3.0 Groundwater Pathway

Results in Brief: 2009 Groundwater Pathway

Groundwater Remedy

Since 1993

- 27,365 M gal (103,577 M liters) of water have been pumped from the Great Miami Aquifer.
- 9,711 net pounds (4,409 kg) of uranium have been removed from the Great Miami Aquifer.

During 2009

- 2,447 M gal (9,262 M liters) of water were pumped from the Great Miami Aquifer.
- 585 pounds (266 kg) of total uranium were removed from the Great Miami Aquifer.

Groundwater Monitoring Results— Uranium concentrations within the footprint of the maximum uranium plume continue to decrease in response to pumping. The maximum uranium plume in 2009 was approximately 186 acres in size.

Direct push sampling in the off-property South Plume indicated that the off property footprint of the 50 µg/L total uranium plume decreased by approximately 16 acres from what was mapped in 2008. The area will continue to be monitored using direct-push technology when deemed appropriate.

Since 2005, the percentage of treatment needed to achieve discharge limits has been decreasing significantly. Very soon, treatment will no longer be required.

On-Site Disposal Facility Monitoring—In 2009, every sampling horizon of each cell was sampled quarterly for 15 parameters. The leachate collection system (LCS) was sampled annually for Appendix I and polychlorinated biphenol (PCB) parameters. Flow data from the engineered facility coupled with the water quality monitoring results, and the results of quarterly disposal facility physical inspections, indicate that the facility performed as designed in 2009.

This chapter provides background information on the nature and extent of groundwater contamination in the Great Miami Aquifer due to past operations at the Fernald Preserve and summarizes aquifer restoration progress and groundwater monitoring activities and results for 2009.

Restoration of the affected portions of the Great Miami Aquifer and continued protection of the groundwater pathway are primary considerations in the groundwater remediation strategy for the Fernald Preserve. The groundwater pathway will continue to be monitored following remediation to ensure the protection of this primary exposure pathway.

3.1 Summary of the Nature and Extent of Groundwater Contamination

Groundwater Modeling at the Fernald Preserve

The Fernald Preserve uses a computer model to make predictions about how the concentration/location of contaminants in the aquifer will change over time. Because the model contains simplifying assumptions about the aquifer and the contaminants, the predictions about future behavior must be verified with laboratory analyses of groundwater samples collected during monitoring activities.

If groundwater monitoring data indicate the need for operational changes to the groundwater remedy, the groundwater model is run to predict the effect those changes might have on the aquifer and the contaminants. If the predictions indicate the proposed changes would increase cleanup efficiency and reduce the cleanup time and cost, the operational changes are made, and monitoring data are collected after the changes to verify whether model predictions were correct. If model predictions prove to be incorrect, modifications are made to the model to improve its predictive capabilities.

The nature and extent of groundwater contamination from operations at the Fernald site were investigated, and the risk to human health and the environment from those contaminants was evaluated in the Operable Unit 5 Remedial Investigation Report (DOE 1995b). As documented in that report, the primary groundwater contaminant at the site is uranium.

Groundwater contamination resulted from infiltration of contaminated surface water through the bed of Paddys Run, the storm sewer outfall ditch (SSOD), the Pilot Plant drainage ditch, and the Waste Storage Area ditch (previously located between the Plant 1 Pad and Paddys Run). In these areas, the glacial overburden is absent (eroded), creating a direct pathway between surface water and the sand and gravel of the aquifer. To a lesser degree, groundwater contamination also resulted where past excavations (such as the waste pits) removed some of the protective clay contained in the glacial overburden and exposed the aquifer to contamination.

3.2 Selection and Design of the Groundwater Remedy

While a remedial investigation and feasibility study was in progress and a groundwater remedy was being selected, off-property contaminated groundwater was being pumped from the South Plume area by the South Plume Removal Action System (referred to as the South Plume Module). In 1993, this system was installed south of Willey Road and east of Paddys Run Road to stop the uranium plume in this area from migrating any farther to the south. Figure 3−1 shows South Plume Module extraction wells 3924, 3925, 3926, and 3927. These extraction wells have successfully stopped further southern migration of the uranium plume beyond the wells and have contributed to significantly reducing total uranium concentrations in the off-property portion of the plume.

After the nature and extent of groundwater contamination was defined in the *Remedial Investigation Report for Operable Unit 5* (DOE 1995b), various remediation technologies were evaluated in the *Feasibility Study Report for Operable Unit 5* (DOE 1995c). Remediation cost, efficiency, and various land-use scenarios were considered during the development of the preferred remedy for restoring the quality of groundwater in the aquifer. The *Feasibility Study Report for Operable Unit 5* recommended a concentration-based, pump-and-treat remedy for the groundwater contaminated with uranium, consisting of 28 groundwater extraction wells located on and off property. Computer modeling suggested that the 28 extraction wells pumping at a combined rate of 4,000 gallons per minute (gpm) (15,140 liters per minute [Lpm]) would remediate the aquifer within 27 years.

The recommended groundwater remedy was presented to EPA, OEPA, and stakeholders in the *Proposed Plan for Operable Unit 5* (DOE 1995d) as the preferred groundwater remedy. Once the proposed plan was approved, the *Record of Decision for Remedial Actions at Operable Unit 5* (OU5 ROD) (DOE 1996) was presented to stakeholders and subsequently approved by EPA and OEPA in January 1996. The OU5 ROD formally defines the selected groundwater remedy and establishes FRLs for all constituents of concern.

Re-injection at the Fernald Site

From 1998 to 2004, re-injection was an enhancement to the groundwater remedy at the Fernald site, supplementing pump-and-treat operations. The term "well-based" refers to the injection of treated groundwater through specially designed re-injection wells. Groundwater pumped from the aquifer was treated via ion exchange to remove contaminants and then re-injected into the aquifer at strategic well locations. Because the treatment process was not 100 percent efficient, a small amount of uranium was re-injected into the aquifer with the treated water. The re-injected groundwater increased the speed at which dissolved contaminants moved through the aquifer and were pulled by extraction wells, thereby decreasing the overall remediation time. Based on updated groundwater modeling and the unfavorable results of a cost/benefit analysis, well-based re-injection was discontinued in 2004.

The OU5 ROD commits to an ongoing evaluation of innovative remediation technologies so that remedy performance can be improved as such technologies become available. As a result of this commitment, an enhanced groundwater remedy was presented in the Operable Unit 5 *Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)* (DOE 1997).

Groundwater modeling studies conducted to design the enhanced groundwater remedy suggested that, with the early installation of additional extraction wells and the use of re-injection technology, the remedy could potentially be reduced to 10 years. EPA and OEPA approved the enhanced groundwater remedy that relied on pump-and-treat and re-injection technology. The groundwater remedy included the use of well-based re-injection until September 2004.

