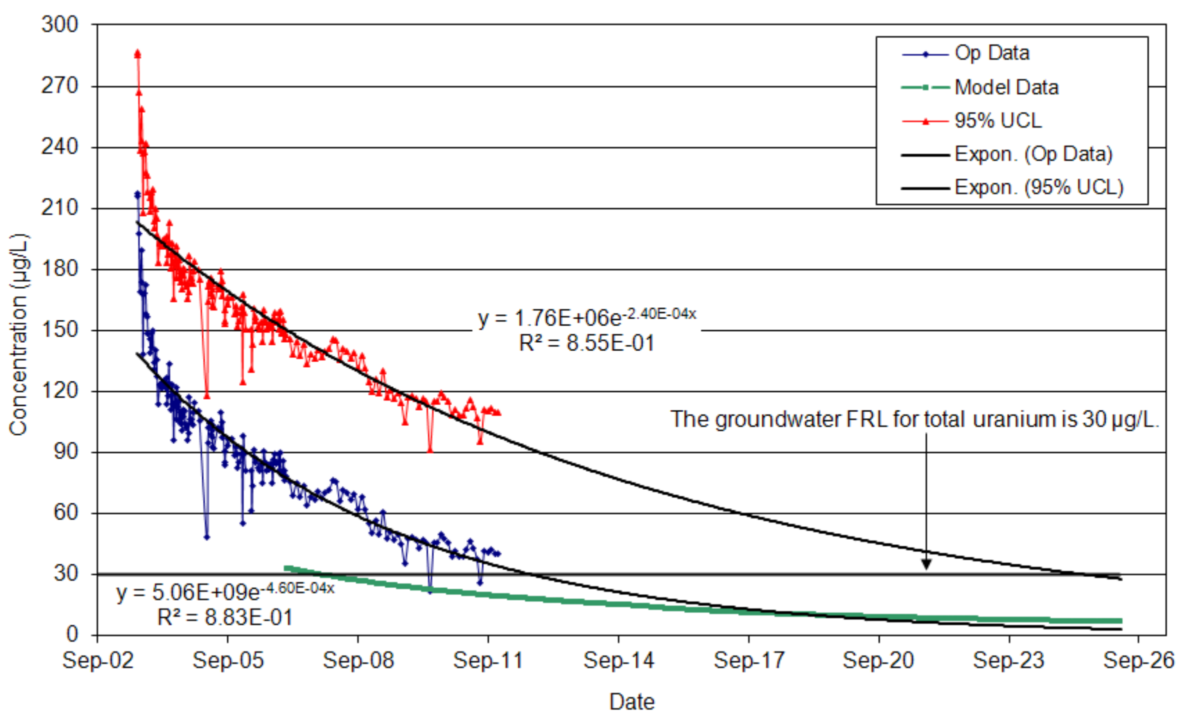



Figure A.1.31. Total Uranium Concentration vs. Time Plot for Extraction Well 33264 (EW-30) with Regression Analysis

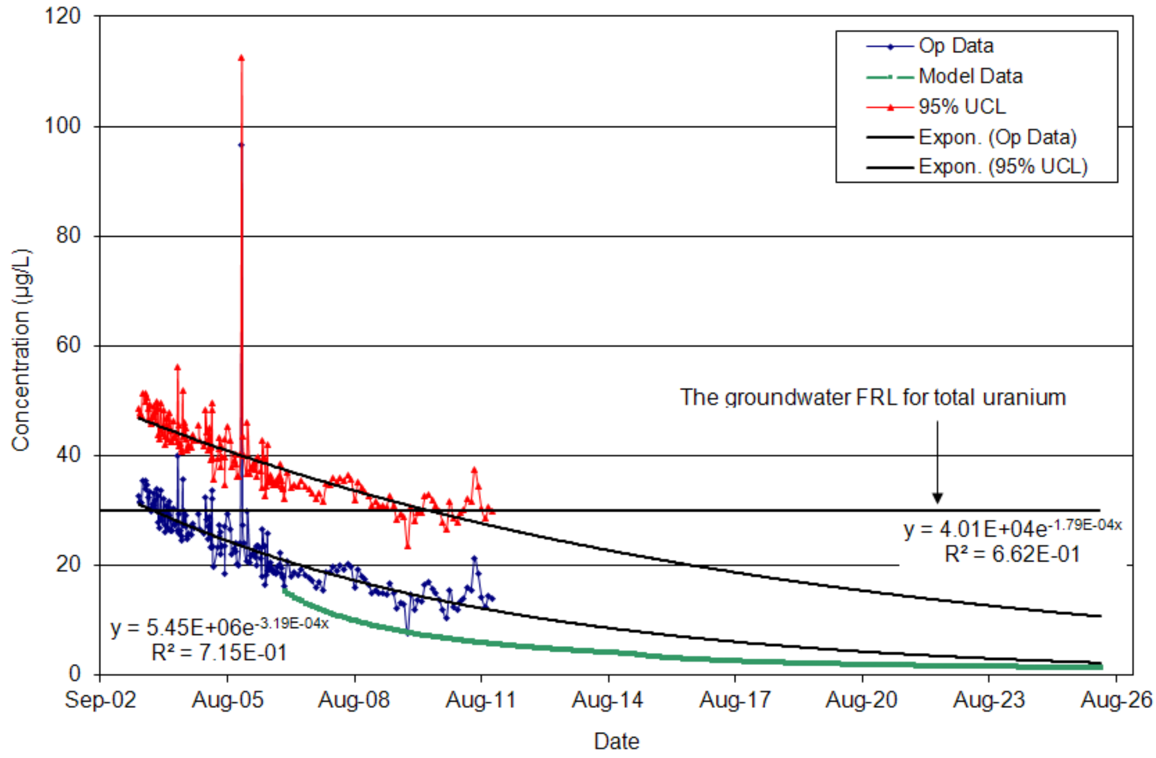



Figure A.1-32. Total Uranium Concentration vs. Time Plot for Extraction Well 33265 (EW-31) with Regression Analysis

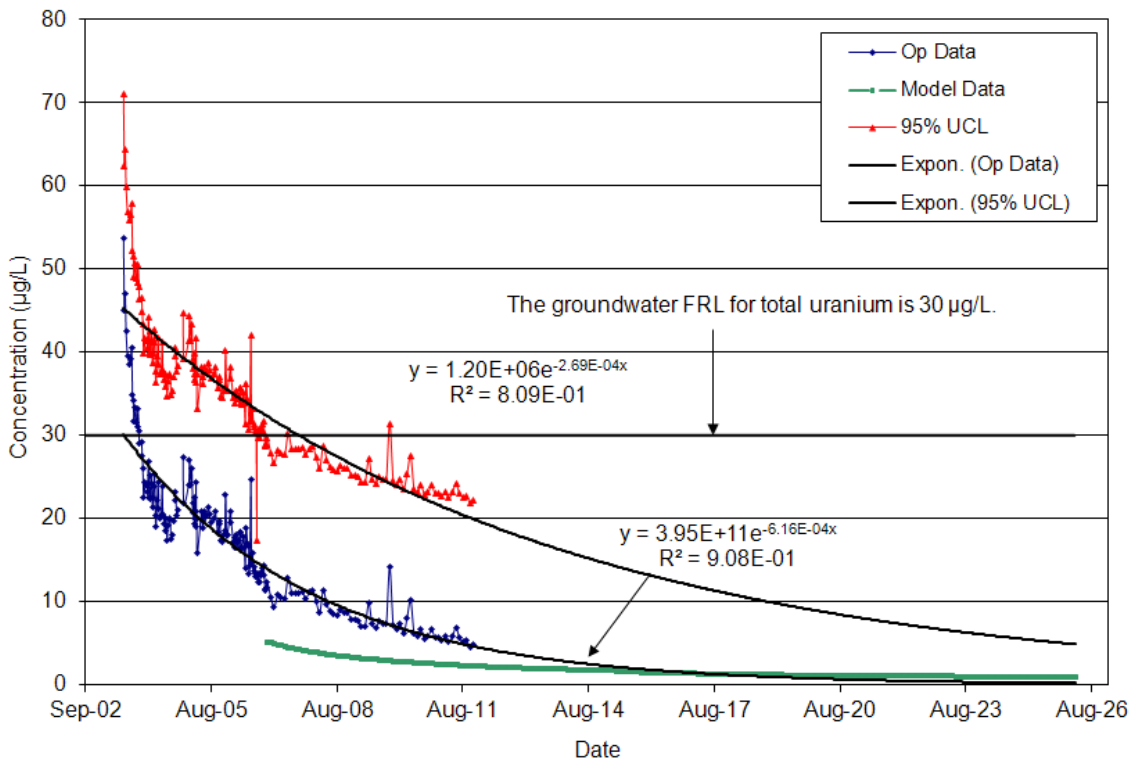



Figure A.1-33. Total Uranium Concentration vs. Time Plot for Extraction Well 33266 (EW-32) with Regression Analysis

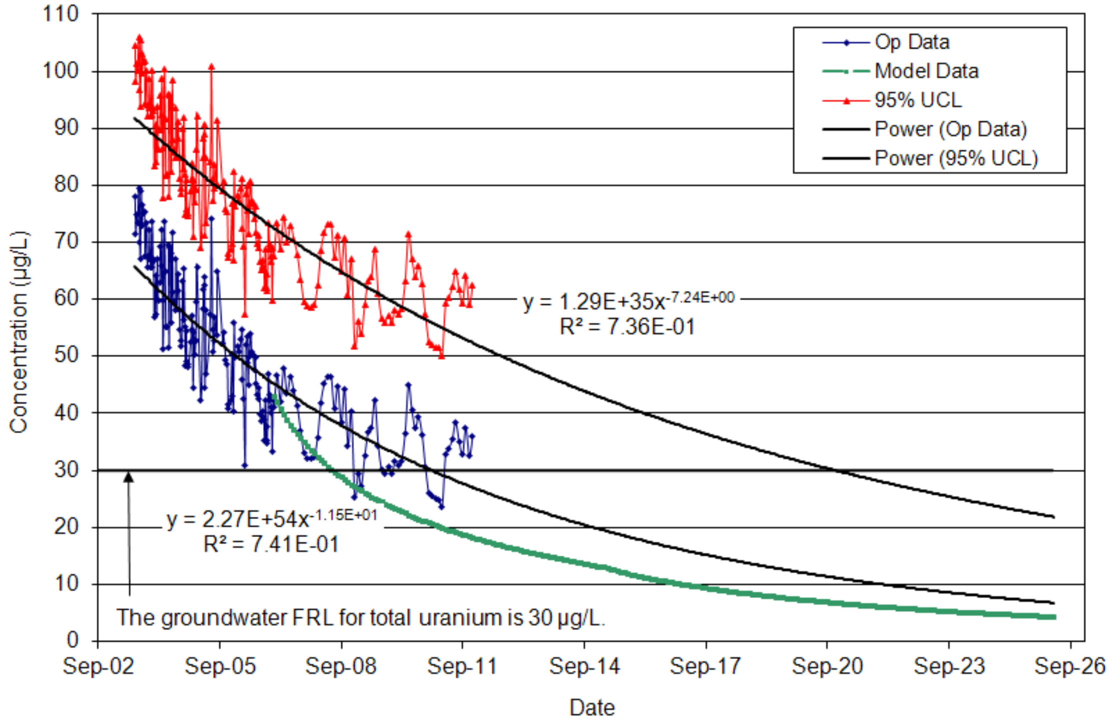



Figure A.1-34. Total Uranium Concentration vs. Time Plot
for Extraction Well 33262 (EW-15a) with Regression Analysis

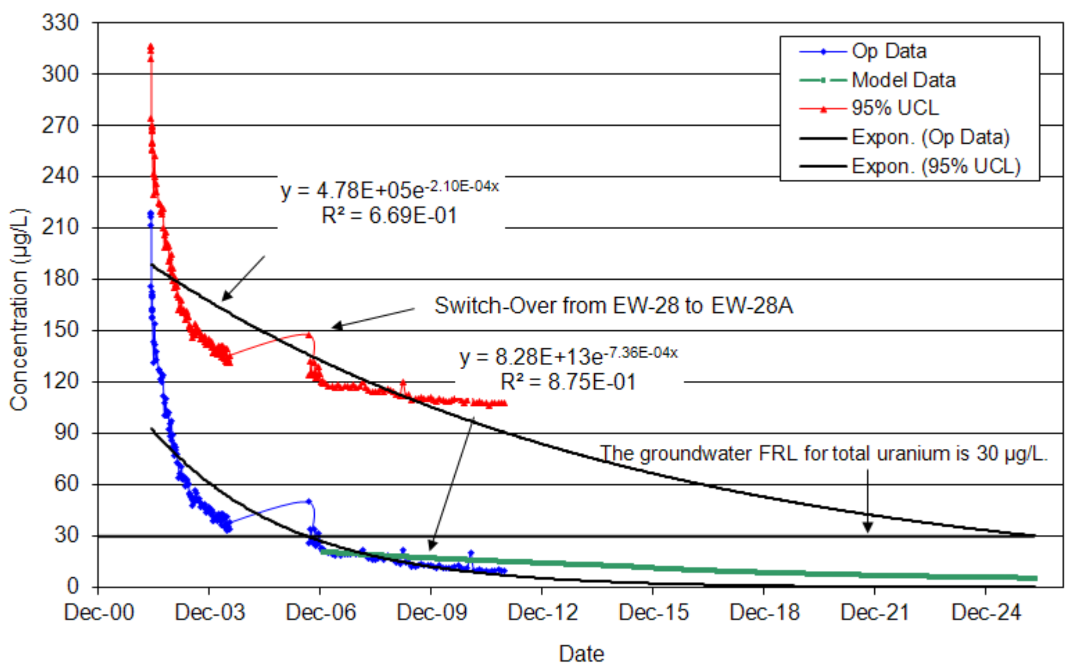



Figure A.1-35. Total Uranium Concentration vs. Time Plot
for Extraction Well 33063 (EW-28) / 33334 (EW-28a) with Regression Analysis

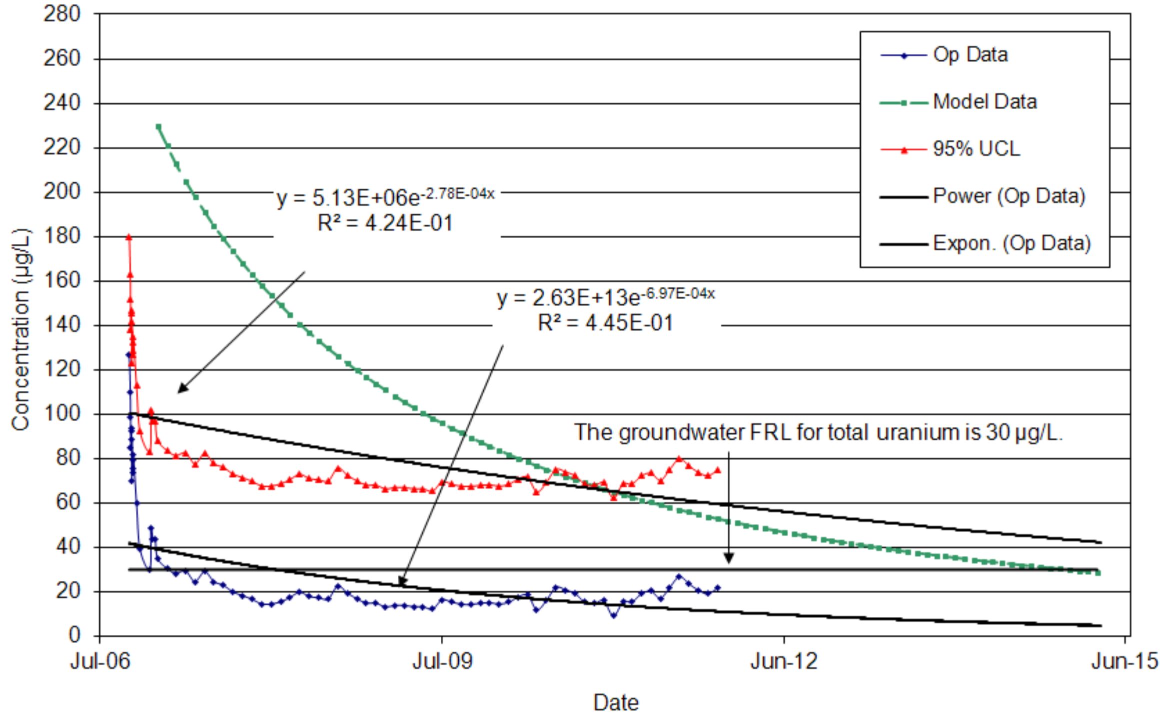



Figure A.1-36. Total Uranium Concentration vs. Time Plot
for Extraction Well 33347 (EW-33a) with Regression Analysis

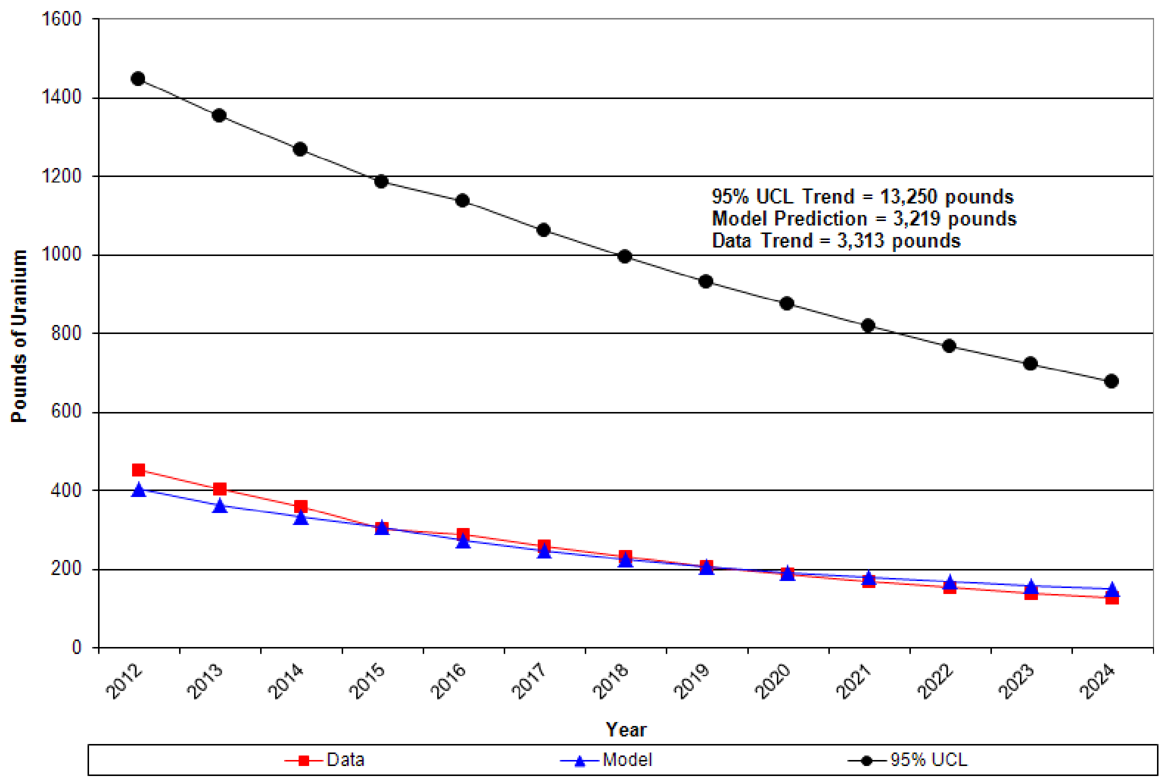



*Figure A.1–37. Estimate of Yearly Pounds of Uranium to be Pumped from Aquifer*
*(Model Predictions vs. Measured Concentration Trends)*
*Data Collected Through 2011*

# Attachment A.2

This page intentionally left blank

# A.2.0 Assessment of Total Uranium Results

This attachment discusses groundwater monitoring total uranium results through 2011. The groundwater total uranium sampling requirements are presented in the Integrated Environmental Monitoring Plan (IEMP), which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan* (LMICP) (DOE 2011a). IEMP groundwater monitoring and extraction well locations are shown in Figure A.2−1. For integration purposes, the OSDF monitoring well locations are also shown on Figure A.2−1. In addition to the routine well monitoring specified in the IEMP, 28 locations were sampled using a direct-push sampling tool (Geoprobe®) in 2011. Direct-push sampling results are presented in Tables A.2–1 through A.2–28.

As reported in Attachment A.3, record high precipitation occurred in 2011. The average annual precipitation for the site is approximately 41 inches a year (OU5 Remedial Investigation [DOE 1995]). Precipitation data collected at the Butler County Regional Airport is reported in the SER. For calendar year 2011, the Butler County Regional Airport recorded 60.20 inches of precipitation. A portion of the large amount of precipitation served to recharge the aquifer and raise the water table. High water levels in the aquifer provide ideal conditions to update the dimensions of the maximum uranium plume because more of the vertical component of the plume can be sampled. DOE took full advantage of the high water levels in 2011 and collected 28 direct push samples to support updating the dimensions of the total uranium plume. As reported below, data obtained from these 28 samples, along with data collected from fixed monitoring well locations, were used to decrease the footprint of the mapped maximum uranium plume in 2011 by approximately 40 acres or 21.6 percent from what was mapped at the end of 2010.

A minor mapping change was initiated in 2011 that also contributed a small decrease (less than 1 acre) to the size of the maximum uranium plume map for 2011. In past years, small circles were arbitrarily drawn around locations that had intermittent uranium FRL exceedances. The arbitrary sizes of the small circles were then counted as part of the overall maximum uranium plume acreage. In 2010, the maximum uranium plume map had four of these small circles adding approximately 0.957 acres to the size of the maximum plume. In 2011, these small circles were eliminated and replaced with symbols indicating intermittent exceedances. This technique provides better estimates of the actual size of the maximum uranium plume. It also serves to keep track of the locations with intermittent uranium groundwater FRL exceedances so that their presence can be carried forward into the certification stage of the remediation project.

Figures A.2−2A, A.2−2B, A.2−3A, and A.2−3B show maximum total uranium plume maps for the first and second halves of 2011, respectively. Figures A.2–2A and A.2–3A show direct-push data. Figures A.2–2B and A.2–3B show monitoring well and extraction well data. Data collected from the aquifer are used to progressively update the maximum total uranium plume maps in the following conservative manner:

- Total uranium concentration data are posted on a map with the contours from the previous map. The highest representative total uranium value at a monitoring well location is posted. The highest concentration associated with each direct-push location is also posted.
- If a recently measured concentration from a well is greater than the previous concentration contour value at that location, then the plume is re-contoured using the higher value.

- If the most recent concentration measurement from a well is less than the previous contour for that location, then the new data are posted, but the plume contours are not adjusted using the new data until confirmatory direct-push sampling can be conducted.
- If direct-push data or multi-level monitoring well data are available and a complete vertical profile of an area indicates that concentrations have changed, then the map is re-contoured using the new direct-push data or multilevel well data. Note, under this strategy, a reduction in the size of the mapped plume is based on vertical profile data.

Table A.2−29 lists the monitoring wells where total uranium concentrations exceeded the 30 µg/L Final Remediation Level (FRL) during 2011. Included in the table are total uranium statistical summaries for each well, which include Mann-Kendall trend analyses. Table A.2−30 provides total uranium statistical summaries for the extraction wells, including Mann-Kendall trend analyses. Figure A.2−4 illustrates the statistics presented in Table A.2−29 (e.g., where total uranium concentrations have, if any, an “up, significant,” “down, significant,” or a “no significant” trend).

Attachment A.2 is subdivided into the following sections:

- A.2.1 Former Waste Storage Area
- A.2.2 Former Plant 6 Area
- A.2.3 South Field and Off-Property South Plume Uranium Plumes
- A.2.4 Flow Monitoring in the Storm Sewer Outfall Ditch

## A.2.1 Former Waste Storage Area

### A.2.1.1 Former Waste Storage Area Maximum Uranium Plume

The mapped footprint of the 30 µg/L maximum uranium plume in the former Waste Storage Area decreased in 2011. In 2010, the mapped footprint was estimated to be 22.429 acres. In 2011, the mapped footprint is estimated to be 15.656 acres, a decrease of 30.2 percent.

Direct push sampling was conducted at three location in the former waste storage area in 2011 (12617C, 13422, and 12618C). Results (provided in Tables A.2–1 through A.2–3) helped define the decrease in plume size noted above. As reported last year, the area around monitoring wells 2821 and 3821 was targeted for direct push sampling in 2011 (Location 12617C). Sampling was conducted in 2011 and results for location 12617C are provided in Table A.2-1. The results indicate that uranium concentrations are below the 30 µg/L uranium FRL, but that groundwater FRL exceedances for technetium-99, nitrate/nitrite, and manganese remain.

Monitoring well 2649 had its highest recorded uranium FRL exceedance in 2011 (954 µg/L) (Figure A.2-5). The high uranium concentration is attributed to sorbed uranium in the vadose zone in this former source area. High water levels within the aquifer in 2011 allowed some of the sorbed uranium to dissolve into the water and raise the uranium concentration.

The northwest corner of the maximum uranium plume in the former Waste Storage Area is bounded by Paddys Run to the west and the former waste pits to the east. Intermittent puddles of surface water collect in this area west of the former Waste Pit 3. Surface water samples are collected and analyzed from these small intermittent puddles. As presented in Appendix B, the uranium concentration of some of the collected samples exceeds the groundwater FRL. Surface water runoff in the former Waste Storage Area is directed to where the Clear Well and Pit 3 were once located. The surface water is allowed to infiltrate into the ground and serve as a source of recharge to the aquifer. The area of infiltration is within capture of the former Waste Storage Area pumping wells.

#### A.2.1.2 Pilot Plant Drainage Ditch Maximum Uranium Plume

The mapped footprint of the 30 µg/L maximum uranium plume in the Pilot Plant Drainage Ditch Area decreased in 2011. In 2010, the mapped footprint was estimated to be 25.733 acres. In 2011, the mapped footprint is estimated to be 9.653 acres, a decrease of 60.48 percent.

Direct push sampling was conducted at four locations in the Pilot Plant Drainage Ditch Area in 2011 (13418A, 13412A, 13428, and 12717B). Results (provided in Tables A.2–4 through A.2–7) helped define the plume decrease noted above. Up until 2011, monitoring well 83335_C2 defined the eastern edge of the Pilot Plant Drainage Ditch Plume even though a uranium FRL exceedance had not been detected in the well for the last 2.5 years (Figure A.2-6). High water level conditions in the aquifer during the second half of 2011 resulted in a uranium FRL exceedance (38.7 µg/L). This monitoring well location is identified on the 2011 maximum uranium plume map as a location with intermittent uranium FRL exceedances. If future monitoring in well 83335 indicates that the intermittent uranium FRL exceedances are continuing or increasing, additional direct-push sampling may be conducted in the area when water levels are high to verify the extent of the intermittent exceedances and revisions to the maximum total uranium plume map will be made if warranted.

### A.2.2 Former Plant 6 Area

Plans for a groundwater restoration module in the former Plant 6 Area were abandoned in 2001 based on the outcome of the *Design for Remediation of the Great Miami Aquifer in the former Waste Storage and Plant 6 Areas* (DOE 2001a). This design provided data that indicated that the total uranium plume in the former Plant 6 area was no longer present. The EPA and Ohio EPA (OEPA) concurred with this decision.

Monitoring well 2389 is the only groundwater monitoring well remaining in the area where Plant 6 was located in the former production area (Figure A.2–1). Figure A.2−7, shows that sporadic uranium FRL exceedances were detected between 2002 and 2007 at monitoring well 2389. As discussed below, the FRL exceedances at this monitoring well are associated with high water table conditions. High water level conditions in 2011 resulted in two uranium FRL exceedances being measured in 2011; 78.2 ug/L in the first half of the year, and 43.2 ug/L in the second half of the year. The 78.2 ug/L concentration is the highest concentration measured in monitoring well 2389 since 1990.

Direct-push sampling in this area indicates that the intermittent uranium FRL exceedances are associated with a thin amount of contamination that is detected under high water table conditions. The former Plant 6 area is targeted for direct-push sampling when the water-table elevation is at an elevation of 514.8 ft amsl or higher. As shown below, unless the water table is at an elevation of 514.8 feet amsl or higher uranium FRL exceedances are not detected. A direct push sample was collected in this area in 2011 (location 13360C). As shown below, the regional water table was high enough for the sample to detect an exceedance. The concentration of the exceedance (37.7 ug/L) is similar to the exceedance detected back in 2008 (37.2 ug/L).

| Year | Location | Uranium Concentration (µg/L) | Midpoint Screen Elevation (ft amsl) |
|---|---|---|---|
| 2007 | 13360 | < 1.0 | 512.3 |
| 2008 | 13360A | 37.2 | 514.8 |
| 2010 | 13360B | 4.4 | 510.3 |
| 2011 | 13360C | 37.7 | 515.1 |

Up until this year, a small uranium plume was arbitrarily drawn circling monitoring well 2389 on the maximum total uranium plume map to represent the intermittent uranium FRL exceedances. This year the monitoring well is identified as an intermittent exceedance location with a symbol rather than a circle. The well will continue to be identified on maximum uranium plume map as being a location where intermittent uranium FRL exceedances have been measured so that its presence will be carried forward into the certification stage of the aquifer remediation.

## A.2.3 South Field and Off-Property South Plume Uranium Plumes

The mapped footprint of the 30 µg/L maximum uranium plume in the South Field and off property South Plume decreased in 2011. In 2010, the mapped footprint was estimated to be 135.513 acres. In 2011, the mapped footprint is estimated to be 117.998 acres, a decrease of 12.9 percent.

Direct push sampling was conducted at twenty locations in the South Field and South Plume in 2011 (12369P, 12372Q, 13241A, 13297A, 13356A, 13357A, 13412A, 13413A, 13419A, 13419B, 13420, 13421, 13423, 13424, 13425, 13426, 13427, 13430, 13431, and 13432). Locations are shown in Figure A.2–3A. Results from these twenty locations were used to help define the plume decrease noted above. The four main areas change to the mapped plume are discussed below.

Area 1: The northern edge of the South Field plume was moved south based on results from direct push sampling locations 13419A, 13419B, 13430, and 13431. This area is located just south of the site access road, and southeast of the stormwater retention basins. Direct-push sampling results are provided in Tables A.2-13 through A.2-16. Location 13419 was sampled twice in 2011. The first sampling event (13419A) stopped at a depth of 67 feet below the ground surface (bgs) because the material encountered was too fine to yield a sample. The second sampling event (13419B) was successful in reaching a deeper depth of 127 feet bgs. The highest uranium concentration measured was from the first sampling event (23.8 ug/L), and was used in the maximum uranium plume map to be conservative.

Area 2: The southeastern edge of the South Field plume was moved west in two areas based on results from direct push sampling locations 13241A, 13356A, and 13432 and monitoring wells in the area. Direct push sampling results from these locations are provided in Tables A.2-9, A.2-20, and A.2-28, respectively. Uranium plume contours just west of direct push location 13241A incorporate direct push sampling results that are over 7 years old. This area is being targeted for direct push sampling in 2012 in order to update the plume profile and provide a more up-to-data maximum plume interpretation.

Area 3: The southern edge of the South Plume was moved north to honor direct push sampling location 13427 and monitoring well sampling results in the area.

Area 4: An off property lobe of the uranium plume was better delineated in 2011 by the collection of direct push data. As discussed in the Fernald Preserve Site Environmental Report, 2010 (DOE 2011a) and the *Third Five-Year Review Report for the Fernald Preserve* (DOE 2011b) stagnation zones within the uranium plume are identified as having the potential to extend remediation completion times for the aquifer beyond that predicted by the groundwater model. Stagnation zones are created by the competition of extraction wells for water within the aquifer. A stagnation zone exists just south of Willy Road, located between the South Plume extraction wells and the South Field extraction wells. Figure A.2–3A is a maximum uranium plume map for the second half of 2011. The subject off-property lobe of the uranium plume can be located on Figure A.2-3A by the dense concentration of direct push sampling data obtained in 2011 just south of Willy Road. The data indicates that the lobe is actually connected to the main off-property plume to the southwest.

With the southern extent of the lobe defined by 2011 direct-push data, potential ways to improve the aquifer remedy design in this area are being explored to see if remediation times can be improved (e.g., change the pumping rates of existing extraction wells; convert an out-of-service injection well just north of the lobe into an additional extraction well; and/or possibly install a new extraction well). DOE will discuss improvement options with EPA and Ohio EPA before taking any action in the area.

**Update of Cross Sections along Willey Road**

Since 1998 several locations along Willey Road have been sampled using a direct-push sampling tool: 12367, 12368, 12369, 12370, 12371, 12372, and 12373. These locations were originally sampled to track re-injection progress along Willey Road. Re-injection was discontinued in September 2004; however, annual sampling continued at five of the seven locations (12368, 12369, 12370, 12371, and 12372) to provide updates on remediation progress. Up until 2010, the results were used to prepare two cross sections of the area.

Sampling of the locations annually was creating a problem in the field, in that it was becoming hard to find a location free of grout from the multiple previous sample collection efforts. Over the years, the plume has decreased so that only two locations remain within the plume (locations 12372 and 12369). DOE is installing multi-level monitoring wells at these locations. Soggy field conditions in 2011 pushed the installations into 2012. The remaining locations, that are no longer in the plume (locations 12373, 12368, and 12370), will not be sampled again until the south plume certification stage of the groundwater remedy, unless it is deemed necessary to do so.

Figure A.2-8 is a cross section of 2011 monitoring results at locations 12372Q and 12369P. The data indicates that the plume continues to decrease in this area. Historical data for location 12373P is provided in the figure for reference purposes to show that a high concentration of uranium was measured at an elevation of approximately 516 feet amsl in 2005. If and when water levels get this high again, additional sampling direct push sampling will be conducted at location 12373 to provide an update.

## A.2.4 Flow Monitoring in the Storm Sewer Outfall Ditch

As reported in the *Groundwater Remedy Evaluation and Field Verification Plan* (DOE 2004a), a modeled infiltration rate of 500 gpm through the SSOD decreased the model-predicted cleanup time estimate by one year. A field study was conducted in 2005 to gauge seasonal flow of water in the Storm Sewer Outfall Ditch (SSOD) and to determine if recharge to the GMA through the SSOD at a rate of 500 gpm was feasible (DOE 2005b). Although the study concluded that the operation would not be cost effective, subsequent discussions in 2006 with EPA and OEPA led to an agreement to continue the infiltration operation.

As shown in Figure A.2−9, six Parshall flumes are installed in the SSOD. These flumes are used to measure flow into and out-of the SSOD. The natural flow into the SSOD is being supplemented (since 2006) with water supplied from a group of three water wells located on the east side of the site (42202, 42471, and 43309). Well 42471 became inoperable in June of 2010 due to an electrical issue. As stated in the Operations and Maintenance Master Plan (OMMP), this is Attachment A of the LMICP (DOE 2010a): Supplemental pumping into the SSOD will continue until the wells, pumps, or motors are no longer serviceable. At that time, operations will be suspended, pending a determination that the remedy is benefiting from the operation (DOE 2011a). The wells are pumped as necessary to supplement natural flow and maintain a flow of approximately 500 gpm into the SSOD. Water pumped from the wells is discharged into a ditch that empties into the Lodge Pond. Water from the Lodge Pond is allowed to overflow into the mouth of the SSOD. Flume 6 is the first flume located downstream of the Lodge Pond. Flumes 2, 3, 4, 5, and 6 all measure flows into the SSOD. Flume 1 is the most southernmost flume. It measures flow emptying out of the SSOD and into Paddys Run.

Pumping Operations

In 2011, 138,680,400 gallons of clean groundwater at an average rate of 359 gpm were pumped into the SSOD. Pumping of clean groundwater into the SSOD began on December 14, 2006. Since pumping began, flow metering indicates 717,739,050 gallons of clean groundwater water have been pumped from the aquifer and used to supplement flow in the SSOD.

| Year | Total Gallons of Water Pumped | Average Pumping Rate (gpm) |
|---|---|---|
| 2006<br>(Dec. 14–Dec. 31) | 8,154,900 | 334 |
| 2007 | 138,900,400 | 264 |
| 2008 | 119,256,249 | 227 |
| 2009 | 132,584,001 | 252 |
| 2010 | 180,163,100 | 343 |
| 2011 | 138,680,400 | 359 |
| **Total** | **717,739,050** | |

Throughout 2011, pumping was intermittently halted due to high pond levels as a result of record high seasonal and annual rainfall, and despite excessive drainage of the Lodge Pond through or near the engineered outlet for the pond. From May 14 to May 23, pumping of water into the

SSOD was temporarily increased by pumping both wells to maintain the water level of the Lodge Pond due to this excessive drainage through or near the engineered outlet for the pond. From November 27 to December 12, pumping was halted so that repairs to the engineered outlet could be made to stem this excessive drainage. Preliminary data after repairs at the end of 2011 indicate that this excessive drainage was largely reduced.

Infiltration Assessment

Figure A.2−10 plots the flow rate into the SSOD (Flumes 2, 3, 4, 5, and 6) and the flow rate out of the SSOD (Flume 1) from March 17, 2011 through December 7, 2011. Until March 17, 2011, nighttime temperatures were still periodically falling low enough to freeze the water in the stilling wells of the flumes causing the water level instrumentation to give incorrect readings. Monitoring in 2011 was interrupted due to a malfunctioning water level instrument in Flume 1 that failed on August 31st, but was not discovered until October 17th. An additional interruption was caused by flooding water knocking out the freeze plug in the Flume 1 standpipe, preventing representative readings. These interruptions are noted in the figure.

As illustrated in Figure A.2−10 from May through August, it appears that infiltration was occurring in the section of the SSOD being monitored. The amount of water entering the SSOD exceeded the amount of water leaving the SSOD indicating that infiltration was occurring. The average amount of infiltration (for those days when infiltration was recorded) is approximately 129 gpm. How much of the water actually reached the aquifer is unknown as evaporation and transpiration are not accounted for.

In 2011, operations were successful in achieving the target flow rate of 500 gpm in the SSOD, aided largely by record high annual precipitation. The average annual flow rate into the SSOD in 2011 was 1,159 gpm. This flow rate consisted of natural flow and supplemented pumping from the clean production wells located on the east side of the site.

Figure A.2−11 shows a monthly comparison of the flow rate into the SSOD from 2006 to 2011. Flow entering the SSOD in 2006 was natural until December of 2006, when supplemental pumping into the SSOD began. As shown in Figure A.2−11 supplemental pumping has helped to keep flow rates higher in the summer months when natural flow is lower. In 2011 the average flow rate was greatly aided by record high seasonal and annual rainfall. In fact, the monthly average flow rate only dipped below the target of 500 gpm in the month of August (495 gpm). The average flow rate for 2011 overall was 1,253 gpm.

