3.0 Groundwater Pathway

Results in Brief: 2002 Groundwater Pathway

Enhanced Groundwater Remedy – During 2002 active restoration of the Great Miami Aquifer continued at the following four groundwater restoration modules:

- South Plume Module, which became operational on August 27, 1993.
- South Field Extraction (Phase I) Module, which became operational on July 13, 1998.
- South Plume Optimization Module, which became operational on August 9, 1998.
- Re-Injection Module, which became operational on September 2, 1998.

Additionally, pumping for the Waste Storage Area (Phase I) Module, which is comprised of three extraction wells, was initiated on May 8, 2002.

Since 1993

- 11,812 million gallons (44,708 million liters) of water have been pumped from the Great Miami Aquifer.
- 1,247 million gallons (4,720 million liters) of water have been re-injected into the Great Miami Aquifer.
- 4,448 net pounds (2,019 kg) of total uranium have been removed from the Great Miami Aquifer.

During 2002

- 2,287 million gallons (8,656 million liters) of water were pumped from the Great Miami Aquifer.
- 241 million gallons (912 million liters) of water were re-injected into the Great Miami Aquifer.
- 1,225 net pounds (556 kg) of total uranium were removed from the Great Miami Aquifer.

Groundwater Monitoring Results – Groundwater sampling data in the South Field Module area continue to indicate total uranium concentration reductions in the western portion of the plume. These reductions are attributed to surface source removal, flushing of the contaminants toward the extraction wells by infiltrating surface water, re-injection of treated groundwater, and pumping of the extraction wells. However, in the eastern portion of the South Field Module, some monitoring wells still show steady or increasing total uranium concentrations. Additional extraction wells were installed in this portion of the plume in 2002 as part of the South Field Phase II Module and pumping will begin in 2003. One extraction well was installed as part of the South Field Phase I Module and pumping was initiated in May 2002.

IEMP Program Changes – Groundwater sampling frequencies were changed from quarterly to semi-annually in July 2002. Additional groundwater monitoring program changes were incorporated into the IEMP, Revision 3 for implementation in January of 2003.

On-Site Disposal Facility Monitoring – The Technical Memorandum for Cells 1, 2, and 3 Baseline Conditions was issued and approved by EPA and OEPA in 2002. Modified sampling protocol for Cells 1 through 3 were approved and initiated in the second half of 2002. Baseline sampling for Cells 4 and 5 continued and was initiated in Cell 6 Great Miami Aquifer wells in December 2002. Waste placement in Cells 4 and 5 was initiated in November 2002.

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 site and summarizes:

- Significant achievements realized by the Operable Unit 5 Aquifer Restoration and Wastewater Project in 2002.
- Groundwater monitoring activities and results for 2002.

Restoration of the affected portions of the Great Miami Aquifer and continued protection of the groundwater pathway are primary considerations in the accelerated remediation strategy for the Fernald site. The FCP will continue to monitor the groundwater pathway throughout 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 Site

The Fernald site uses computer models to make predictions about how the contaminants in the aquifer will look in the future. Because the model contains simplifying assumptions about the aquifer and the contaminants, the predictions about future behavior must be verified with field measurements obtained from groundwater 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 have been investigated, and the risk to human health and the environment from those contaminants has been evaluated in the Operable Unit 5 Remedial Investigation Report. As documented in that report, the primary groundwater contaminant at the site is uranium. Approximately 170 acres (69 hectares) of the Great Miami Aquifer are currently contaminated above the 30 µg/L groundwater FRL for total uranium.

Contamination of the groundwater resulted from infiltration through the bed of Paddys Run, the Storm Sewer Outfall Ditch, and the Pilot Plant Drainage Ditch. In these areas, the glacial overburden is eroded, and the sand and gravel of the aquifer are in direct contact with uranium-contaminated surface water from the site. 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

After the nature and extent of groundwater contamination were defined, various remediation technologies were evaluated in the Feasibility Study Report for Operable Unit 5 (DOE 1995a). Remediation cost, efficiency, and various land-use scenarios were considered during the development of the preferred remedy for restoring the quality of the groundwater in the aquifer.

The Operable Unit 5 Feasibility Study Report recommended a pump-and-treat remedy for the groundwater contaminated with uranium. The remedy consisted 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) (15,000 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 1995b).

Once the preferred groundwater remedy was identified and approved in the Operable Unit 5 Proposed Plan, the Operable Unit 5 Record of Decision was presented to stakeholders and subsequently approved by EPA and OEPA in January 1996. The Operable Unit 5 Record of Decision formally defined the selected groundwater remedy and established FRLs for all constituents of concern. The Operable Unit 5 Record of Decision committed to ongoing evaluation of innovative remediation technologies so that remedy performance could 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 1997a).