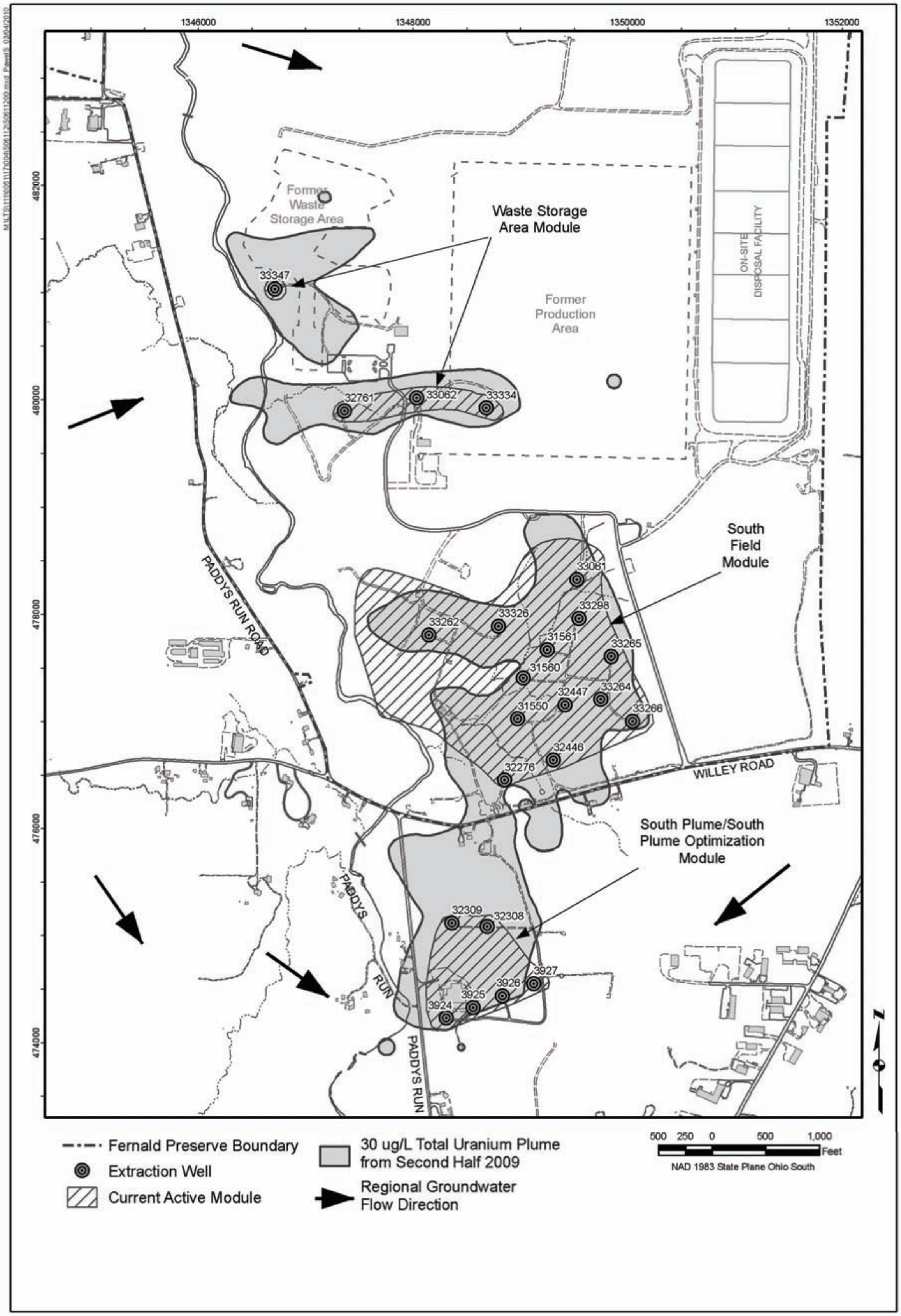


Figure 3–1. Extraction Wells Active in 2009

Evolution of the enhanced groundwater remedy has been documented through a series of approved designs. These designs are: The Operable Unit 5 *Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)* (DOE 1997), *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001c), *Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module* (DOE 2002a), *Comprehensive Groundwater Strategy Report* (DOE 2003), the *Groundwater Remedy Evaluation and Field Verification Plan* (DOE 2004), and the *Waste Storage Area Phase II Design Report* and Addendum (DOE 2005a).

The enhanced groundwater remedy commenced in 1998 with the startup of the South Field (Phase I), the South Plume Optimization, and the Re-injection Demonstration Modules. It focused primarily on the removal of uranium but was also designed to limit further expansion of the plume, achieve removal of all targeted contaminants to concentrations below designated FRLs, and prevent undesirable groundwater drawdown impacts beyond the site boundary. Startup of the enhanced groundwater remedy included a year-long re-injection demonstration that began in September 1998. Through the years, extraction and re-injection wells have been added to and removed from these initial restoration modules.

In 2001, EPA and OEPA approved the *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001c). Approval of this design initiated the installation of the next planned aquifer restoration module. The design specified three extraction wells in the Waste Storage Area to address contamination in the Pilot Plant drainage ditch plume (Phase I) and two extraction wells to address the remaining contamination after the waste pits excavation was completed (Phase II). One of the three Phase I Waste Storage Area wells was installed in 2000 to support an aquifer pumping test to help determine the restoration well field design. The remaining two Phase I wells were installed in summer 2001 after EPA and OEPA approved the design. All three wells became operational on May 8, 2002. One was abandoned in 2004 to facilitate site remediation work. A replacement well was installed and began operating in 2006.

The *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001c) also provided data indicating that the uranium plume in the former Plant 6 Area was no longer present. It was believed that the uranium concentrations in the plume had decreased to levels below the FRL as a result of plant operations shutting down in the late 1980s and the pumping of highly contaminated perched water as part of the Perched Water Removal Action No. 1 in the early 1990s. Because a uranium plume with concentrations above the groundwater FRL was no longer present in the former Plant 6 Area at the time of the design, a restoration module for the area was determined to be unnecessary. Groundwater monitoring continues in the former Plant 6 Area with one well in the area having sporadic total uranium FRL exceedances.

In 2002, EPA and OEPA approved the next planned groundwater restoration design document, the *Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module* (DOE 2002a). The Phase II design presents an updated interpretation of the uranium plume in the South Field area along with recommendations on how to proceed with remediation in the area, based on the updated plume interpretation. Installation of Phase II components was initiated in 2002. The overall system (Phases I and II) is referred to as the South Field Module.

In 2003, groundwater remediation approaches were evaluated to determine the most cost-effective groundwater remedy infrastructure, including the wastewater treatment facility, to remain after site closure. An evaluation of alternatives was presented in the *Comprehensive Groundwater Strategy Report* (DOE 2003). In October 2003, initial discussions were held with the regulators and the public concerning the various alternatives identified in the report. These discussions culminated in an identified path forward to work collaboratively with the Fernald Citizens Advisory Board, EPA, and OEPA to determine the most appropriate course of action for the ongoing aquifer restoration and water treatment activities at the Fernald site.

In 2004, a decision regarding the future aquifer restoration and wastewater treatment approach was made following regulatory and public input. In May, EPA and OEPA approved the decision to reduce the size of the advanced wastewater treatment facility; in June, they approved the decision to discontinue the use of well-based re-injection. Reducing the size of the advanced wastewater treatment facility provided the opportunity to dismantle and dispose of approximately 90 percent of the existing facility in the OSDF in time to meet the 2006 closure schedule. This resulted in a protective, more cost-effective, long-term water treatment facility to complete aquifer restoration. Well-based re-injection was discontinued in 2004 on the basis of groundwater modeling cleanup predictions presented in the *Comprehensive Groundwater Strategy Report* (DOE 2003) and the *Groundwater Remedy Evaluation and Field Verification Plan* (DOE 2004). The updated modeling indicated that the aquifer restoration time frame would likely be extended beyond dates previously predicted as a result of refined modeling input. The updated modeling also indicated that continued use of the groundwater re-injection wells would shorten the aquifer remedy by approximately 3 years. Therefore, the benefit of continuing re-injection did not justify the cost. Well-based re-injection was discontinued in September 2004 to support construction of the Converted Advanced Wastewater Treatment facility. All re-injection wells remain in place as potential groundwater remedy performance monitoring locations.

In 2005, the *Waste Storage Area Phase II Design Report* (DOE 2005a) was issued. Comments received from EPA and OEPA resulted in the issuance of an addendum to the report in December 2005. The design consisted of the installation of one more extraction well in the former Waste Storage Area, near the former silos area.

In 2005, an infiltration test was conducted in the SSOD. The test consisted of gauging the flow into and out of the SSOD with six Parshall flumes. This was done so that the overall infiltration rate along the SSOD could be obtained. Findings from the test were included in the *Storm Sewer Outfall Ditch Infiltration Test Report* (DOE 2005b). The decision was made that natural storm water flow into the SSOD will be supplemented with pumped clean groundwater.

The *Fernald Groundwater Certification Plan* (DOE 2006b) was issued and approved by EPA in 2005. OEPA approved Revision 2 of the plan in 2006. Revision 2 addressed comments that the OEPA had on the 2005 submittal. The certification plan defines a programmatic strategy for certifying completion of the aquifer remedy. It was developed through a series of four technical information exchange meetings held in 2005 among DOE, EPA, and OEPA. The *Fernald Groundwater Certification Plan* (DOE 2006b) identifies that the IEMP will continue to be the plan that includes remedy performance monitoring requirements.

In 2006, the Waste Storage Area Phase II Module components became operational, marking completion of the groundwater remediation system design. Completion of the Waste Storage Area

Phase II Module brought the total number of extraction wells in the former Waste Storage Area to four.

On December 14, 2006, the site began pumping clean groundwater from three existing construction wells located on the east side of the Fernald Preserve to the former SSOD. This water is being pumped as needed to maintain a flow of approximately 500 gpm (1,890 Lpm) into the former SSOD. Pumping will continue until the existing wells, pumps, or motors are no longer serviceable. At that time the operation will be suspended, pending a determination by DOE regarding the benefits to the aquifer remedy. Also, with the completion of site soil remediation, surface water runoff from portions of the Former Production Area is being directed to the former SSOD.

Figure 3–1 shows the extraction well locations that were active in 2009. The operational information associated with these modules is presented in the following subsections.

3.3 Groundwater Monitoring Highlights for 2009

For this annual site report, groundwater monitoring results are discussed in terms of restoration and compliance monitoring.

The key elements of the Fernald Preserve groundwater monitoring program design are described below.

- **Sampling**—Sample locations, frequency, and constituents address operational assessment, restoration assessment, and compliance requirements. Monitoring is conducted to ascertain groundwater quality and groundwater flow direction. Figure 3−2 shows a typical groundwater monitoring well at the site, and Figure 3−3 identifies the relative placement depths of groundwater monitoring wells at the site.

  As part of the comprehensive groundwater monitoring program specified in the current IEMP, approximately 140 wells were monitored for water quality in 2009. Figure 3−4 and Figure 3−5 identify the locations of the current water quality monitoring wells. In addition to water quality monitoring, approximately 178 wells were monitored quarterly for groundwater elevations to determine groundwater flow direction. Figure 3−6 depicts the routine water level (groundwater elevation) monitoring wells as specified in the current IEMP.

  Additionally, 14 locations were sampled using a direct-push sampling tool in 2009. Results are provided in Appendix A, Attachments A.2.

- **Data Evaluation**—The integrated data evaluation process involves review and analysis of the data collected from wells and direct-push sampling locations to determine capture and restoration of the uranium plume, capture and restoration of non-uranium FRL constituents, water quality conditions in the aquifer that indicate a need to modify the design and installation of restoration modules, and the impact of ongoing groundwater restoration on the Paddys Run Road Site plume (a separate contaminant plume unrelated to the Fernald Preserve, resulting from industrial activities in the area located south of the Fernald Preserve along Paddys Run Road).