Proposed Change

Heavy rain events in 2011 damaged Flume 2. Water flowing down the channel eroded the stream bank back from the wing-walls of the flume, silted up the upgradient side of the flume, and dispersed sandbags that once supported the wing-walls down the channel. This damage indicates that the flume was undersized to handle the large periodic storm events that occurred in 2011.

Rather than continue with potential repairs to this flume, DOE proposes to remove the flume and only calculate infiltration rates when flow down this channel is not occurring. No changes would be made to the other flumes. Infiltration assessments would be made over shorter time periods when flow measurements in the remaining flumes indicate that infiltration could be occurring. The calculation would rely mostly on flow measurements in Flumes 6, 4, and 1 with minor contributions from Flumes 5 and 3.

*Table A.2−1. Geoprobe Location 12617C*

**Easting '83: 1347225.04 feet**
**Northing '83: 481284.9 feet**
**Ground Elevation: 581.39 feet above mean sea level (AMSL)**
**Depth to Water Table: 62 feet below ground surface (BGS)**
**Water Table Elevation: 519.39 feet AMSL**

**Work Completed: 5/16/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium (ug/L) (FRL=30) | Tc-99 (pCi/L) (FRL=94) | Nitrate/Nitrite (mg/L) (FRL=11) | Manganese (mg/L) (FRL=0.9) | Molybdenum (mg/L) (FRL=0.1) | Nickel (mg/L) (FRL=0.1) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **514** | **67.0** | 0 - 10 | 14.9 | 5.85 | 58.5 | 3.15 | 0.0403 | 0.0539 | 13.8 | 6.85 | 1.74 | >1000 | 10.0 | 8.90 |
| **2** | **504** | **77.0** | 10 - 20 | 6.02 | 5.36 | 57.5 | 1.97 | 0.0334 | 0.0314 | 15.0 | 7.33 | 1.47 | >1000 | 3.06 | 9.23 |
| **3** | **504** | **77.0** | 10 - 20 | 6.03 | 2.99 | 53.8 | 2.21 | 0.0358 | 0.0369 | 15.0 | 7.33 | 1.47 | >1000 | 3.06 | 9.23 |
| **4** | **494** | **87.0** | 20 - 30 | 3.64 | 6.78 | 45.0 | 0.833 | 0.0119 | 0.0153 | 14.6 | 7.27 | 1.33 | >1000 | 19.7 | 5.20 |
| **5** | **484** | **97.0** | 30 - 40 | 5.09 | 121 | 68.3 | 0.733 | 0.0053 | 0.0166 | 14.7 | 7.08 | 1.83 | >1000 | 19.7 | 6.90 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−2. Geoprobe Location 12618C*

**Easting '83: 1347181.43 feet**
**Northing '83: 480411.73 feet**
**Ground Elevation: 579.31 feet above mean sea level (AMSL)**
**Depth to Water Table: 60 feet below ground surface (BGS)**
**Water Table Elevation: 519.31 feet AMSL**

**Work Completed: 5/5/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium (ug/L) (FRL=30) | Tc-99 (pCi/L) (FRL=94) | Nitrate/Nitrite (mg/L) (FRL=11) | Manganese (mg/L) (FRL=0.9) | Molybdenum (mg/L) (FRL=0.1) | Nickel (mg/L) (FRL=0.1) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **514** | **65.0** | 0 - 10 | 117 | 5.80 | 2.17 | 0.598 | 0.0180 | 0.0126 | 11.1 | 6.81 | 0.803 | >1000 | 21.0 | 9.00 |
| **2** | **504** | **75.0** | 10 - 20 | 6.79 | 5.85 | 2.89 | 0.644 | 0.0178 | 0.00922 | 13.2 | 6.80 | 0.830 | >1000 | 34.8 | 8.64 |
| **3** | **504** | **75.0** | 10 - 20 | 6.87 | 5.75 | 1.57 | 0.596 | 0.0160 | 0.00812 | 13.2 | 6.80 | 0.830 | >1000 | 34.8 | 8.64 |
| **4** | **494** | **85.0** | 20 - 30 | 4.79 | 5.75 | 1.96 | 0.501 | 0.0241 | 0.0113 | 17.1 | 7.61 | 0.805 | >1000 | 26.0 | 6.17 |
| **5** | **484** | **95.0** | 30 - 40 | 7.05 | 5.75 | 1.65 | 0.401 | 0.0129 | 0.00925 | 14.8 | 7.41 | 0.663 | >1000 | 34.0 | 5.61 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−3. Geoprobe Location 13422*

**Easting '83: 1347388.25 feet**
**Northing '83: 480697.16 feet**
**Ground Elevation: 577.18 feet above mean sea level (AMSL)**
**Depth to Water Table: 58 feet below ground surface (BGS)**
**Water Table Elevation: 519.18 feet AMSL**

**Work Completed: 5/18/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium (ug/L) (FRL=30) | Tc-99 (pCi/L) (FRL=94) | Nitrate/Nitrite (mg/L) (FRL=11) | Manganese (mg/L) (FRL=0.9) | Molybdenum (mg/L) (FRL=0.1) | Nickel (mgL) (FRL=0.1) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **514** | **63.0** | 0 - 10 | 11.7 | 5.80 | 1.84 | 0.604 | 0.0293 | 0.0132 | 13.1 | 7.06 | 0.750 | >1000 | 6.75 | 8.53 |
| **2** | **504** | **73.0** | 10 - 20 | 8.18 | 5.65 | 1.62 | 0.839 | 0.0331 | 0.0142 | 13.5 | 7.38 | 0.794 | >1000 | 6.10 | 10.8 |
| **3** | **504** | **73.0** | 10 - 20 | 8.18 | 5.70 | 2.12 | 0.810 | 0.0309 | 0.0137 | 13.5 | 7.38 | 0.794 | >1000 | 6.10 | 10.8 |
| **4** | **494** | **83.0** | 20 - 30 | 8.01 | 5.90 | 1.96 | 0.398 | 0.0173 | 0.00696 | 13.4 | 7.38 | 0.724 | >1000 | 5.45 | 8.77 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−4. Geoprobe Location 12717B*

**Easting '83: 1348134.99 feet**
**Northing '83: 480201.41 feet**
**Ground Elevation: 575.01 feet above mean sea level (AMSL)**
**Depth to Water Table: 55.5 feet below ground surface (BGS)**
**Water Table Elevation: 519.51 feet AMSL**
**Work Completed: 6/15/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 515 | 60.5 | 0 - 10 | 3.90 | 15.2 | 6.75 | 1.23 | > 1000 | 49.4 | 5.35 |
| **2** | 505 | 70.5 | 10 - 20 | 1.10 | 15.0 | 7.03 | 1.27 | > 1000 | 35.7 | 4.60 |
| **3** | 505 | 70.5 | 10 - 20 | 1.40 | 15.0 | 7.03 | 1.27 | > 1000 | 35.7 | 4.60 |
| **4** | 495 | 80.5 | 20 - 30 | 1.30 | 14.8 | 7.28 | 1.14 | > 1000 | 20.9 | 4.25 |
| **5** | 485 | 90.5 | 30 - 40 | 3.70 | 15.2 | 7.22 | 0.898 | > 1000 | 27.7 | 3.64 |
| **6** | 475 | 100.5 | 40 - 50 | 1.00 | 14.9 | 7.24 | 0.687 | > 1000 | 10.9 | 4.19 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−5. Geoprobe Location 13412A*

**Easting '83: 1346721.47 feet**
**Northing '83: 479727.87 feet**
**Ground Elevation: 551.92 feet above mean sea level (AMSL)**
**Depth to Water Table: 31 feet below ground surface (BGS)**
**Water Table Elevation: 520.92 feet AMSL**
**Work Completed: 6/7/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 516 | 36.0 | 0 - 10 | 6.70 | 14.9 | 7.21 | 0.596 | > 1000 | 21.2 | 7.86 |
| **2** | 506 | 46.0 | 10 - 20 | 5.00 | 16.9 | 7.32 | 0.846 | > 1000 | 23.7 | 8.45 |
| **3** | 506 | 46.0 | 10 - 20 | 4.70 | 16.9 | 7.32 | 0.846 | > 1000 | 23.7 | 8.45 |
| **4** | 496 | 56.0 | 20 - 30 | 3.60 | 14.8 | 7.76 | 0.625 | > 1000 | 47.6 | 8.25 |
| **5** | 486 | 66.0 | 30 - 40 | 8.20 | 16.3 | 7.58 | 0.716 | > 1000 | 128 | 6.46 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−6. Geoprobe Location 13418A*

**Easting '83: 1346540.23 feet**
**Northing '83: 480130.6 feet**
**Ground Elevation: 551.35 feet above mean sea level (AMSL)**
**Depth to Water Table: 30 feet below ground surface (BGS)**
**Water Table Elevation: 521.35 feet AMSL**
**Work Completed: 6/6/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 516.35 | 35.0 | 0 - 10 | 1.30 | 16.3 | 7.37 | 0.619 | > 1000 | 891 | 9.37 |
| **2** | 506.35 | 45.0 | 10 - 20 | 3.90 | 14.5 | 7.58 | 0.562 | > 1000 | > 1000 | 9.58 |
| **3** | 506.35 | 45.0 | 10 - 20 | 3.90 | 14.5 | 7.58 | 0.562 | > 1000 | > 1000 | 9.58 |
| **4** | 496.35 | 55.0 | 20 - 30 | 5.40 | 17.8 | 7.88 | 0.477 | > 1000 | 141 | 8.76 |
| **5** | 486.35 | 65.0 | 30 - 40 | 11.4 | 17.0 | 7.75 | 0.597 | > 1000 | 390 | 7.97 |
| **6** | 476.35 | 75.0 | 40 - 50 | 10.1 | 15.4 | 7.91 | 0.582 | > 1000 | 28.9 | 6.62 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−7. Geoprobe Location 13428*

**Easting '83: 1347354.36 feet**
**Northing '83: 479994.53 feet**
**Ground Elevation: 566.06 feet above mean sea level (AMSL)**
**Depth to Water Table: 45.5 feet below ground surface (BGS)**
**Water Table Elevation: 520.56 feet AMSL**
**Work Completed: 7/6/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 515.56 | 50.5 | 0 - 10 | 71.0 | 20.3 | 7.04 | 0.806 | > 1000 | 737 | 5.46 |
| **2** | 505.56 | 60.5 | 10 - 20 | 11.9 | 18.9 | 7.58 | 0.754 | > 1000 | 315 | 6.45 |
| **3** | 505.56 | 60.5 | 10 - 20 | 13.5 | 18.9 | 7.58 | 0.754 | > 1000 | 315 | 6.45 |
| **4** | 495.56 | 70.5 | 20 - 30 | 6.10 | 16.7 | 7.62 | 0.661 | > 1000 | 65.3 | 6.19 |
| **5** | 485.56 | 80.5 | 30 - 40 | 7.10 | 15.8 | 7.54 | 0.618 | > 1000 | 31.9 | 6.50 |
| **6** | 475.56 | 90.5 | 40 - 50 | 0.50 | 17.7 | 7.61 | 0.652 | > 1000 | 39.8 | 5.41 |
| **7** | 465.56 | 100.5 | 50 - 60 | 0.50 | 15.7 | 7.60 | 0.612 | > 1000 | 45.3 | 4.48 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−8. Geoprobe Location 13360C*

**Easting '83: 1349832.67 feet**
**Northing '83: 480171.24 feet**
**Ground Elevation: 574.41 feet above mean sea level (AMSL)**
**Depth to Water Table: 54 feet below ground surface (BGS)**
**Water Table Elevation: 520.41 feet AMSL**
**Work Completed: 5/31/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (µg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 515.41 | 59 | 0 - 10 | 37.7 | 17.6 | 6.76 | 1.61 | > 1000 | >1000 | 7.50 |
| **2** | 505.41 | 69 | 10 - 20 | 4.90 | 18.8 | 6.93 | 1.25 | > 1000 | >1000 | 7.26 |
| **3** | 505.41 | 69 | 10 - 20 | 2.20 | 18.8 | 6.93 | 1.25 | > 1000 | >1000 | 7.26 |
| **4** | 495.41 | 79 | 20 - 30 | 2.60 | 18.4 | 6.97 | 1.09 | > 1000 | 493 | 5.20 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−9. Geoprobe Location 13241A*

**Easting '83: 1350068.84 feet**
**Northing '83: 477048.29 feet**
**Ground Elevation: 579.38 feet above mean sea level (AMSL)**
**Depth to Water Table: 60.5 feet below ground surface (BGS)**
**Water Table Elevation: 518.88 feet AMSL**
**Work Completed: 6/1/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (µg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 513.88 | 65.5 | 0 - 10 | 6.90 | 18.5 | 6.73 | 1.00 | > 1000 | 1000 | 6.43 |
| **2** | 503.88 | 75.5 | 10 - 20 | 1.30 | 20.5 | 7.03 | 1.04 | > 1000 | 89.0 | 6.13 |
| **3** | 503.88 | 75.5 | 10 - 20 | 1.90 | 20.5 | 7.03 | 1.04 | > 1000 | 89.0 | 6.13 |
| **4** | 493.88 | 85.5 | 20 - 30 | 2.00 | 17.1 | 7.08 | 1.02 | > 1000 | 195 | 7.29 |
| **5** | 483.88 | 95.5 | 30 - 40 | 3.30 | 16.9 | 7.06 | 0.934 | > 1000 | 139 | 4.64 |
| **6** | 473.88 | 105.5 | 40 - 50 | 2.60 | 18.2 | 7.07 | 0.907 | > 1000 | 193 | 4.91 |
| **7** | 463.88 | 115.5 | 50 - 60 | 2.60 | 17.9 | 7.37 | 0.837 | > 1000 | 157 | 7.81 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−10. Geoprobe Location 13413A*

**Easting '83: 1349041.94 feet**
**Northing '83: 477749.1 feet**
**Ground Elevation: 554.63 feet above mean sea level (AMSL)**
**Depth to Water Table: 37 feet below ground surface (BGS)**
**Water Table Elevation: 517.63 feet AMSL**
**Work Completed: 5/10/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 512.63 | 42.0 | 0 - 10 | 15.8 | 15.3 | 7.03 | 0.846 | > 1000 | >1000 | 8.55 |
| 2 | 502.63 | 52.0 | 10 - 20 | 19.8 | 15.3 | 7.14 | 0.837 | > 1000 | 314 | 6.80 |
| 3 | 502.63 | 52.0 | 10 - 20 | 19.0 | 15.3 | 7.14 | 0.837 | > 1000 | 314 | 6.80 |
| 4 | 492.63 | 62.0 | 20 - 30 | 3.25 | 15.1 | 7.22 | 0.654 | > 1000 | 41.0 | 2.39 |
| 5 | 482.63 | 72.0 | 30 - 40 | 1.40 | 15.0 | 7.25 | 0.609 | > 1000 | 95.0 | 3.40 |
| 6 | 472.63 | 82.0 | 40 - 50 | 0.858 | 13.9 | 7.17 | 0.594 | > 1000 | 111 | 2.88 |
| 7 | 462.63 | 92.0 | 50 - 60 | 4.31 | 14.8 | 7.17 | 0.600 | > 1000 | 66.3 | 4.51 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−11. Geoprobe Location 13421*

**Easting '83: 1349309.74 feet**
**Northing '83: 476024.38 feet**
**Ground Elevation: 570.68 feet above mean sea level (AMSL)**
**Depth to Water Table: 60 feet below ground surface (BGS)**
**Water Table Elevation: 510.68 feet AMSL**
**Work Completed: 2/11/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 505.68 | 65.0 | 0 - 10 | 43.9 | 10.1 | 7.01 | 0.806 | > 1000 | 292 | 6.35 |
| 2 | 495.68 | 75.0 | 10 - 20 | 181 | 9.89 | 7.53 | 0.784 | > 1000 | 716 | 9.09 |
| 3 | 495.68 | 75.0 | 10 - 20 | 185 | 9.89 | 7.53 | 0.784 | > 1000 | 716 | 9.09 |
| 4 | 485.68 | 85.0 | 20 - 30 | 97.8 | 10.8 | 7.68 | 0.721 | > 1000 | 673 | 6.87 |
| 5 | 475.68 | 95.0 | 30 - 40 | 5.11 | 9.48 | 7.09 | 0.712 | > 1000 | 954 | 6.13 |
| 6 | 465.68 | 105.0 | 40 - 50 | 3.45 | 7.37 | 7.24 | 0.744 | > 1000 | > 1000 | 8.01 |
| 7 | 455.68 | 115.0 | 50 - 60 | 61.8 | 8.95 | 7.35 | 0.722 | > 1000 | > 1000 | 6.86 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−12. Geoprobe Location 13421A*

**Easting '83: 1349311.17 feet**
**Northing '83: 476025.03 feet**
**Ground Elevation: 570.76 feet above mean sea level (AMSL)**
**Depth to Water Table: 52 feet below ground surface (BGS)**
**Water Table Elevation: 518.76 feet AMSL**
**Work Completed: 7/13/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (µg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 513.76 | 57.0 | 0 - 10 | 3.70 | 18.5 | 7.20 | 0.830 | > 1000 | 208 | 7.79 |
| **2** | 503.76 | 67.0 | 10 - 20 | 116 | 16.3 | 8.23 | 0.828 | > 1000 | >1000 | 7.50 |
| **3** | 503.76 | 67.0 | 10 - 20 | 112 | 16.3 | 8.23 | 0.828 | > 1000 | >1000 | 7.50 |
| **4** | 493.76 | 77.0 | 20 - 30 | 216 | 16.9 | 7.47 | 0.768 | > 1000 | 602 | 6.00 |
| **5** | 483.76 | 87.0 | 30 - 40 | 82.3 | 17.1 | 7.53 | 0.722 | > 1000 | 17.4 | 3.90 |
| **6** | 473.76 | 97.0 | 40 - 50 | 5.10 | 16.6 | 7.55 | 0.716 | > 1000 | 10.6 | 3.61 |
| **7** | 463.76 | 107.0 | 50 - 60 | 3.50 | 17.1 | 7.52 | 0.731 | > 1000 | 475 | 4.50 |
| **6** | 453.76 | 117.0 | 60 - 70 | 7.20 | 18.4 | 7.45 | 0.759 | > 1000 | 522 | 3.49 |
| **7** | 443.76 | 127.0 | 70 - 80 | 6.40 | 20.5 | 7.64 | 0.794 | > 1000 | >1000 | 6.80 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−13. Geoprobe Location 13419A*

**Easting '83: 1349215.19 feet**
**Northing '83: 478810.95 feet**
**Ground Elevation: 560.72 feet above mean sea level (AMSL)**
**Depth to Water Table: 42 feet below ground surface (BGS)**
**Water Table Elevation: 518.72 feet AMSL**
**Work Completed: 6/2/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (µg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 513.72 | 47 | 0 - 10 | 18.0 | 19.0 | 6.74 | 1.27 | > 1000 | 294 | 6.48 |
| **2** | 503.72 | 57 | 10 - 20 | 23.6 | 16.5 | 6.75 | 1.39 | > 1000 | 25.2 | 6.03 |
| **3** | 503.72 | 57 | 10 - 20 | 23.8 | 16.5 | 6.75 | 1.39 | > 1000 | 25.2 | 6.03 |
| **4** | 493.72 | 67 | 20 - 30 | 2.14 | 15.4 | 6.73 | 1.60 | > 1000 | 31.7 | 3.69 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−14. Geoprobe Location 13419B*

**Easting '83: 1349215.19 feet**
**Northing '83: 478810.95 feet**
**Ground Elevation: 560.72 feet above mean sea level (AMSL)**
**Depth to Water Table: 41 feet below ground surface (BGS)**
**Water Table Elevation: 519.72 feet AMSL**
**Work Completed: 7/5/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 514.72 | 46.0 | 0 - 10 | 7.40 | 25.1 | 6.85 | 1.39 | > 1000 | >1000 | 5.75 |
| 2 | 504.72 | 56.0 | 10 - 20 | 16.8 | 18.0 | 6.60 | 1.43 | > 1000 | 31.0 | 2.54 |
| 3 | 504.72 | 56.0 | 10 - 20 | 17.7 | 18.0 | 6.60 | 1.43 | > 1000 | 31.0 | 2.54 |
| 4 | 494.72 | 66.0 | 20 - 30 | 2.90 | 16.4 | 6.94 | 1.18 | > 1000 | 671 | 5.16 |
| 5 | 484.72 | 76.0 | 30 - 40 | 0.50 | 18.5 | 7.12 | 0.971 | > 1000 | 49.0 | 0.38 |
| 6 | 474.72 | 86.0 | 40 - 50 | 0.50 | 18.7 | 7.27 | 0.587 | > 1000 | 42.0 | 3.00 |
| 7 | 464.72 | 96.0 | 50 - 60 | 0.50 | 18.2 | 7.25 | 0.584 | > 1000 | 365 | 4.13 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−15. Geoprobe Location 13430*

**Easting '83: 1349215.91 feet**
**Northing '83: 478472.08 feet**
**Ground Elevation: 575.04 feet above mean sea level (AMSL)**
**Depth to Water Table: 55 feet below ground surface (BGS)**
**Water Table Elevation: 520.04 feet AMSL**
**Work Completed: 6/29/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 515 | 60.0 | 0 - 10 | 134 | 15.1 | 6.97 | 1.50 | > 1000 | 592 | 5.86 |
| 2 | 505.04 | 70.0 | 10 - 20 | 19.9 | 15.5 | 7.09 | 1.04 | > 1000 | 53.1 | 4.81 |
| 3 | 505.04 | 70.0 | 10 - 20 | 22.5 | 15.5 | 7.09 | 1.04 | > 1000 | 53.1 | 4.81 |
| 4 | 495 | 80.0 | 20 - 30 | 7.60 | 16.8 | 7.36 | 0.827 | > 1000 | 68.9 | 5.35 |
| 5 | 485.04 | 90.0 | 30 - 40 | 10.0 | 16.3 | 7.34 | 0.699 | > 1000 | 116 | 4.95 |
| 6 | 475.04 | 100.0 | 40 - 50 | 2.10 | 16.9 | 7.54 | 0.580 | > 1000 | 99.2 | 3.43 |
| 7 | 465.04 | 110.0 | 50 - 60 | 3.20 | 17.9 | 7.51 | 0.568 | > 1000 | 115 | 3.27 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−16. Geoprobe Location 13431*

**Easting '83: 1349534.36 feet**
**Northing '83: 478506.57 feet**
**Ground Elevation: 575.58 feet above mean sea level (AMSL)**
**Depth to Water Table: 55 feet below ground surface (BGS)**
**Water Table Elevation: 520.58 feet AMSL**
**Work Completed: 6/30/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 515.58 | 60.0 | 0 - 10 | 124 | 15.1 | 6.67 | 1.69 | > 1000 | >1000 | 6.75 |
| **2** | 505.58 | 70.0 | 10 - 20 | 21.0 | 15.2 | 6.95 | 1.10 | > 1000 | 17.3 | 2.82 |
| **3** | 505.58 | 70.0 | 10 - 20 | 30.3 | 15.2 | 6.95 | 1.10 | > 1000 | 17.3 | 2.82 |
| **4** | 495.58 | 80.0 | 20 - 30 | 24.1 | 15.4 | 7.09 | 0.914 | > 1000 | 490 | 4.95 |
| **5** | 485.58 | 90.0 | 30 - 40 | 12.2 | 15.6 | 7.19 | 0.931 | > 1000 | >1000 | 3.35 |
| **6** | 475.58 | 100.0 | 40 - 50 | 1.90 | 16.4 | 7.22 | 0.868 | > 1000 | 51.1 | 4.36 |
| **7** | 465.58 | 110.0 | 50 - 60 | 0.50 | 16.9 | 7.26 | 0.868 | > 1000 | 47.0 | 4.26 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−17. Geoprobe Location 12369P*

**Easting '83: 1348853.58 feet**
**Northing '83: 476056.79 feet**
**Ground Elevation: 574.76 feet above mean sea level (AMSL)**
**Depth to Water Table: 57.5 feet below ground surface (BGS)**
**Water Table Elevation: 517.26 feet AMSL**
**Work Completed: 7/25/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 512 | 62.5 | 0 - 10 | 67.8 | 20.3 | 7.08 | 0.953 | >1000 | 400 | 7.67 |
| **2** | 502.26 | 72.5 | 10 - 20 | 11.5 | 18.7 | 7.08 | 0.746 | >1000 | 518 | 5.50 |
| **3** | 502.26 | 72.5 | 10 - 20 | 11.4 | 18.7 | 7.08 | 0.746 | >1000 | 518 | 5.50 |
| **4** | 492.26 | 82.5 | 20 - 30 | 6.2 | 19.3 | 7.15 | 0.698 | >1000 | 40.3 | 6.50 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−18. Geoprobe Location 12372Q*

**Easting '83: 1348558.39 feet**
**Northing '83: 476215.36 feet**
**Ground Elevation: 576.43 feet above mean sea level (AMSL)**
**Depth to Water Table: 58 feet below ground surface (BGS)**
**Water Table Elevation: 518.43 feet AMSL**
**Work Completed: 7/19/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 513 | 63.0 | 0 - 10 | 23.8 | 20.1 | 7.20 | 0.874 | >1000 | 84.4 | 4.78 |
| 2 | 503.43 | 73.0 | 10 - 20 | 12.1 | 18.5 | 7.59 | 0.826 | >1000 | 1000 | 6.95 |
| 3 | 503.43 | 73.0 | 10 - 20 | 14.7 | 18.5 | 7.59 | 0.826 | >1000 | 1000 | 6.95 |
| 4 | 493.43 | 83.0 | 20 - 30 | 7.8 | 18.3 | 7.75 | 0.773 | >1000 | 781 | 4.93 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−19. Geoprobe Location 13297A*

**Easting '83: 1349400.49 feet**
**Northing '83: 475889.75 feet**
**Ground Elevation: 573.74 feet above mean sea level (AMSL)**
**Depth to Water Table: 62 feet below ground surface (BGS)**
**Water Table Elevation: 511.74 feet AMSL**
**Work Completed: 2/8/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 506.74 | 67.0 | 0 - 10 | 0.984 | 11.5 | 6.69 | 0.773 | > 1000 | 1000 | 5.26 |
| 2 | 496.74 | 77.0 | 10 - 20 | 0.360 | 8.83 | 7.57 | 0.750 | > 1000 | 464 | 7.00 |
| 3 | 496.74 | 77.0 | 10 - 20 | 0.465 | 8.83 | 7.57 | 0.750 | > 1000 | 464 | 7.00 |
| 4 | 486.74 | 87.0 | 20 - 30 | 0.452 | 9.59 | 7.58 | 0.713 | > 1000 | 385 | 6.95 |
| 5 | 476.74 | 97.0 | 30 - 40 | 2.25 | 9.17 | 7.62 | 0.744 | > 1000 | 753 | 6.99 |
| 6 | 466.74 | 107.0 | 40 - 50 | 0.641 | 11.6 | 7.60 | 0.768 | > 1000 | 485 | 5.40 |
| 7 | 456.74 | 117.0 | 50 - 60 | 0.779 | 10.6 | 7.42 | 0.781 | > 1000 | 214 | 4.61 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−20. Geoprobe Location 13356A*

| |
|---|
| **Easting '83: 1349682.93 feet** |
| **Northing '83: 476451.82 feet** |
| **Ground Elevation: 580.86 feet above mean sea level (AMSL)** |
| **Depth to Water Table: 32.5 feet below ground surface (BGS)** |
| **Water Table Elevation: 548.36 feet AMSL** |
| **Work Completed: 6/8/2011** |

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 543.36 | 37.5 | 0 - 10 | 16.1 | 17.1 | 7.35 | 1.00 | > 1000 | >1000 | 9.14 |
| **2** | 533.36 | 47.5 | 10 - 20 | 17.8 | 19.8 | 7.24 | 1.03 | > 1000 | 32.1 | 3.11 |
| **3** | 533.36 | 47.5 | 10 - 20 | 18.1 | 19.8 | 7.24 | 1.03 | > 1000 | 32.1 | 3.11 |
| **4** | 523.36 | 57.5 | 20 - 30 | 27.6 | 10.6 | 7.34 | 0.951 | > 1000 | 16.9 | 2.82 |
| **5** | 513.36 | 67.5 | 30 - 40 | 5.20 | 19.9 | 7.37 | 0.931 | > 1000 | 54.7 | 3.65 |
| **6** | 503.36 | 77.5 | 40 - 50 | 2.60 | 18.1 | 7.28 | 0.904 | > 1000 | 22.0 | 5.26 |
| **7** | 493.36 | 87.5 | 50 - 60 | 0.50 | 17.7 | 7.25 | 0.921 | > 1000 | 12.1 | 4.45 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−21. Geoprobe Location 13357A*

| |
|---|
| **Easting '83: 1349119.38 feet** |
| **Northing '83: 475740.11 feet** |
| **Ground Elevation: 580.89 feet above mean sea level (AMSL)** |
| **Depth to Water Table: 68 feet below ground surface (BGS)** |
| **Water Table Elevation: 512.89 feet AMSL** |
| **Work Completed: 2/14/2011** |

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 508 | 73.0 | 0 - 10 | 44.4 | 11.3 | 6.82 | 0.890 | > 1000 | 127 | 6.73 |
| **2** | 497.89 | 83.0 | 10 - 20 | 49.3 | 11.6 | 7.50 | 0.788 | > 1000 | 231 | 6.54 |
| **3** | 497.89 | 83.0 | 10 - 20 | 47.1 | 11.6 | 7.50 | 0.788 | > 1000 | 231 | 6.54 |
| **4** | 488 | 93.0 | 20 - 30 | 3.43 | 12.1 | 7.51 | 0.733 | > 1000 | 157 | 3.00 |
| **5** | 477.89 | 103.0 | 30 - 40 | 1.76 | 11.8 | 7.42 | 0.720 | > 1000 | 440 | 5.28 |
| **6** | 467.89 | 113.0 | 40 - 50 | 0.831 | 11.9 | 7.35 | 0.708 | > 1000 | 189 | 2.30 |
| **7** | 457.89 | 123.0 | 50 - 60 | 0.762 | 11.4 | 7.39 | 0.683 | > 1000 | 281 | 3.58 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−22. Geoprobe Location 13420*

**Easting '83: 1349173.35 feet**
**Northing '83: 475858.71 feet**
**Ground Elevation: 581.66 feet above mean sea level (AMSL)**
**Depth to Water Table: 68 feet below ground surface (BGS)**
**Water Table Elevation: 513.66 feet AMSL**
**Work Completed: 2/3/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 508.66 | 73.0 | 0 - 10 | 65.7 | 9.16 | 7.22 | 0.905 | > 1000 | 139 | 8.78 |
| **2** | 498.66 | 83.0 | 10 - 20 | 44.5 | 10.33 | 7.45 | 0.865 | > 1000 | 2.63 | 3.19 |
| **3** | 498.66 | 83.0 | 10 - 20 | 41.7 | 10.33 | 7.45 | 0.865 | > 1000 | 2.63 | 3.19 |
| **4** | 488.66 | 93.0 | 20 - 30 | 85.0 | 9.59 | 7.55 | 0.754 | > 1000 | 14.3 | 4.67 |
| **5** | 478.66 | 103.0 | 30 - 40 | 2.26 | 8.83 | 6.78 | 0.697 | > 1000 | 5.39 | 4.38 |
| **6** | 468.66 | 113.0 | 40 - 50 | 5.93 | 9.48 | 7.37 | 0.712 | > 1000 | 733 | 7.69 |
| **7** | 458.66 | 123.0 | 50 - 60 | 4.85 | 9.27 | 7.42 | 0.710 | > 1000 | 282 | 9.01 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−23. Geoprobe Location 13423*

**Easting '83: 1349407.32 feet**
**Northing '83: 476023.97 feet**
**Ground Elevation: 570.18 feet above mean sea level (AMSL)**
**Depth to Water Table: 51 feet below ground surface (BGS)**
**Water Table Elevation: 519.18 feet AMSL**
**Work Completed: 7/12/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 514.18 | 56.0 | 0 - 10 | 1.20 | 21.0 | 7.26 | 0.865 | > 1000 | 23.1 | 7.18 |
| **2** | 504.18 | 66.0 | 10 - 20 | 3.70 | 18.5 | 7.33 | 0.816 | > 1000 | 56.7 | 3.46 |
| **3** | 504.18 | 66.0 | 10 - 20 | 3.20 | 18.5 | 7.33 | 0.816 | > 1000 | 56.7 | 3.46 |
| **4** | 494.18 | 76.0 | 20 - 30 | 73.7 | 19.7 | 7.40 | 0.755 | > 1000 | 33.4 | 2.95 |
| **5** | 484.18 | 86.0 | 30 - 40 | 16.0 | 21.7 | 7.56 | 0.759 | > 1000 | >1000 | 5.34 |
| **6** | 474.18 | 96.0 | 40 - 50 | 3.90 | 20.0 | 8.52 | 0.749 | > 1000 | 69.6 | 5.23 |
| **7** | 464.18 | 106.0 | 50 - 60 | 3.10 | 19.4 | 7.02 | 0.770 | > 1000 | >1000 | 6.26 |
| **6** | 454.18 | 116.0 | 60 - 70 | 0.50 | 17.2 | 7.26 | 0.781 | > 1000 | 55.4 | 2.82 |
| **7** | 444.18 | 126.0 | 70 - 80 | 2.70 | 18.7 | 7.25 | 0.783 | > 1000 | 27.9 | 6.20 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−24. Geoprobe Location 13424*

| |
|---|
| **Easting '83: 1349244.7 feet** |
| **Northing '83: 475743.2 feet** |
| **Ground Elevation: 579.55 feet above mean sea level (AMSL)** |
| **Depth to Water Table: 61 feet below ground surface (BGS)** |
| **Water Table Elevation: 518.55 feet AMSL** |
| **Work Completed: 5/12/2011** |

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 513.55 | 66.0 | 0 - 10 | 2.91 | 19.6 | 7.18 | 0.935 | > 1000 | 24.5 | 8.36 |
| **2** | 503.55 | 76.0 | 10 - 20 | 20.9 | 17.4 | 7.43 | 0.816 | > 1000 | 80.7 | 4.50 |
| **3** | 503.55 | 76.0 | 10 - 20 | 22.7 | 17.4 | 7.43 | 0.816 | > 1000 | 80.7 | 4.50 |
| **4** | 493.55 | 86.0 | 20 - 30 | 8.50 | 17.5 | 7.59 | 0.736 | > 1000 | 729 | 8.10 |
| **5** | 483.55 | 96.0 | 30 - 40 | 1.82 | 17.8 | 7.49 | 0.735 | > 1000 | 196 | 5.38 |
| **6** | 473.55 | 106.0 | 40 - 50 | 9.69 | 18.1 | 7.35 | 0.720 | > 1000 | 320 | 5.01 |
| **7** | 463.55 | 116.0 | 50 - 60 | 5.30 | 17.4 | 7.29 | 0.759 | > 1000 | 792 | 5.73 |
| **6** | 453.55 | 126.0 | 60 - 70 | 5.66 | 16.2 | 6.94 | 0.702 | > 1000 | >1000 | 9.52 |
| **7** | 443.55 | 136.0 | 70 - 80 | 4.35 | 15.0 | 7.13 | 0.702 | > 1000 | >1000 | 9.72 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−25. Geoprobe Location 13425*

**Easting '83: 1349040.38 feet**
**Northing '83: 475678.36 feet**
**Ground Elevation: 579.39 feet above mean sea level (AMSL)**
**Depth to Water Table: 61 feet below ground surface (BGS)**
**Water Table Elevation: 518.39 feet AMSL**
**Work Completed: 5/11/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (μg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 513.39 | 66.0 | 0 - 10 | 2.60 | 16.5 | 7.05 | 0.956 | > 1000 | 527 | 8.23 |
| **2** | 503.39 | 76.0 | 10 - 20 | 17.0 | 18.6 | 7.50 | 0.796 | > 1000 | >1000 | 7.65 |
| **3** | 503.39 | 76.0 | 10 - 20 | 20.7 | 18.6 | 7.50 | 0.796 | > 1000 | >1000 | 7.65 |
| **4** | 493.39 | 86.0 | 20 - 30 | 49.0 | 16.5 | 7.60 | 0.697 | > 1000 | >1000 | 7.69 |
| **5** | 483.39 | 96.0 | 30 - 40 | 17.3 | 16.4 | 7.55 | 0.693 | > 1000 | 803 | 7.75 |
| **6** | 473.39 | 106.0 | 40 - 50 | 1.10 | 16.9 | 7.52 | 0.739 | > 1000 | 28.0 | 3.88 |
| **7** | 463.39 | 116.0 | 50 - 60 | 0.50 | 16.3 | 7.37 | 0.715 | > 1000 | 152 | 3.23 |
| **6** | 453.39 | 126.0 | 60 - 70 | 1.30 | 16.7 | 7.42 | 0.722 | > 1000 | >1000 | 6.78 |
| **7** | 443.39 | 136.0 | 70 - 80 | 1.60 | 16.4 | 7.29 | 0.732 | > 1000 | 357 | 5.48 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−26. Geoprobe Location 13426*

**Easting '83: 1349554.51 feet**
**Northing '83: 476014.02 feet**
**Ground Elevation: 568.85 feet above mean sea level (AMSL)**
**Depth to Water Table: 51 feet below ground surface (BGS)**
**Water Table Elevation: 517.85 feet AMSL**
**Work Completed: 7/20/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (µg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 512.85 | 56.0 | 0 - 10 | 2.70 | 23.4 | 7.49 | 0.877 | > 1000 | 34.1 | 7.16 |
| **2** | 502.85 | 66.0 | 10 - 20 | 0.50 | 19.8 | 7.58 | 0.883 | > 1000 | 19.0 | 3.92 |
| **3** | 502.85 | 66.0 | 10 - 20 | 0.50 | 19.8 | 7.58 | 0.883 | > 1000 | 19.0 | 3.92 |
| **4** | 492.85 | 76.0 | 20 - 30 | 3.80 | 18.5 | 7.45 | 0.766 | > 1000 | 253 | 3.46 |
| **5** | 482.85 | 86.0 | 30 - 40 | 1.20 | 18.0 | 7.73 | 0.767 | > 1000 | 448 | 5.13 |
| **6** | 472.85 | 96.0 | 40 - 50 | 0.50 | 21.5 | 10.7 | 0.795 | > 1000 | 325 | 6.35 |
| **7** | 462.85 | 106.0 | 50 - 60 | 2.00 | 18.2 | 10.7 | 0.804 | > 1000 | 923 | 6.97 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−27. Geoprobe Location 13427*

**Easting '83: 1348271.87 feet**
**Northing '83: 474448.65 feet**
**Ground Elevation: 533.5 feet above mean sea level (AMSL)**
**Depth to Water Table: 19 feet below ground surface (BGS)**
**Water Table Elevation: 514.5 feet AMSL**
**Work Completed: 8/2/2011**

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (µg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 509.5 | 24.0 | 0 - 10 | 21.0 | 21.0 | 6.82 | 0.928 | > 1000 | 108 | 6.36 |
| **2** | 499.5 | 34.0 | 10 - 20 | 6.90 | 24.0 | 7.57 | 0.779 | > 1000 | 22.7 | 5.88 |
| **3** | 499.5 | 34.0 | 10 - 20 | 6.70 | 24.0 | 7.57 | 0.779 | > 1000 | 22.7 | 5.88 |
| **4** | 489.5 | 44.0 | 20 - 30 | 3.30 | 19.1 | 7.59 | 0.677 | > 1000 | 18.4 | 0.65 |
| **5** | 479.5 | 54.0 | 30 - 40 | 18.4 | 17.9 | 7.42 | 0.616 | > 1000 | 16.0 | 5.12 |
| **6** | 469.5 | 64.0 | 40 - 50 | 1.80 | 16.6 | 7.41 | 0.807 | > 1000 | 25.3 | 4.02 |
| **7** | 459.5 | 74.0 | 50 - 60 | 8.40 | 16.8 | 7.20 | 0.749 | > 1000 | 20.0 | 4.31 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2−28. Geoprobe Location 13432*

| |
|---|
| **Easting '83: 1349488.62 feet** |
| **Northing '83: 476401.27 feet** |
| **Ground Elevation: 579.69 feet above mean sea level (AMSL)** |
| **Depth to Water Table: 62.5 feet below ground surface (BGS)** |
| **Water Table Elevation: 517.19 feet AMSL** |
| **Work Completed: 7/26/2011** |

| Sample Point | Elevation (ft AMSL) | Depth (ft BGS) | Sample Interval (ft) | Uranium filtered[a] (µg/L) | Temp filtered[a] (C) | pH filtered[a] (SU) | Specific Conductance filtered[a] (mS/cm) | Turbidity unfiltered (NTU) | Turbidity filtered[a] (NTU) | Dissolved Oxygen filtered[a] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 512 | 67.5 | 0 - 10 | 1.90 | 18.1 | 7.07 | 0.874 | > 1000 | 15.5 | 9.00 |
| **2** | 502.19 | 77.5 | 10 - 20 | 1.80 | 19.0 | 7.00 | 0.889 | > 1000 | 534 | 6.90 |
| **3** | 502.19 | 77.5 | 10 - 20 | 1.80 | 19.0 | 7.00 | 0.889 | > 1000 | 534 | 6.90 |
| **4** | 492 | 87.5 | 20 - 30 | 1.40 | 18.1 | 7.05 | 0.758 | > 1000 | 232 | 5.10 |
| **5** | 482.19 | 97.5 | 30 - 40 | 4.70 | 20.1 | 7.01 | 0.769 | > 1000 | 233 | 4.55 |
| **6** | 472.19 | 107.5 | 40 - 50 | 2.70 | 20.7 | 7.02 | 0.771 | > 1000 | 149 | 3.90 |
| **7** | 462.19 | 117.5 | 50 - 60 | 3.30 | 17.6 | 7.12 | 0.777 | > 1000 | >1000 | 4.30 |

[a]Samples are filtered through a 5 micron filter.