- **Reporting**—All data are reported in the annual Site Environmental Reports.

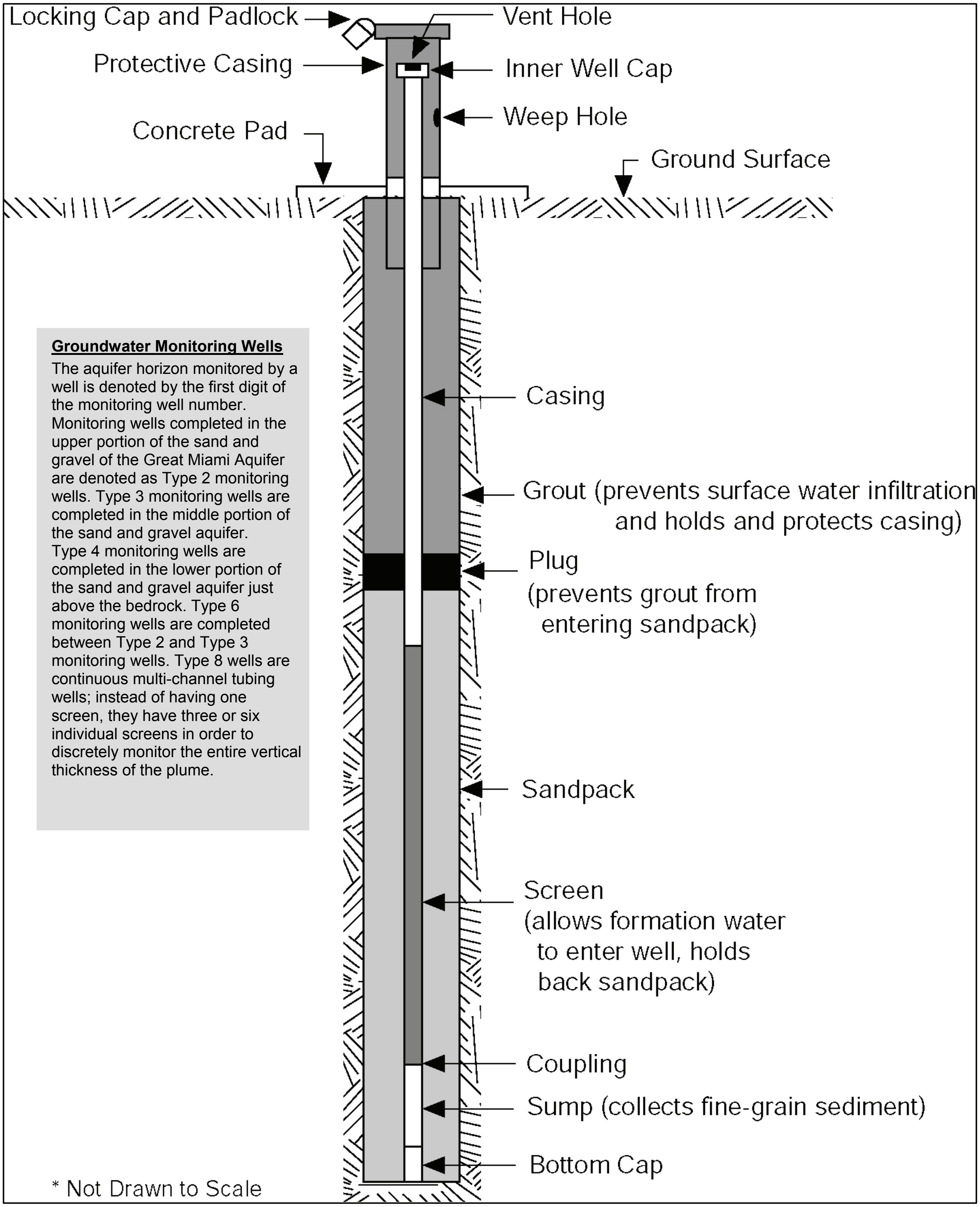


Figure 3–2. Diagram of a Typical Groundwater Monitoring Well

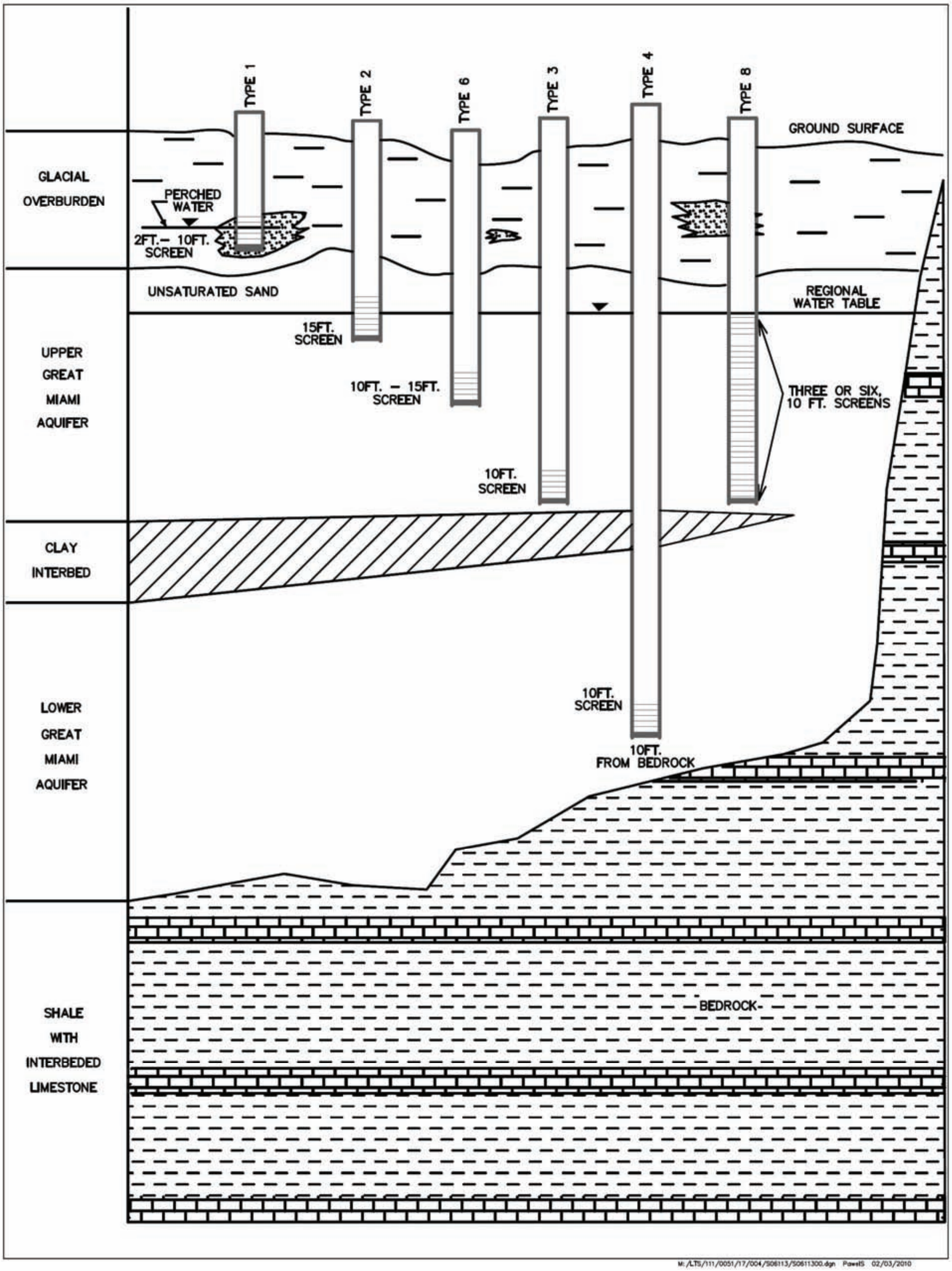


Figure 3–3. Monitoring Well Relative Depths and Screen Locations

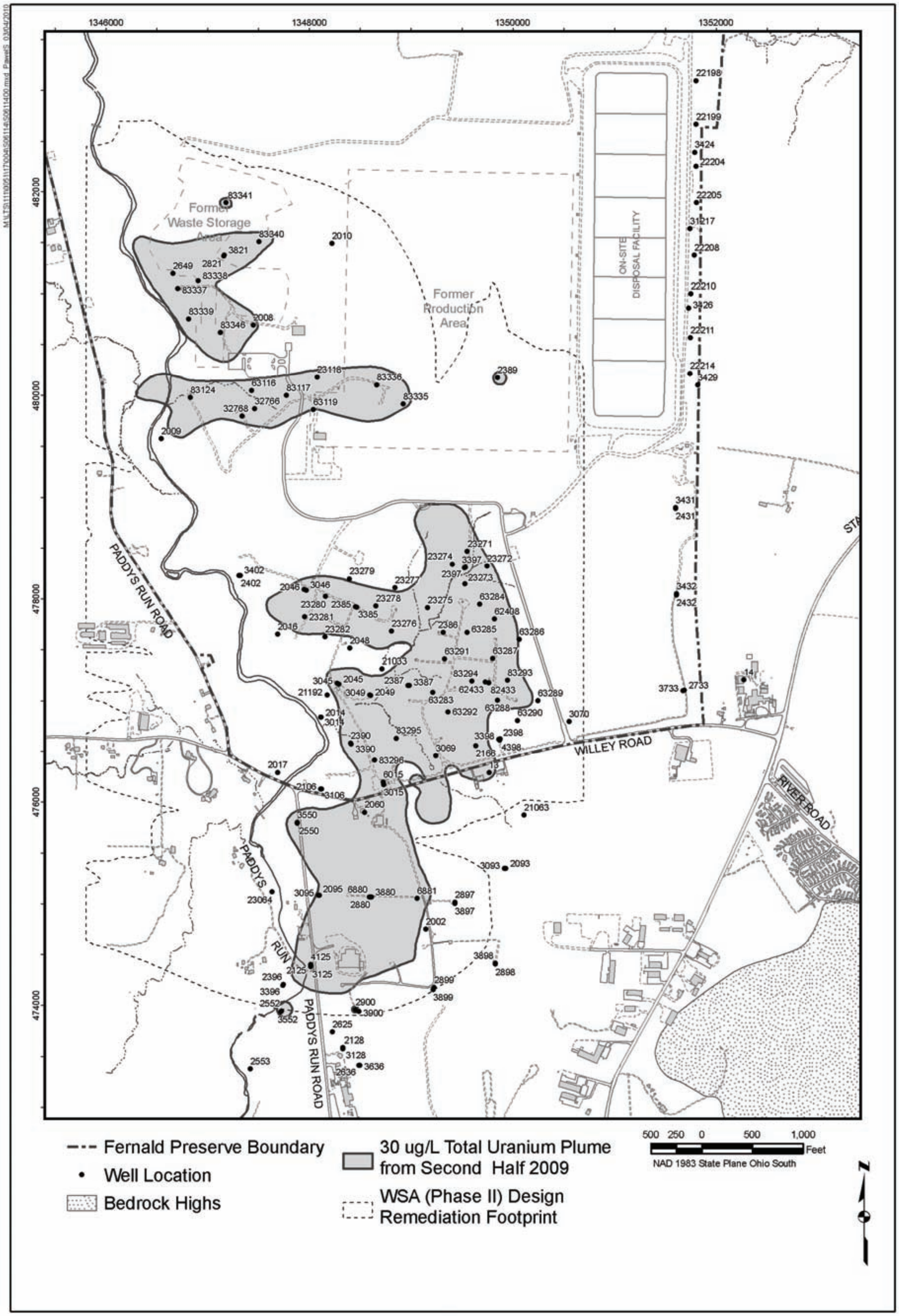


Figure 3–4. Locations for Semiannual Total Uranium Monitoring

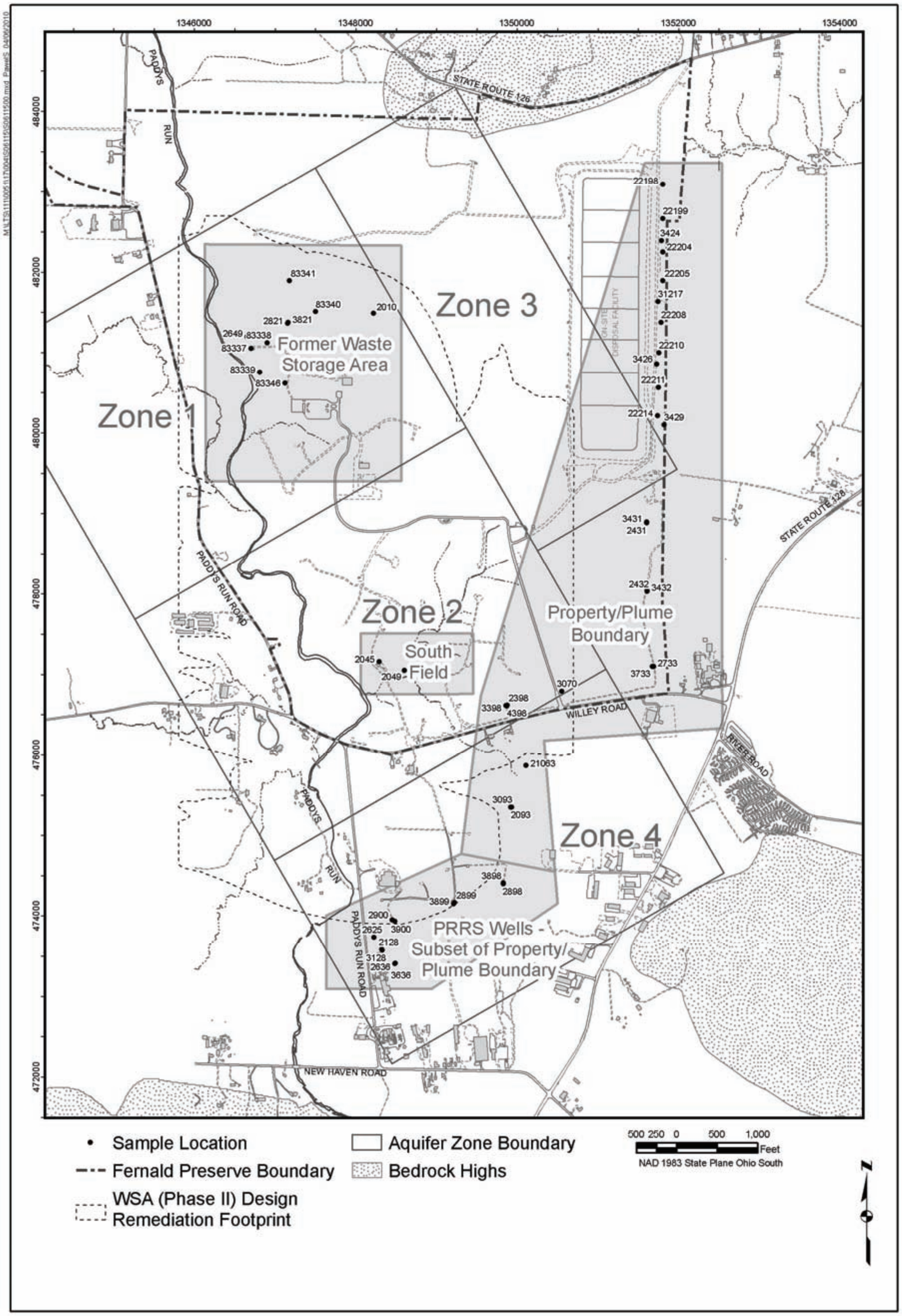


Figure 3–5. Locations for Semiannual Non-Uranium Monitoring

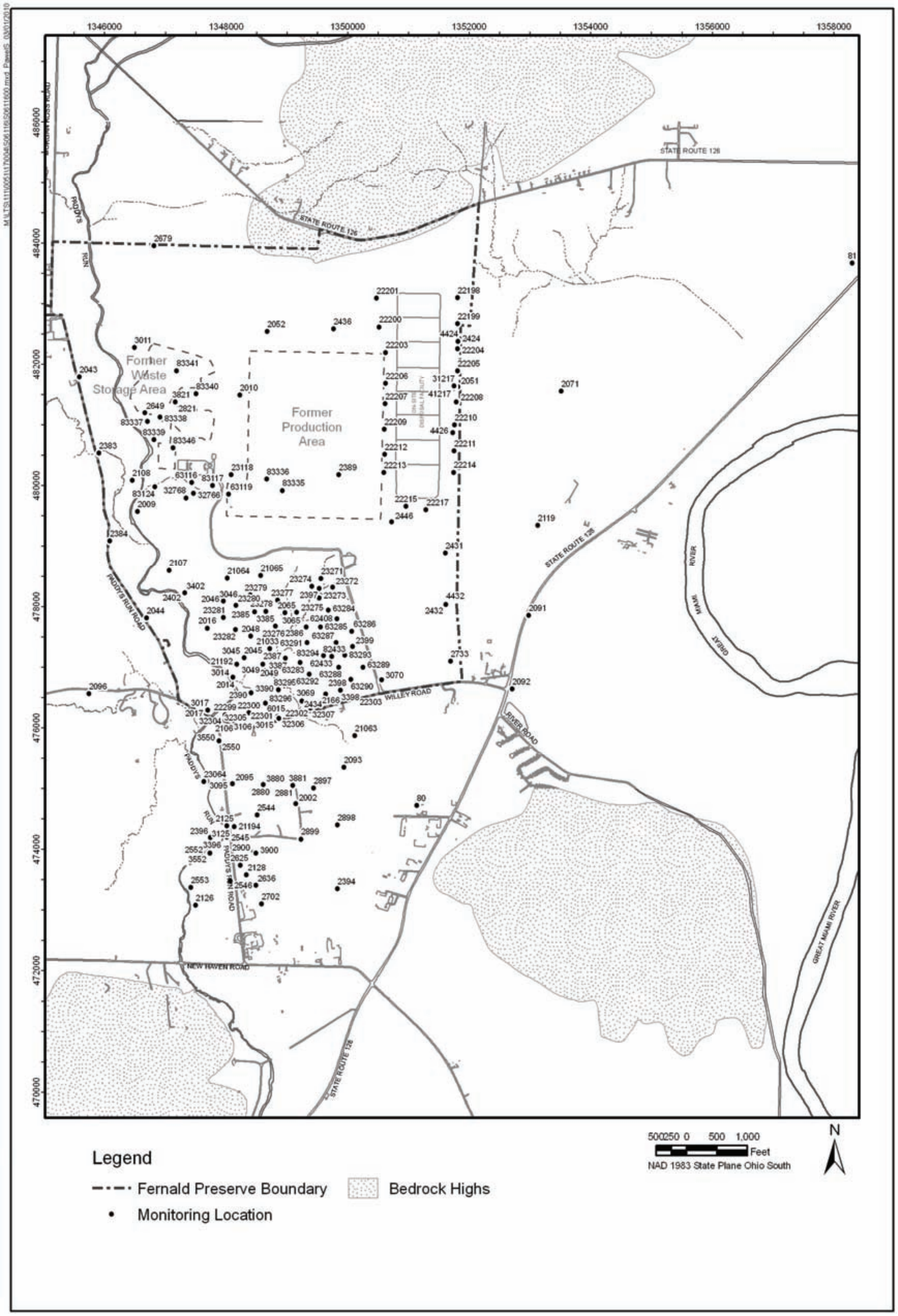


Figure 3–6. IEMP Groundwater Elevation Monitoring Wells

3.3.1 Restoration Monitoring

In general, restoration monitoring tracks the progress of the pump-and-treat stage of the groundwater remedy and water quality conditions. All operational modules are evaluated during the year to determine the progress of aquifer remediation. Uranium concentration maps are developed from analytical data and compared with groundwater elevation maps depicting the location of capture zones.

Appendix A provides more-detailed information. Sections that follow identify the specific attachment of Appendix A where the detailed information can be found.

3.3.1.1 Operational Summary

Figure 3−1 shows the extraction well locations associated with the restoration modules operating in 2009. Table 3−1 summarizes the mass of uranium removed and the volume of groundwater pumped during 2009. Unplanned operational disruptions in 2009 were minimal. Additional details are provided in the module operational summaries in Sections 3.3.1.2 through 3.3.1.4. Figure 3−7 identifies the yearly and cumulative mass of uranium removed from the Great Miami Aquifer from 1993 through 2009.

Table 3–1. Groundwater Restoration Module Status for 2009

Modules and Restoration Wells	Target Pumping		Volume Pumped (Millions)		Uranium Removed	
	gpm	Lpm	gallons	liters	lb	kg
South Plume/ South Plume Optimization Module: 3924, 3925, 3926, 3927, 32308, 32309	1,200	4,542	638	2,415	114	52
South Field Module: 31550, 31560, 31561, 32276, 32446, 32447, 33061, 33262, 33264, 33265, 33266, 33298, 33326	2,575	9,746	1,305	4,939	371	168
Waste Storage Area Module: 32761, 33062, 33334, 33347	1,000	3,785	503	1,904	100	45
Aquifer Restoration System Total Pumped	4,775	18,073	2,446	9,258	585	265

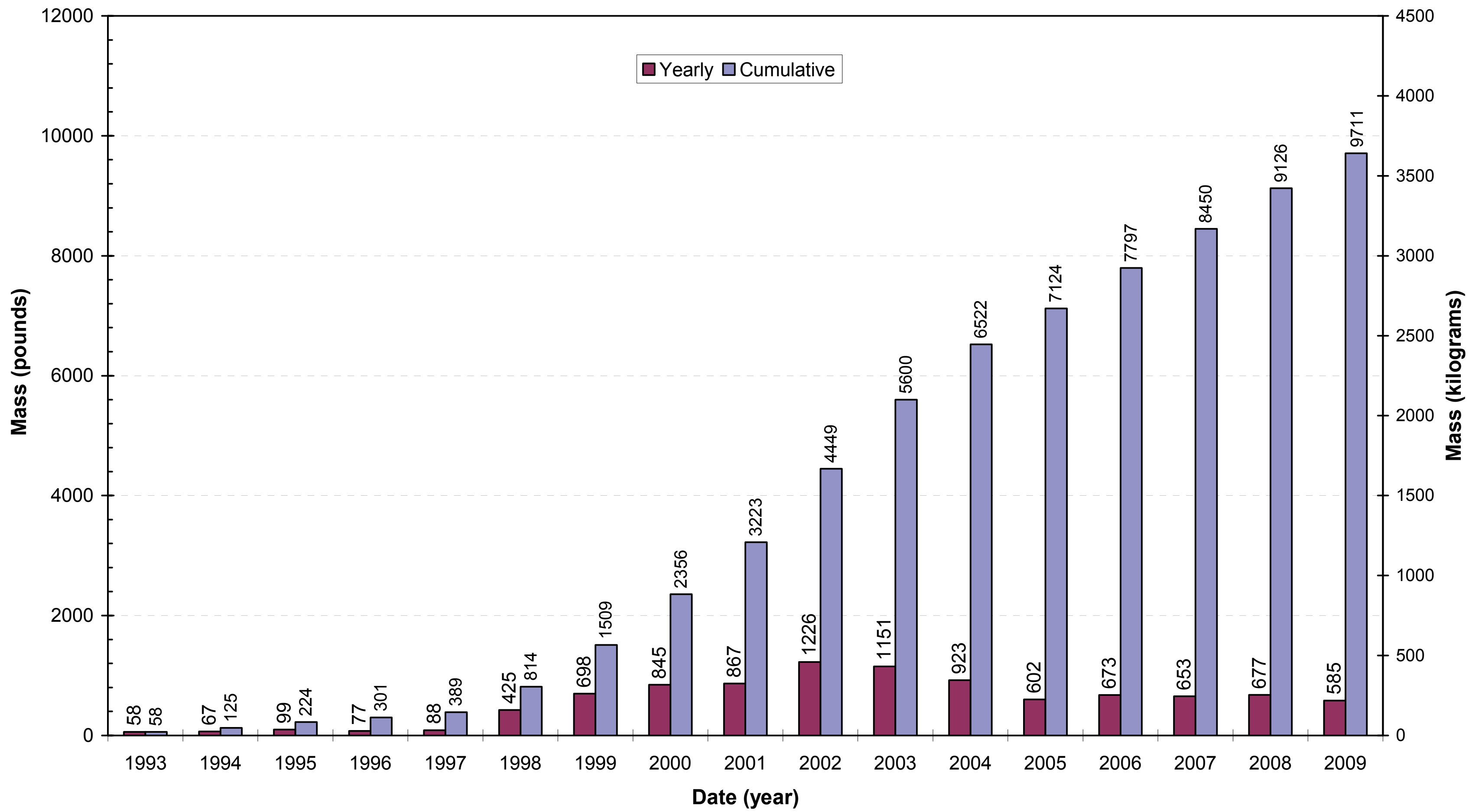


Figure 3–7. Net Mass of Uranium Removed from the Great Miami Aquifer, 1993–2009

Since 1993:

- 27,365 M gal (103,577 M liters) of water have been pumped from the Great Miami Aquifer.
- 1,936 M gal (7,328 M liters) of treated water have been re-injected into the Great Miami Aquifer.
- 9,711 net lb (4,409 kg) of total uranium have been removed from the Great Miami Aquifer.

Appendix A, Attachment A.1, provides detailed operational information on each extraction well. The following sections provide an overview of the individual modules.

3.3.1.2 South Plume/South Plume Optimization Module Operational Summary

The four extraction wells (3924, 3925, 3926, and 3927) of the South Plume Module began operating in August 1993. The two extraction wells (32308 and 32309) of the South Plume Optimization Module began operating in August 1998. Figure 3−8 illustrates the southern extent of capture observed for the South Plume/South Plume Optimization Module in the fourth quarter of 2009.