*Table A.2–29. Summary Statistics and Trend Analysis of Monitoring Wells for Total Uranium with 2011 Results Above FRLs*

| Well | No. of Sample | Minimum (µg/L)[a,b,c,d] | Maximum (µg/L)[a,b,c,d] | Average (µg/L)[a,b,c,d,e] | Standard Deviation (µg/L)[a,b,c,d,e] | Trend[a,b,c,d,e,f] |
|---|---|---|---|---|---|---|
| 2045 | 62 | 12.0 | 462 | 127 | 110 | **Up, Significant** |
| 2046 | 61 | 20.0 | 907 | 164 | 214 | No Significant Trend |
| 2049 | 49 | 3.0 | 178 | 80.1 | 43.1 | Down, Significant |
| 2060 | 77 | 8.4 | 332 | 80.0 | 61.2 | No Significant Trend |
| 2095 | 62 | 27.0 | 208 | 105 | 46 | Down, Significant |
| 23271 | 20 | 34.6 | 144 | 76.9 | 32.3 | Down, Significant |
| 23273 | 20 | 114 | 421 | 261 | 80 | No Significant Trend |
| 23274 | 31 | 120 | 384 | 188 | 67 | Down, Significant |
| 23275 | 19 | 119 | 349 | 173 | 60 | **Up, Significant** |
| 23276 | 20 | 60.4 | 115 | 85.9 | 14.5 | **Up, Significant** |
| 23278 | 20 | 44.9 | 201 | 102 | 44 | Down, Significant |
| 23280 | 20 | 57.2 | 700 | 173 | 154 | Down, Significant |
| 23281 | 20 | 41.5 | 367 | 150 | 81 | Down, Significant |
| 2385 | 43 | 76.6 | 592 | 244 | 107 | Down, Significant |
| 2387 | 43 | 18.1 | 492 | 147 | 85 | **Up, Significant** |
| 2389 | 32 | 0.90 | 120 | 27.2 | 25.3 | **Up, Significant** |
| 2390 | 42 | 31.6 | 163 | 76.3 | 30.0 | Down, Significant |
| 2397 | 30 | 212 | 737 | 396 | 125 | No Significant Trend |
| 2550 | 53 | 3.3 | 120 | 60.9 | 19.9 | Down, Significant |
| 2649 | 38 | 6.01 | 954 | 137 | 243 | **Up, Significant** |
| 2880 | 43 | 0.40 | 62.9 | 15.1 | 20.5 | **Up, Significant** |
| 3069 | 69 | 0.50 | 398 | 129 | 96 | Down, Significant |
| 3095 | 63 | 2.0 | 94 | 25.4 | 17.6 | No Significant Trend |
| 32766 | 21 | 24.4 | 79.9 | 44.3 | 15.3 | Down, Significant |
| 62408 | 31 | 29.5 | 157 | 82.4 | 43.9 | Down, Significant |
| 62433 | 32 | 82.6 | 845 | 361 | 190 | Down, Significant |
| 63285 | 20 | 74.9 | 277 | 207 | 50 | **Up, Significant** |
| 63287 | 20 | 82.3 | 316 | 171 | 62 | Down, Significant |
| 63288 | 20 | 34.3 | 267 | 94.2 | 65.8 | Down, Significant |
| 6880 | 30 | 62.8 | 145 | 90.3 | 22.2 | Down, Significant |
| 82433_C2 | 13 | 20.0 | 214 | 95.2 | 68.9 | Down, Significant |
| 82433_C3 | 22 | 70.7 | 506 | 233 | 133 | Down, Significant |
| 83117_C1 | 22 | 440 | 1620 | 902 | 277 | No Significant Trend |
| 83117_C2 | 11 | 44.8 | 330 | 156 | 117 | Down, Significant |
| 83117_C3 | 11 | 40.6 | 128 | 85.1 | 31.6 | Down, Significant |
| 83117_C4 | 11 | 71.3 | 111 | 88.2 | 12.4 | **Up, Significant** |
| 83124_C1 | 33 | 185 | 1070 | 481 | 204 | No Significant Trend |
| 83124_C2 | 16 | 27.8 | 103 | 55.1 | 20.1 | Down, Significant |
| 83124_C4 | 11 | 25.4 | 62.2 | 38.9 | 10.5 | **Up, Significant** |
| 83124_C5 | 11 | 24.4 | 61.4 | 50.8 | 9.8 | No Significant Trend |
| 83294_C1 | 17 | 98.5 | 198 | 170 | 29 | **Up, Significant** |
| 83294_C2 | 24 | 188 | 575 | 387 | 90 | No Significant Trend |
| 83294_C3 | 13 | 161 | 539 | 346 | 137 | Down, Significant |
| 83295_C2 | 16 | 92.3 | 178 | 148 | 23 | No Significant Trend |

*Table A.2–29 (continued). Summary Statistics and Trend Analysis of Monitoring Wells for Total Uranium with 2011 Results Above FRLs*

| Well | No. of Sample | Minimum (µg/L)[a,b,c,d] | Maximum (µg/L)[a,b,c,d] | Average (µg/L)[a,b,c,d,e] | Standard Deviation (µg/L)[a,b,c,d,e] | Trend[a,b,c,d,e,f] |
|---|---|---|---|---|---|---|
| 83295_C3 | 14 | 99.2 | 175 | 141 | 25 | Down, Significant |
| 83295_C4 | 12 | 47.8 | 199 | 113 | 57 | Down, Significant |
| 83295_C5 | 11 | 57.2 | 155 | 86.0 | 30.3 | Down, Significant |
| 83295_C6 | 11 | 3.4 | 64.4 | 30.0 | 23.0 | **Up, Significant** |
| 83296_C1 | 8 | 56.7 | 135 | 87.4 | 26.4 | No Significant Trend |
| 83296_C2 | 17 | 32.0 | 117 | 60.4 | 23.5 | Down, Significant |
| 83335_C2 | 11 | 4.5 | 49.5 | 26.6 | 14.7 | No Significant Trend |
| 83337_C1 | 14 | 871 | 2430 | 1490 | 510 | No Significant Trend |
| 83337_C2 | 21 | 2.7 | 835 | 161 | 220 | Down, Significant |
| 83338_C1 | 9 | 454 | 710 | 556 | 81 | No Significant Trend |
| 83338_C2 | 12 | 22.7 | 648 | 194 | 186 | Down, Significant |
| 83340_C1 | 8 | 13.2 | 44.8 | 24.5 | 9.8 | No Significant Trend |
| 83341_C1 | 5 | 28.8 | 39.4 | 36.0 | 4.1 | No Significant Trend |
| 83346_C1 | 8 | 39.7 | 70.7 | 46.8 | 10.1 | No Significant Trend |

[a] Summary statistics and Mann-Kendall test for trend are primarily based on unfiltered samples with some filtered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 2011 groundwater data.
[b] If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation) and Mann-Kendall test for trend.
[c] Rejected data qualified with an R were not included in this count, the summary statistics, or Mann-Kendall test for trend.
[d] If the number of samples is greater than or equal to four, then all of the summary statistics and the Mann-Kendall test for trend are reported. If the total number of samples is equal to three, then the minimum, maximum, and average are reported. If the total number of samples is equal to two, then the minimum and maximum are reported. If the total number of samples is equal to one, then the data point is reported as the minimum.
[e] For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[f] Mann-Kendall test for trend is performed using data from third quarter 1998 through 2011.

*Table A.2–30. Summary Statistics and Trend Analysis of Extraction Wells for Total Uranium*

| Well | Number of Samples[a,b] | Minimum (µg/L)[a,b,c] | Maximum (µg/L)[a,b,c] | Average (µg/L)[a,b,c] | Standard Deviation (µg/L)[a,b,c] | Trend[a,b,c] |
|---|---|---|---|---|---|---|
| South Plume Module (August 27, 1993, through December 31, 2011) | | | | | | |
| 3924 | 573 | 1.8 | 180 | 31 | 15 | Down, Significant |
| 3925 | 574 | 0.5 | 84.0 | 24.6 | 7.7 | Down, Significant |
| 3926 | 563 | 1.5 | 42.4 | 25.4 | 8.3 | **Up, Significant** |
| 3927 | 571 | 1.0 | 17.0 | 2.6 | 1.1 | **Up, Significant** |
| South Plume Optimization Module (August 9, 1998, through December 31, 2011) | | | | | | |
| 32308 | 499 | 18.4 | 100 | 55 | 15 | Down, Significant |
| 32309 | 507 | 24.8 | 123 | 56 | 19 | Down, Significant |
| South Field Module (July 13, 1998, through December 31, 2011) | | | | | | |
| 31550 | 524 | 16.2 | 128 | 52 | 19 | Down, Significant |
| 31560 | 547 | 12.1 | 183 | 61 | 37 | Down, Significant |
| 31561 | 521 | 18.1 | 114[d] | 41 | 10 | Down, Significant |
| 32276 | 564 | 20.2 | 290 | 103 | 62. | Down, Significant |
| 32446 | 420 | 24.5 | 168 | 61 | 20 | Down, Significant |
| 32447 | 440 | 21.9 | 302 | 110 | 53 | Down, Significant |
| 33061 | 320 | 18.3 | 98.5 | 47.1 | 13.8 | Down, Significant |
| 33262 | 277 | 23.5 | 110 | 48 | 13 | Down, Significant |
| 33264 | 273 | 15.8 | 364 | 86 | 40 | Down, Significant |
| 33265 | 272 | 7.5 | 96.5 | 22.0 | 7.5 | Down, Significant |
| 33266 | 270 | 4.5 | 105 | 16 | 10 | Down, Significant |
| 33298 | 228 | 19.5 | 76.2 | 52.8 | 8.7 | Down, Significant |
| 33326 | 178 | 16.2 | 62.2 | 26.9 | 6.3 | Down, Significant |
| Waste Storage Area Module (May 8, 2002, through December 31, 2011) | | | | | | |
| 32761 | 312 | 24.1 | 161 | 63 | 32 | Down, Significant |
| 33062 | 326 | 21.2 | 236 | 71 | 45 | Down, Significant |
| 33334 | 141 | 8.7 | 50.0 | 17.7 | 6.8 | Down, Significant |
| 33347 | 136 | 7.0 | 126 | 27 | 22 | Down, Significant |

[a] If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation ) and Mann-Kendall test for trend.
[b] Rejected data qualified with an R were not included in this count, the summary statistics, or Mann-Kendall test for trend.
[c] For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[d] This result (sampled August 31, 1998) appears to be an outlier. It is suspected that the sample for this well was switched with the sample from extraction well 31562.

This page intentionally left blank

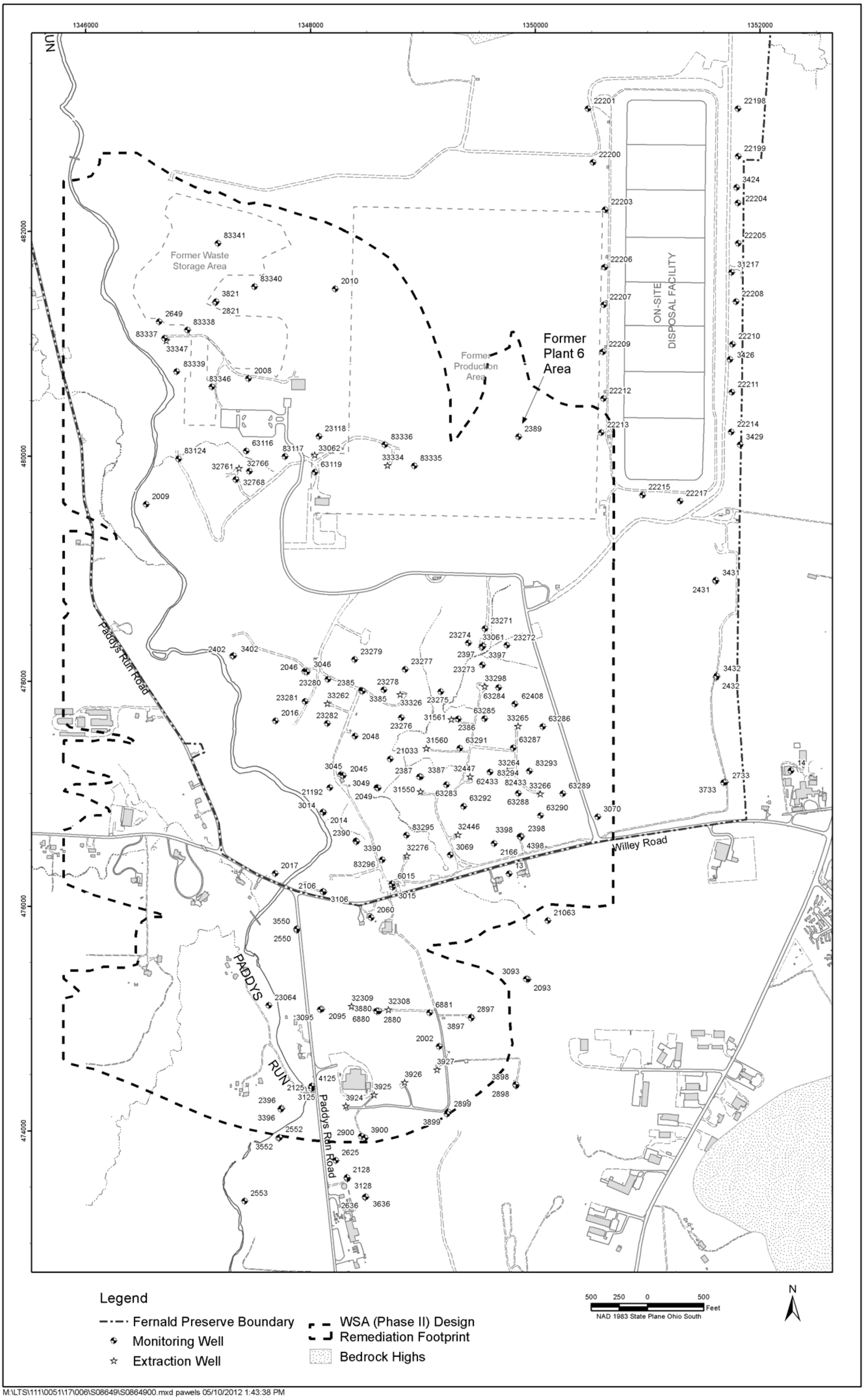



*Figure A.2−1. IEMP Water Quality Monitoring Wells and Extraction Wells*

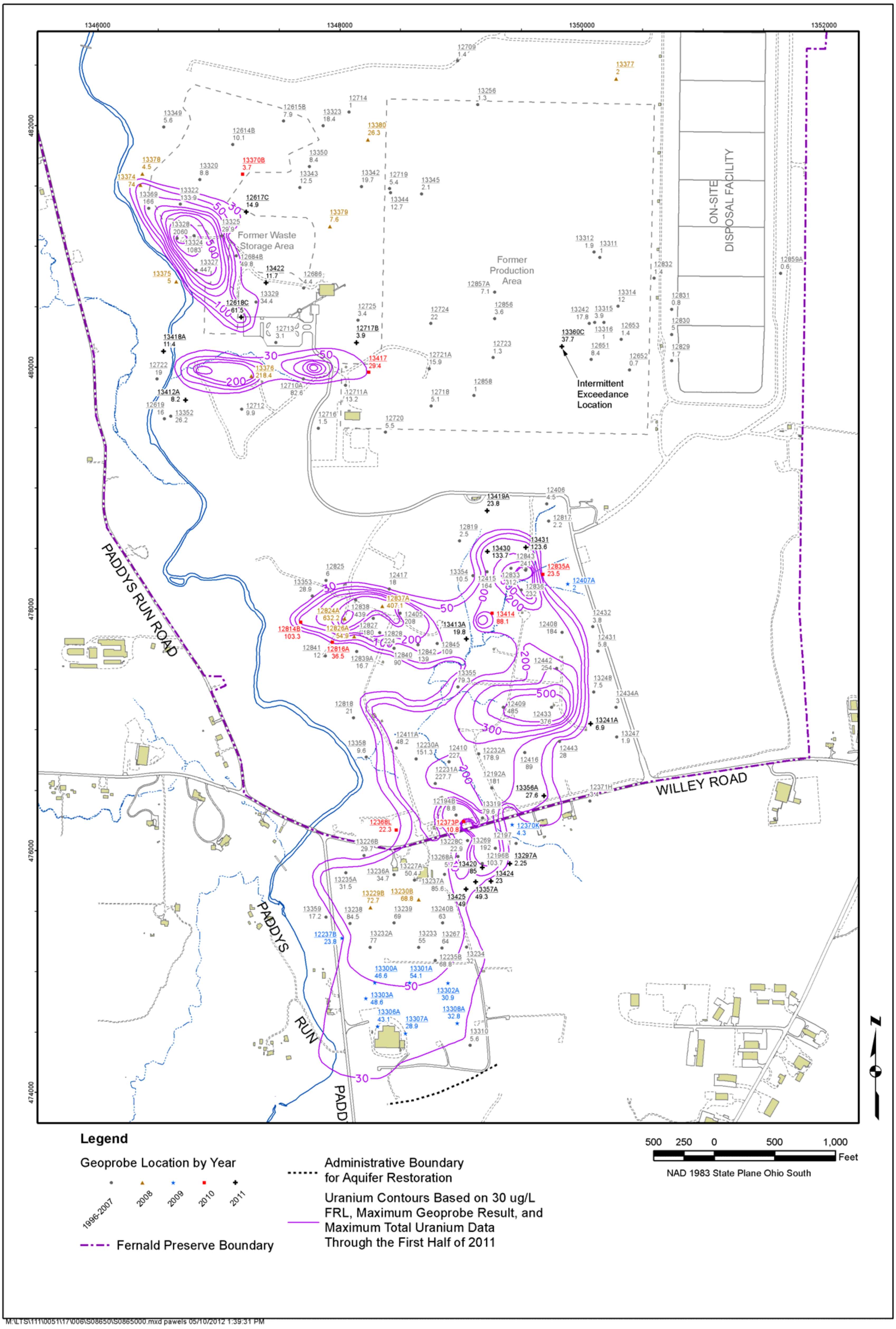



*Figure A.2−2A. Direct-Push Data and Maximum Total Uranium Plume through the First Half of 2011*

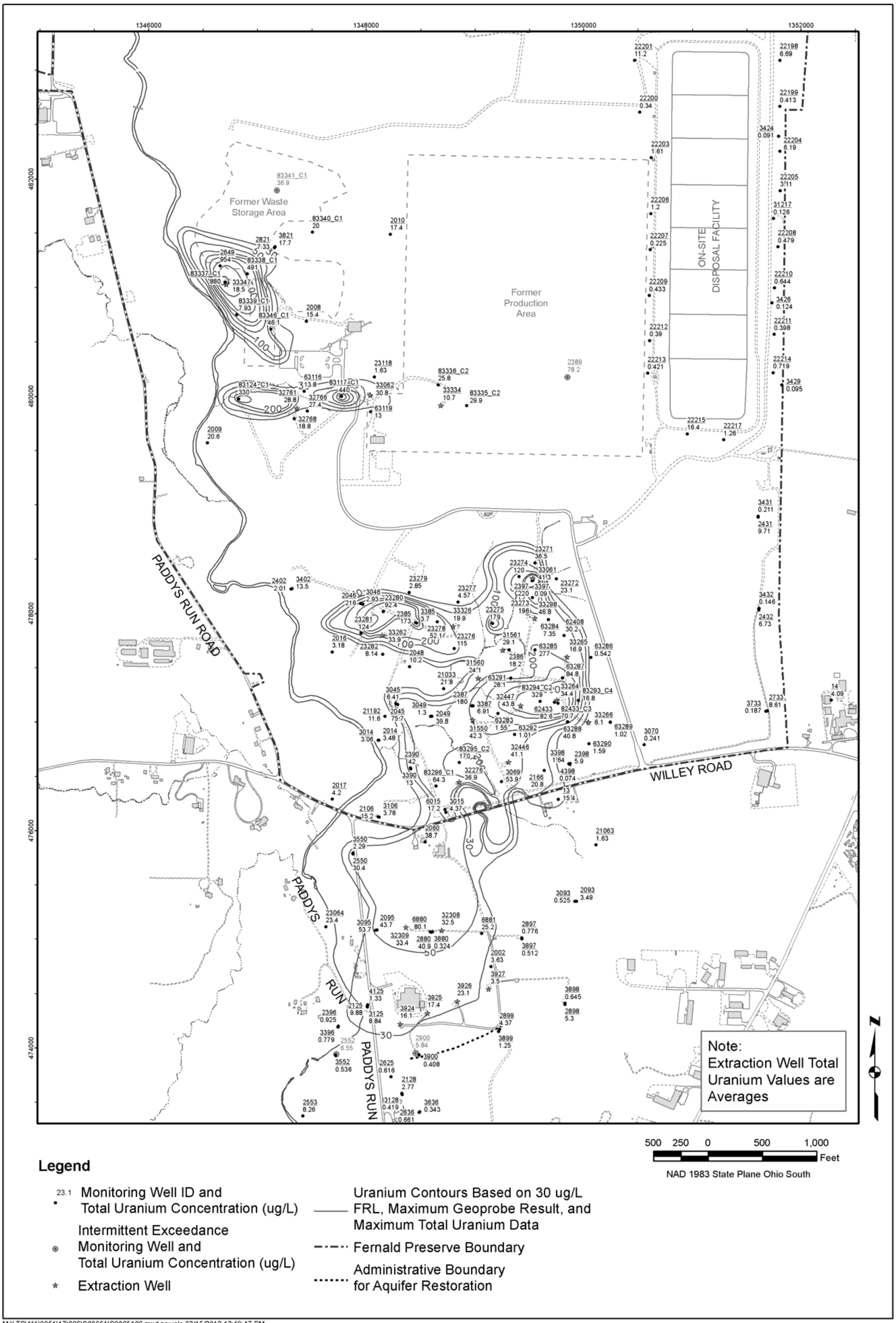



*Figure A.2−2B. Monitoring Well Data and Maximum Total Uranium Plume through the First Half of 2011*

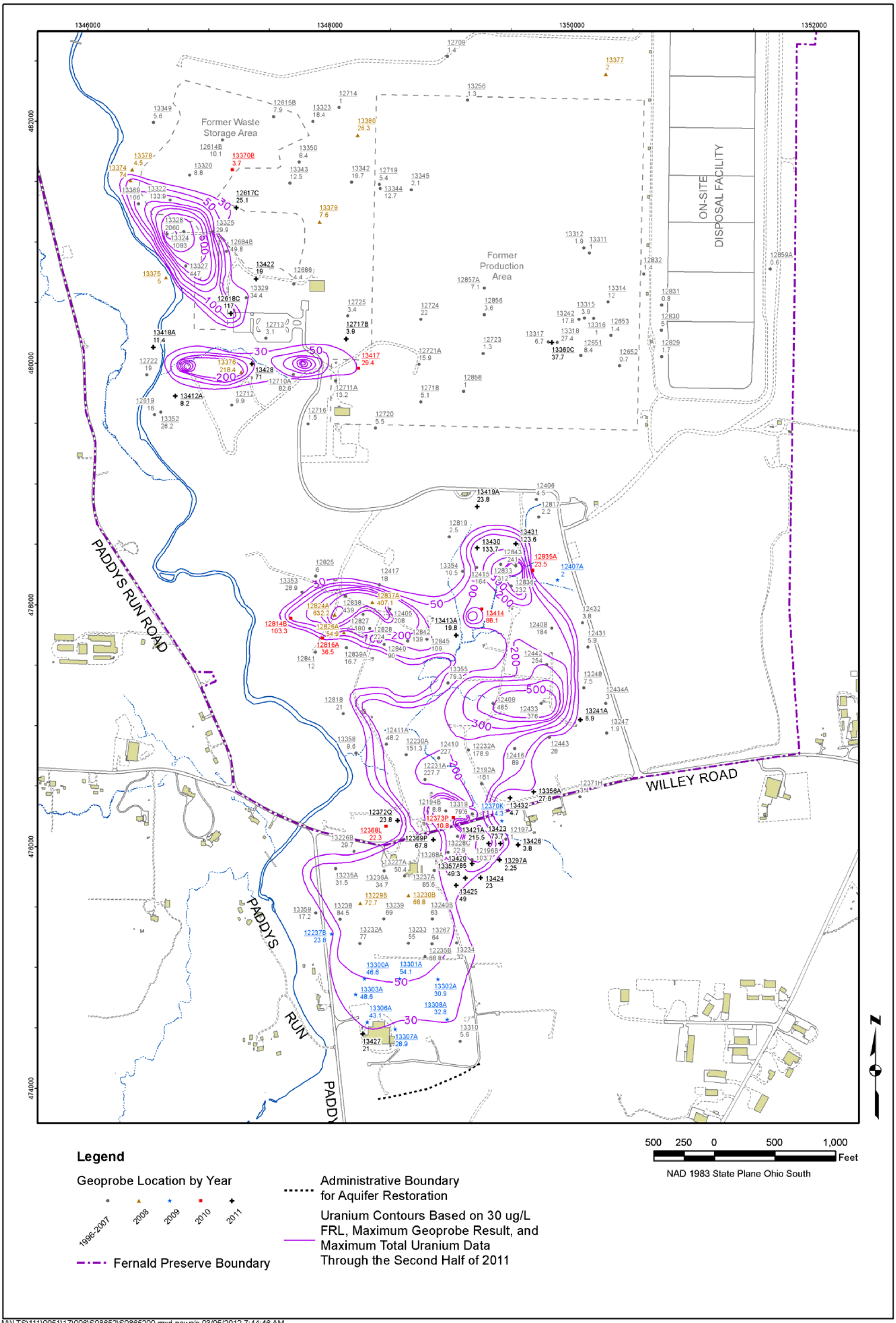
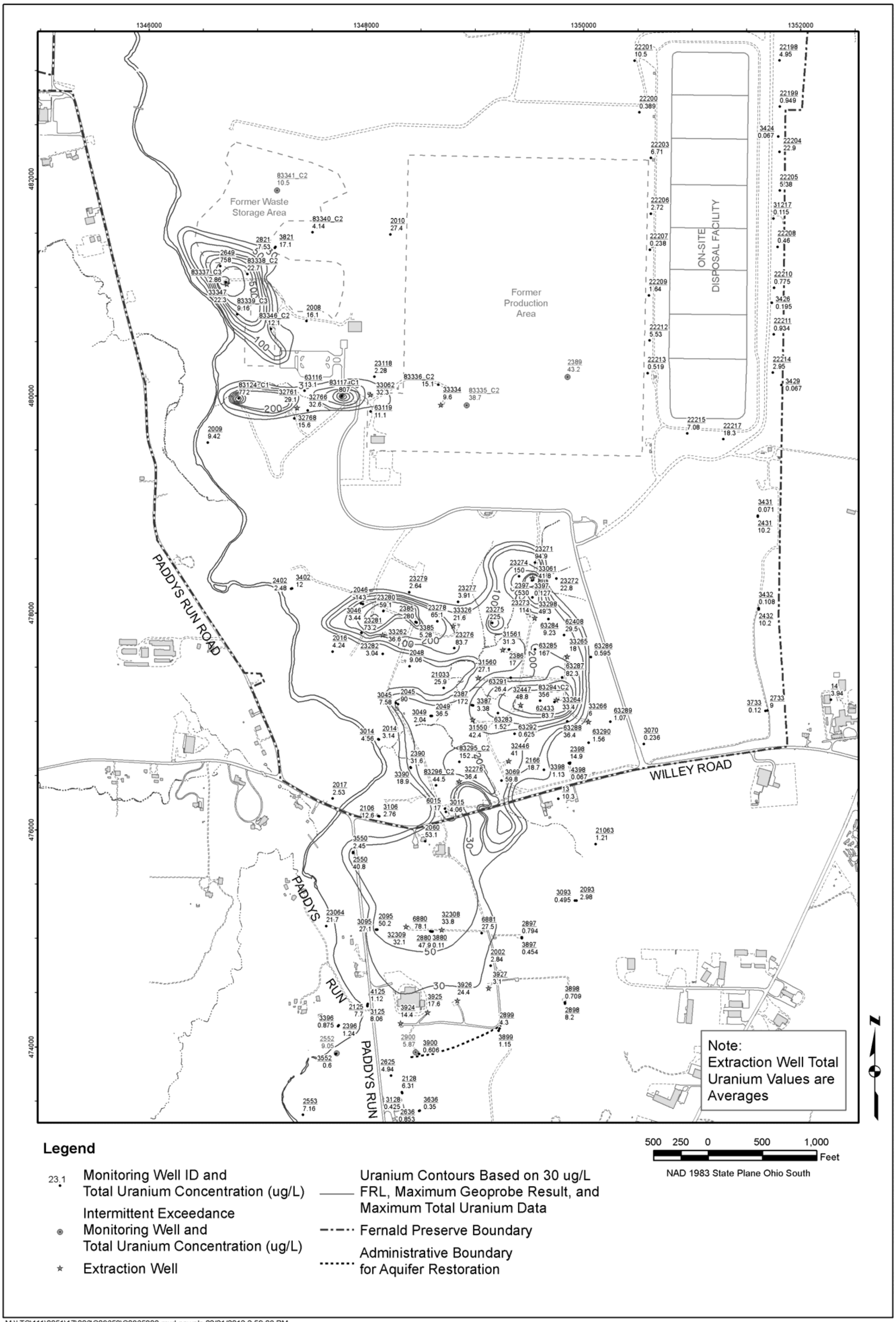



*Figure A.2−3A. Direct-Push Data and Maximum Total Uranium Plume through the Second Half of 2011*




M:\LTS\111\0051\17\006\S08653\S0865300.mxd pawels 02/21/2012 2:59:08 PM

*Figure A.2−3B. Monitoring Well Data and Maximum Total Uranium Plume through the Second Half of 2011*

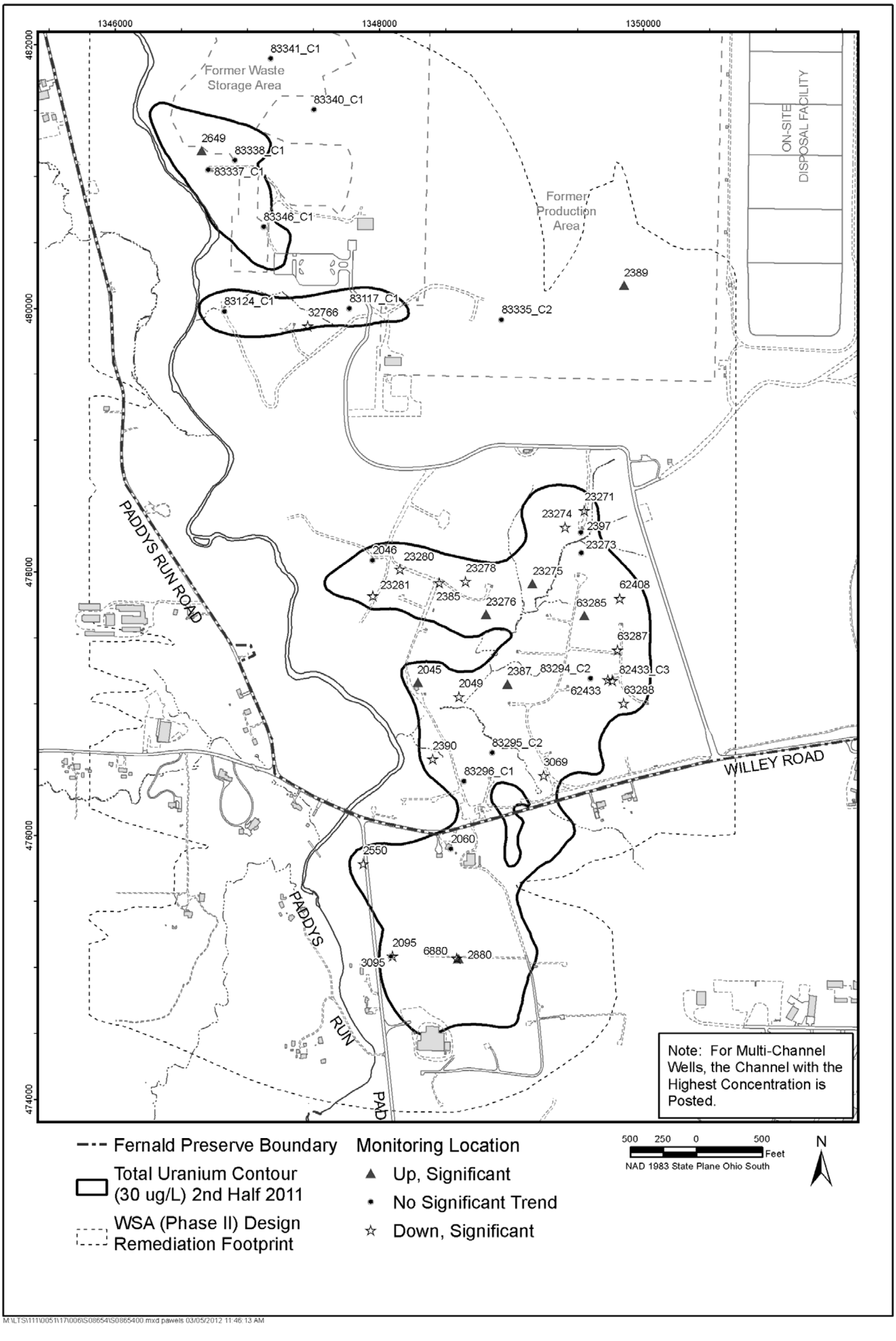



*Figure A.2−4. Monitoring Wells with 2011 Exceedances for Total Uranium with Up, Down, or No Significant Trends*