During 2009, 638 M gal (2,415 M liters) of groundwater and 114 lb (52 kg) of uranium were removed from the Great Miami Aquifer by the South Plume/South Plume Optimization Module. Based on analysis of the data collected in 2009, the module continues to meet its primary objectives as demonstrated by the following:

- Southward movement of the uranium plume beyond the southernmost extraction wells has not been detected.
- Active remediation of the central portion of the off-property uranium plume continues to reduce plume concentration. Direct-push sampling in 2009 indicated that the off-property footprint of the 50 µg/L total uranium plume decreased by approximately 16 acres from what was mapped in 2008. Nearly the entire off-property uranium plume concentration is now below 100 µg/L. When pumping began in 1993, areas in the off-property uranium plume had concentrations over 300 µg/L.
- Paddys Run Road Site plume, located south of the extraction wells, is not being adversely affected by the pumping.

3.3.1.3 South Field Module Operational Summary

The South Field Module was constructed in two phases. Phase I began operating in July 1998, and Phase II began operating in July 2003. During 2009, 13 extraction wells were operational.

The 10 original extraction wells installed under Phase I were 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276. Six of the original 10 wells have been shut down (31564, 31565, 31566, 31563, 31562, and 31567).

- Extraction wells 31564 and 31565 were shut down in December 2001 and May 2001, respectively, because these wells were located near the upgradient edge of the plume, uranium concentrations in that region of the aquifer were low, and soil remediation was under way in the area around the wells.

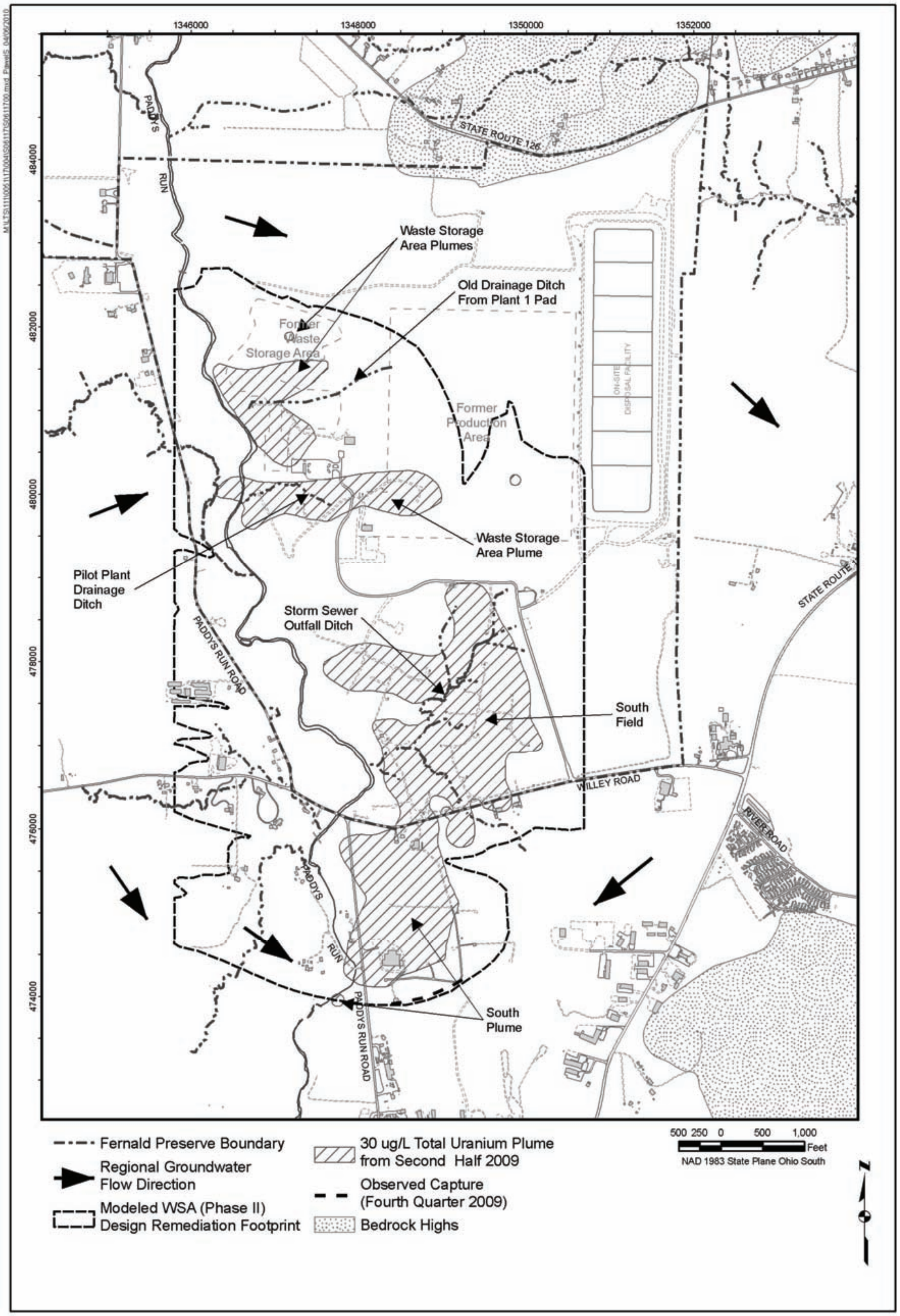


Figure 3–8. Total Uranium Plume in the Aquifer with Concentrations Greater Than 30 µg/L at the End of 2009

- Extraction well 31566 was shut down in August 1998 and was replaced by extraction well 33262, which was installed as part of South Field (Phase II) Module.
- Extraction well 31563 was shut down in December 2002 and converted to a re-injection well that operated in 2003 and 2004.
- Extraction well 31562 was shut down in March 2003 and replaced by extraction well 33298.
- Extraction well 31567 was shut down in September 2005 and replaced by extraction well 33326.

Three new extraction wells (32446, 32447, and 33061) were added to the South Field Module between 1998 and 2002. These new wells were installed in the eastern, downgradient portion of the South Field plume, at locations where total uranium concentrations were considerably above the FRL. Two of these three wells (32446 and 32447) were installed in late 1999 and began pumping in February 2000. The third extraction well (33061) was installed in 2001 and became operational in 2002.

Phase II components of the South Field Module are described in the *Design for Remediation of the Great Miami Aquifer, South Field (Phase II) Module* (DOE 2002a), which was issued in May 2002. The design provides an updated characterization of the uranium plume in the Great Miami Aquifer beneath the southern portion of the site and a modeled design for the South Field Module located in that area. All Phase II design components became operational in 2003. The components include:

- Four additional extraction wells, one in the former Southern Waste Units area (extraction well 33262) and three along the eastern edge of the on-property portion of the southern uranium plume (extraction wells 33264, 33265, and 33266).
- One additional re-injection well in the former Southern Waste Units area (re-injection well 33263).
- An extraction well (31563) that was converted into a re-injection well.
- An injection pond that was located in the western portion of the former Southern Waste Units excavations.

South Field Module re-injection components were shut down in September 2004.

During 2009, 1,305 M gal (4,939 M liters) of groundwater and 371 lb (168 kg) of uranium were removed from the Great Miami Aquifer by the South Field Module.

3.3.1.4 Waste Storage Area Module Operational Summary

The Waste Storage Area Module was constructed in two phases. Phase I became operational on May 8, 2002, nearly 17 months ahead of the October 1, 2003, start date established in the Operable Unit 5 Remedial Action Work Plan. Phase I consisted of three extraction wells (32761, 33062, and 33063). These three wells were installed to remediate a uranium plume in the Pilot Plant drainage ditch area, according to the *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001c). In July 2004, extraction well 33063 was plugged and abandoned to make way for surface excavation activities required for site remediation. A replacement well for extraction well 33063 was installed in 2005 (extraction well 33334) and became operational June 29, 2006. Phase II consisted of one additional extraction well (extraction well 33347), which became operational on October 5, 2006.

During 2009, 503 M gal (1,904 M liters) and 100 lb (45 kg) of uranium were removed from the Great Miami Aquifer through the Waste Storage Area Module.

3.3.1.5 Monitoring Results for Total Uranium

The Waste Storage Area (Phase II) Design remediation footprint illustrates how far a particle of water will travel in response to pumping over the 16-year time period modeled for the Waste Storage Area (Phase II) Design.

Total uranium is the primary FRL constituent because it is the most prevalent site contaminant, and it has affected the largest area of the aquifer. Figure 3−8 shows general groundwater flow directions observed during the fourth quarter of 2009 and the interpretation of the uranium plume in the aquifer updated through the end of 2009. The shaded areas represent the interpreted size of the maximum uranium plume that is above the 30 µg/L groundwater FRL for total uranium. At the end of 2009, approximately 186 acres (75 hectares) of the Great Miami Aquifer were contaminated above the 30 µg/L groundwater FRL for total uranium. Capture observed during the fourth quarter of 2009 for the active restoration modules is also identified in Figure 3−8. The map indicates that the South Plume is being captured by the existing system and that further movement of uranium to the south of the extraction wells is being prevented. Figure 3−8 also depicts the time-of-travel remediation footprint that was predicted by modeling the Waste Storage Area (Phase II) Remediation Design.

Appendix A, Attachment A.2, provides individual monitoring well total uranium results and detailed uranium plume maps for 2009. Appendix A, Attachment A.3, provides quarterly groundwater elevation maps and capture interpretations, along with graphical displays of groundwater elevation data. Highlights for 2009 for the former Waste Storage Area, former Plant 6 Area, and South Field/South Plume area are provided below.

Geoprobe (Direct-Push Sampling)

The Geoprobe, a hydraulically powered, direct-push sampling tool, is used at the Fernald Preserve to obtain groundwater samples at specific intervals without installing a permanent monitoring well. Direct-push means that the tool employs the weight of the vehicle it is mounted on and percussive force (hammering) to push into the ground without drilling (or cutting) to displace soil in the tool's path. The Fernald Preserve uses this technique to collect data on the progress of aquifer restoration and to determine the optimal location and depth of additional monitoring and extraction wells that may be installed in the future.

Former Waste Storage Area—In 2009 no direct-push sampling was conducted in the former Waste Storage Area to supplement routine sampling of monitoring wells.

Data are presented in Appendix A, Attachment A.2. Figure 3−8, shows the outline of the maximum uranium plumes in the former Waste Storage Area.

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

Monitoring well 2389 is the only well remaining in the area. Sporadic uranium FRL exceedances have been detected at this well since 2002. In 2009, no groundwater FRL exceedances were measured at monitoring well 2389.

South Field and South Plume Areas—The mapped footprint of the South Field/South Plume Maximum Uranium Plume was 137.05 acres in 2009, reduced slightly from the size defined in 2008 (137.9 acres). Direct-push sampling was conducted at 14 locations (one on the east edge of the uranium plume in the south field, five along Willey Road, and eight in the off-property South Plume). Details for 2009 are presented in Appendix A, Attachment A.2.