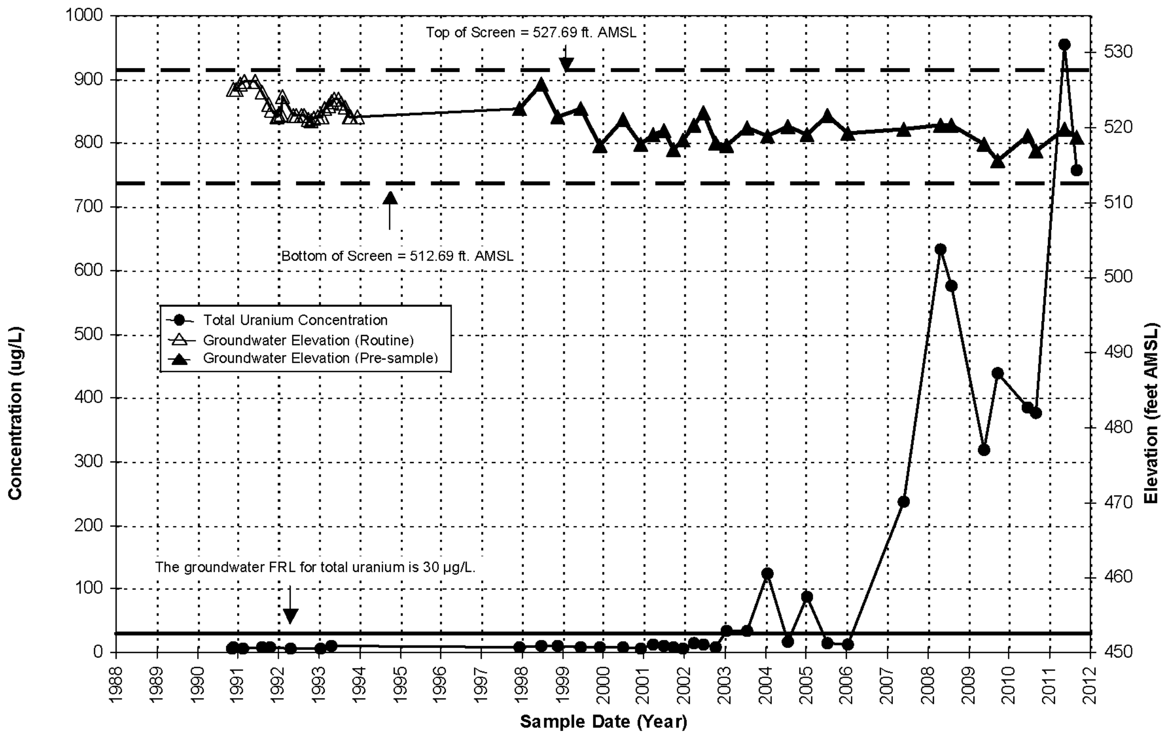



FIGURE A.2-5. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2649

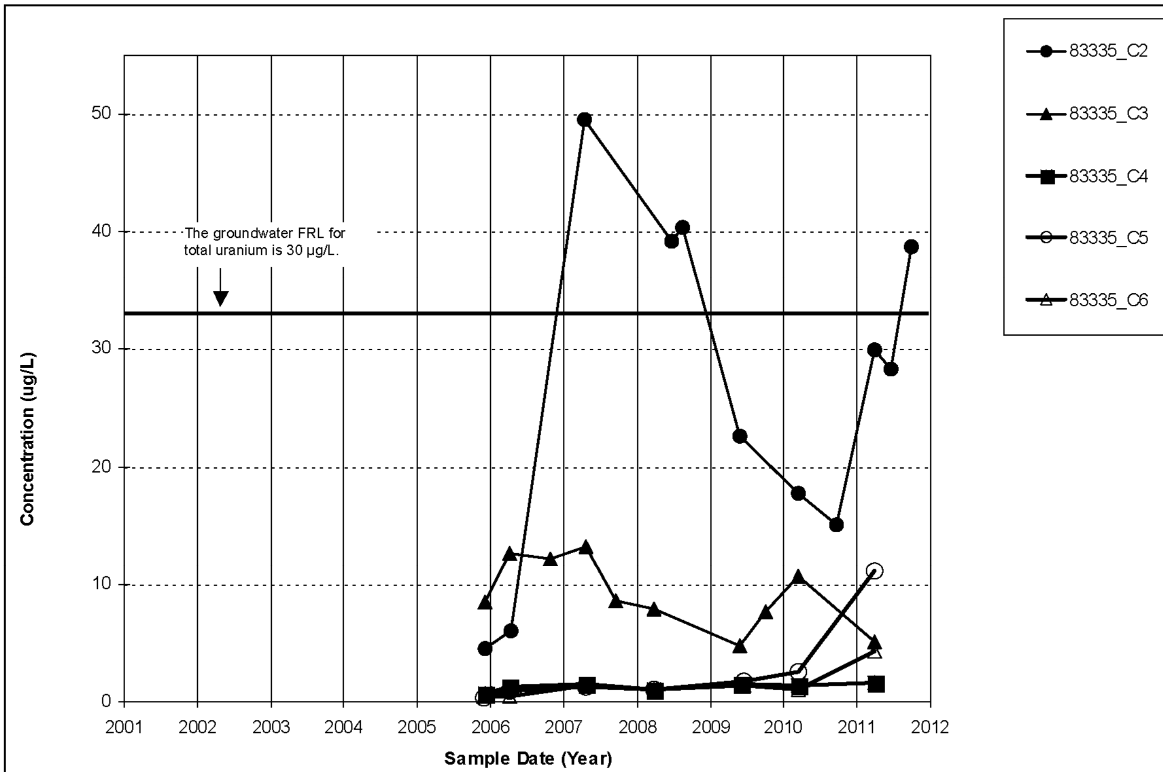



FIGURE A.2-6. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 83335

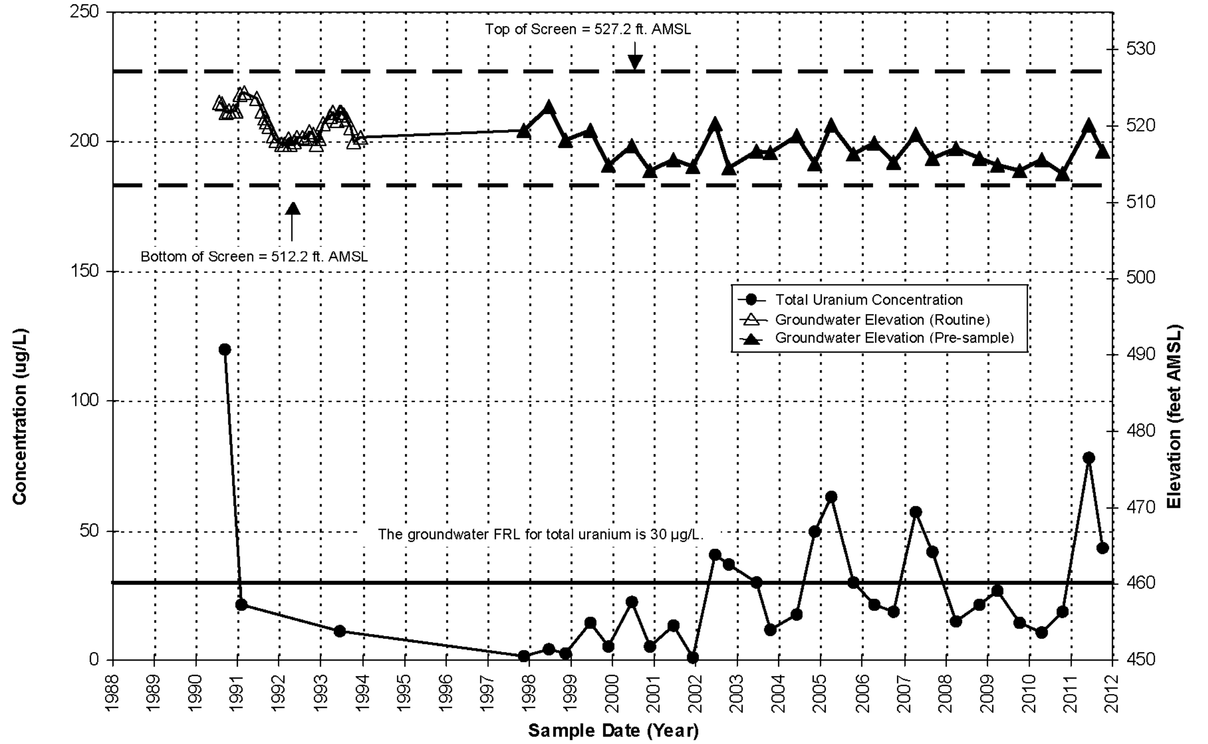
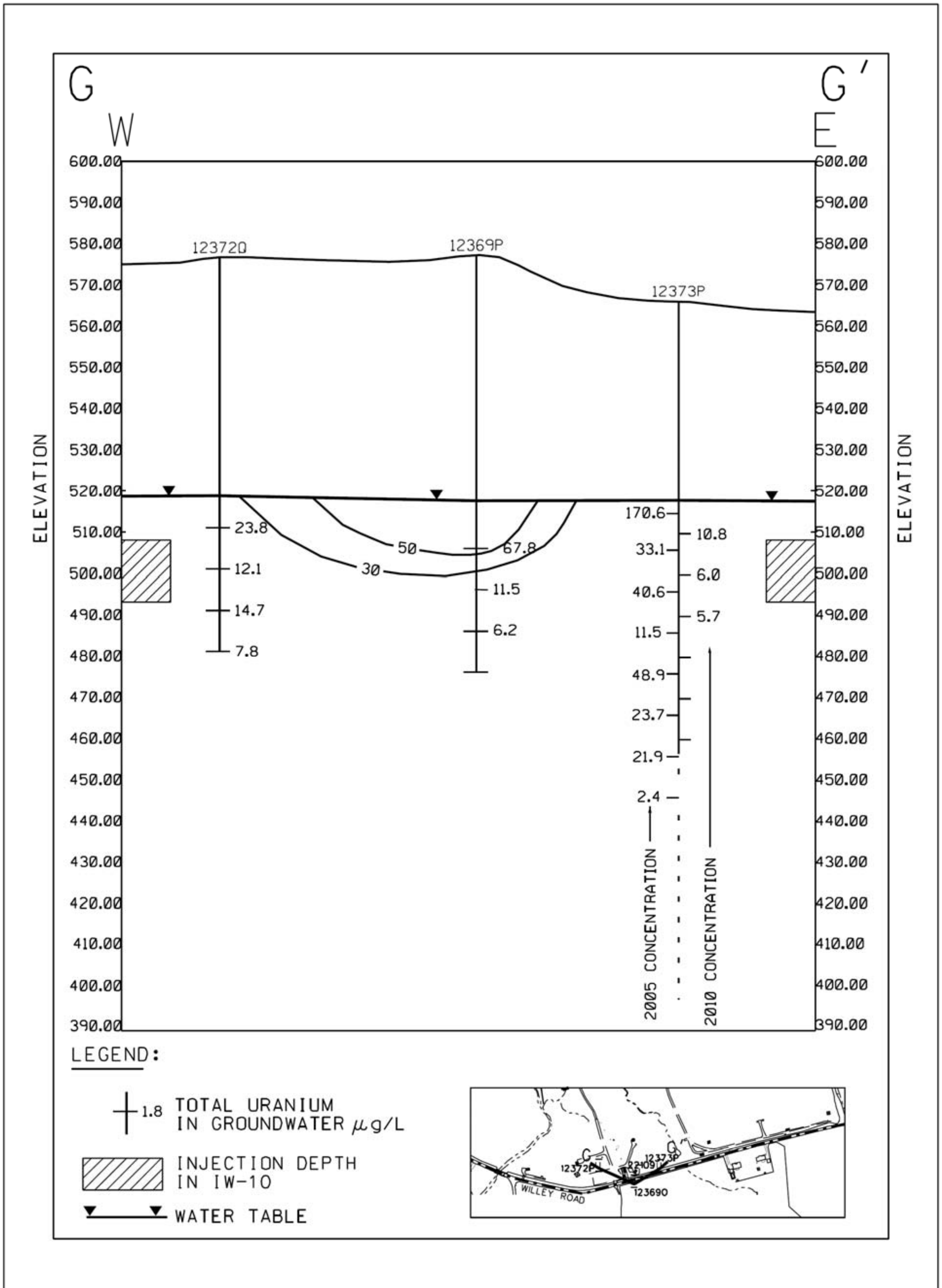



FIGURE A.2-7. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2389




V:/LTS/111/0051/17/005/S07438/S0743800.DGN

*Figure A.2–8. Total Uranium in Groundwater (2011) Next to and South of IW-10*

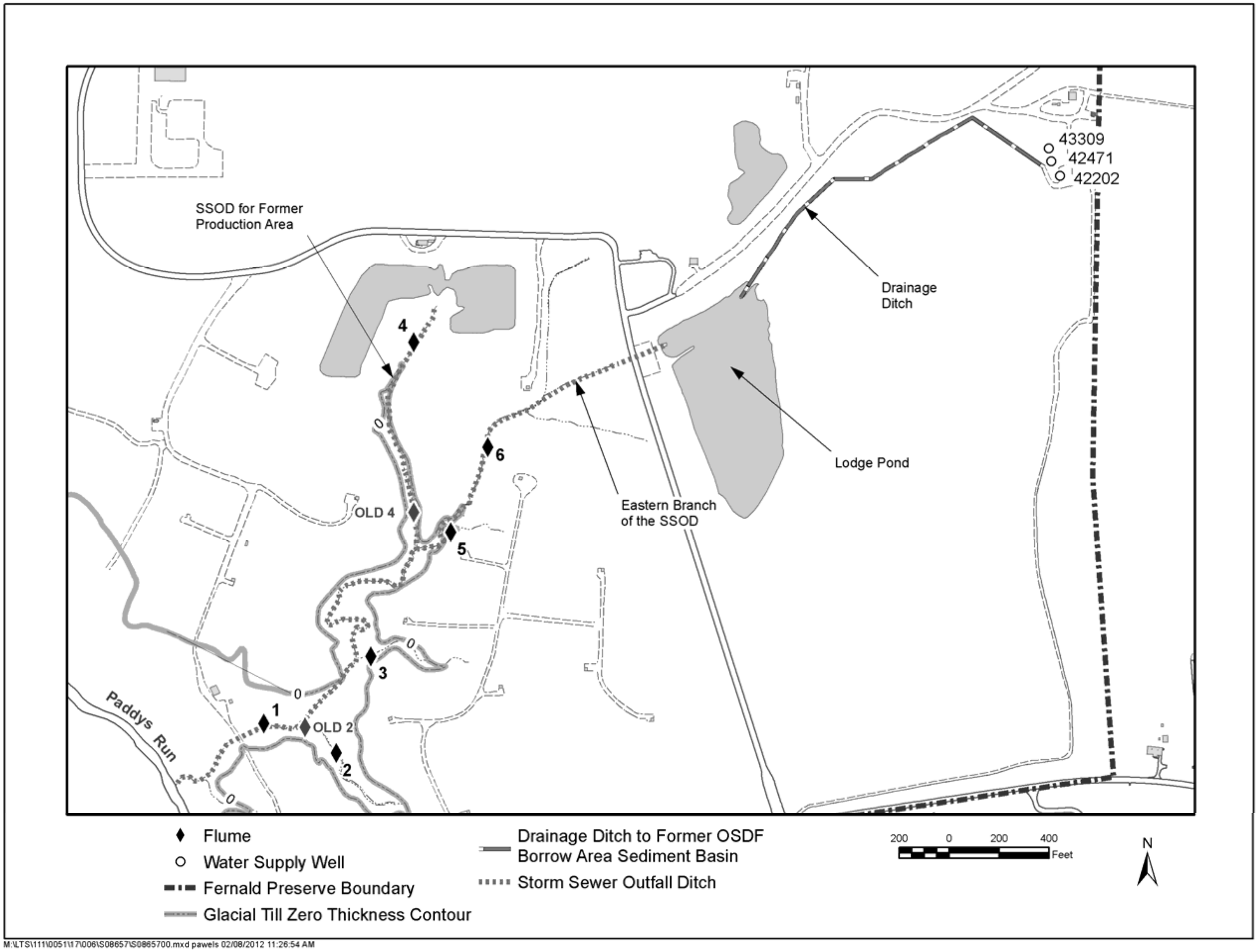



*Figure A.2–9. SSOD Flumes and Water Supply Wells*

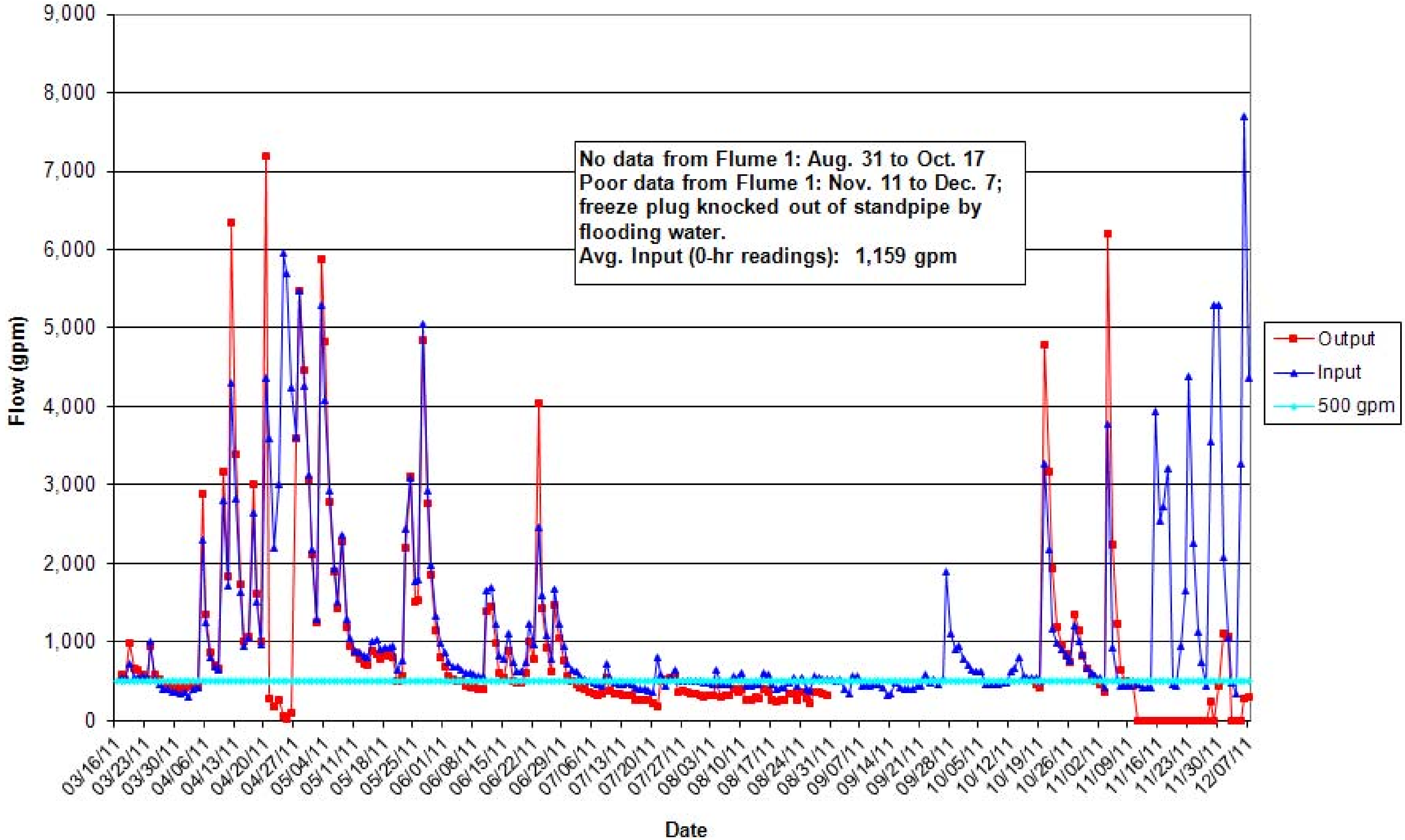



*Figure A.2−10. Flow In and Out of the SSOD in 2011*

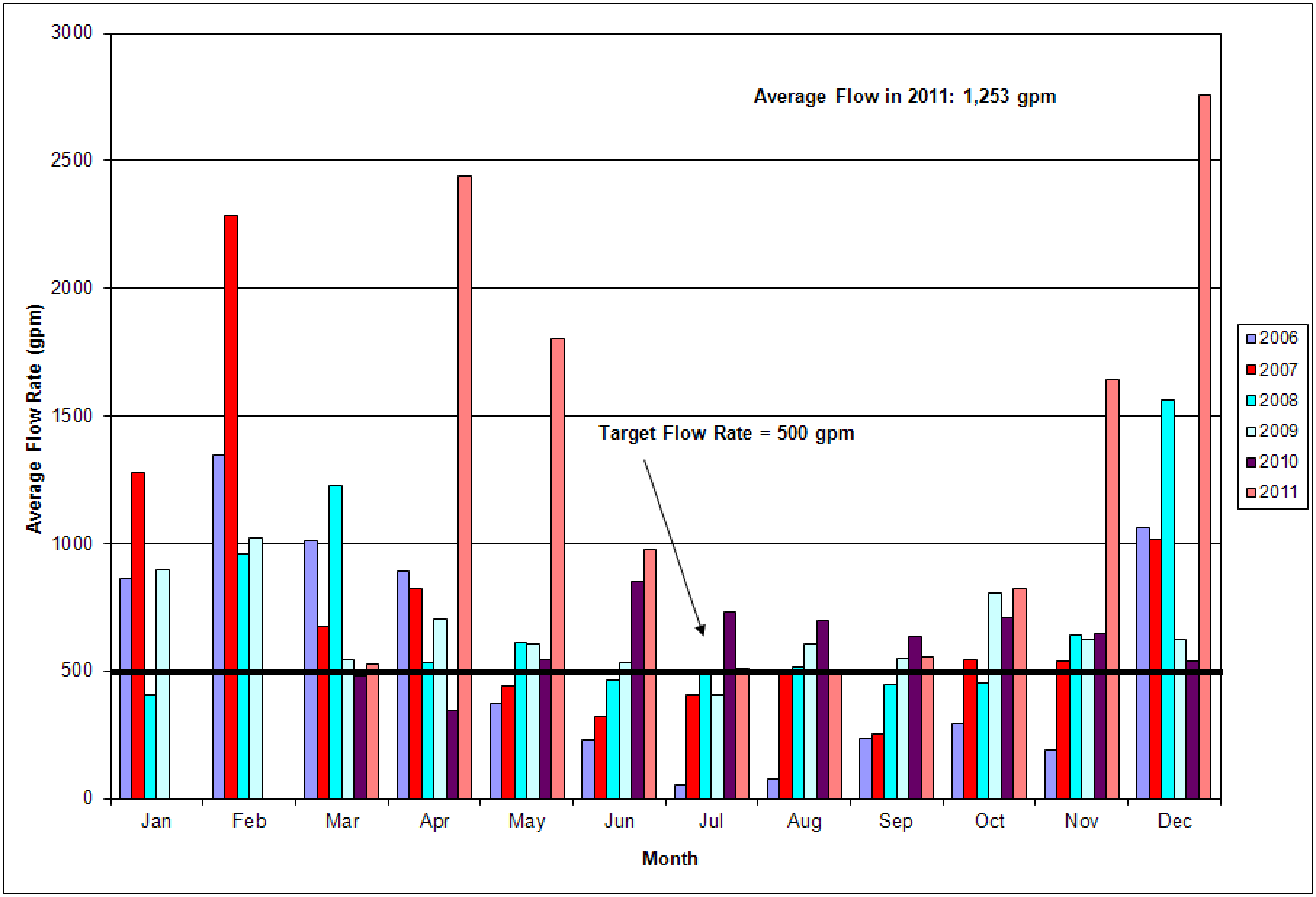



*Figure A.2−11. Average Flow Rate into SSOD: 2006–2011 Flumes 2, 3, 4, 5 and 6*

**Attachment A.3**

# A.3.0 Groundwater Elevations and Capture Assessment

## A.3.1 Groundwater Elevations and Capture Assessment

Quarterly groundwater elevation maps for 2011 are provided in Figures A.3−1 through A.3−4. Each groundwater elevation map contains the following quarter-specific information:

- Groundwater elevation data.
- Interpreted water table contours, capture zones, and flow divides.
- Bedrock highs.
- Waste Storage Area (Phase II) Design particle track defined remediation footprint.
- Extent of the maximum 30 µg/L total uranium plume.
- Module-specific pumping rates during the time period in which the groundwater elevation measurements were collected and the number of wells in each module.

Water levels in 2011 were measured at 178 locations, as specified in the IEMP (DOE 2011a).

| Quarter | Measurement Dates | Number of Days | Average Water Level (ft amsl) |
|---|---|---|---|
| 1 | 1/17/11 to 1/20/11 | 4 | 511.98 |
| 2 | 4/11/11 to 4/12/11 | 2 | 515.96 |
| 3 | 7/18/11 to 7/21/11 | 4 | 519.48 |
| 4 | 10/10/11 to 10/12/11 | 3 | 515.71 |

Twenty-one monitoring wells were not measured at various times in 2011 because the wells were dry. A summary is provided below.

| Well | First Quarter | Second Quarter | Third Quarter | Fourth Quarter |
|---|---|---|---|---|
| 2014 | DRY | DRY | | DRY |
| 21192 | DRY | DRY | | DRY |
| 22303 | DRY | | | |
| 2384 | DRY | | | |
| 2544 | DRY | | | |
| 2636 | DRY | | | DRY |
| 82433_C1 | DRY | DRY | | DRY |
| 83117_C1 | DRY | | | |
| 83293_C1 | DRY | DRY | | DRY |
| 83294_C1 | DRY | DRY | | DRY |
| 83295_C1 | DRY | DRY | | DRY |
| 83296_C1 | DRY | | | |
| 83335_C1 | DRY | DRY | DRY | DRY |
| 83335_C2 | DRY | DRY | | |
| 83336_C1 | DRY | DRY | DRY | DRY |
| 83337_C1 | DRY | DRY | | DRY |
| 83338_C1 | DRY | | | |
| 83339_C1 | DRY | | | |
| 83340_C1 | DRY | DRY | | |
| 83341_C1 | DRY | DRY | | |
| 83346_C1 | DRY | | | |

The 2011 quarterly groundwater elevation maps shown in Figures A.3–1 through A.3–4 illustrate capture of the maximum total uranium plume by means of groundwater elevation contours derived from quarterly water level measurements and predicted capture based on Waste Storage Area (Phase II) design particle track modeling. The pumping rates reported on Figures A.3−1 through A.3−4 are averages of the actual pumping rates during the measurement period.

The Waste Storage Area (Phase II) design remediation footprint used in this report was constructed using reverse, non-retarded, particle path interpretations from the VAM 3D, Zoom Groundwater Model. Figure A.3−5 shows the resulting particle tracks that were used to define the Waste Storage Area (Phase II) design remediation footprint. Model particles were seeded at each extraction well. The resulting particle tracks represent the individual path that each particle traveled over the time period modeled for the Waste Storage Area (Phase II) design (2007 to 2023). The limits of most of the particle tracks are truncated because the particles reached the edge of the VAM 3D Zoom Groundwater Model domain.

A groundwater flow divide between Paddys Run Outlet and the New Baltimore Outlet is not readily distinguishable. Groundwater flow diverges around the bedrock high that separates the Paddys Run Outlet from the New Baltimore Outlet, but without additional measurement locations in the New Baltimore Outlet, the location where flow is dividing is not apparent. Additional measurement locations in the New Baltimore Outlet though are not needed for capture assessment purposes.

During 2011, the flow direction in the vicinity of the OSDF was generally northeast to south/southwest. This flow direction is influenced by active pumping taking place for the groundwater remediation which is predicted to last until 2023. Prior to the start of pumping for the groundwater remediation, flow in the vicinity of the OSDF was generally west to east. It is anticipated that when pumping stops, flow direction in the vicinity of the OSDF will return to a generally west to east direction.

Average annual water table fluctuations and yearly ranges for 2006 through 2011 are as follows:

| Year | Average Fluctuation (ft) | Fluctuation Range (ft) |
|---|---|---|
| 2011 | 7.50 | 7.4 to 14.5 |
| 2010 | 3.78 | 0.06 to 12.1 |
| 2009 | 2.46 | 0.1 to 5.5 |
| 2008 | 5.7 | 1.0 to 10.46 |
| 2007 | 4.45 | 1.7 to 7.7 |
| 2006 | 3.4 | 2.0 to 7.1 |

Quarterly capture zone interpretations coupled with the Waste Storage Area (Phase II) particle track interpretations and contoured water table gradients indicate that the 30-µg/L total uranium plume was being captured in 2011.

## A.3.2 Annual Planned Well Field Shutdown

Unplanned well field pumping disruptions were minimal in 2011. The entire well field (excluding the South Plume recovery wells) was shut down once in 2011 for a total of 28 days from June 13 to July 11 as planned to allow water levels to recover to non-pumping elevations. Routine quarterly water level measurements were not collected in 2011 during the planned shutdowns.

Uranium contamination is bound to aquifer sediments in the unsaturated portion of the GMA beneath former contamination source areas. This contamination will remain bound unless water levels in the aquifer rise, saturate the contaminated sediments, and allow the bound contamination to dissolve into the groundwater.

Planned annual well field shutdowns have been conducted since 2007 to allow water levels in the aquifer to rise as high as possible to saturate aquifer material that is not normally saturated. To achieve the highest water level rise possible, the well field shutdowns are planned to coincide with seasonal high-water levels in the aquifer.

Regional water levels in 2011 were high due to the large amount of precipitation received during the year. The high regional water levels provided ideal conditions for the shut down exercise. Figure A.3−6 shows cumulative annual precipitation levels for 2004 through 2011, as recorded at the Butler County Regional Airport. Cumulative precipitation in 2011 was approximately 60.20 inches. This is the highest amount of annual precipitation recorded in the last seven years.

**Water Level Results**

Pressure transducers were installed in 11 groundwater monitoring wells (2045, 2046, 2649, 23274, 62433, 32763, 23118, 22301, 22302, 22303, and 63119) for the shutdown (Figure A.3−7). Water level measurements were recorded at the top of each hour.

The zero hour transducer readings (midnight) were used to track water level changes in the transducer wells during the shutdown period. The maximum water level rise measured during the shutdown in 2011 at each transducer are presented below:

| Location | Just Prior to Shutdown 6/13/2011 | Just Prior to Restart 7/11/2011 | Water Level Rise (ft) |
|---|---|---|---|
| 2045 | 519.94 | 521.62 | 1.68 |
| 2046 | 519.77 | 521.41 | 1.64 |
| 2649 | 520.07 | 522.34 | 2.27 |
| 23274 | 519.23 | 520.97 | 1.74 |
| 63119 | 518.89 | 521.20 | 2.31 |
| 22302 | 520.74 | 524.15 | 3.41 |
| 23118 | 519.26 | 521.48 | 2.22 |
| 22301 | 518.74 | 520.45 | 1.71 |
| 22303 | 520.76 | 522.47 | 1.71 |
| 32763 | 518.77 | 521.99 | 3.22 |
| 62433 | 518.44 | 520.66 | 2.22 |

The water level rise calculations indicate that during the shutdown the water level rise at the transducer wells ranged from 1.64 ft to 3.41 ft.

Figure A.3−8 shows water levels verses precipitation from May 25, 2007, through February 2, 2012. Three wells are shown on the figure, well 2649 (former Waste Storage Area), well 2046 (west side of South Field Area), and well 62433 (east side of South Field Area). The combination of the shutdown and seasonal water level rise in 2011 resulted in a water level rise of approximately:

- 8.23 feet in the former Waste Storage Area (monitoring well 2649);
- 9.38 feet in the west side of the South Field (monitoring well 2046); and
- 11.06 feet in the east side of the South Field (monitoring well 62433).

**Uranium Concentration Results**

Uranium concentrations were measured in six groundwater monitoring wells (2045, 2046, 23274, 83124, 83294, and 83337 [Figure A.3–9]) before, during, and after the 2011 shutdown. The results of the 2011 IEMP first-half uranium sampling are used to represent uranium concentrations in the well before the shutdown. Groundwater samples collected on either July 6 or July 7 represent concentrations during the shutdown, and the results of the 2011 IEMP second-half uranium sampling are used to represent uranium concentrations in the well after the shutdown exercise was completed. The two shallowest channels (Channels 1 and 2) of the Type-8 monitoring wells were sampled. Uranium concentration measurements at the six monitoring wells before, during, and after the 2011 shutdown are provided in Table A.3–1.

A comparison of pre-shutdown uranium concentrations to pre-startup uranium concentrations in the monitoring wells yields mixed results. In some wells uranium concentrations during the shutdown increased (i.e., 2045, 23274, 83124_C1, 83294_C1 and 83337_C1); in other monitoring wells the uranium concentrations during the shutdown decreased (i.e., 2046, 83124_C2, 83294_C2, and 83337_C1). During the second half of the year, the channel with the highest uranium concentration (as measured during the first half of the year) is sampled. Therefore, no sample was collected from 83124_C2 during the second half of 2011.

Uranium concentrations were also measured at the extraction wells before and daily for 4 days after the wells were restarted. The first water sample was collected after the well had been pumping for approximately 5 minutes. Results are provided in Table A.3–2. The last column of the table provides the difference between the maximum uranium concentration measured after the wells were restarted, and the average uranium concentration measured in June at the extraction well. As the data indicate, the uranium concentration increased at most of the wells. As reported in Table A.3–2, during the shutdown, wells RW-6 and EW-28A underwent rehabilitation. During rehabilitation the well is shut down, liquid acid descalar (LAD) and hydrochloric acid (HCL) are placed in the well and the well is surged to clean the screen and loosen up the formation around the well screen. The objective is to restore pumping efficiency.

## A.3.3 Continued Transducer Monitoring

Although not required by the IEMP, pressure transducers installed in 2007 to support the first annual well field shutdown remain in the wells and continue to operate so that daily changes in water levels can be recorded on a continuous, routine basis at key points in the aquifer. The transducers are programmed to record a water level measurement at the top of each hour. Data from three of the six locations (former Waste Storage Area [2649], east side of the South Field Area [2046], and west side of the South Field Area [62433]) (locations shown in Figure A.3–7) are plotted in Figure A.3−8 along with precipitation data collected through February 2, 2012. The intent is to leave these transducers operating. The data will provide a more complete record of seasonal and short-term water table fluctuations and should prove helpful for planning the timing of future well field shutdowns.

*Table A.3–1. Uranium Concentrations at Monitoring Wells Before, During, and After the 2011 Well Field Shutdown*

| Well | Easting | Northing | First Half 2010 Pre-Shutdown Concentrations | | Pre-Start-Up Concentrations | | Second Half 2011 Post-Shutdown Concentrations | |
|---|---|---|---|---|---|---|---|---|
| | | | Date | Uranium (µg/L) | Date | Uranium (µg/L) | Date | Uranium (µg/L) |
| 2045 | 1348291 | 477158.9 | 4/18/2011 | 75.7 | 7/6/2011 | 90 | 9/7/2011 | 72.5 |
| 2046 | 1347950 | 478087.8 | 6/9/2011 | 216 | 7/6/2011 | 143 | 10/5/2011 | 67.5 |
| 23274 | 1349406 | 478337 | 4/7/2011 | 120 | 7/6/2011 | 127 | 9/29/2011 | 150 |
| 83124_C1 | 1346826 | 479977.2 | 3/16/2011 | 330 | 7/6/2011 | 579 | 9/27/2011 | 772 |
| 83124_C2 | 1346826 | 479977.2 | 3/16/2011 | 54.6 | 7/6/2011 | 46.9 | NA[a] | NA[a] |
| 83294_C1 | 1349599 | 477189.5 | 6/7/2011 | 171 | 7/6/2011 | 173 | 10/11/2011 | DRY |
| 83294_C2 | 1349599 | 477189.5 | 4/6/2011 | 329 | 7/6/2011 | 308 | 10/3/2011 | 356 |
| 83337_C1 | 1346704 | 481051.9 | 4/18/2011 | 880 | 7/7/2011 | 871 | 9/6/2011 | DRY |
| 83337_C2 | 1346704 | 481051.9 | 4/18/2011 | 15.3 | 7/7/2011 | 306 | 9/6/2011 | 2.93 |

[a]NA = not applicable

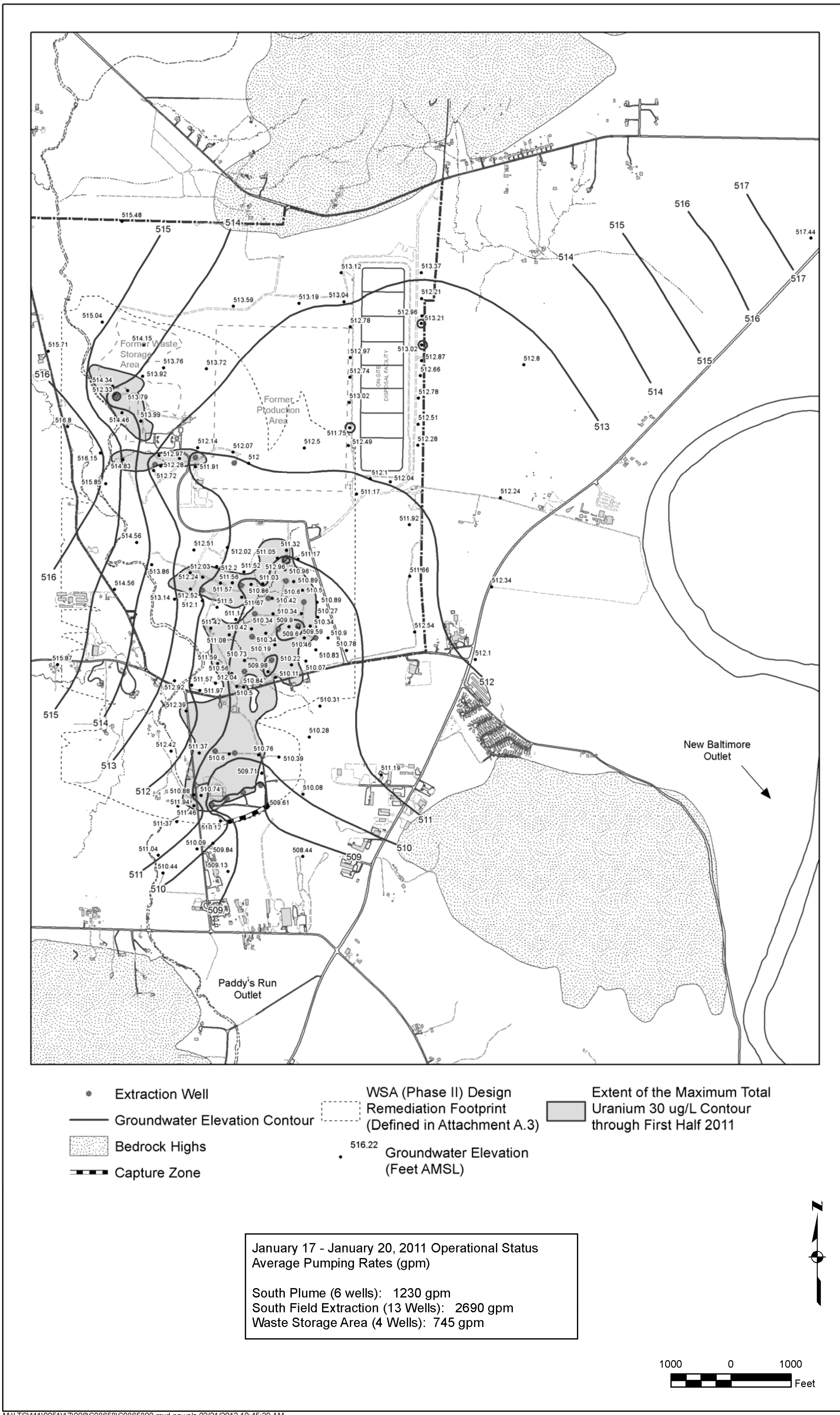
Only the highest elevation channel was sampled during the second half of 2011.

*Table A.3–2. Uranium Concentrations at Extraction Wells Before and After the Well Field Shutdown*

| Extraction Well | June Avg. Uranium Conc. (ug/L) | Uranium Concentration (ug/L) After Well Field Re-Start | | | | | | | Max. after Re-Start Minus June Avg.[a] (ug/L) |
|---|---|---|---|---|---|---|---|---|---|
| | | 7/11/2011 | 7/12/2011 | 7/13/2011 | 7/14/2011 | Min[a] | Max[a] | Range[a] | |
| RW-1 | 14.5 | 14.2 | 13.9 | 14.0 | 14.4 | 13.9 | 14.4 | 0.5 | -0.1 |
| RW-2 | 16.7 | 18.8 | 18.2 | 17.9 | 18.2 | 17.9 | 18.8 | 0.9 | 2.1 |
| RW-3 | 20.6 | 24.2 | 23.9 | 23.6 | 24.5 | 23.6 | 24.5 | 0.9 | 3.9 |
| RW-4 | 3.7 | 3.6 | 3.4 | 3.3 | 3.4 | 3.3 | 3.6 | 0.3 | -0.1 |
| RW-6 | 31.6 | REHAB | REHAB | REHAB | REHAB | NA | NA | NA | NA |
| RW-7 | 33.3 | 35.4 | 34.7 | 33.8 | 33.9 | 33.8 | 35.4 | 1.6 | 2.1 |
| EW-15A | 34.9 | 37.8 | 36.9 | 36.7 | 40.8 | 36.7 | 40.8 | 4.1 | 5.9 |
| EW-17A | 19.9 | 23.7 | 23.4 | 21.6 | 23.7 | 21.6 | 23.7 | 2.1 | 3.8 |
| EW-18 | 45.2 | 42.7 | 46.0 | 46.7 | 45.8 | 42.7 | 46.7 | 4.0 | 1.5 |
| EW-19 | 27.9 | 30.7 | 31.2 | 30.3 | 32.4 | 30.3 | 32.4 | 2.1 | 4.5 |
| EW-20 | 28.8 | 29.6 | 29.4 | 28.1 | 30.1 | 28.1 | 30.1 | 2.0 | 1.3 |
| EW-21A | 49.9 | 63.5 | 51.8 | 50.6 | 53.9 | 50.6 | 63.5 | 12.9 | 13.6 |
| EW-22 | 33.7 | 44.8 | 40.7 | 38.4 | 39.1 | 38.4 | 44.8 | 6.4 | 11.1 |
| EW-23 | 49.5 | 45.6 | 47.7 | 48.5 | 50.0 | 45.6 | 50.0 | 4.4 | 0.5 |
| EW-24 | 41.0 | 43.8 | 42.3 | 42.4 | 42.3 | 42.3 | 43.8 | 1.5 | 2.8 |
| EW-25 | 63.4 | 46.6 | 46.5 | 46.3 | 47.6 | 46.3 | 47.6 | 1.3 | -15.8 |
| EW-26 | 29.1 | 33.4 | 31.8 | 29.6 | 31.1 | 29.6 | 33.4 | 3.8 | 4.3 |
| EW-27 | 29.7 | 33.3 | 31.5 | 31.2 | 32.8 | 31.2 | 33.3 | 2.1 | 3.6 |
| EW-28A | 9.8 | REHAB | 8.7 | 8.7 | 8.8 | 8.7 | 8.8 | 0.1 | -1 |
| EW-30 | 43.2 | 15.8 | 19.8 | 21.7 | 26.7 | 15.8 | 26.7 | 10.9 | -16.5 |
| EW-31 | 16.6 | 23.6 | 23.4 | 23.2 | 23.3 | 23.2 | 23.6 | 0.4 | 7 |
| EW-32 | 5.0 | 7.4 | 7.0 | 6.6 | 6.4 | 6.4 | 7.4 | 1.0 | 2.4 |
| EW-33 | 23.8 | 24.7 | 23.9 | 23.2 | 25.8 | 23.2 | 25.8 | 2.6 | 2 |

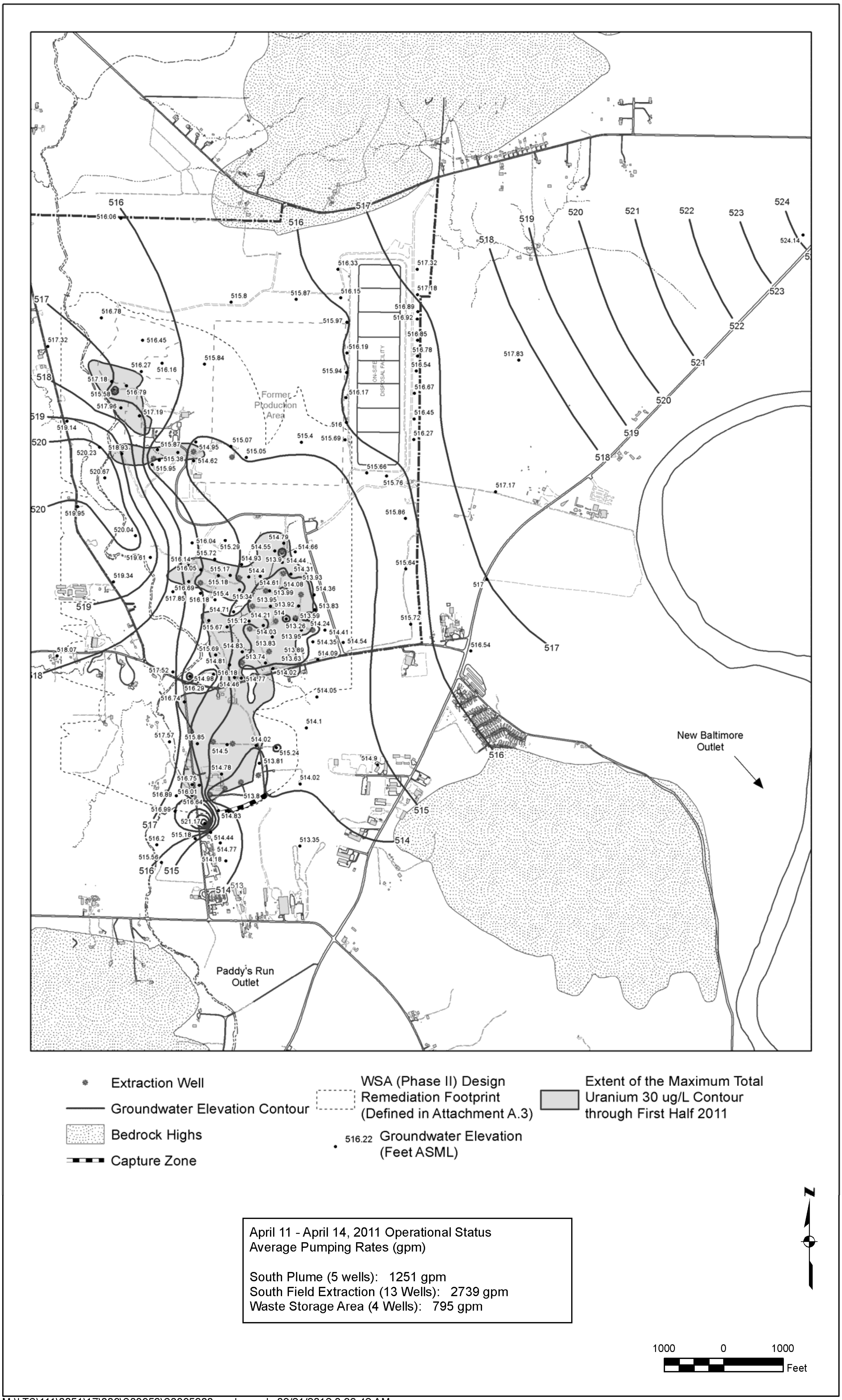
Shading indicates Uranium concentration after well field re-start is greater than June average uranium concentration.
[a]NA = not applicable

**Shutdown began on 6-13-2011 @ 8:30 AM**
**Shutdown ended on 7-11-2011 @ 9:30 AM**



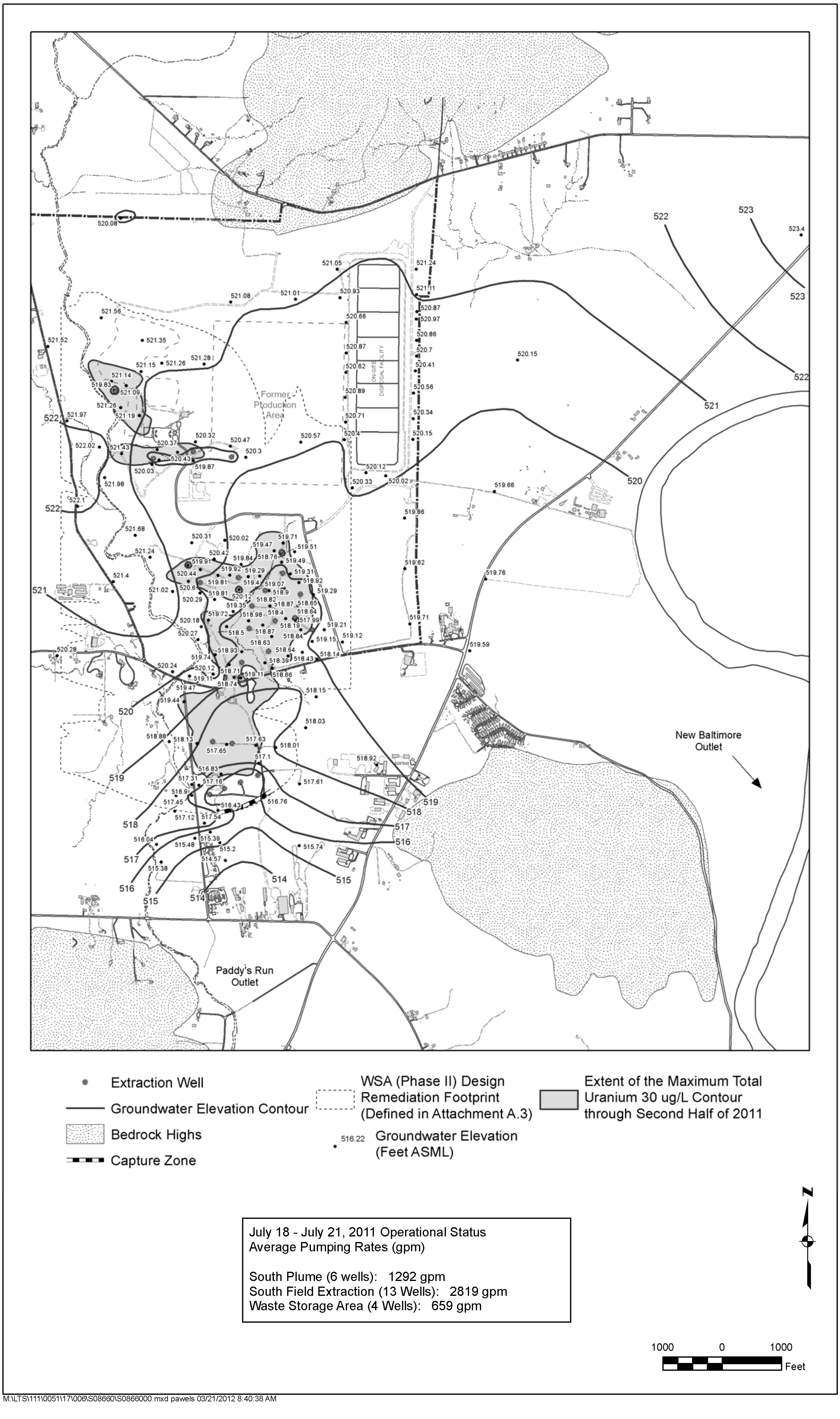

M:\LTS\111\0051\17\006\S08658\S0865800.mxd pawels 02/21/2012 10:45:30 AM

*Figure A.3−1. Routine Groundwater Elevation Map, First Quarter 2011 (January 17 through January 20, 2011)*



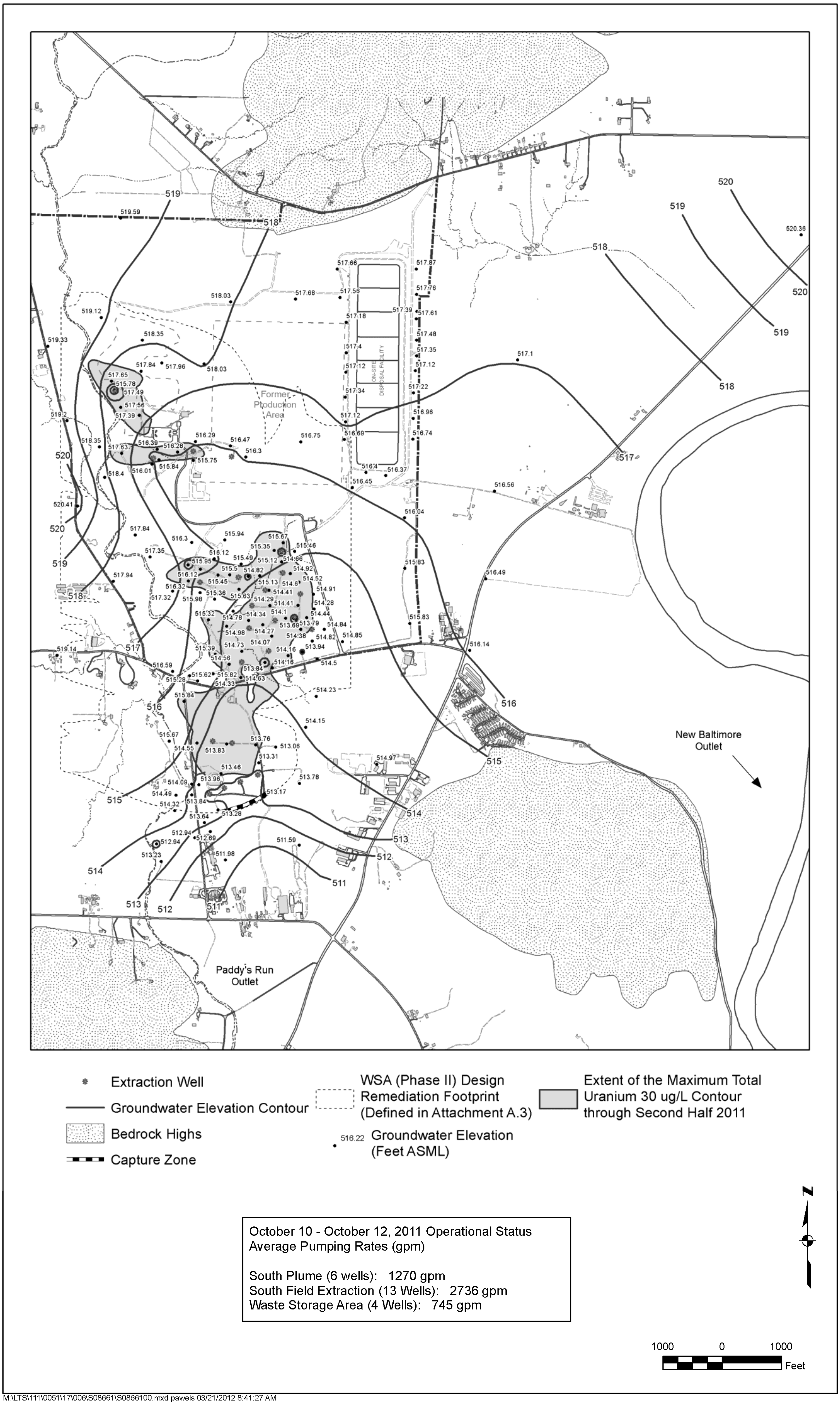

M:\LTS\111\0051\17\006\S08659\S0865900.mxd pawels 03/21/2012 8:39:42 AM

*Figure A.3−2. Routine Groundwater Elevation Map, Second Quarter 2011 (April 11 through April 14, 2011)*




M:\LTS\111\0051\17\006\S08660\S0866000.mxd pawels 03/21/2012 8:40:38 AM

*Figure A.3−3. Routine Groundwater Elevation Map, Third Quarter 2011 (July 18 through July 121, 2011)*



M:\LTS\111\0051\17\006\S08661\S0866100.mxd pawels 03/21/2012 8:41:27 AM

*Figure A.3−4. Routine Groundwater Elevation Map, Fourth Quarter 2011 (October 10 through October 12, 2011)*

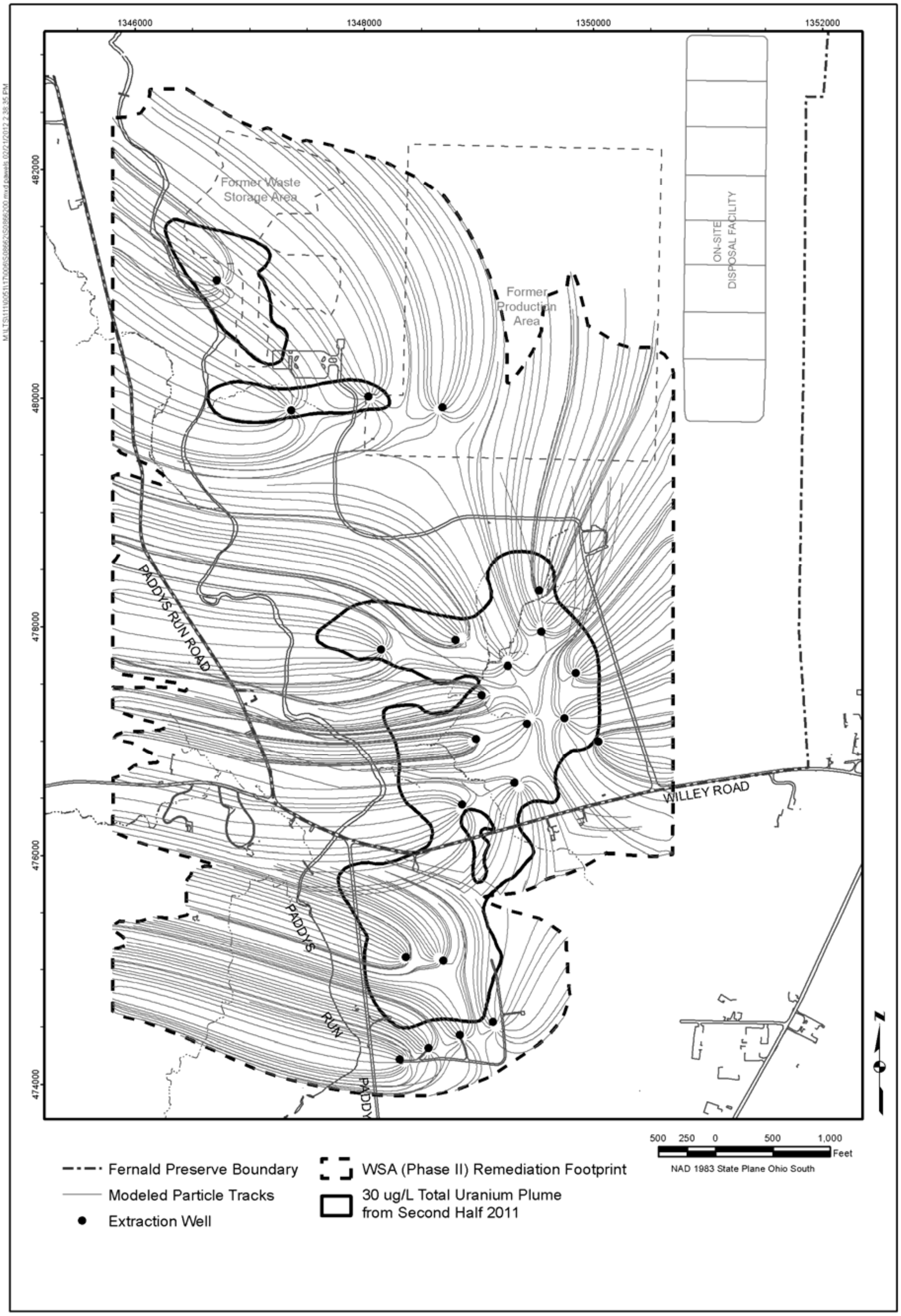



*Figure A.3−5. WSA (Phase II) Design Remediation Footprint*

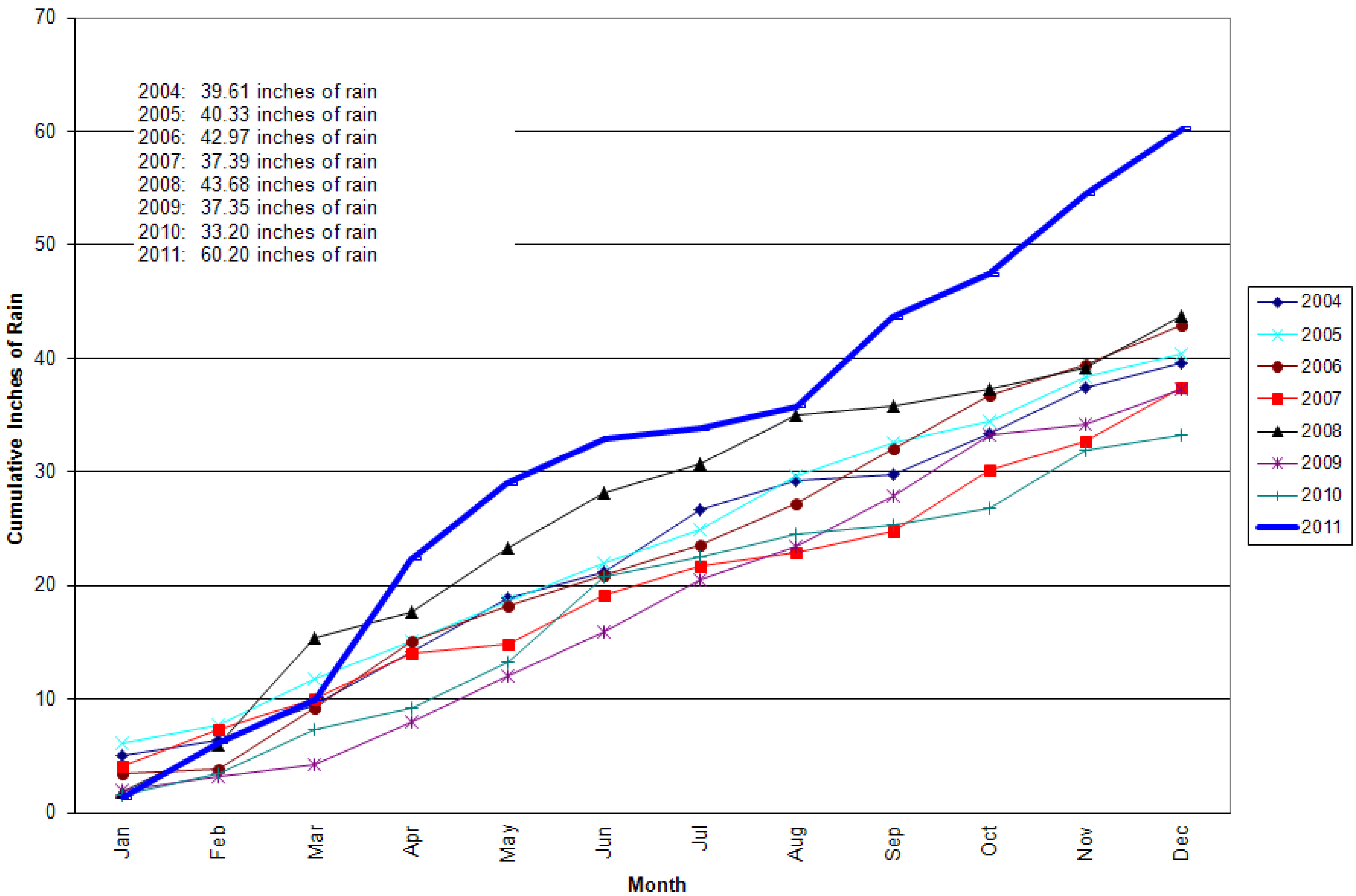



*Figure A.3−6. Cumulative Annual Precipitation: 2004 through 2011 as Recorded at the Butler County Regional Airport*

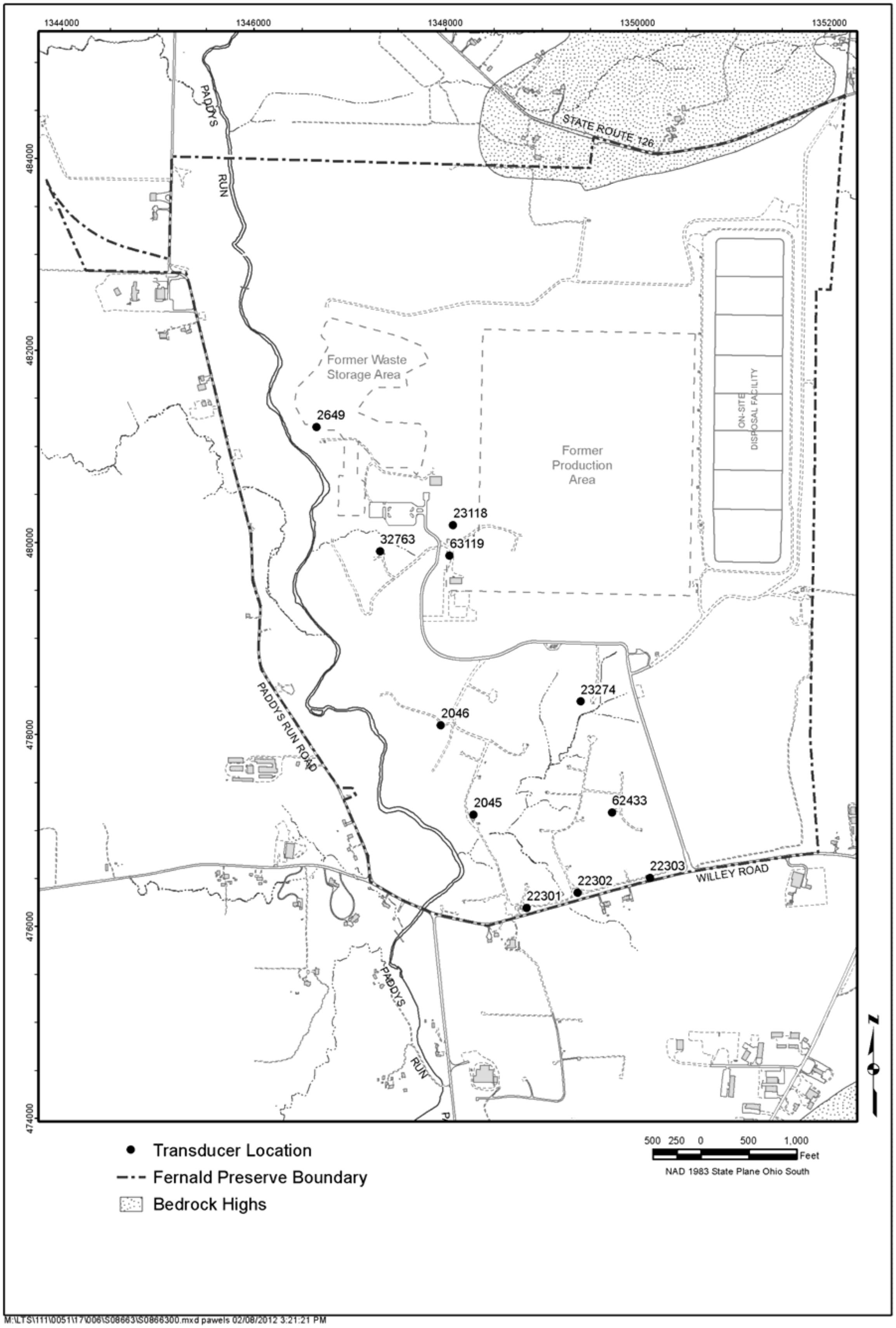



*Figure A.3−7. Transducer Locations for the 2011 Operational Shutdown*

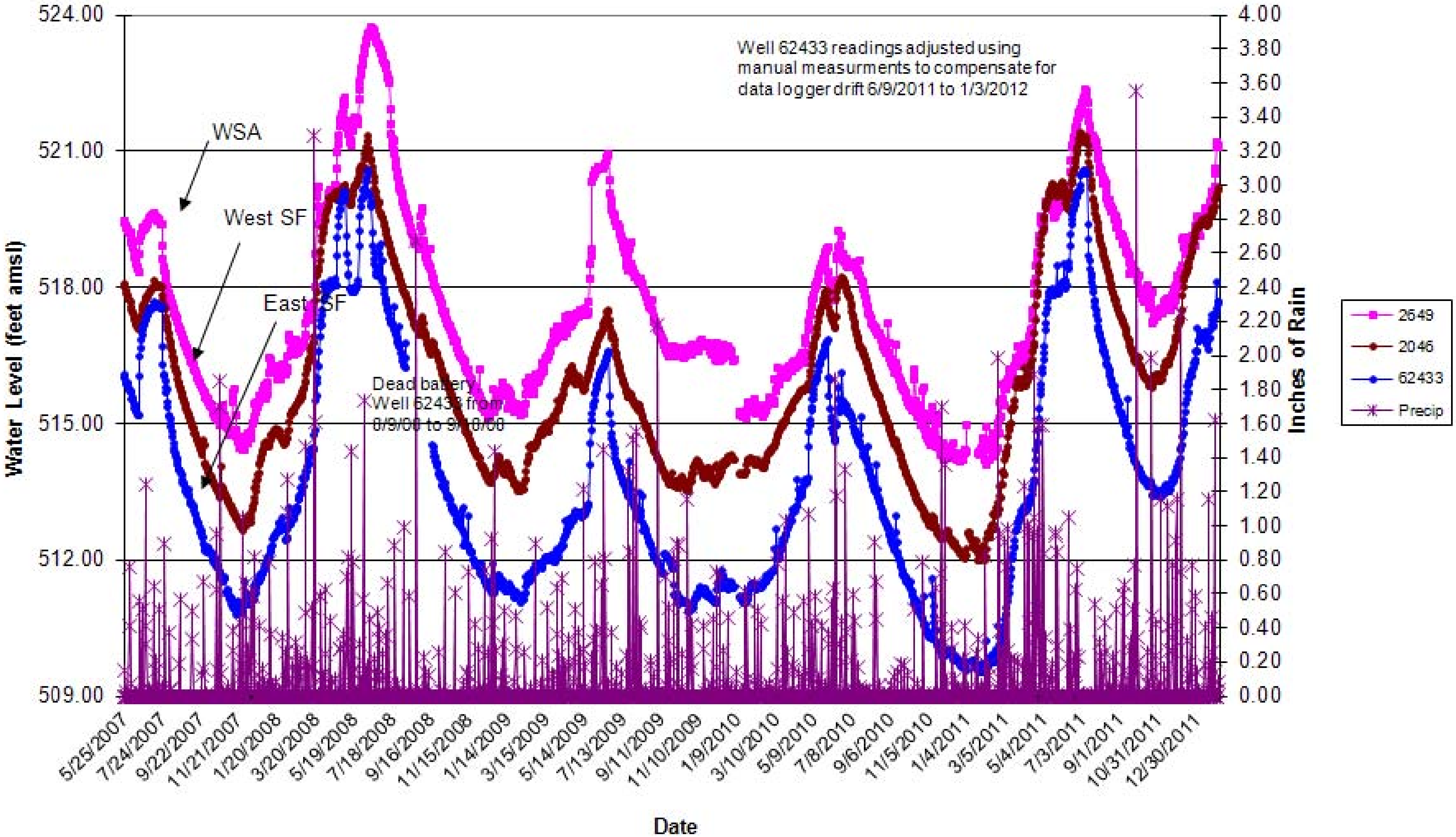



*Figure A.3−8. Water Levels versus Precipitation May 25, 2007, through February 2, 2012*

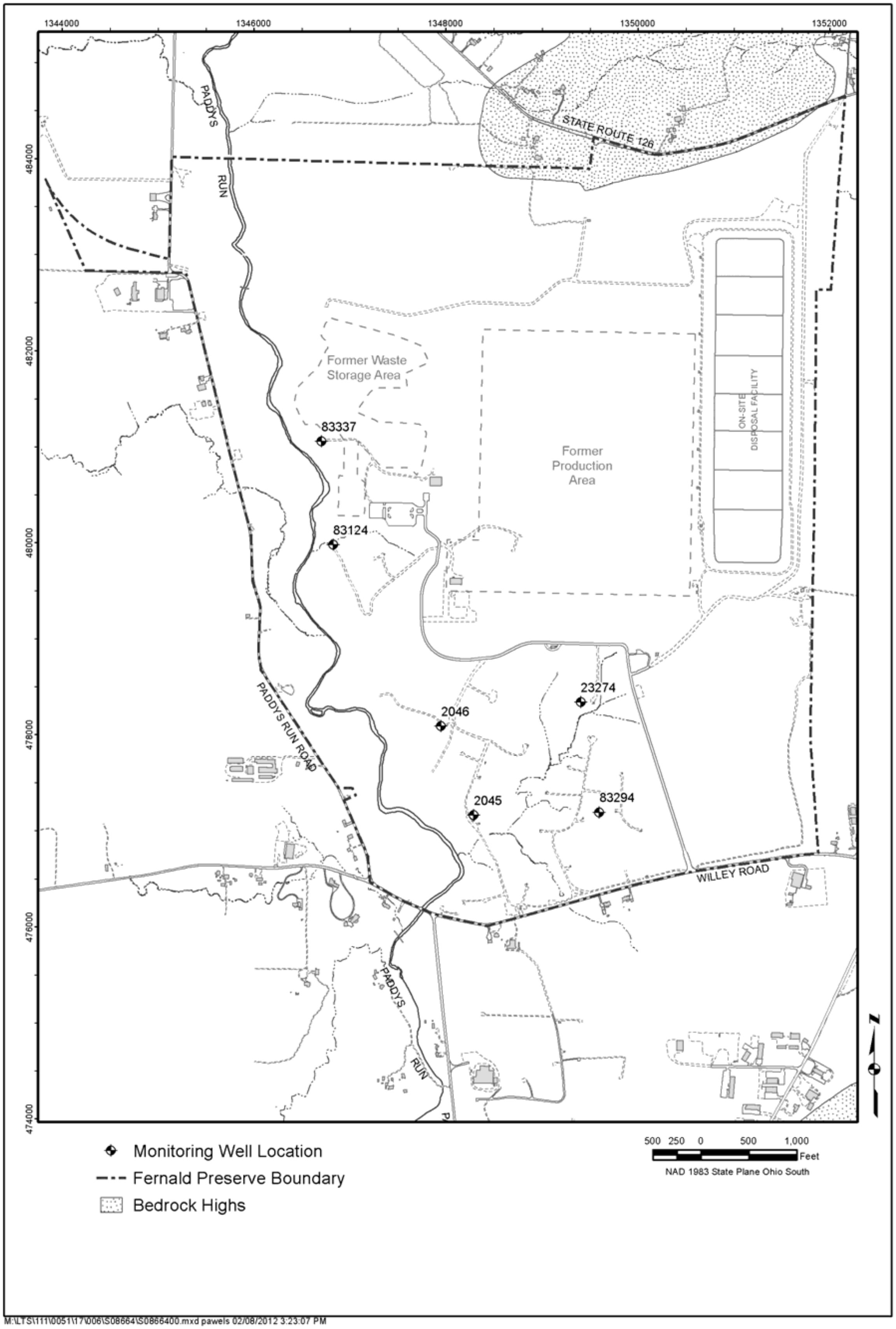



*Figure A.3−9. Monitoring Well Locations for the 2011 Operational Shutdowns*

This page intentionally left blank

**Attachment A.4**

This page intentionally left blank

# A.4.0 Non-Uranium FRL Results

This attachment evaluates non-uranium FRL results for 2011. The purpose of the evaluation is to:

- Identify 2011 non-uranium FRL exceedances (Section A.4.1).
- Determine the persistence of non-uranium FRL exceedances outside the Waste Storage Area (Phase II) design remediation footprint (Section A.4.2).
- Present conclusions (Section A.4.3).

## A.4.1 Non-Uranium FRL Exceedances for 2011

Table A.4−1 shows the summary statistics and trend analysis for the 2011 non-uranium FRL exceedances from monitoring wells both inside and outside the Waste Storage Area (Phase II) design footprint. As indicated in Table A.4−1, eight non-uranium FRL constituents had one or more FRL exceedances during 2011. Figure A.4−1 identifies the location of these FRL exceedances.

Figure A.4−1 shows that the non-uranium FRL exceedances in 2011 for monitoring wells were located in the former Waste Storage Area, along the eastern edge of the site, and in the PRRS area. Those in the former Waste Storage Area were within the Waste Storage Area (Phase II) design remediation footprint. Those along the eastern property boundary and in the PRRS area were located outside the Waste Storage Area (Phase II) design remediation footprint. Specific discussion regarding exceedances and persistence outside the footprint is provided in Section A.4.2.

Table A.4−2 identifies all the locations and constituents that had non-uranium FRL exceedances between 1997 and 2011. The first column in Table A.4−2 lists the groundwater FRL constituents monitored in 2011. The second column identifies the wells monitored that have had an exceedance since 1997 for each constituent. The third column identifies the associated aquifer zone monitored. The fourth column identifies the associated monitoring program for each well/constituent. The remaining columns show monitoring years that reflect a semiannual sampling frequency, although the monitoring was performed quarterly prior to 2003. For the sampling that occurred prior to 2003, a "1" denotes an exceedance for one of the two quarters and a "2" denotes an exceedance for both quarters. Table A.4−2 also indicates whether exceedances occurred inside or outside of the remediation footprint (shading indicates the well is located outside the footprint).

There were 13 non-uranium constituents monitored in 2011; 8 had exceedances. The following table summarizes the 2011 non-uranium monitoring information:

| Constituent | Monitoring Program | 2011 Monitoring Summary |
|---|---|---|
| Antimony | Property/Plume Boundary for PRRS Constituents | Exceedance in the PRRS area |
| Arsenic | Property/Plume Boundary for PRRS Constituents | No exceedances |
| Boron | South Field | No exceedances |
| Carbon Disulfide | Waste Storage Area | No exceedances |
| Fluoride | Property/Plume Boundary | No exceedances |
| Lead | Property/Plume Boundary | Exceedance in the PRRS area |
| Manganese | Property/Plume Boundary, Waste Storage Area | Exceedances in former Waste Storage Area wells and along the eastern site boundary |
| Molybdenum | Waste Storage Area | Exceedances in former Waste Storage Area wells |
| Nickel | Waste Storage Area | No exceedances |
| Nitrate/Nitrite | Waste Storage Area | Exceedances in former Waste Storage Area wells |
| Technetium-99 | Waste Storage Area | Exceedances in former Waste Storage Area wells |
| Trichloroethene | Waste Storage Area | Exceedance in former Waste Storage Area wells |
| Zinc | Property/Plume Boundary | Exceedances along the eastern site boundary and in the PRRS area |

## A.4.2 Evaluation of 2011 Non-Uranium FRL Exceedances Outside the Waste Storage Area (Phase II) Design Remediation Footprint

This section presents an evaluation of the persistence of non-uranium FRL exceedances outside the Waste Storage Area (Phase II) design remediation footprint.