3.3.1.6 Monitoring Results for Non-Uranium Constituents

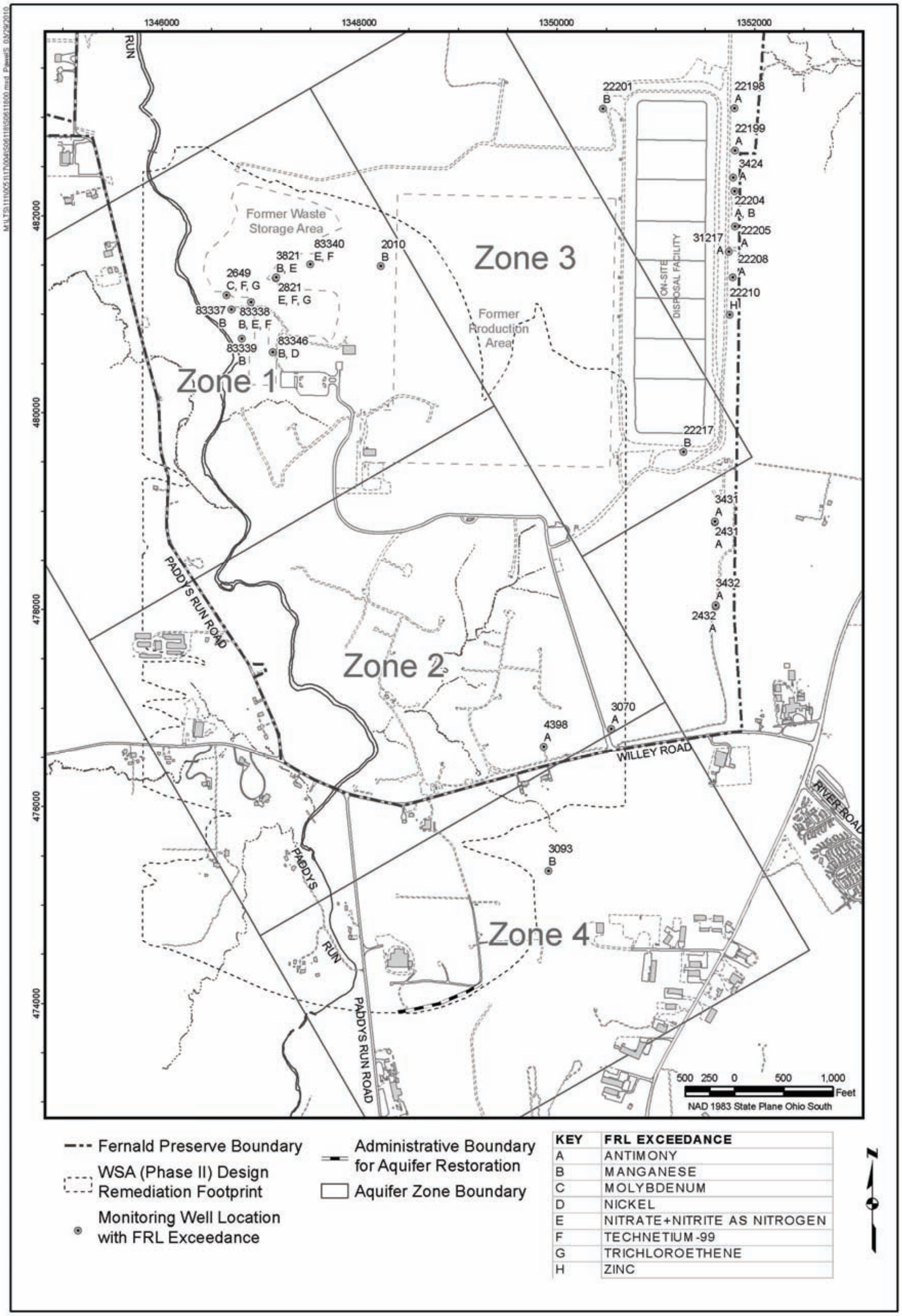
Although the groundwater remedy is primarily targeting remediation of the uranium plume, other FRL constituents within the uranium plume are also being monitored. Figure 3−9 identifies the locations of the wells that had non-uranium FRL exceedances. Table 3−2 shows the number of wells with constituents exceeding FRLs in 2009, the number of wells with constituents exceeding FRLs outside the Waste Storage Area (Phase II) remediation footprint, the groundwater FRLs, and the range of 2009 data inside and outside the Waste Storage Area (Phase II) remediation footprint.

Table 3–2. Non-Uranium Constituents with Results Above FRLs During 2009

Constituent	Number of Wells Exceeding the FRL	Number of Wells Exceeding the FRL Outside the Waste Storage Area (Phase II) Remediation Footprint	Groundwater FRL	Range of 2009 Data Inside the Waste Storage Area (Phase II) Remediation Footprint[a]	Range of 2009 Data Outside the Waste Storage Area (Phase II) Remediation Footprint[a]
General Chemistry			(mg/L)	(mg/L)	(mg/L)
Nitrate/Nitrite	7	0	11[b]	0.01 to 171	NA
Inorganics					
Antimony	13	11	0.0060	0.00005 to 0.0118	0.000032 to 0.0109
Manganese	11	4	0.90	0.001 to 2.96	0.0322 to 2.06
Molybdenum	1	0		0.178 to 0.434	
Nickel	1	0	0.10	0.01 to 0.109	NA
Zinc	1	1	0.021	NA	0.0087 to 0.0222
Volatile Organics			(µg/L)	(µg/L)	(µg/L)
Trichloroethene	2	0	5.0	0.125 to 10.1	NA
Radionuclides			(pCi/L)	(pCi/L)	(pCi/L)
Technetium-99	7	0	94	0.253 to 313	NA

[a]NA = not applicable
[b]FRL based on nitrate, from OU5 ROD, Table 9−4; however, the sampling results are for nitrate/nitrite.

During 2009, non-uranium FRL exceedances were observed at 26 monitoring wells as shown in Figure 3−9. A total of eight non-uranium FRL constituents exceeded FRLs in monitoring wells in 2009.



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

Figure 3–9. Non-Uranium Constituents with 2009 Results Above FRLs

Several of the locations are outside the Waste Storage Area (Phase II) remediation footprint. No plumes for the non-uranium constituents above FRLs at the locations outside the Waste Storage Area (Phase II) remediation footprint were identified in the extensive groundwater characterization efforts evaluated as part of the *Remedial Investigation Report for Operable Unit 5* (DOE 1995b).

Non-uranium constituents with FRL exceedances at the well locations outside the Waste Storage Area (Phase II) remediation footprint were further evaluated to determine if they were random events or if they were persistent according to criteria discussed in Appendix A, Attachment A.4. One of the exceedances in 2009 is classified as persistent (manganese at monitoring well 22204). Manganese concentrations have exceeded the FRL at this location since 2004. In past years, many of the exceedances identified as persistent became nonpersistent in later years. A change in the design of the aquifer remedy to address the exceedance at monitoring well 22204 is not planned. Additional sampling for manganese near the OSDF was conducted in 2008 (and reported in the 2008 SER) to determine if a localized manganese plume was present. Results did not support the presence of a localized manganese plume.

3.3.2 Other Monitoring Commitments

Two other groundwater monitoring activities are included in the IEMP: private well monitoring and property boundary monitoring. As stated earlier, the groundwater data from these activities, along with the data from all other IEMP groundwater monitoring activities, are collectively evaluated for total uranium and, where necessary, non-uranium constituents of concern. The discussion that follows provides additional details on the two compliance monitoring activities.

The three private wells (monitoring wells 2060, 13, and 14) located along Willey Road are monitored under the IEMP to assist in the evaluation of the uranium plume migration (for well locations, refer to Figure 2−2 in Chapter 2). Off-property groundwater contamination was initially detected at one of these wells (Well 2060) in 1981. In 1997 a DOE-sponsored public water supply became available to Fernald site neighbors who were affected by off-property groundwater contamination. The availability of the public water supply resulted in the discontinuation of monitoring at many private wells in off-property areas. Data from the three private wells sampled under the IEMP were incorporated into the uranium plume map shown in Figure 3−8.

During 2009, Property/Plume Boundary monitoring consisted of 36 monitoring wells located downgradient of the Fernald Preserve, along the eastern and southern portions of the property boundary. Twenty-five of these wells were monitored along the eastern Fernald Preserve boundary and slightly downgradient of the South Plume to determine if contaminants were migrating off site. Eleven of these wells were sampled in the Paddys Run Road area to document the influence, or lack thereof, that pumping in the South Plume was having on the Paddys Run Road Site plume. Data from the Property/Plume Boundary wells were integrated with other groundwater data for 2009 and were incorporated into the uranium plume maps shown in Figure 3−8 and in Attachment A.2. Non-uranium data from these wells are included in Section 3.3.1.6.

As indicated in Chapter 2, OEPA issued the Director's Findings and Orders on September 7, 2000. These orders specify that the site's groundwater monitoring activities will be implemented in accordance with the IEMP. The revised language allows modification of the groundwater monitoring program as necessary, via the IEMP revision process (subject to OEPA approval), without issuance of a new Director's Order. As determined by OEPA, the IEMP will remain in effect following remediation.