### A.4.2.1 Background

The *Restoration Area Verification Sampling Program Summary Report* (DOE 1998) states that any FRL exceedance detected at the property boundary during routine monitoring outside the 10-year uranium-based restoration footprint (DOE 1997a) would also be evaluated for persistence. The evaluation would be performed using the same conservative data evaluation method approved in the *Restoration Area Verification Sampling Program Project-Specific Plan* (DOE 1997b) to determine if a change in the aquifer restoration remedy is required. This evaluation was expanded beginning with the *2000 Site Environmental Report* (DOE 2001b) to include all non-uranium FRL exceedances detected outside of the 10-year uranium-based restoration footprint, not just those detected at the property boundary. In the *2003 Site Environmental Report* (DOE 2004b), the 10-year uranium-based restoration footprint was replaced with a 10-year time-of-travel remediation footprint based on 2003 target pumping rates and using the VAM 3D Zoom Groundwater Model. The footprint was updated in 2005 to reflect capture during the time period modeled for the Waste Storage Area (Phase II) remediation design. The footprint is shown in Figure A.4–1.

Analytical data from samples collected immediately following an FRL exceedance are evaluated to determine if the exceedance is persistent. In accordance with the approved Restoration Area

Verification Sampling method, if two or more consecutive sampling events following an FRL exceedance indicate that the concentration has decreased below the groundwater FRL, then the exceedance is not considered persistent. If an FRL exceedance outside the Waste Storage Area (Phase II) design remediation footprint is determined to not be persistent, then no additional action is required beyond the routine groundwater monitoring specified in the current IEMP. If an FRL exceedance is determined to be persistent, then the cause of the persistent exceedance will be identified and its effect on the aquifer remedy design assessed. Ultimately, the cause needs to be addressed either through a modification of the aquifer remedy or by other means.

#### A.4.2.2 Evaluation and Discussion

Ten possible persistent FRL exceedances were identified in 2010 requiring additional data to be collected through routine monitoring in 2011. The exceedances were for antimony in wells 22198 and 2636, arsenic in well 2636, lead in well 22198, manganese in wells 22201, and 22205, and zinc in monitoring wells 2625, 2636, 22198, and 22204. The non-uranium FRL exceedances for 2011 along with the possible persistent exceedances identified in 2010 are addressed below.

Figure A.4−1 and the shaded portion of Table A.4−1 identify the 2011 non-uranium FRL exceedances outside the Waste Storage Area (Phase II) design remediation footprint. In 2011, four constituents had one or more FRL exceedance at 9 wells located outside the Waste Storage Area (Phase II) design remediation footprint:

- Antimony at monitoring well 2636.
- Lead at monitoring well 2625.
- Manganese at monitoring wells 22201, 22204, 22212, 22214, 22215, and 22217.
- Zinc at monitoring wells 2625 and 22200.

Table A.4−3 addresses possible persistent FRL exceedances that occur outside the Waste Storage Area (Phase II) design remediation footprint. It includes the exceedances for 2011 listed in the bullets above, as well as those still being evaluated or deemed persistent from 2010. If the results of two or more sampling events immediately following an FRL exceedance indicate that the concentration decreased below the FRL, then the exceedance is identified as not persistent in Table A.4−3. As shown in Table A.4−3, an FRL exceedance for manganese was identified as being persistent in 2011 at monitoring well 22204. The manganese exceedance at monitoring well 22204 has been identified since 2004. The persistent exceedance identified in 2010 at monitoring well 22217 did not have an exceedance in the first half of 2011.

The following is a summary of results presented in Table A.4−3:

- The FRL exceedance recorded for antimony at monitoring well 22198 in 2010 is not persistent. Additional data, to be collected through routine monitoring in 2012, are necessary to determine the persistence of the antimony exceedance at monitoring well 2636.
- The FRL exceedance recorded for arsenic at monitoring well 2636 in 2010 is not persistent.
- The FRL exceedance recorded for lead at monitoring well 22198 in 2010 is not persistent. Additional data, to be collected through routine monitoring in 2012, are necessary to determine the persistence of the lead exceedance at monitoring well 2625.

- The FRL exceedance recorded for manganese at monitoring well 22204 in 2011 is persistent (Figure A.4–7).
- The FRL exceedance recorded for manganese at monitoring well 22205 in 2010 is not persistent. Additional data, to be collected through routine monitoring in 2012, are necessary to determine the persistence of the manganese exceedances at monitoring wells 22201, 22212, 22214, 22215, and 22217.
- The FRL exceedances recorded for zinc in monitoring wells 2636, 22198, and 22204 in 2010 are not persistent. Additional data, to be collected through routine monitoring in 2012, are necessary to determine the persistence of the zinc exceedances at monitoring well 2625 and 22200.

Figures A.4−2 through A.4−11 present individual graphs of time versus concentration for the wells listed on Table A.4−3 that are identified persistent or requiring additional data. Quarterly sampling results from OSDF monitoring activities are included in the evaluation of property boundary wells. Therefore, some wells were sampled more than semi-annually as reflected in Table A.4–3 and Figures A.4–2 through A.4–11.

The evaluation for persistence of non-uranium FRL exceedances in wells located outside the Waste Storage Area (Phase II) design remediation footprint in 2011 marks 15 years that an evaluation has been conducted as part of the IEMP. In the past, many exceedances identified as persistent became nonpersistent in later years. To date, the only persistent exceedance outside the remediation footprint appears to be isolated to monitoring well 22204 (manganese).

Manganese was a process chemical used in the former production area. The manganese groundwater FRL is 0.900 milligram per liter (mg/L) and is based on background values in the aquifer. Additional manganese data were collected from the GMA near the OSDF in 2008. Results were reported in the Fernald Preserve Site Environmental Report for 2008 (DOE 2009b). The purpose for collecting the additional data was to determine if manganese exceedances in the GMA near the OSDF indicate the presence of a localized plume. The additional data collected in 2008 indicated that the manganese exceedances were likely a background issue. Unconsolidated glacial fluvial aquifers in Ohio have relatively high manganese concentrations. Manganese is an impurity in shale, which is a major component of bedrock in the area. The background value upon which the groundwater FRL is based may not be representative of actual natural aquifer conditions. In past reports, biofouling has also been discussed as a possibility for the persistent manganese exceedance that was only seen at one monitoring well.

At this time, no change to the aquifer remedy is planned to address the persistent manganese exceedance at monitoring well 22204.

### A.4.3 Conclusions

From the information provided in this attachment, the following conclusions can be made:

- Non-uranium FRL exceedances occurring in the former Waste Storage Area were taken into consideration for the Waste Storage Area (Phase II) Remediation Module Design.
- One persistent non-uranium FRL exceedance outside the Waste Storage Area (Phase II) design footprint was identified in 2011: manganese at monitoring well 22204. The exceedance is most likely a background definition issue. A change in the design of the aquifer remedy to address the exceedance is not being considered at this time.
- Additional data are needed to verify whether the antimony, arsenic, lead, manganese, and zinc exceedances detected in 2011 outside the Waste Storage Area (Phase II) design footprint (identified in Table A.4−3) are persistent.

*Table A.4–1. Summary Statistics and Trend Analysis for Non-Uranium Constituents with 2011 Results Above FRLs*

| Constituent (FRL)[a] | Monitoring Well | No. of Samples[b,c,d] | No. of Samples Above FRL[b,c,d] | No. of Samples Above FRL for 2010[c,d] | Minimum[b,c,d,e,f] | Maximum[b,c,d,e,f] | Average[b,c,d,e,f] | Standard Deviation[b,c,d,e,f] | Trend[b,c,d,e,f,g] |
|---|---|---|---|---|---|---|---|---|---|
| Antimony | | | | | (mg/L) | (mg/L) | (mg/L) | (mg/L) | |
| (0.006 mg/L) | 2636 | 8 | 5 | 1 | 0.0015 | 0.00741 | 0.00488 | 0.00269 | No Significant Trend |
| Lead (0.015 mg/L) | 2625 | 9 | 1 | 1 | 0.00015 | 0.0154 | 0.00361 | 0.00474 | Up |
| Manganese (0.90 mg/L) | 2010 | 20 | 16 | 2 | 0.525 | 6.14 | 2.24 | 1.77 | No Significant Trend |
| | 22201 | 13 | 6 | 2 | 0.0322 | 2.06 | 0.93 | 0.74 | No Significant Trend |
| | 22204 | 29 | 24 | 4 | 0.418 | 3.01 | 1.32 | 0.51 | No Significant Trend |
| | 22212 | 11 | 1 | 1 | 0.219 | 1.23 | 0.43 | 0.30 | No Significant Trend |
| | 22214 | 25 | 1 | 1 | 0.244 | 0.972 | 0.42 | 0.17 | No Significant Trend |
| | 22215 | 11 | 2 | 2 | 0.240 | 1.94 | 0.56 | 0.59 | Up |
| | 22217 | 11 | 5 | 1 | 0.537 | 1.57 | 0.98 | 0.35 | No Significant Trend |
| | 3821 | 24 | 19 | 2 | 0.145 | 11.4 | 2.66 | 2.49 | No Significant Trend |
| | 83339_C3 | 10 | 2 | 1 | 0.00289 | 1.29 | 0.41 | 0.48 | No Significant Trend |
| | 83341_C2 | 10 | 3 | 1 | 0.127 | 2.16 | 0.65 | 0.71 | Down |
| Molybdenum (0.10 mg/L) | 2649 | 22 | 22 | 2 | 0.178 | 0.794 | 0.47 | 0.16 | No Significant Trend |
| Nitrate + Nitrite as N (11 mg/L)[h] | 2649 | 30 | 24 | 1 | 0.805 | 102 | 43.4 | 28.2 | No Significant Trend |
| | 2821 | 32 | 15 | 2 | 1.38 | 120 | 26.7 | 32.6 | Up |
| | 3821 | 32 | 9 | 2 | 0.010 | 171 | 20.1 | 39.8 | Up |
| | 83338_C1 | 8 | 3 | 2 | 0.404 | 73.8 | 22.7 | 29.0 | Up |
| | 83338_C2 | 11 | 5 | 1 | 1.98 | 109 | 28.1 | 33.0 | Up |
| | 83338_C3 | 11 | 7 | 2 | 2.42 | 105 | 34.8 | 34.3 | No Significant Trend |
| | 83340_C1 | 7 | 7 | 2 | 11.3 | 58.2 | 36.3 | 17.1 | Down |
| | 83340_C2 | 10 | 10 | 2 | 12.5 | 86.7 | 51.8 | 29.2 | No Significant Trend |
| | 83340_C3 | 10 | 10 | 2 | 11.6 | 133 | 61.7 | 42.9 | Down |

*Table A.4–1 (continued). Summary Statistics and Trend Analysis for Non-Uranium Constituents with 2011 Results Above FRLs*

| Constituent (FRL)[a] | Monitoring Well | No. of Samples[b,c,d] | No. of Samples Above FRL[b,c,d] | No. of Samples Above FRL for 2010[c,d] | Minimum[b,c,d,e,f,] | Maximum[b,c,d,e,f] | Average[b,c,d,e,f] | Standard Deviation[b,c,d,e,f] | Trend[b,c,d,e,f,g] |
|---|---|---|---|---|---|---|---|---|---|
| Zinc (0.021 mg/L) | | | | | (mg/L) | (mg/L) | (mg/L) | (mg/L) | |
| | 22200 | 11 | 2 | 1 | 0.00165 | 0.0377 | 0.016 | 0.011 | No Significant Trend |
| | 2625 | 8 | 4 | 2 | 0.00325 | 0.0751 | 0.024 | 0.025 | Up |
| Technetium-99 | | | | | (pCi/L) | (pCi/L) | (pCi/L) | (pCi/L) | |
| (94 pCi/L) | 2649 | 30 | 30 | 2 | 101 | 1660 | 654 | 463 | No Significant Trend |
| | 2821 | 32 | 19 | 1 | 0.253 | 651 | 163 | 166 | Up |
| | 83338_C1 | 8 | 3 | 2 | 10.1 | 181 | 69 | 73 | Up |
| | 83338_C2 | 11 | 6 | 2 | 7.12 | 587 | 168 | 173 | No Significant Trend |
| | 83338_C3 | 11 | 6 | 1 | 0.059 | 313 | 130 | 115 | Up |
| | 83340_C1 | 7 | 7 | 2 | 186 | 817 | 349 | 223 | No Significant Trend |
| | 83340_C3 | 10 | 7 | 1 | 66.1 | 428 | 187 | 121 | Down |
| | | | | | (µg/L) | (µg/L) | (µg/L) | (µg/L) | |
| Trichloroethene | 2649 | 22 | 17 | 2 | 0.125 | 120 | 42.9 | 34.7 | Down |
| (5.0 µg/L) | 2821 | 24 | 9 | 2 | 0.125 | 11.5 | 3.97 | 4.21 | Up |

Note: Shading indicates well is outside the Waste Storage Area (Phase-II) design remediation footprint.

[a]From *Record of Decision for Remedial Actions at Operable Unit 5* (DOE 1996), Table 9-4.
[b]Based on samples from August 1997 through 2011.
[c]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation) and Mann-Kendall test for trend.
[d]Rejected data qualified with either an R were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[e]If the number of samples is greater than or equal to four, then the Mann-Kendall test for trend and all of the summary statistics are reported. If the total number of samples is equal to three, then the minimum, maximum, and average are reported. If the total number of samples is equal to two, then the minimum and maximum are reported. If the total number of samples is equal to one, then the data point is reported as the minimum.
[f]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[g]Mann-Kendall test for trend is performed using data from third quarter 1998 through 2011.
[h]FRL based upon nitrate from *Record of Decision for Remedial Actions at Operable Unit 5* (DOE 1996), Table 9–4.

*Table A.4−2. Groundwater FRL Exceedances From 1997 Through 2011 Quarterly/Semiannually*

| Constituent | Well[a] | Aquifer Zone | Project[b] | 1997 | 1998 | | 1999 | | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | | 2011 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2[c] | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| **Antimony** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 22198 | 0 | OSDF | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | |
| | 22199 | 0 | OSDF | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| | 22204 | 0 | OSDF | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| | 22205 | 0 | OSDF | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| | 22208 | 0 | OSDF | | | | | | | | | | | | | 1 | | | | | | | | | | | | 1 | | | | |
| | 2398 | 2 | P/PB | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| | 2431 | 0 | P/PB | | | | | | | | | | | | | 1 | | | | | | | | | | | | 1 | | | | |
| | 2432 | 0 | P/PB | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | |
| | 2636 | 4 | PRRS | | | | | | | | | | | | | | 1 | | 1 | | | | 1 | | | | | | 1 | | | 1 |
| | 2733 | 0 | P/PB | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| | 3070 | 2 | P/PB | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | |
| | 31217 | 0 | P/PB | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| | 3398 | 2 | P/PB | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| | 3424 | 0 | P/PB | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | |
| | 3426 | 0 | P/PB | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| | 3431 | 0 | P/PB | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| | 3432 | 0 | P/PB | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | |
| | 4398 | 2 | P/PB | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | | |
| **Arsenic** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2625 | 4 | PRRS | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | 2636 | 4 | PRRS | 1 | 1 | | 2 | | | | | | 1 | | | | 1 | | | | | | | | | | | | 1 | | | |
| | 2898 | 4 | PRRS | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | 2900 | 4 | PRRS | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| **Boron** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2045 | 2 | SF | | | | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | 2049 | 2 | SF | 2 | | 2 | 2 | 2 | 2 | 1 | | | | 1 | | | | | | | | | | | | | | | | | | |
| **Carbon disulfide** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2649 | 1 | WSA | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 3821 | 1 | WSA | | | | | 1 | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| **Fluoride** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2431 | 0 | P/PB | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |

*Table A.4−2 (continued). Groundwater FRL Exceedances From 1997 Through 2011 Quarterly/Semiannually*

| Constituent | Well[a] | Aquifer Zone | Project[b] | 1997 | 1998 | | 1999 | | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | | 2011 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2[c] | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| **Lead** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 22198 | 0 | P/PB | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| | 2431 | 0 | PRRS | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | 3733 | 0 | P/PB | 1 | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 |
| **Manganese** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2010 | 1 | WSA | | | | | | | 1 | | 1 | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | | |
| | 22198 | 0 | OSDF | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | 1 | 1 |
| | 22201 | 0 | OSDF | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | |
| | 22204 | 0 | OSDF | | | | | | | | | | | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | |
| | 22205 | 0 | OSDF | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | 1 | 2 | 2 |
| | 22217 | 3 | OSDF | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | 2 | | |
| | 2431 | 0 | P/PB | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| | 2432 | 0 | P/PB | | | | | | | 1 | | 2 | 1 | | 1 | | | | | | | | | | | | | | | | | 1 |
| | 2648 | 1 | WSA | 1 | | 1 | | 1 | 1 | | 1 | | 1 | | | | | 1 | 1 | | 1 | | | | | | | | | | 1 | 1 |
| | 2898 | 4 | PRRS | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | 1 |
| | 2899 | 4 | PRRS | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | 2900 | 4 | PRRS | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | 3093 | 4 | P/PB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 3821 | 1 | WSA | | | | | 1 | 1 | | 1 | | 1 | | 1 | 1 | 1 | | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| | 83337_C1 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | |
| | 83337_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | |
| | 83337_C3 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | | | |
| | 83338_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | 1 | | | | 1 | 1 |
| | 83339_C1 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | | 1 | 1 | | | | | | |
| | 83339_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | |
| | 83339_C3 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| | 83341_C1 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | | 1 | 1 | | | | | | |
| | 83341_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | | |
| | 83346_C1 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | | 1 | 1 | 1 | | | | | |
| | 83346_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | 1 | | 1 | 1 | | | | | |
| **Molybdenum** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2649 | 1 | WSA | 1 | | 1 | | 1 | 1 | | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

*Table A.4−2 (continued). Groundwater FRL Exceedances From 1997 Through 2011 Quarterly/Semiannually*

| Constituent | Well[a] | Aquifer Zone | Project[b] | 1997 | 1998 | | 1999 | | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | | 2011 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2[c] | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| **Nickel** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 22198 | 0 | OSDF | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2398 | 2 | P/PB | 1 | 2 | 2 | | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | 4398 | 2 | P/PB | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | 83346_C1 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | |
| | 83346_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | |
| **Nitrate/Nitrite** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2648 | 1 | WSA | | 1 | | | 1 | 1 | | 1 | | | | | 1 | 1 | 1 | | | 1 | | | | | | | | | | | |
| | 2649 | 1 | WSA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | | 1 | 1 | | | | | 1 | |
| | 2821 | 1 | WSA | | | | | 1 | | | | | | | 1 | | | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 3821 | 1 | WSA | | | | | | | 1 | | 1 | | | | | | | | 1 | | | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| | 83338_C1 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | 1 |
| | 83338_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 | 1 | 1 | 1 | |
| | 83338_C3 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 |
| | 83340_C1 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | | 1 | 1 | 1 | | 1 | | 1 | 1 |
| | 83340_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 83340_C3 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 83341_C1 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | |
| | 83341_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | |
| | 83341_C3 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | | | | | | |
| **Technetium-99** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2648 | 1 | WSA | | | | | 1 | | | 2 | | | | 1 | | | | | | | | | | | | | | | | | |
| | 2649 | 1 | WSA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 2821 | 1 | WSA | | | | | 1 | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 83338_C1 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | 1 |
| | 83338_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 | 1 | 1 | 1 | 1 |
| | 83338_C3 | 1 | WSA | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | 1 | 1 | 1 | 1 | |
| | 83340_C1 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | | 1 | 1 | 1 | | 1 | | 1 | 1 |
| | 83340_C2 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | |
| | 83340_C3 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | 1 |
| **Trichloroethene** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2649 | 1 | WSA | | | 1 | | 1 | 1 | | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | 1 | 1 | | | | 1 | 1 |
| | 2821 | 1 | WSA | | | | | | | | | | | | | | | | | | | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

*Table A.4−2 (continued). Groundwater FRL Exceedances From 1997 Through 2011 Quarterly/Semiannually*

| Constituent | Well[a] | Aquifer Zone | Project[b] | 1997 | 1998 | | 1999 | | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | | 2011 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2[c] | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| **Zinc** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 22198 | 0 | OSDF | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| | 22199 | 0 | OSDF | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | |
| | 22200 | 0 | OSDF | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | |
| | 22204 | 0 | OSDF | | | | | | | | | | | | 1 | | | | | | | | | | 1 | | | | 1 | | | |
| | 22210 | 0 | OSDF | | | | | | | | | | | | | | | | 1 | | 1 | | | | | | 1 | | | | | |
| | 22213 | 3 | OSDF | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | |
| | 2398 | 2 | P/PB | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2431 | 0 | P/PB | | | 2 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | 2432 | 0 | P/PB | | | | 1 | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | 2625 | 0 | PRRS | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | 1 | 1 |
| | 2636 | 0 | PRRS | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | |
| | 2733 | 0 | P/PB | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2900 | 4 | PRRS | | | | | | | 1 | | | | | | | 1 | | | | | | | 1 | | | | | | | | |
| | 3128 | 4 | PRRS | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | |
| | 3426 | 0 | P/PB | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| | 3429 | 0 | P/PB | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 3431 | 0 | P/PB | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| | 3733 | 0 | P/PB | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | |
| | 3899 | 4 | PRRS | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | |

Note: Shading indicates well is outside the Waste Storage Area (Phase-II) design remediation footprint.

[a] From 1997 through 2002, all monitoring was quarterly. Where a “2” is indicated there was a FRL exceedance in each quarter of the semiannual time period. As of 2003, all monitoring is semiannual except as of 2009 OSDF monitoring is quarterly.

[b] WSA = Waste Storage Area

SF = South Field

P/PB = Property/Plume Boundary for FRL exceedances

PRRS = Property/Plume Boundary for Paddys Run Road Site

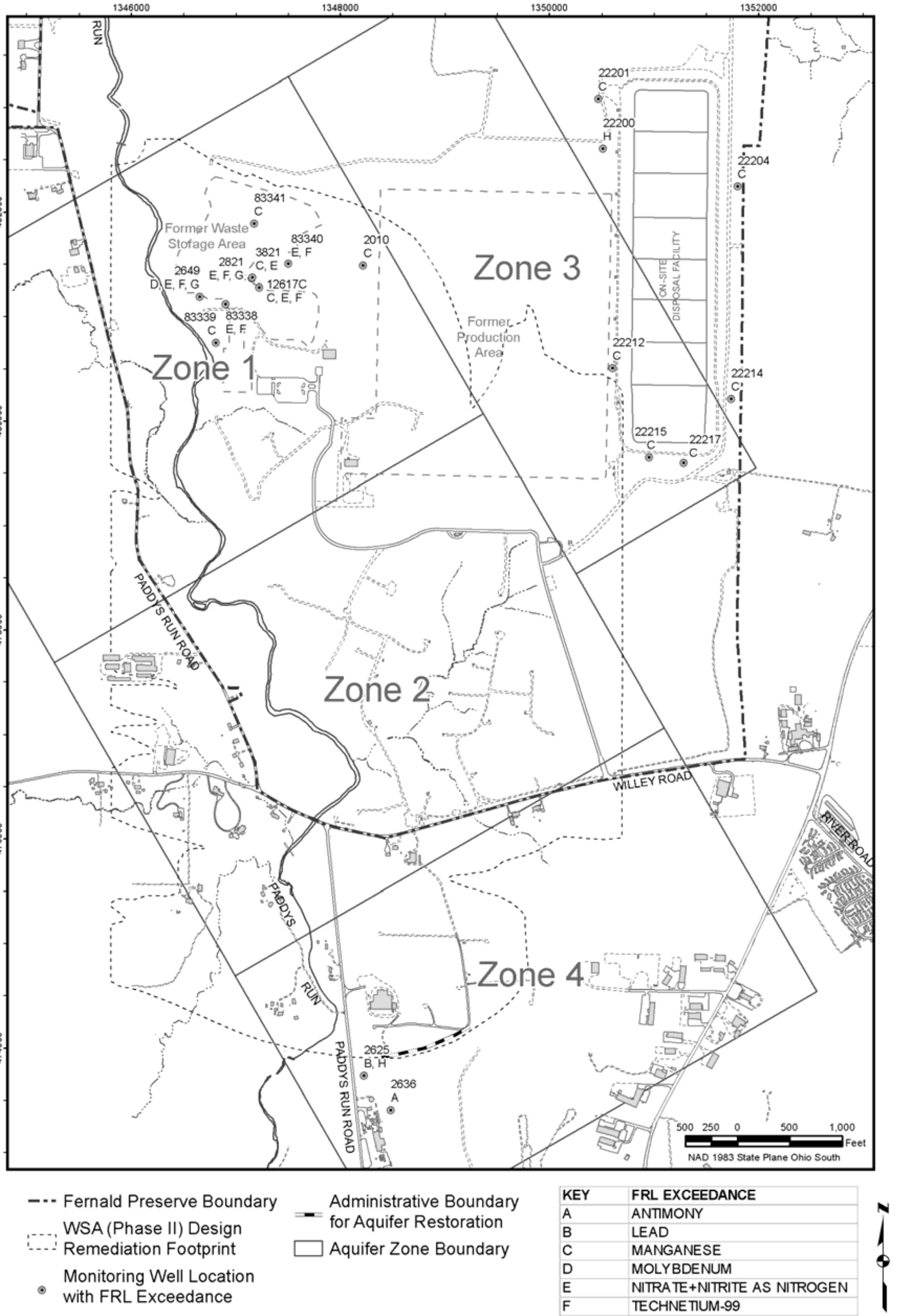
OSDF = Property/Plume Boundary for on-site disposal facility

[c] Sampling for the IEMP was initiated in August 1997.

*Table A.4–3. Summary of Persistence Evaluation of Non-Uranium FRL Exceedances Outside the Waste Storage Area (Phase-II) Design Remediation Footprint*

| Constituent | Monitoring Well | Pertinent 2010 Results[a] | 2011 FRL Exceedance | | Evaluation Results for 2011 | Figure Number[a] |
|---|---|---|---|---|---|---|
| | | | 1st Half of 2011 | 2nd Half of 2011 | | |
| Antimony | 22198 | Additional Routine Data Required | No | No | Not Persistent | NA |
| | 2636 | Additional Routine Data Required | No | Yes | Additional Routine Data Required | A.4–2 |
| Arsenic | 2636 | Additional Routine Data Required | No | No | Not Persistent | NA |
| Lead | 22198 | Additional Routine Data Required | No | No | Not Persistent | NA |
| | 2625 | NA | No | Yes | Additional Routine Data Required | A.4-3 |
| Manganese | 22201 | Additional Routine Data Required | Yes | No | Additional Routine Data Required | A.4–4 |
| | 22204 | **Persistent** | Yes | Yes | **Persistent** | A.4–5 |
| | 22205 | Additional Routine Data Required | No | No | Not Persistent | NA |
| | 22217 | **Persistent** | No | Yes | Additional Routine Data Required | A.4–6 |
| | 22212 | NA | No | Yes | Additional Routine Data Required | A.4–7 |
| | 22214 | NA | No | Yes | Additional Routine Data Required | A.4–8 |
| | 22215 | NA | Yes | Yes | Additional Routine Data Required | A.4–9 |
| Zinc | 2625 | Additional Routine Data Required | Yes | Yes | Additional Routine Data Required | A.4–10 |
| | 2636 | Additional Routine Data Required | No | No | Not Persistent | NA |
| | 22198 | Additional Routine Data Required | No | No | Not Persistent | NA |
| | 22200 | Not Persistent | Yes | No | Additional Routine Data Required | A.4–11 |
| | 22204 | Additional Routine Data Required | No | No | Not Persistent | NA |

[a] NA = not applicable




| KEY | FRL EXCEEDANCE |
|---|---|
| A | ANTIMONY |
| B | LEAD |
| C | MANGANESE |
| D | MOLYBDENUM |
| E | NITRATE+NITRITE AS NITROGEN |
| F | TECHNETIUM-99 |
| G | TRICHLOROETHENE |
| H | ZINC |

M:\LTS\111\0051\17\006\S08665\S0866500.mxd pawels 02/16/2012 2:22:32 PM

*Figure A.4−1. Non-Uranium Constituents with 2011 Results Above FRLs*

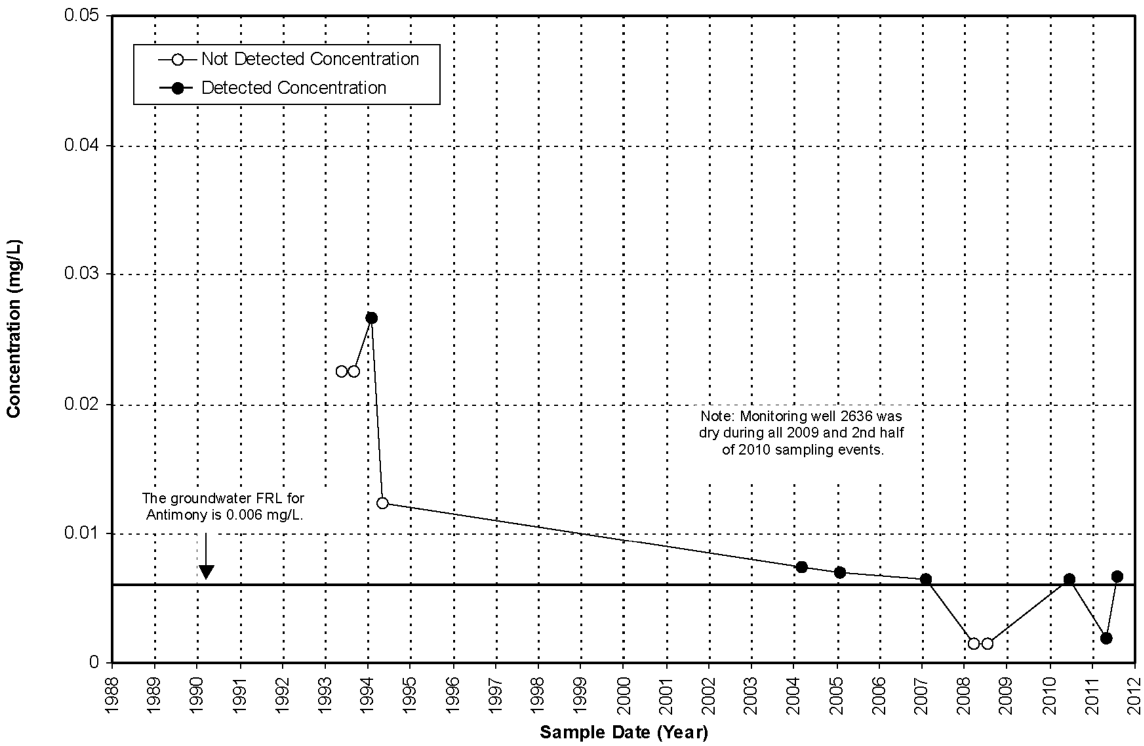



Figure A.4-2. Antimony Concentration vs. Time Plot for Monitoring Well 2636

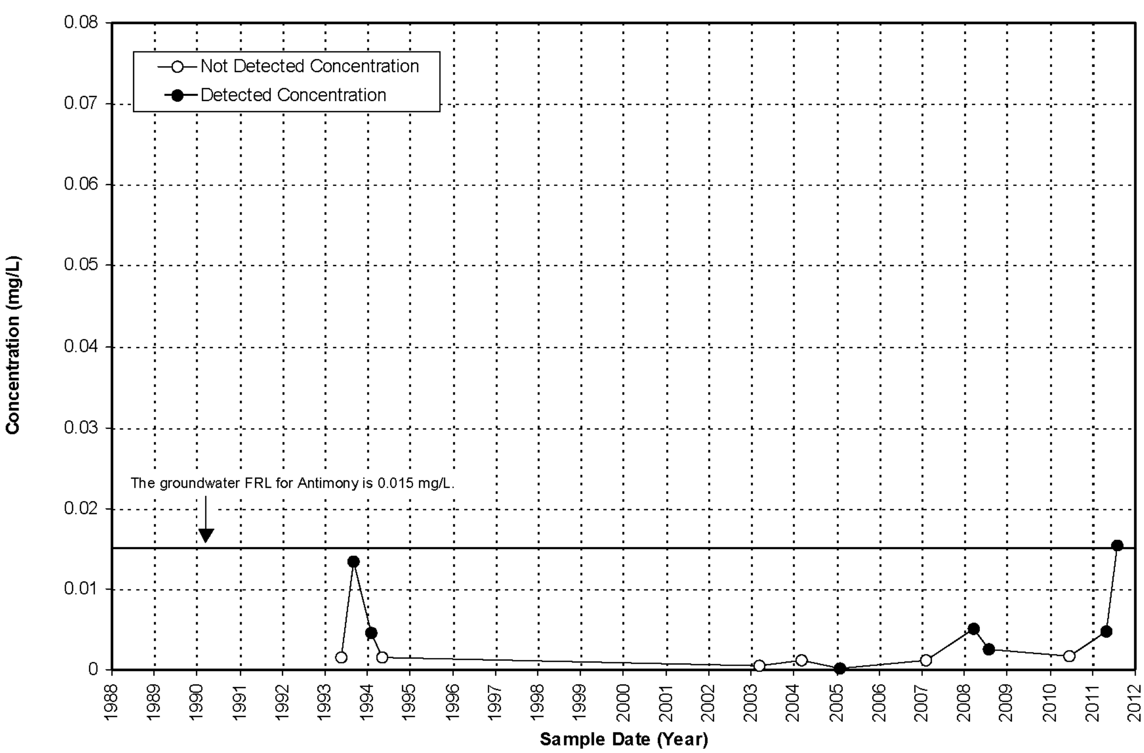



Figure A.4-3. Lead Concentration vs. Time Plot for Monitoring Well 2625

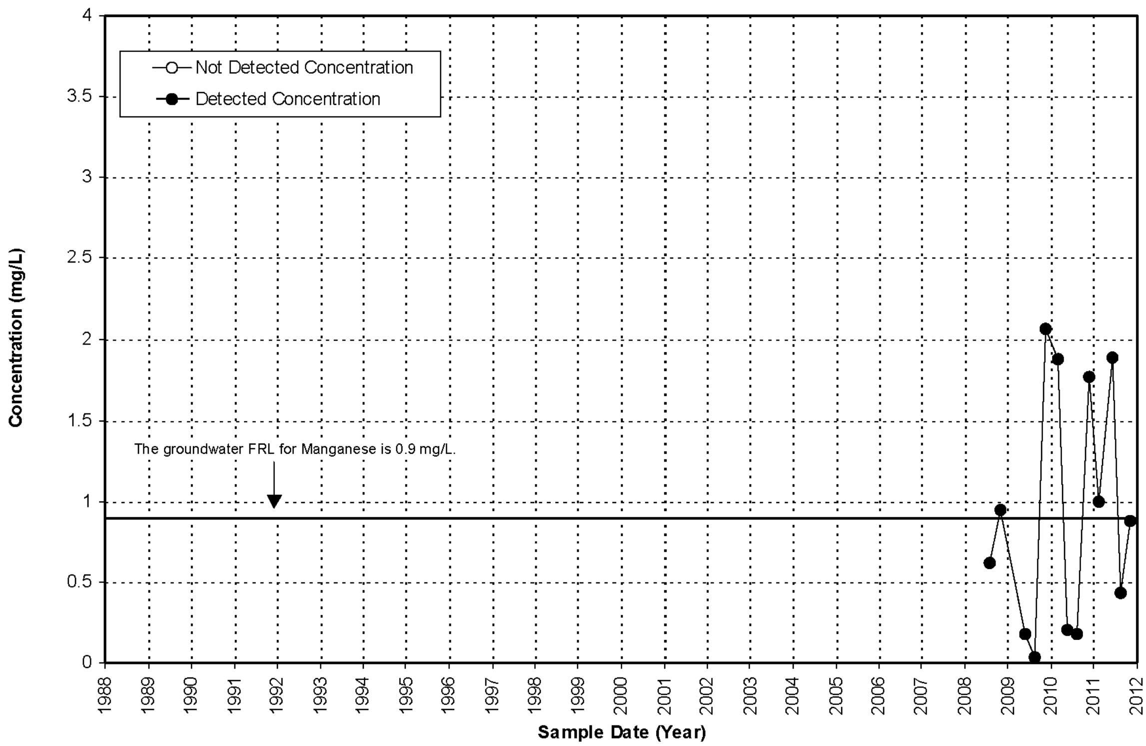



Figure A.4-4. Manganese Concentration vs. Time Plot for Monitoring Well 22201

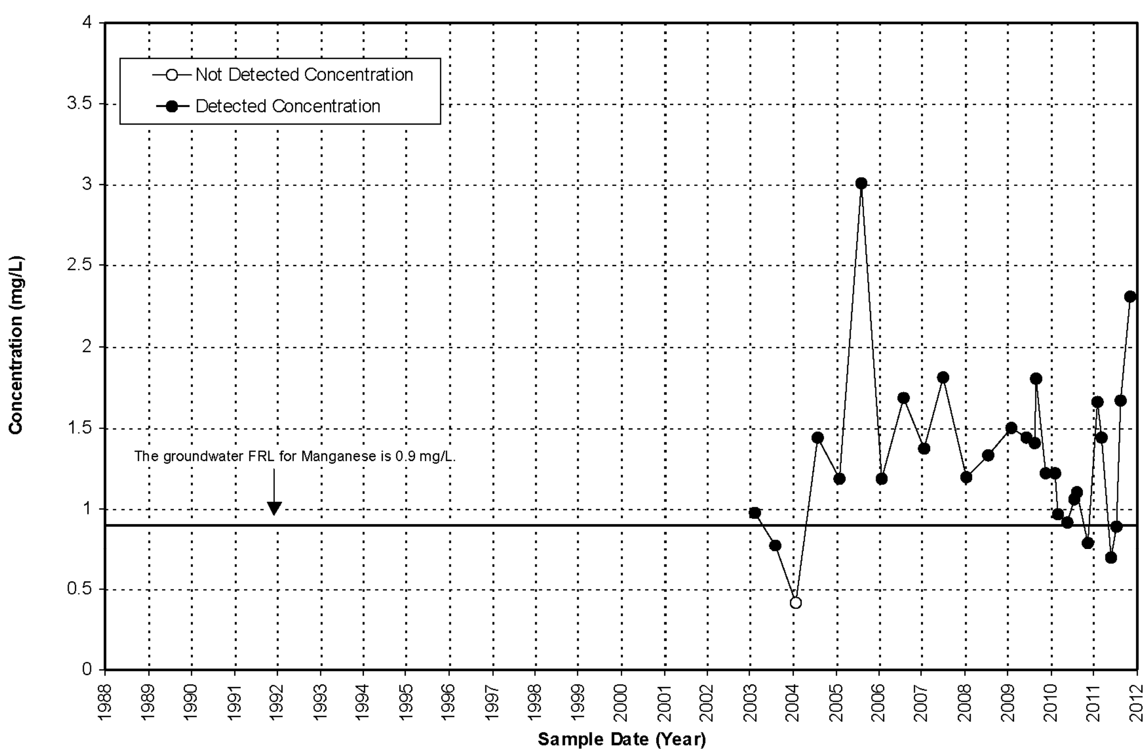



Figure A.4-5. Manganese Concentration vs. Time Plot for Monitoring Well 22204

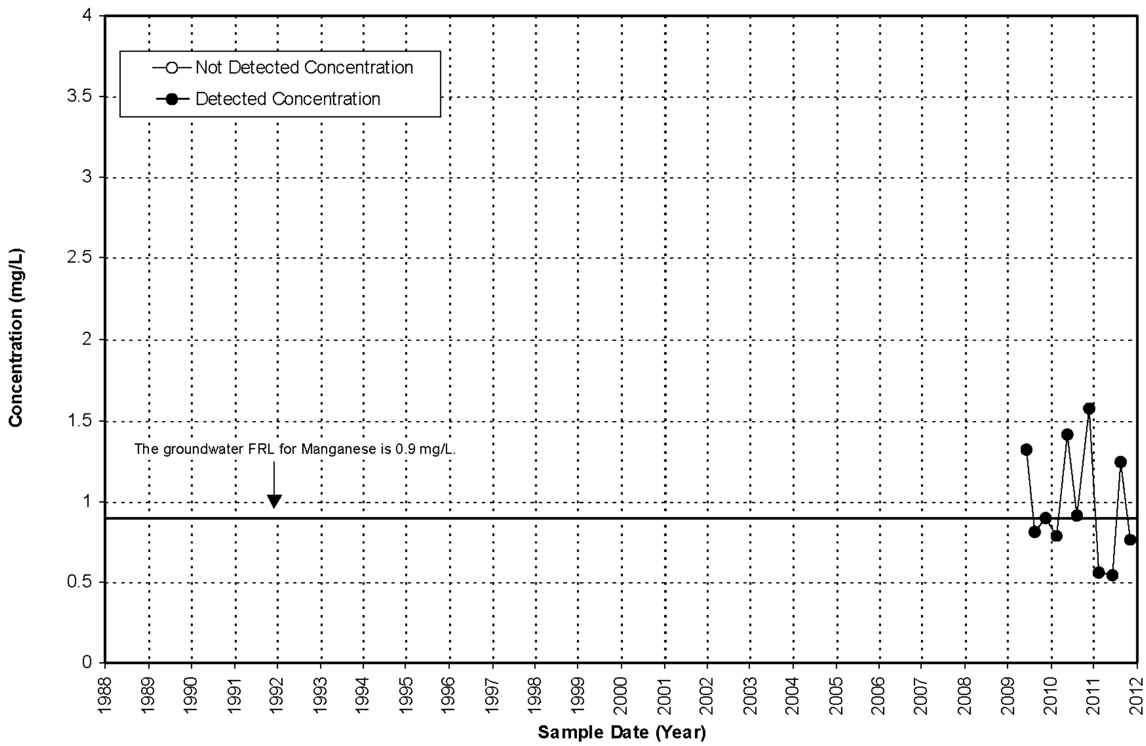



Figure A.4-6. Manganese Concentration vs. Time Plot for Monitoring Well 22217

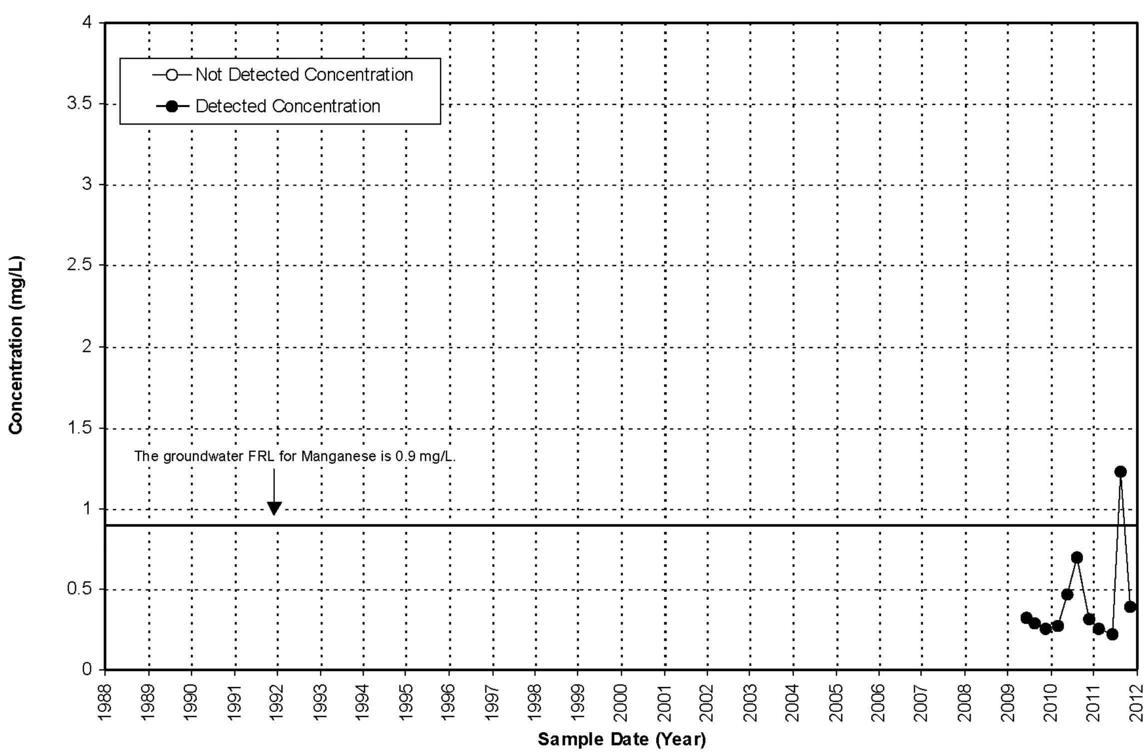



Figure A.4-7. Manganese Concentration vs. Time Plot for Monitoring Well 22212

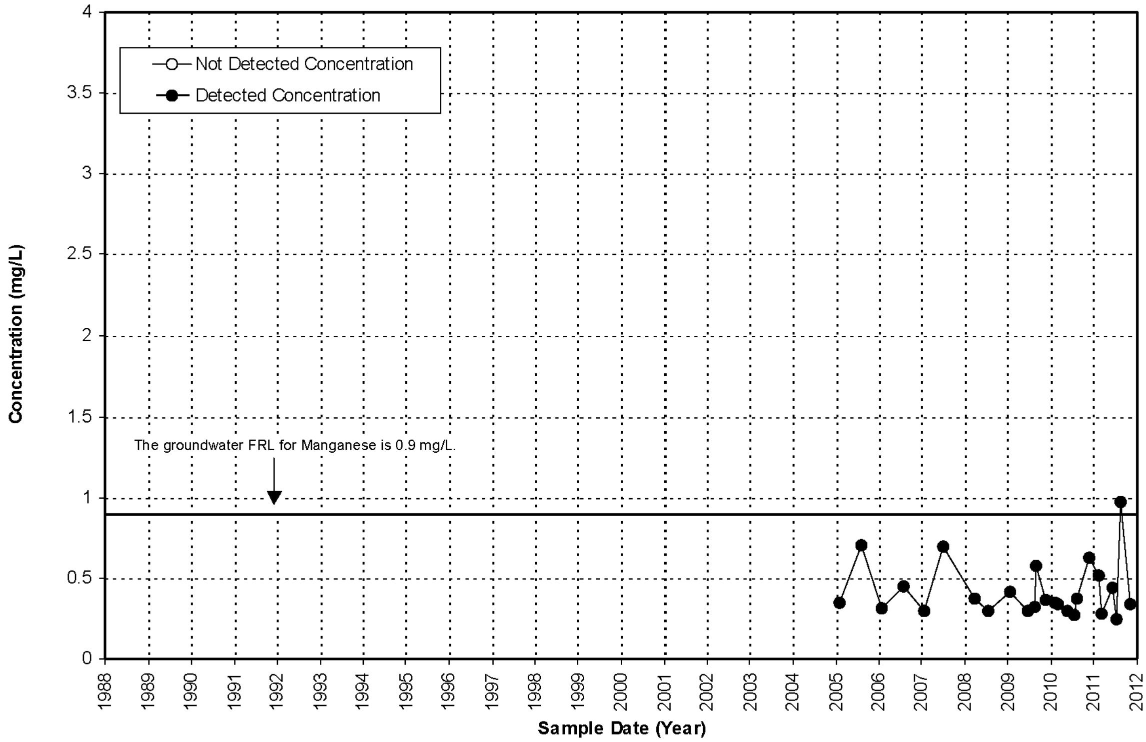



Figure A.4-8. Manganese Concentration vs. Time Plot for Monitoring Well 22214

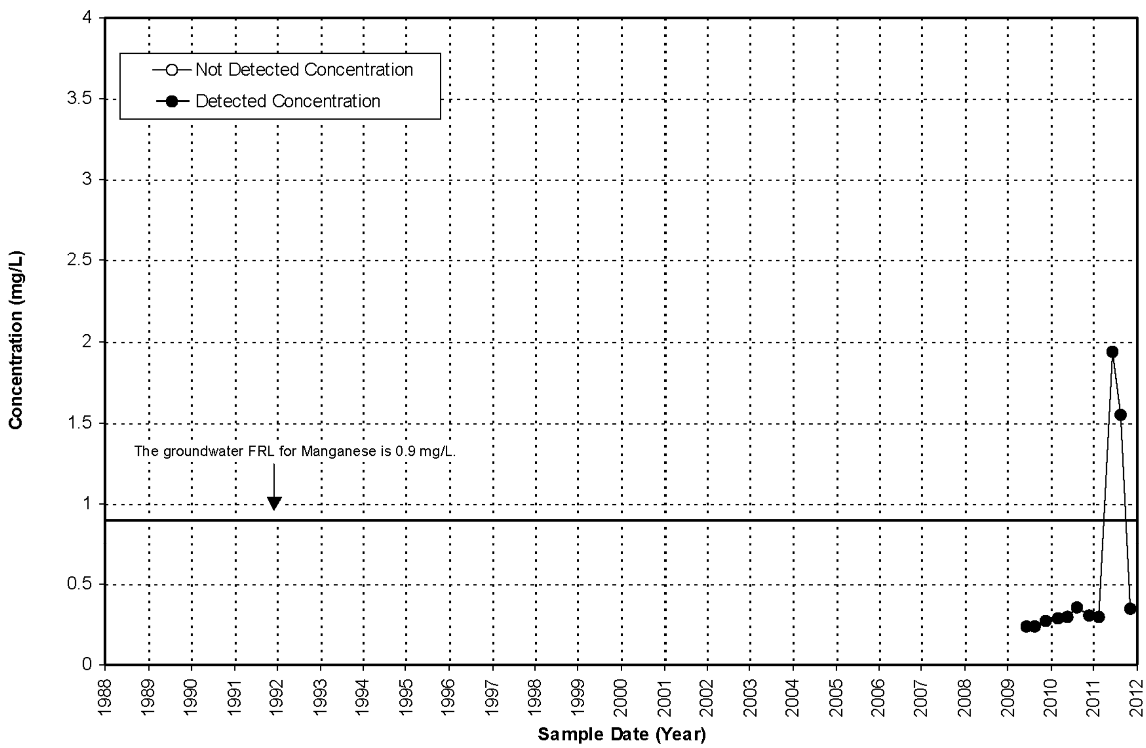



Figure A.4-9. Manganese Concentration vs. Time Plot for Monitoring Well 22215

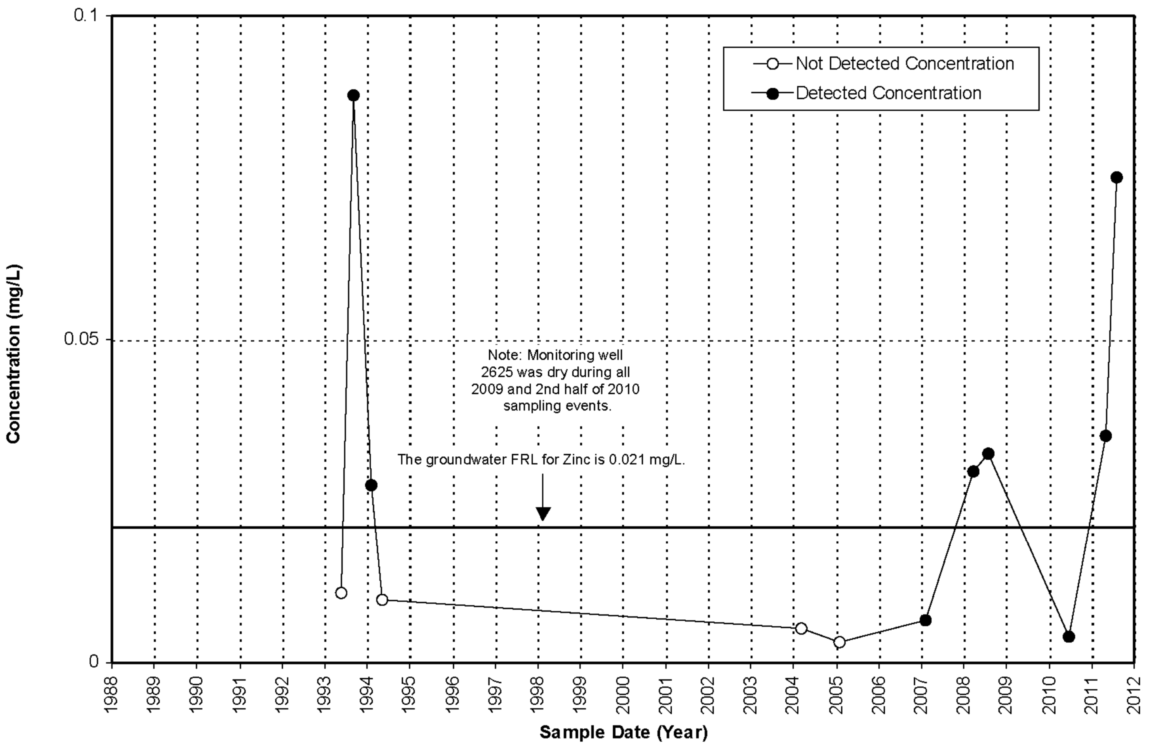



Figure A.4-10. Zinc Concentration vs. Time Plot for Monitoring Well 2625

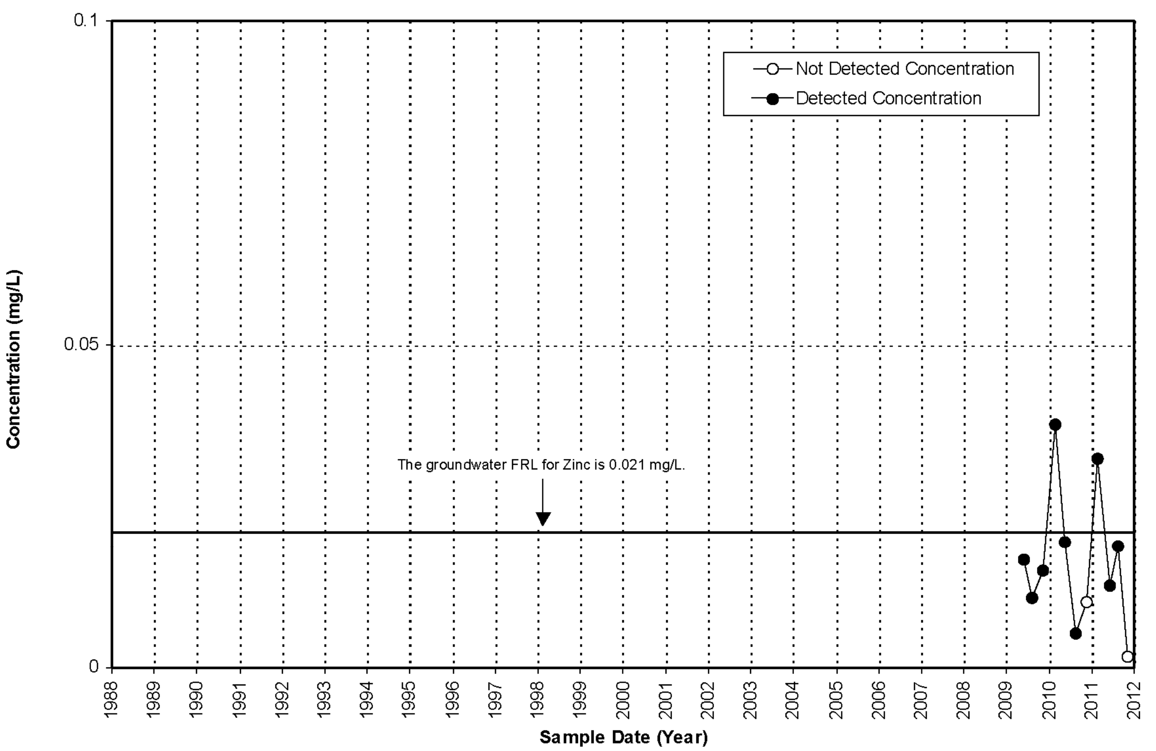



Figure A.4-11. Zinc Concentration vs. Time Plot for Monitoring Well 22200

# Attachment A.5

This page intentionally left blank

# A.5.0 On-Site Disposal Facility Monitoring Results

This attachment provides results for the on-site disposal facility (OSDF) leak detection and leachate monitoring program for 2011. Monitoring and sampling were conducted in accordance with the *Comprehensive Legacy Management and Institutional Controls Plan* (LMICP), Attachment C "Groundwater/Leak Detection and Leachate Monitoring Plan" (GWLMP) (DOE 2010a). The objective of the GWLMP is to meet regulatory requirements for groundwater detection monitoring in the Great Miami Aquifer (GMA) and perched groundwater system and to provide leachate monitoring information.

Facility Description

The OSDF is situated in the northeast area of the Fernald Preserve. It has a capacity of 2.96 million cubic yards ($yd^3$) (2.26 million cubic meters [$m^3$]), a maximum height of approximately 65 feet (ft) (20 meters [m]), and covers an area of approximately 75 acres (30 hectares). The facility consists of eight individual cells. All eight cells were 100 percent full and capped by October 2006.

Protection of the GMA and the overlying perched groundwater system includes the following measures for each of the eight cells (refer to Figure A.5−1 for a cross section of the liner system):

- Leachate collection system (LCS),
- Leak detection system (LDS),
- Multilayer composite liner system, and
- Multilayer composite cap system.

The LCS consists of a gravel layer installed beneath the waste to collect rainwater that came in contact with the waste during cell construction and additional moisture that is draining from the waste following capping. The LDS is located beneath both the LCS and the primary geosynthetic liner system and provides a mechanism for collecting and monitoring leakage through the primary liner layer of the OSDF prior to any releases to the environment. Both systems drain to the west and extend beyond the synthetic liner systems into valve houses, where leachate becomes accessible for monitoring.

The base of each cell liner also slopes toward the centerline of the cell, and the centerline of the base is sloped toward the west. Leachate moving along the top of a liner would first travel toward the centerline and then west along the centerline to be drained from the cell via piping at the penetration box, which is the lowest elevation point of the cell.

Each cell is monitored below the penetration box with a horizontal till well (HTW), which represents the first monitoring point for a release from a cell. HTWs provide monitoring of the perched groundwater quality beneath the point where the LCS and LDS pipes exit the liner system. The GMA is monitored via both an upgradient and a downgradient monitoring well for each cell. Figure A.5−2 identifies the well locations associated with the OSDF. Table A.5−1 identifies specific dates for the following cell activities:

- Sample initiation for each monitoring horizon,
- Waste placement initiation,
- LDS volume measurement initiation,
- Cap geomembrane layer completion, and
- Cap completion (through seeding).

A construction quality assurance/quality control program was executed for each cell of the OSDF. The synthetic liners and caps of each cell were inspected and tested for defects at the time of installation. Given the attention to quality assurance/quality control during the installation of the OSDF liner system, it is doubtful that a breach in the liner would have gone unnoticed, but it is possible that a breach could develop. Such a breach would provide a potential pathway for leachate migration, but adequate hydraulic head is needed to drive leachate through the breach and clay liner into the underlying horizon.

The GWLMP provides the facility performance assessment strategy for the OSDF and covers the following topics:

- Understanding how a cell can leak,
- Monitoring hydraulic head in the LDS and the action leakage rate,
- Water quality monitoring in the LCS, LDS, HTW, and GMA wells, and
- Residual soil contamination beneath the facility and its possible impact to HTW water quality results.

Information Organization

The 2011 OSDF leak detection and leachate monitoring information is organized in the following sections:

- Flow and Hydraulic Performance (Section A.5.1),
- Water Quality: Data Presentations and Evaluations (Section A.5.2),
- Cell Cap Inspections (Section A.5.3),
- Monitoring Changes (Section A.5.4), and
- Summary of Overall Performance/Findings and Recommendations (Section A.5.5).

Sub-attachments A.5.1 through A.5.8 provide cell-specific information for disposal cells 1 through 8.

## A.5.1 Flow and Hydraulic Performance

### A.5.1.1 Overall LCS Volumes

In 2011, leachate volumes pumped from the LCS tanks were measured by recording readings from capacitance probes installed in each primary containment vessel. The probes are attached through a remote control unit to the Converted Advanced Wastewater Treatment Facility (CAWWT) control room, where water levels are converted automatically to volumes based on the tank manufacturer's design specifications for the tanks.

Leachate volumes have been measured since waste placement began. Figure A.5−3 is a graph showing monthly leachate volumes from October 2006 through December 2011. The data collected in 2011 indicate that 161,682 gallons of leachate were collected and pumped to the CAWWT Backwash Basin for subsequent treatment at the CAWWT. The total volume measured in 2011 represents an 8 percent decrease from the total volume measured in 2010 (176,087 gallons). The volume of precipitation that fell on the OSDF in 2011 was approximately 88.5 million gallons (60.2 inches of rain over 54.1 acres). The facility cap inhibits rainwater from permeating the OSDF. Collected leachate in 2011 represents approximately 0.2 percent of the precipitation that fell on the OSDF in 2011, indicating that the cap is performing as designed to reduce infiltration.

The GWLMP identifies that trend analysis of the LCS flow-monitoring measurements will be conducted for capped cells to provide an indication of changes in system performance. Monthly accumulation volumes for Cells 1 through 8 are plotted and provided in Sub-attachments A.5.1 through A.5.8. The semi-log plots indicate that leachate volumes from the capped cells continue to decline over time, but the rate of decline is decreasing. In 2011 the overall monthly facility leachate flow declined by 821 gallons or approximately 5.5 percent (14,938 gallons for January 2011 versus 14,117 gallons for December 2011).

### A.5.1.2 LDS Accumulation Rates and Volumes

Quantitative measurement of the volumes accumulating in and pumped from the LDS tanks was initiated according to the various dates in Table A.5−1. These measurements were taken using the same methodology as described above for the LCS. These data are used to determine both accumulation rates (in gallons per acre per day [gpad]) and accumulation volumes (in gallons) for each cell’s LDS.

The GWLMP states that trend analysis of the LDS flow monitoring measurements will be conducted for capped cells to provide an indication of changes in system performance. Monthly accumulation volumes for Cells 1 through 8 are provided and graphically displayed in Sub-attachments A.5.1 through A.5.8. The graphs indicate that overall LDS flows are declining.

The *On-site Disposal Facility Final Design Calculation Package* (DOE 1997c) defines an initial response leakage rate for individual cells of 20 gpad. The 2011 maximum LDS accumulation rates and the percent of the initial response leakage rate for each cell are as follows:

| Cell | LDS Maximum Accumulation Rate (gpad) | Initial Response Leakage Rate (percent) |
|---|---|---|
| 1 | 0.01 | 0.0 |
| 2 | 0.14 | 0.7 |
| 3 | 0.00 | 0.0 |
| 4 | 0.11 | 0.5 |
| 5 | 0.11 | 0.5 |
| 6 | 0.28 | 1.4 |
| 7 | 0.04 | 0.2 |
| 8 | 0.38 | 1.9 |

These LDS accumulation rates indicate that the liner systems for the cells are performing well within the specifications outlined in the approved OSDF design. The initial response leakage rate of 20 gpad is a design criterion for commencing an investigation into the possibility that the cell is not performing as designed. Because all of the cells are closed and capped, it is expected that LDS accumulation rates will continue to diminish over time. Rates will continue to be closely tracked to document if the primary liner systems continue to perform as designed.

#### A.5.1.3 Liner Efficiencies

Cell-specific apparent liner hydraulic efficiencies are calculated using the following equation:

$$\text{Hydraulic efficiency} = [1-(\text{Volume}_{LDS}/\text{Volume}_{LCS})] \times 100$$

Apparent liner hydraulic efficiency is a measure of how a cell's liner is performing. The above equation considers *all* the LDS volume to be leakage through the primary liner, which is a conservative measure. In the *Report on the 1995 Workshop on Geosynthetic Clay Liners* (EPA 1996), several sources of flow from leak detection layers are identified. These sources include:

- Top liner leakage,
- Construction water and compression water,
- Consolidation water, and
- Water from groundwater infiltration.

Quarterly apparent liner efficiencies were consistently greater than 97 percent for Cells 1 through 8 throughout 2011. Quarterly apparent liner efficiencies (in percentages) are provided for Cells 1 through 8 below.

*Apparent Liner Efficiency (percent), Quarterly for 2011*

| Quarter | Cell 1 | Cell 2 | Cell 3 | Cell 4 | Cell 5 | Cell 6 | Cell 7 | Cell 8 |
|---|---|---|---|---|---|---|---|---|
| First | 99.96 | 100 | 100 | 99.81 | 99.20 | 99.40 | 99.78 | 99.58 |
| Second | 99.96 | 99.98 | 99.98 | 99.81 | 99.88 | 99.67 | 99.97 | 97.61 |
| Third | 99.98 | 97.48 | 100 | 99.39 | 99.77 | 98.23 | 99.85 | 99.91 |
| Fourth | 100 | 99.89 | 100 | 100 | 100 | 99.32 | 100 | 100 |

#### A.5.1.4 HTW Water Yields

HTW water yields are monitored at each cell to document trends in perched-water purge volumes. In 2011 the HTWs were purged four times (February, May, August, and November). Average purge water yields from the HTWs ranged from 0 gallons beneath Cell 8 to 1,056 gallons beneath Cell 5. The Cell 3 HTW water yield, which had been trending upward from 2001 through 2005, showed a sixth-year decline in average yield. The HTW water yields will continue to be tracked and factored into the OSDF leak detection evaluation, where appropriate. The water-yield graphs are provided in each cell's sub-attachment and are updated with purge volume data collected prior to each sampling event.

## A.5.2 Water Quality: Data Presentations/Evaluations

The water quality and data presentations/evaluations presented in this report consist of the following:

- Quarterly monitoring summary statistics (Section A.5.2.1)
- Concentration plots (Section A.5.2.2)
  - LCS, LDS, and HTW, of each cell
  - HTW and GMA wells of each cell
- Control charts (Section A.5.2.3)
- Annual LCS monitoring results (Section A.5.2.4)
- Parameter selection process statistics/results for Cells 7 and 8 based on annual LCS samples (Section A.5.2.5)
- Bivariate plots for each cell (Section A.5.2.6)
- Summary of Increasing Concentration Trends in the HTW and GMA Downgradient Wells (Section A.5.2.7).

#### A.5.2.1 Quarterly Monitoring Summary Statistics

Summary statistics for the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells of each cell in 2011 are provided in Sub-attachments A.5.1 to A.5.8 (Tables A.5.1−1 through A.5.8−1). The information provided in each summary table is based on a standardized quarterly sampling frequency.

The process used for conducting the summary statistics is illustrated in Figure A.5−4. Table A.5–2 lists the rules that are used to report the data provided on Tables A.5.1−1 to A.5.8−1. For results where the concentrations are below the detection limit, the results used in the average, standard deviation, distribution, trend, serial correlation, and outliers are each set at half the detection limit. One objective of conducting the summary statistics is to identify the parameters that meet the requirements for control charts (i.e., normal or lognormal distribution, no trend, and no serial correlation).

Data used in the summary statistics were "quarterized" (i.e., normalized to quarterly data). The rationale behind this is that during different time periods, data were collected at varying time intervals. For example, from October 30, 1997 through December 8, 1997 there were 15 uranium measurements taken at HTW 12338. In all of 1998 only 4 were taken, in 1999 there were 7, in 2000 there were 6, and 4 each were taken in 2001 through 2003. So, in a 5 to 6 week period in 1997, nearly as much data were collected as were collected from 1998 to 2000.Without normalizing the data, the time periods with more sampling activity would carry more weight, and, therefore, with respect to the calculations, be considered more important. Additionally, sampling the same well at too short of an interval (often just one day apart in 1997) also violated the statistical assumption of independence. Well data that are collected too closely in time are serially correlated and can distort the statistics underlying the control charts. Even with quarterly sampling, there is often an issue with serial correlation.

ChemStat®, Version 6.3, (a Starpoint Software Program) was used to conduct the statistics. ChemStat® is software used to perform the statistical analysis of groundwater monitoring data at Resource Conservation Recovery Act (RCRA) facilities. The website for the software is www.pointstar.com.

Data set distributions were checked using the Shapiro Wilks Test (95 percent confidence interval) for data sets with less than 50 samples, and the Shapiro-Francia Test (95 percent confidence interval) for data sets with 50 samples or more. The Mann-Kendall test for trend (95 percent confidence interval) was used to determine the presence of either an upward or downward concentration trend over time. The rank Von Neumann test (confidence interval of 99 percent) was used to check for serial correlation.

### A.5.2.2 Concentration Plots

Concentration plots for the 23 parameters monitored quarterly in the LCS, LDS, and HTW of each cell in 2011 are presented in Sub-attachments A.5.1 to A.5.8. The plots are presented with a common *y*-scale based on the parameter.

Concentration plots are also presented in Sub-attachments A.5.1 to A.5.8 for the 23 parameters monitored quarterly in the HTW and GMA wells of each cell in 2011. The plots are also constructed with a common *y*-scale based on the parameter.

### A.5.2.3 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background. The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-cumulative sum (CUSUM) control chart works as follows. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared “out of control” if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat® software to define the baseline for a control chart. Therefore, only sample sets with greater than 8 samples were selected for control charts. By default, the ChemStat® software plots both a CUSUM control limit (h) and a Shewart control limit (SCL) on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL control limit (SCL).

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat® software though, by default, plots both the SCL and CUSUM control limits on the charts. As a “work-a-round”, the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

One hundred and forty Shewart-CUSUM control charts are presented in Sub-attachments A.5.1 through A.5.8 for parameters monitored quarterly in the HTW and GMA wells in 2011 and had data sets that achieved control chart criteria (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation). Last year, only 59 data sets met the control chart criteria listed above.

Of the 140 control charts presented, 129 (92 percent) exhibit “in control” conditions, and 11 (8 percent) exhibit “out of control” conditions.

#### A.5.2.4 Annual LCS Monitoring Results

Once a year, the LCS of each cell is sampled for Appendix I parameters and polychlorinated biphenols (PCBs) listed in Ohio Administrative Code (OAC) 3745-27-10. A summary of the results for each cell is provided in Sub-attachments A.5.1 thru A.5.8 (Tables A.5.1−2 thru A.5.8−2). As stated in Appendix B of the GWLMP (DOE 2010a) “two consecutive detects in a cell’s LCS will trigger sampling in the cell’s LDS during the next scheduled sampling round.” Highlights of sampling results from 2011 are provided below.

- No new parameters were detected in the LCS of Cells 1 thru 7.
- Cadmium was detected for the first time in the LCS of Cell 8. If cadmium is detected again in the LCS of Cell 8 in 2012, sampling in the LDS for cadmium will begin with the next subsequent scheduled sampling event.
- Lead was not detected in the LCS of Cell 4. In 2010, lead was detected for the first time in Cell 4.
- Chromium was detected for the second consecutive time in the LCS of Cell 6. Chromium will be added to the analyte list for the Cell 6 LDS in the next subsequent sampling round. Chromium was detected in the LCS of Cell 6 for the first time in 2010.
- The LDS of Cell 3 was dry in 2011 so ammonia was not sampled. Ammonia will be sampled in the LDS of Cell 3 the next time a sample can be collected. Ammonia was detected in the LCS of Cell 3 for the first time in 2009, and for the second consecutive time in 2010.

- 1,1-dichloroethene was not detected in the LDS of Cell 7. 1,1-dichloroethene was detected for the first time in the LCS of Cell 7 in 2009 and for the second consecutive time in 2010.
- 1,1-dichloroethene was not detected in the LDS of Cell 8. 1,1-dichloroethene was detected for the first time in the LCS of Cell 8 in 2009 and for the second consecutive time in 2010.

### A.5.2.5 Parameter Selection for Cells 7 and 8 based on Annual LCS Samples

Parameter selection results reported herein, marks the completion of a parameter selection process that was established in consultation with the Ohio EPA in 2005 and 2006. The objective of the process was to identify the Appendix I and PCB parameters detected in the LCS that would provide the most promise for detecting a leak from the facility and therefore warrant more frequent and robust monitoring (i.e., quarterly monitoring). The process is presented in Figures A.5−5A and A.5−5B.

As shown in Figure A.5−5A, the parameter selection process involves data sets with a minimum of eight samples and 25 percent or more detects. As shown in Figure A.5–5B, statistical procedures were used to determine if the mean concentration of a cells LCS data set was statistically different from the mean concentration of either the pre-design or background data set. Specifically, the null hypothesis that was created for each test states that the mean concentration of the LCS data set was less than or equal to the mean of the pre-design or background data set. Therefore, failure of the null hypothesis for a specific test parameter indicates that the mean of the LCS data set is greater than the mean of the pre-design or background data set.

Selection of a statistical method is based on the percentage of detects within the data sets. More specifically:

- If there are greater than or equal to 85 percent detects, and both data sets have either a normal or lognormal distribution (based on a Shapiro-Wilks or Shapiro-Francia test): a parametric test method is used (i.e., *t*-test, with a 95 percent confidence interval).
- If there are greater than 85 percent detects, but both data sets do not have a normal or lognormal distribution (based on a Shapiro-Wilks or Shapiro-Francia test) a nonparametric test method is used (i.e., Wilcoxon Rank Sum Test and Quantile Test, 95 percent confidence interval).
- If there are less than 85 percent detects, a nonparametric test method is used (i.e., Tarone-Ware test, 95 percent confidence interval).

In regard to the first bullet, the Shapiro-Wilks procedure (95 percent confidence interval) was used to check the distribution of data sets. EPA recommends this as the preferred test for normality in data sets less than or equal to 50 measurements (EPA 1992b). The Shapiro-Francia method (95 percent confidence interval) was used to check data sets with more than 50 measurements. If the test failed using the original data set, data were transformed into the natural log and checked for a lognormal distribution.

In regard to the second bullet, the Wilcoxon Rank Sum Test is a nonparametric group comparison method for comparing compliance measurements to background. It follows U.S. Navy guidance (U.S. Navy 1999). Because the test is nonparametric, normality is not required.

The Quantile Test, a nonparametric method is used to determine if observations as a group are statistically elevated when compared to background point measurements as a group. It follows the U.S. Navy guidelines (U.S. Navy 1999). Because the test is nonparametric, normality is not required.

If either the Wilcoxon Rank Sum Test or Quantile Test fails the null hypothesis, it is concluded that the mean of the LCS data set is greater than the mean of the pre-design or background data set. These two tests are used in conjunction, because the Wilcoxon Rank Sum Test is effective at detecting differences in central tendency (means and medians) but not in detecting differences in the tails of distributions. On the other hand, the Quantile Test is not effective at detecting differences in central tendency, but is effective at detecting differences in the tails of distributions. Used in conjunction, the two tests are effective at detecting differences in both the central tendency and tails of distributions.

In regard to the third bullet, the Tarone-Ware Two Sample Test for censored data is recommended in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance* (EPA 2009). The Tarone-Ware procedure is designed to provide a valid statistical test, even with a large fraction of censored (e.g., non-detected) data. The parameter selection process was revised in 2010 by replacing the use of a Poisson Test with the Tarone Ware Two Sample Test for Censored Data. The Poisson Test needed to be replaced because it exhibited scale dependency issues. The Tarone-Ware test is recommended in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance* (EPA 2009) for use with data sets that contain a large fraction of non-detects (left censored data).

Results from the parameter selection process for LCS data from Cells 1, 2, and 3 were reported in the *Fernald Preserve 2007 Site Environmental Report* (DOE 2008). Six additional parameters were identified for more frequent and robust monitoring (arsenic, cobalt, nickel, selenium, total dissolved solids [TDS], and zinc). Quarterly sampling for these additional six new parameters in the LCS, LDS, HTW, and GMA wells of each cell began in 2009.

Results from the parameter selection process for LCS data from Cells 4 and 5 were presented in the *Fernald Preserve 2009 Site Environmental Report* (DOE 2010b). Eight additional parameters were identified for more frequent and robust monitoring (alkalinity, chloride, nitrate/nitrite, barium, calcium, copper, magnesium, and potassium). Quarterly sampling for these additional eight parameters in the LCS, LDS, HTW, and GMA wells of each cell began in 2011. Vanadium was also identified for quarterly sampling in the LCS, LDS, HTW, and GMA wells of Cell 5.

Results from the parameter selection process for LCS data from Cell 6 were presented in the *Fernald Preserve 2010 Site Environmental Report* (DOE 2011b). No new parameters were identified for quarterly monitoring.

The data sets for Cell 7 and Cell 8 reached a minimum size of eight samples in 2011. Specific details concerning the assessment for Cell 7 and Cell 8 are provided in Table A.5.7−4 (contained in Sub-attachment A.5.7) and Table A.5.8–4 (contained in Sub-attachment A.5.8) respectively. Results are summarized below.

Cell 7

Four Appendix I parameters (not on the quarterly sampling list) reached the 25 percent detection criterion in 2011; ammonia, beryllium, chromium, and technetium-99. Pre-design and/or background data does not exist for beryllium so parameter selection statistics could not be conducted. The low beryllium concentrations detected (maximum of 0.00025 mg/L) imply that adding it to the quarterly sampling list would not significantly enhance early detection capability of the monitoring program. Therefore, beryllium will not be added to the quarterly sampling list for Cell 7. As reported in the *Fernald Preserve 2009 Site Environmental Report*, technetium-99 was already evaluated for Cell 7 and passed the null hypothesis therefore it was not evaluated again this year. Parameter selection statistics were conducted on ammonia and chromium. Ammonia passed the null hypothesis and chromium failed the null hypothesis. Chromium will be added to the quarterly monitoring list for the LCS, LDS, and GMA wells of each cell beginning in January 2013.

Cell 8

Three Appendix I parameters (not on the quarterly sampling list) reached the 25 percent detection criterion in 2011: ammonia, chromium, and tetrachloroethene. Parameter selection statistics were conducted on ammonia and chromium. Both passed the null hypothesis of the Tarone-Ware test so do not need to be added to the quarterly sampling list. (Note: Chromium failed the null hypothesis in Cell 7 so is on the quarterly sampling list beginning in January 2013).