3.4 OSDF Monitoring

Monitoring of the OSDF is conducted in the LCS, leak detection system (LDS), glacial till (perched water), and the Great Miami Aquifer. Figure 3−10 identifies the OSDF footprint and monitoring well locations for Cells 1 through 8. Both flow and water quality are monitored within the facility. Data collected in 2009 indicate that the liner systems are performing well within the specification outlined in the approved facility design.

Table 3−3 summarizes the groundwater, LCS, and LDS monitoring information for Cells 1 through 8 of the OSDF, by providing the range of total uranium concentrations measured.

Concentrations of three non-uranium constituents (antimony, manganese, and zinc) exceeded FRLs in OSDF aquifer monitoring wells in 2009. For additional information on non-uranium groundwater FRL exceedances and on the groundwater, LDS, and LCS sampling results for the OSDF, refer to Appendix A, Attachments A.4 and A.5.

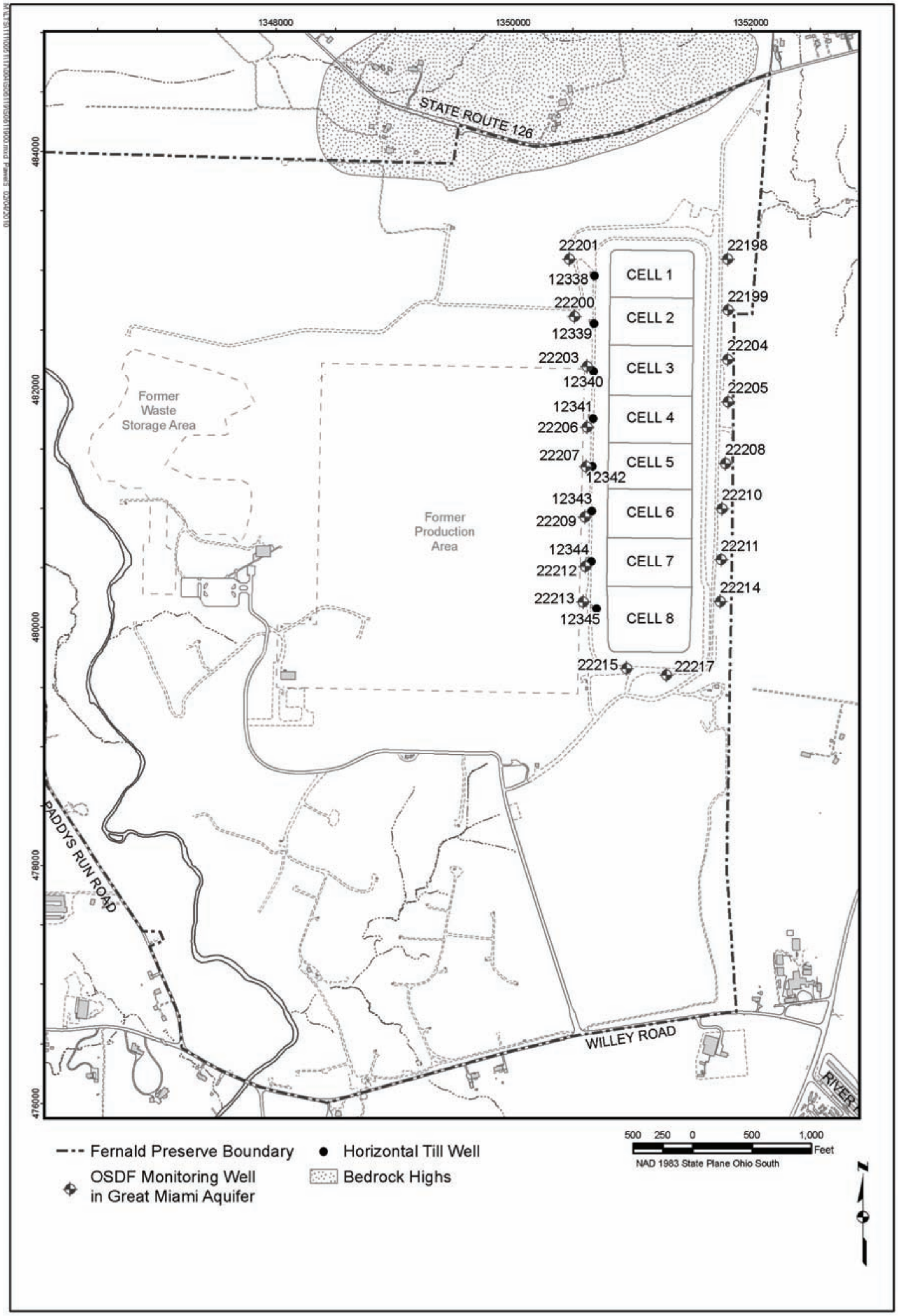


Figure 3–10. OSDF Footprint and Monitoring Well Locations

Table 3–3. OSDF Groundwater, Leachate, and LDS Monitoring Summary

Cell (Waste Placement Start Date)	Monitoring Location	Monitoring Zone	Date Sampling Started	Total # Samples	Range of Total Uranium Concentrations[a] (µg/L)
Cell 1 (Dec. 1997)	12338C	LCS	Feb. 17, 1998	47	ND–142
	12338D	LDS	Feb. 18, 1998	36	1.5–24.4
	12338	Glacial Till	Oct. 30, 1997	67	ND–19
	22201	Great Miami Aquifer	Mar. 31, 1997	62	ND–8.33
	22198	Great Miami Aquifer	Mar. 31, 1997	93	0.577–15.2
Cell 2 (Nov. 1998)	12339C	LCS	Nov. 23, 1998	43	4.51–197
	12339D	LDS	Dec. 14, 1998	20	4.08–22.3[b]
	12339	Glacial Till	Jun. 29, 1998	66	ND–36.9
	22200	Great Miami Aquifer	Jun. 30, 1997	57	ND–1.11
	22199	Great Miami Aquifer	Jun. 25, 1997	68	ND–12.1
Cell 3 (Oct. 1999)	12340C	LCS	Oct. 13, 1999	40	9.27–91.9
	12340D	LDS	Aug. 26, 2002	20	8.9–27.7[b]
	12340	Glacial Till	Jul. 28, 1998	59	ND–58.5
	22203	Great Miami Aquifer	Aug. 24, 1998	55	ND–7.92
	22204	Great Miami Aquifer	Aug. 24, 1998	67	ND–19.2
Cell 4 (Nov. 2002)	12341C	LCS	Nov. 04, 2002	26	4.41–171
	12341D	LDS	Nov. 04, 2002	27	5.74–21.3
	12341	Glacial Till	Feb. 26, 2002	39	4.89–7.91
	22206	Great Miami Aquifer	Nov. 06, 2001	43	ND–5.78
	22205	Great Miami Aquifer	Nov. 05, 2001	54	0.446–19.7
Cell 5 (Nov. 2002)	12342C	LCS	Nov. 04, 2002	28	3.39–285
	12342D	LDS	Nov. 04, 2002	26	2.93–27.1
	12342	Glacial Till	Feb. 26, 2002	40	7.45–21.1
	22207	Great Miami Aquifer	Nov. 06, 2001	43	ND–4.48
	22208	Great Miami Aquifer	Nov. 05, 2001	56	ND–2.1
Cell 6 (Nov. 2003)	12343C	LCS	Oct. 27, 2003	25	8.03–197
	12343D	LDS	Oct. 27, 2003	24	3.1–29.5
	12343	Glacial Till	Mar. 14, 2003	32	ND–24.2
	22209	Great Miami Aquifer	Dec. 16, 2002	38	ND–2.43
	22210	Great Miami Aquifer	Dec. 16, 2002	48	ND–1.02
Cell 7 (Sep. 2004)	12344C	LCS	Sep. 02, 2004	21	4.72–355
	12344D	LDS	Sep. 02, 2004	20	12.2–33.7
	12344	Glacial Till	Feb. 24, 2004	30	0.674–8.61
	22212	Great Miami Aquifer	Jan. 21, 2004	31	ND–4.46
	22211	Great Miami Aquifer	Jan. 21, 2004	38	ND–3.21
Cell 8 (Dec. 2004)	12345C	LCS	Oct. 18, 2004	20	1.51–228
	12345D	LDS	Oct. 18, 2004	19	9.38–36.4
	12345	Glacial Till	May 19, 2004	20	3.48–7.3
	22213	Great Miami Aquifer	Mar. 31, 2004	30	ND–0.589
	22214	Great Miami Aquifer	Mar. 31, 2004	38	ND–1.53
	22215	Great Miami Aquifer	Aug. 22, 2005	21	ND–0.77
	22217[c]	Great Miami Aquifer	Aug. 22, 2005	20	ND–15.1

[a]ND = not detected
[b]Some data are not considered representative of true LDS uranium concentrations in Cell 2 (December 14, 1998, through May 23, 2000, data set) due to malfunction in the Cell 2 leachate pipeline and the resulting mixing of individual flows. Additionally, it is suspected that some November 2004 samples (i.e., 12339C and 12339D, 12340C, and 12340D) were switched. If data from these events were included above, the maximum total uranium concentrations would be 71 µg/L for 12339D and 72.4 µg/L for 12340D.
[c]Monitoring location 22216 was plugged and abandoned in April 2006. Monitoring location 22217 is its replacement. The results listed for location 22217 also include the results for location 22216.

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