Pre-design and/or background data does not exist for tetrachloroethene so parameter selection statistics could not be conducted. Since 2004, tetrachloroethene has been sampled 19 times and detected 6 times. Four of the six detects were at concentrations that were greater than the MDL but less than either the practical quantitation limit (PQL) or required detection limit (RDL). The two other detects were also very low (1.1 ug/L and 1.24 ug/L). Given the low concentrations, adding tetrachloroethene to the quarterly sampling list would not significantly enhance the early detection capability of the monitoring program.

After the earlier parameter selection process was performed for Cells 1 through 5, a decision was made to include those parameters selected for quarterly monitoring in Cells 1 through 5 for all eight cells. Therefore, chromium that was selected for Cell 7 this year will be added to the quarterly monitoring list for the LCS, LDS, and GMA wells of each cell beginning in January 2013.

Table A.5−3 provides an overview of the parameters that have been selected for quarterly sampling in the LCS, LDS, and GMA wells of each cell based on the evaluation for Cells 1 through 8. Also identified in the table are those parameters that were detected in 2011, but are not being sampled quarterly, and those parameters that were not detected in 2011, but have been detected at least 25 percent of the time based on previous years' results.

The table illustrates that the list of parameters chosen for quarterly sampling is very comprehensive when compared to the list of parameters detected in the LCS in 2011 or have been detected at least 25 percent of the time based on previous years. This robust list of parameters should be adequate to detect a leak from the facility. These are the parameters that are most detected in the LCS at concentrations large enough to be measured beneath the facility should a leak in the facility occur, have been detected at least 25 percent of the time in the LCS, and have been shown statistically to have a mean concentration in the LCS that is larger than the mean concentration of the pre-design or background data sets.

The parameter selection process has now been completed for all eight cells, DOE plans to conduct a final comprehensive look to determine if the list of parameters can be further optimized. Results of the final evaluation will be made available to the Ohio EPA as soon as they are available.

#### A.5.2.6 Bivariate Plots for Each Cell

Bivariate plots for (uranium-sodium) are presented for each cell in Sub-attachments A.5.1 through A.5.8. The bivariate plots illustrate the concentration signatures for uranium-sodium in each monitoring horizon. Distinct clustering of horizon concentrations indicates that the fluids in the different horizons are not mixing. In response to an Ohio EPA comment on the *Fernald Preserve 2009 Site Environmental Report* (DOE 2010b) (OEPA Comment Number 35) the closest points between monitoring horizons are dated.

An additional bivariate plot for (uranium–sulfate) is presented for Cell 8 in Sub-attachment A.5.8. The additional uranium-sulfate bivariate plot provides supporting information concerning the water chemistry signatures that are present in the LDS and HTW of Cell 8; specifically that they are separate and distinct.

#### A.5.2.7 Increasing Concentration Trends in the HTW and GMA Wells

As presented in subsections A.5.1 through A.5.8, several parameter concentrations are increasing in the GMA beneath the OSDF. Bivariate plots (uranium-sodium and uranium-sulfate) indicate separate and distinct chemical signatures for the LCS, LDS, and HTW of all 8 cells. This indicates that water is not mixing from inside the facility to outside the facility, leading to the conclusion that the facility is not leaking. Therefore, concentration increases observed in the GMA wells are attributed to fluctuating ambient concentrations beneath the cells, and not to cell performance. Additional information is provided in Sub-attachments A.5.1 through A.5.8.

### A.5.3 Cell Cap Inspections

OSDF cell cap inspections are conducted quarterly. The inspection team typically includes representatives from Ohio EPA, Ohio Department of Health (ODH), and S.M. Stoller Corporation. Issues identified during inspections typically include small erosion rills, rocks that surface as top soil settles, animal burrows and digging, small areas that require reseeding, and the presence of woody vegetation, thistle, or other noxious species.

The issues are addressed as follows:

- Erosion rills are repaired if they exceed 3 inches wide by 6 inches deep.
- Rocks that surface are removed, especially if they will interfere with mowing activities or may be a source location for erosion.
- Animal burrows and holes are filled in and reseeded, if necessary.
- Areas that require reseeding are seeded and covered with jute matting to help prevent erosion of the seed.
- Woody vegetation is removed and herbicide is applied to the noxious weeds.

Following each inspection, a report is submitted to the agencies documenting the inspection, issues and stating how issues will be addressed. These reports are available to the public on the Fernald Preserve website http://www.lm.doe.gov/fernald/Sites.aspx. In 2011, inspections were conducted in March, June, September, and December. In 2011, there were no visual signs that the integrity of the cap had been compromised in any way.

### A.5.4 Monitoring Changes

Beginning in the second quarter of 2011, DOE implemented the following monitoring changes:

- For one year, tritium was added to the quarterly sampling list for all four horizons of all eight cells.
- The quarterly sampling list for the HTW of each cell was reduced to tritium, uranium, arsenic, and sodium. Sodium was retained to support the preparation of bi-variate plots.

These changes stem from an informal proposal made to DOE by Ohio EPA in February 2011 via e-mail.

Three quarters of tritium data were collected in 2011. The last quarter will be collected during the first quarter of 2012. Preliminary results show that tritium was only detected in one sample. The August 4, 2011 sample from the Cell 8 LCS (12345C) had a concentration of 296 picocuries per liter (pCi/L), with a “J” validation qualifier indicating that the concentration was estimated.

The fourth quarter of tritium data will be collected in 2012. If the fourth quarter results are consistent with the first three quarters, DOE plans to discontinue sampling for tritium altogether. Quarterly sampling in the HTW will continue for uranium, arsenic, sodium, and sulfate. Arsenic is included at the request of Ohio EPA, and uranium, sodium and sulfate are included to provide data for bivariate plots.

### A.5.5 Summary of Overall Performance/Findings and Recommendations

Based on LCS and LDS flow data, engineered drainage features within the OSDF continue to perform as designed. Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of each cell (and uranium and sulfate in Cell 8) indicate that waters from the different horizons are not mixing, and therefore it can be inferred that the primary and secondary liners are not leaking. Water quality constituent concentration increases noted in the

HTW and GMA wells are attributed to fluctuating ambient concentrations beneath the OSDF, and not to OSDF performance.

Specific findings are listed below:

- LCS volumes continue to diminish with time, but the decline is decreasing. Total facility leachate volume in 2011 was 8 percent less than in 2010 (approximately 161,682 gallons compared to 176,087 gallons).
- The largest LDS maximum accumulation rate recorded in 2011 was 0.38 gpad in Cell 8; approximately 2 percent of the initial response leakage rate of 20 gpad.
- LDS accumulation rates indicate that the liner systems are performing well within the specification outlined in the approved cell design.
- Quarterly apparent liner efficiencies were consistently greater than 97 percent for Cells 1 through 8 throughout 2011.
- Bivariate plots continue to illustrate that the water chemistries in the LCS, LDs, and HTW of each cell are distinct and separate indicating that waters from the different horizons are not mixing.
- In 2011, 140 data sets met the criteria for control Shewart-CUSUM control charts. In 2010 only 59 data sets met the criteria for control charts. Of the 140 control charts presented for 2011, 127 (92 percent) exhibited “in control” conditions, and 11 (8 percent) exhibited “out of control” conditions.
- Annual LCS sampling for Appendix I and PCB parameters led to the following results.
    - No new Appendix I or PCB parameters were detected in the LCS of Cells 1 through 7.
    - One Appendix I parameter (cadmium) was detected for the first time in 2011 in the LCS of Cell 8. If cadmium is detected in the LCS of Cell 8 in 2012, the LDS of Cell 8 will be sampled for cadmium in the next subsequent scheduled sampling round.
    - Chromium was detected for the second time in the LCS of Cell 6. Chromium will be added to the analyte list for the Cell 6 LDS in the next subsequent scheduled sampling round.
    - 1,1-dichloroethene was not detected in the LDS of either Cell 7 or Cell 8 even though it has been detected two consecutive times in the LCS of each cell.
- Parameter selection results reported herein marks the completion of a parameter selection process that was established in consultation with the Ohio EPA in 2005 and 2006. The parameter selection process was applied to the LCS data sets from Cell 7 and Cell 8. The result was the addition of chromium to the quarterly sampling list for the LCS, LDS, and GMA wells of each cell beginning in January 2013. DOE plans to conduct a final comprehensive look at the list of twenty-four parameters that have been selected for quarterly monitoring to determine if the list of parameters can be further optimized. Results of the evaluation will be made available to the Ohio EPA as soon as they are available.

- Three of four quarters of tritium data were collected in 2011 in the LCS, LDS, HTW, and GMA wells of each cell. All of the samples were non-detects, except one. The August 4, 2011 sample from the Cell 8 LCS (12345C) had a concentration of 296 pCi/L, with a validation qualifier of "J" indicating that the concentration was estimated. The fourth quarter of tritium data will be collected in 2012. If the fourth quarter results are consistent with the first three quarters, DOE plans on discontinuing sampling for tritium altogether. Quarterly sampling in the HTW will continue for uranium, arsenic, sodium, and sulfate. Arsenic is included at the request of Ohio EPA, and uranium, sodium and sulfate are included to provide data for bivariate plots.
- In 2011, quarterly physical inspections of the OSDF revealed no visual signs that the integrity of the OSDF cap had been compromised.

*Table A.5−1. OSDF Initiation and Completion Dates*

| Cell | Sample Initiation per Horizon[a] | Waste Placement Initiation | LDS Volume Measurement Initiation[b] | Cap Geomembrane Layer Completion[c] | Cap Completion[d] |
|---|---|---|---|---|---|
| 1 | LCS: February 17, 1998<br>LDS: February 18, 1998<br>HTW: October 30, 1997<br>GMA-U: March 31, 1997<br>GMA-D: March 31, 1997 | December 23, 1997 | May 1999 | August 17, 2001 | December 20, 2001 |
| 2 | LCS: November 23, 1998<br>LDS: December 14, 1998<br>HTW: June 29, 1998<br>GMA-U: June 30, 1997<br>GMA-D: June 25, 1997 | November 12, 1998 | May 1999 | July 17, 2003 | November 12, 2003 |
| 3 | LCS: October 13, 1999<br>LDS: August 26, 2002<br>HTW: July 28, 1998<br>GMA-U: August 24, 1998<br>GMA-D: August 24 1998 | October 26, 1999 | October 1999 | July 16, 2004 | September 20, 2004 |
| 4 | LCS: November 4, 2002<br>LDS: November 4, 2002<br>HTW: February 26, 2002<br>GMA-U: November 6, 2001<br>GMA-D: November 5, 2001 | November 08, 2002 | November 2002 | December 18, 2004 | April 29, 2005 |
| 5 | LCS: November 4, 2002<br>LDS: November 4, 2002<br>HTW: February 26, 2002<br>GMA-U: November 6, 2001<br>GMA-D: November 5, 2001 | November 19, 2002 | November 2002 | June 22, 2005 | August 29, 2005 |
| 6 | LCS: October 27, 2003<br>LDS: October 27, 2003<br>HTW: March 14, 2003<br>GMA-U: December 16, 2002<br>GMA-D: December 16, 2002 | November 18, 2003 | January 2004 | October 28, 2005 | January 12, 2006 |

*Table A.5−1 (continued). OSDF Initiation and Completion Dates*

| Cell | Sample Initiation per Horizon[a] | Waste Placement Initiation | LDS Volume Measurement Initiation[b] | Cap Geomembrane Layer Completion[c] | Cap Completion[d] |
|---|---|---|---|---|---|
| 7 | LCS: September 2, 2004<br>LDS: September 2, 2004<br>HTW: February 24, 2004<br>GMA-U: January 21, 2004<br>GMA-D: January 21, 2004 | September 9, 2004 | September 2004 | July 2006 | October 25, 2006 |
| 8 | LCS: October 18, 2004<br>LDS: October 18, 2004<br>HTW: May 19, 2004<br>GMA-U: March 31, 2004<br>GMA-D: March 31, 2004<br>GMA-SW: August 22, 2005<br>GMA-SE: August 22, 2005 | December 2, 2004 | December 2004 | September 24, 2006 | October 25, 2006 |

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; GMA-SW = southwest Great Miami Aquifer; and GMA-SE = southeast Great Miami Aquifer
[b]Prior to 1999, overall LDS volumes were measured. From 1999 on, LDS volumes were measured by cell.
[c]The cap geomembrane layer is made of high density polyethylene.
[d]Cap completion includes seeding.

*Table A.5−2. Rules for Summary Statistics for Cells 1 through 8*

| Rules | No. of Detected Samples | Total No. of Samples | Percent of Detects | Min[a,b] | Max[a,b] | Average | Std. Dev. | Distribution Type | Trend | Serial Correlation | Outliers |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Include outliers** | Yes | Yes | Yes | No | No | No | No | No | No | No | |
| **Only one result** | Yes | Yes | Yes | report "NA" | report value | report "Insuff" | report "Insuff" | report "Insuff" | report "Insuff" | report "Insuff" | |
| **Only two results** | Yes | Yes | Yes | report value | report value | report "Insuff" | report "Insuff" | report "Insuff" | report "Insuff" | report "Insuff" | |
| **All non-detects** | Yes | Yes | Yes | report "ND" | report "NA" | report "Insuff" | report "Insuff" | report "Insuff" | report "Insuff" | report "Insuff" | |
| **Other rules** | | | | | | Need 3 detections otherwise report "Insuff" | Need 4 detections otherwise report "Insuff" | Need at least 3 samples to report distriburtion | Need at least 4 samples to report trend | Need at least 6 samples to report serial correlation | Need at least 4 samples to report outliers |
| **Other rules** | | | | | | If distribution is "Lognormal," substitute "LogMean" | | | | | |
| **Other rules** | | | | | | If distribution is "Undefined," substitute "Median" | | | | | |

[a]NA=not applicable; ND=not detected

[b]If reported value is a nondetected result, report ND.

*Table A.5−3. Overview of Constituents Selected for Quarterly Monitoring from LCS Annual Monitoring*

| Parameters Selected for Quarterly Sampling in All Cells | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Constiuent** | **Cell 1** | **Cell 2** | **Cell 3** | **Cell 4** | **Cell 5** | **Cell 6** | **Cell 7** | **Cell 8** |
| Alkalinity | X | X | X | X | X | X | X | X |
| Chloride | X | X | X | X | X | X | X | X |
| Nitrate/nitrite | X | X | X | X | X | X | X | X |
| TDS | X | X | X | X | X | X | X | X |
| TOC | X | X | X | X | X | X | X | X |
| TOX | X | X | X | X | X | X | X | X |
| Sulfate | X | X | X | X | X | X | X | X |
| Arsenic | 25% | X | | | X | | 25% | |
| Barium | X | X | X | X | X | X | X | X |
| Boron | X | X | X | X | X | X | X | X |
| Calcium | X | X | X | X | X | X | X | X |
| Cobalt | X | X | X | X | X | X | X | X |
| Copper | X | X | X | X | X | X | X | X |
| Iron | X | X | X | X | X | X | X | X |
| Lithium | X | X | X | X | X | X | X | X |
| Magnesium | X | X | X | X | X | X | X | X |
| Manganese | 25% | X | X | X | X | 25% | X | X |
| Nickel | X | X | X | X | X | X | X | X |
| Potassium | X | X | X | X | X | X | X | X |
| Selenium | X | X | X | X | X | X | X | X |
| Sodium | X | X | X | X | X | X | X | X |
| Zinc | X | X | X | X | X | X | X | X |
| Uranium | X | X | X | X | X | X | X | X |
| Chromium | X | X | X | X | X | X | X | X |

| Parameters Selected for Quarterly Sampling in Some Cells | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Constiuent** | **Cell 1** | **Cell 2** | **Cell 3** | **Cell 4** | **Cell 5** | **Cell 6** | **Cell 7** | **Cell 8** |
| Technetium-99 (Cell 8) | | | | 25% | 25% | 25% | 25% | 25% |
| Vanadium (Cell 5) | | X | | | | | | |

| Not Sampled Quarterly | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Constiuent** | **Cell 1** | **Cell 2** | **Cell 3** | **Cell 4** | **Cell 5** | **Cell 6** | **Cell 7** | **Cell 8** |
| Ammonia | X | X | X | X | X | X | X | X |
| Antimony | | X | | | | | | |
| Beryllium | | | | | | | 25% | |
| Cadmium | X | X | | | | | | 1 |
| Lead | | X | | | | | | |
| Acetone | | | | | | | | |
| Thallium | | X | | | | | | |
| 1,1-dichloroethene | | | 25% | | | | X | X |
| Toluene | | | | | | | | |
| Tetrachloroethene | | | | | | | | X |

A blank indicates that it was not detected in 2011, and has not been detected 25% of the time overall

**X** Detected in 2011.

**X** (shaded) Detected in 2011 and at least 25% of time overall.

**25%** Not detected in 2011, but has been detected at least 25% of time overall

**1** First time detect in 2011.

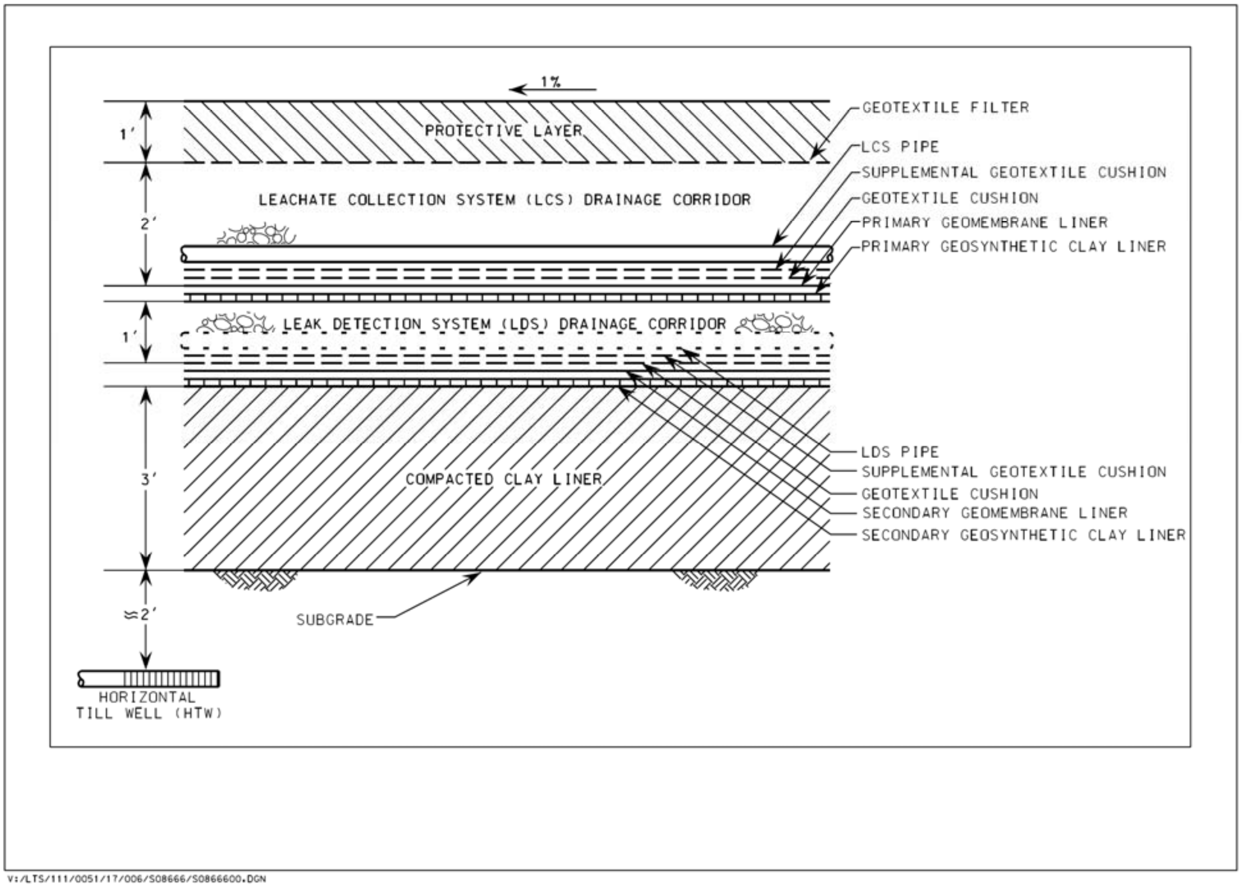



*Figure A.5−1. On-Site Disposal Facility Liner System with HTW at the Drainage Corridor*

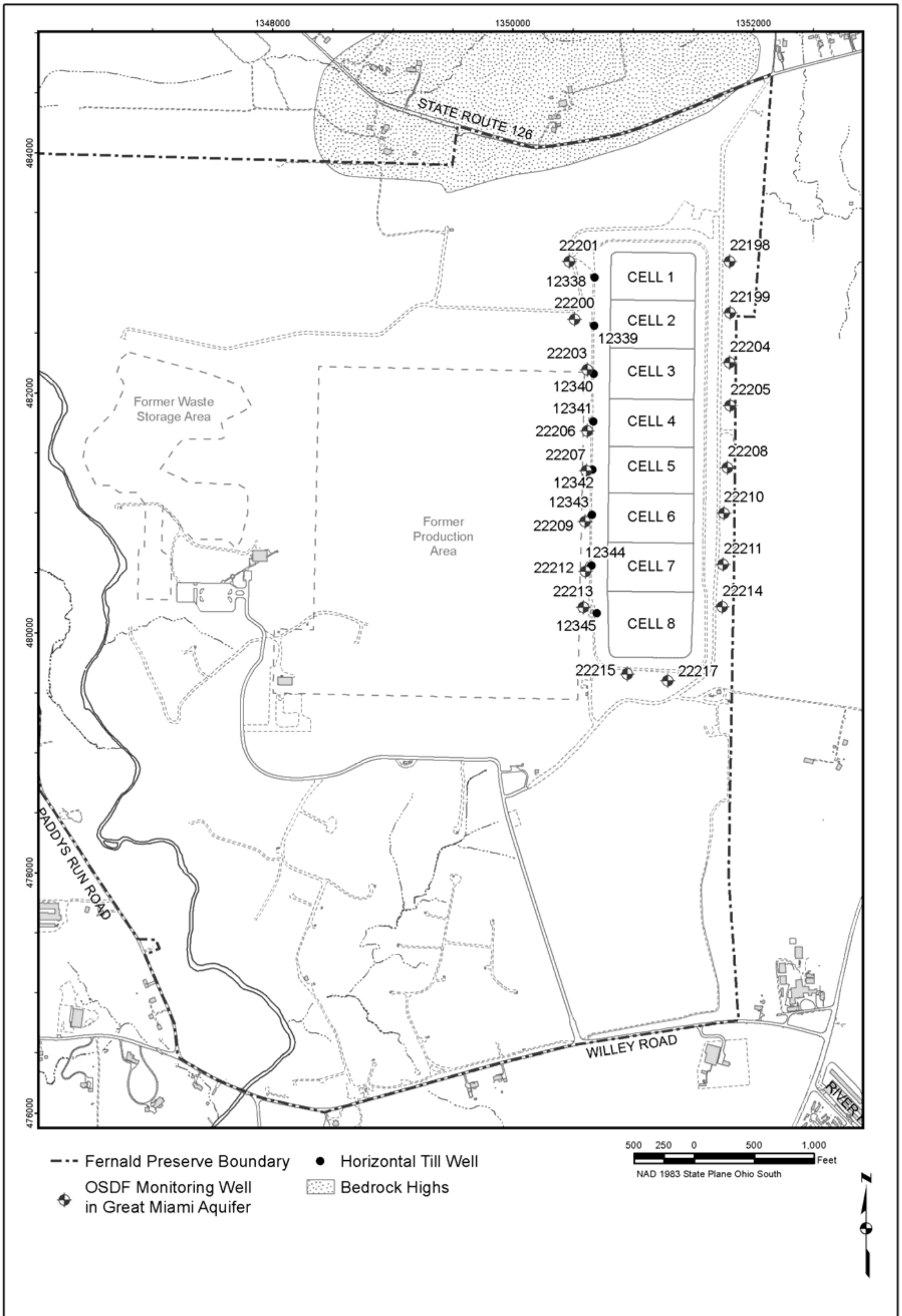



*Figure A.5−2. On-Site Disposal Facility Footprint and Monitoring Well Locations*

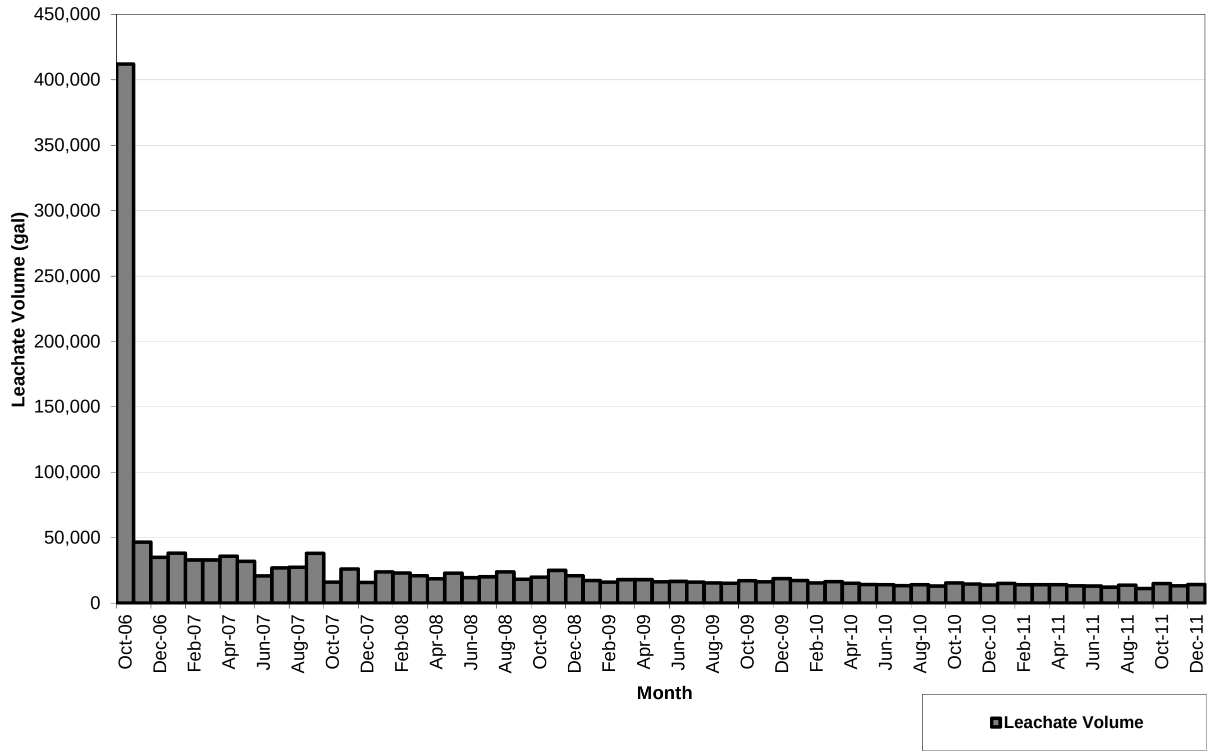



*Figure A.5−3. OSDF Monthly LCS Flow (October 2006 through December 2011)*

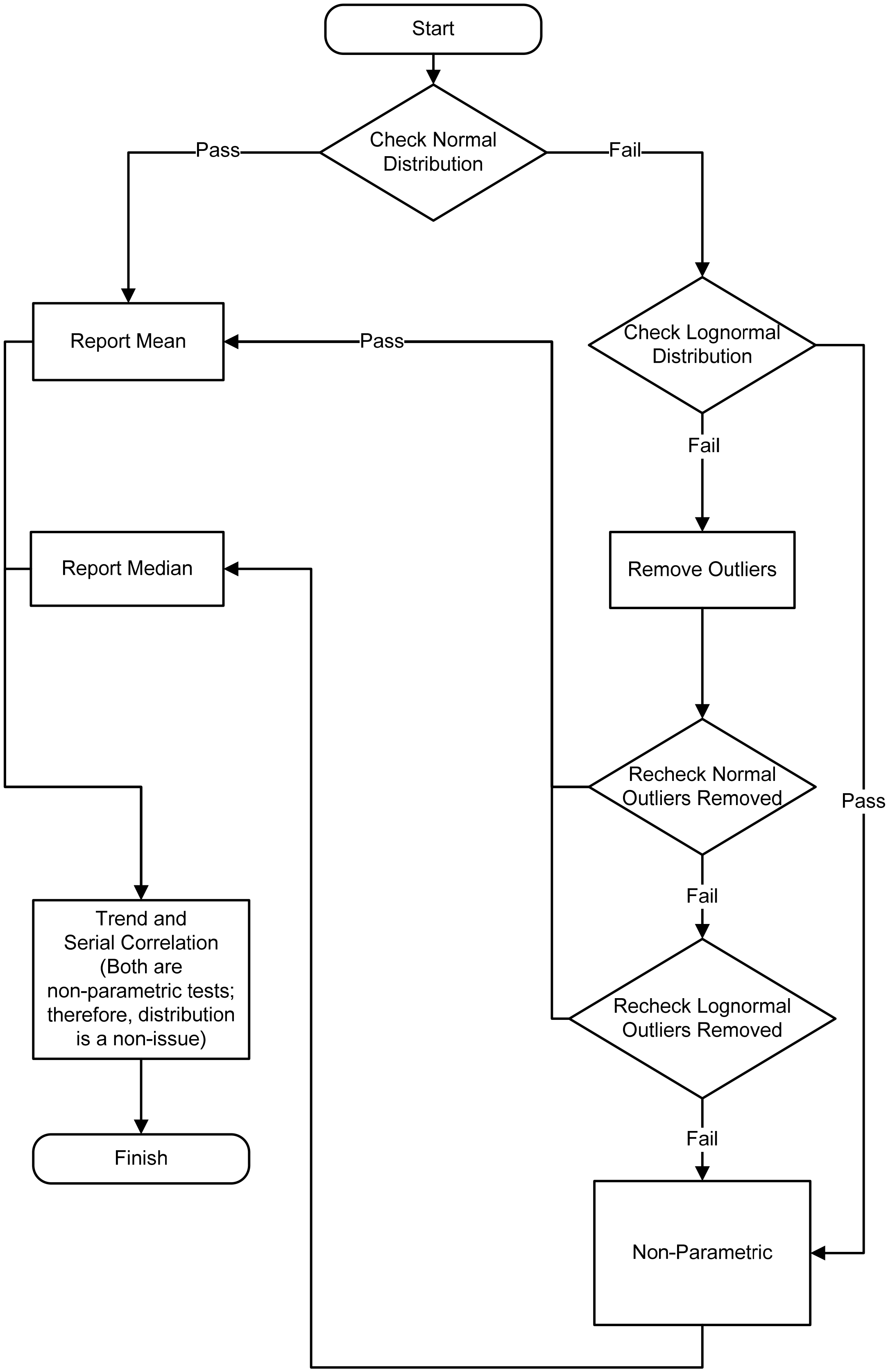



*Figure A.5−4. OSDF Statistical Evaluation Process*

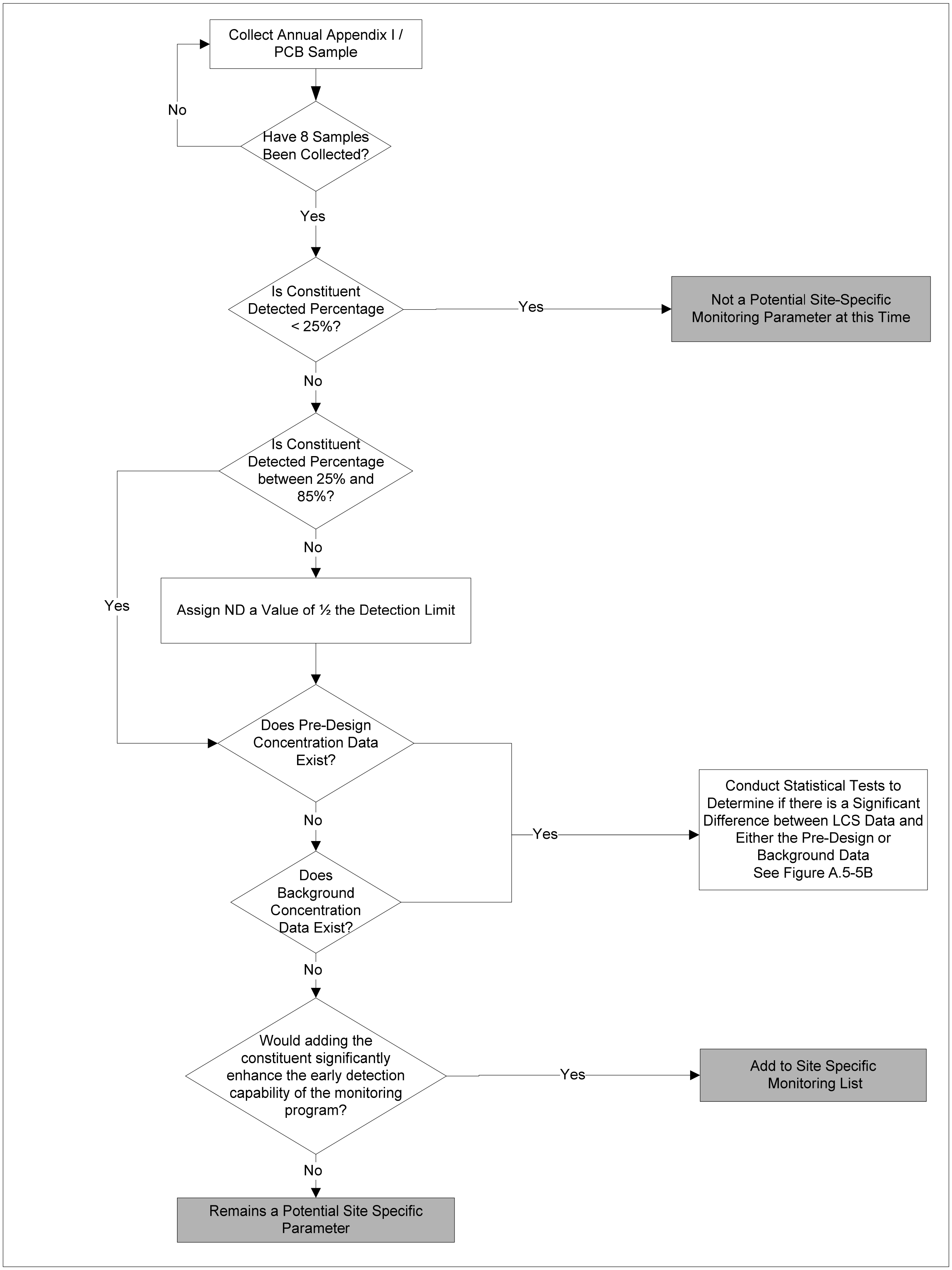



*Figure A.5−5A. OSDF Site-Specific Leachate Monitoring Parameter Selection Approach*

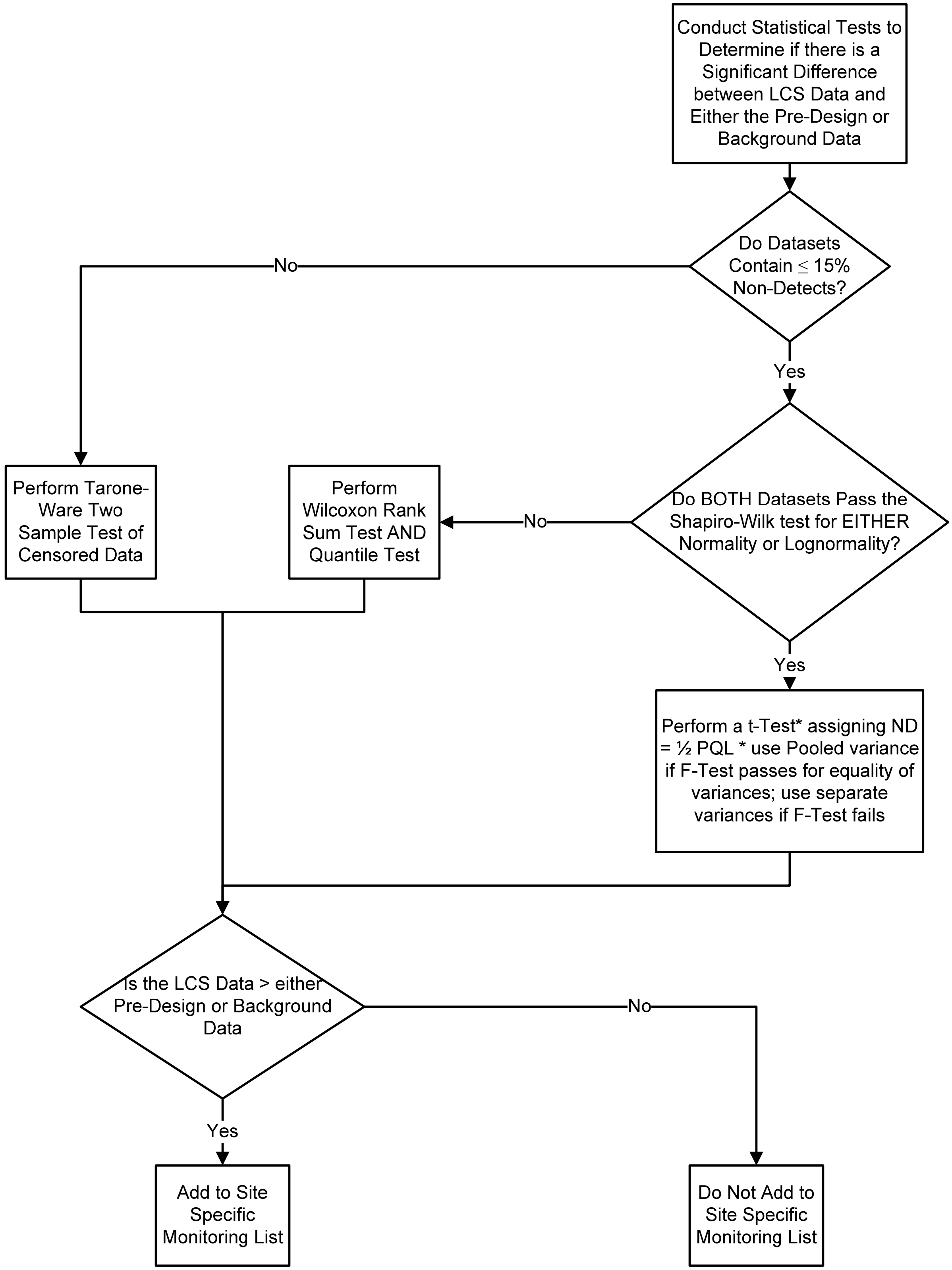



*Figure A.5−5B. OSDF Site-Specific Leachate Monitoring Parameter Selection Approach*