The enhanced groundwater remediation strategy, which relies on pump-and-treat and re-injection technology, is being used to conduct a concentration-based cleanup of the Great Miami Aquifer. Active remediation commenced in 1998 with the start-up of the South Field (Phase I), South Plume Optimization, and Re-Injection Demonstration Modules. The restoration strategy primarily focuses on the removal of uranium, but also has been designed to limit the 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's boundary.

Re-Injection at the Fernald Site

Re-injection is an enhancement to the groundwater remedy. Groundwater pumped from the aquifer is treated to remove contaminants and then re-injected back into the aquifer at strategic locations. The re-injected groundwater increases the speed at which contaminants move through the aquifer and are pulled by extraction wells, thereby decreasing the overall remediation time.

A groundwater re-injection demonstration was also initiated at the Fernald site in September 1998. Following completion of the re-injection demonstration in September of 1999, the Re-Injection Demonstration Test Report (DOE 2000) was issued to EPA and OEPA on May 30, 2000. The report detailed the demonstration and recommended its incorporation into the site's aquifer restoration strategy. Based on the results of the demonstration, re-injection is continuing at the site. The Re-Injection Module Operational Summary section within this chapter provides more discussion of this topic.

The enhanced groundwater remedy also included additional extraction wells in on-site areas of aquifer contamination. Groundwater modeling studies conducted in support of the enhanced groundwater remedy suggested that, with the early installation of additional extraction wells and re-injection technology, the remedy could potentially be reduced to 10 years. EPA and OEPA approved the enhanced groundwater remedy.

While the remedial investigation and feasibility study process 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 total uranium plume in this area from migrating any further to the south. Figure 3-1 shows the South Plume Module Extraction Wells 3924, 3925, 3926, and 3927. These extraction wells have successfully stopped further southern migration of the total uranium plume beyond the wells and have contributed to significantly reducing total uranium concentrations in the off-property portion of the plume.

The EPA and OEPA approved the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas in 2001. The design specified three extraction wells in the waste storage area (Phase I) to address contamination in the Pilot Plant Drainage Ditch plume and two extraction wells to address the remaining contamination after the waste pit excavation is completed (Phase II). One of the three Phase I wells was installed in 2000 to support an aquifer pumping test to help determine the restoration wellfield design. The remaining two Phase I wells were installed in the summer of 2001 after the design was approved by EPA and OEPA. These three wells became operational on May 8, 2002. Nine new monitoring wells were installed as part of Phase I. The waste storage area design report also provided data indicating that the total uranium plume in the Plant 6 area was no longer present (DOE 2001a). It was believed that the total uranium plume had dissipated to concentrations below the FRL as a result of the shut-down of plant operations in the late 1980s and the pumping of highly contaminated perched water as part of the Perched Water Removal Action #1 in the early 1990s. Because a total uranium plume with concentrations above the groundwater FRL was no longer present in the Plant 6 area at the time of the design, a restoration module for this area was determined to be unnecessary and was no longer planned. However, groundwater monitoring continued in the Plant 6 area in 2002 and one well in the area had a uranium concentration above 30 µg/L in 2002. On June 12, 2002 the uranium concentration was 40.9 µg/L and on October 21, 2002 the concentration was measured at 36.7 µg/L. Therefore, Figure 3-1 shows a small uranium plume in the Plant 6 Area. Continued monitoring will determine whether or not this small plume will dissipate or require some type of pumping action.

The EPA and OEPA approved the Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module in 2002. 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 pending the updated plume interpretation. In the Phase II design, the existing Phase I module will be supplemented with four new extraction wells, and one new re-injection well. In addition, an existing extraction well (31563) will be converted into a re-injection well. The decision was also made to permanently shut down Extraction Wells 31565 and 31566 which had been inactive since May 22, 2001 and August 7, 1998, respectively. Phase II wells are scheduled to become operational in 2003.

During 2002 active remediation of the Great Miami Aquifer began in the waste storage area and continued at the following groundwater restoration modules: South Plume/South Plume Optimization Module, South Field Extraction (Phase I) Module, and Re-Injection Module. Figure 3-1 depicts the current extraction and re-injection well locations. The operational information associated with these modules is presented in subsequent subsections.

Figure 3-2 identifies current and future extraction and re-injection well locations. The location of the future wells in the South Field are based on the South Field (Phase II) design discussed above. The location of future waste storage area wells are based on the waste storage area (Phase I) design discussed above.

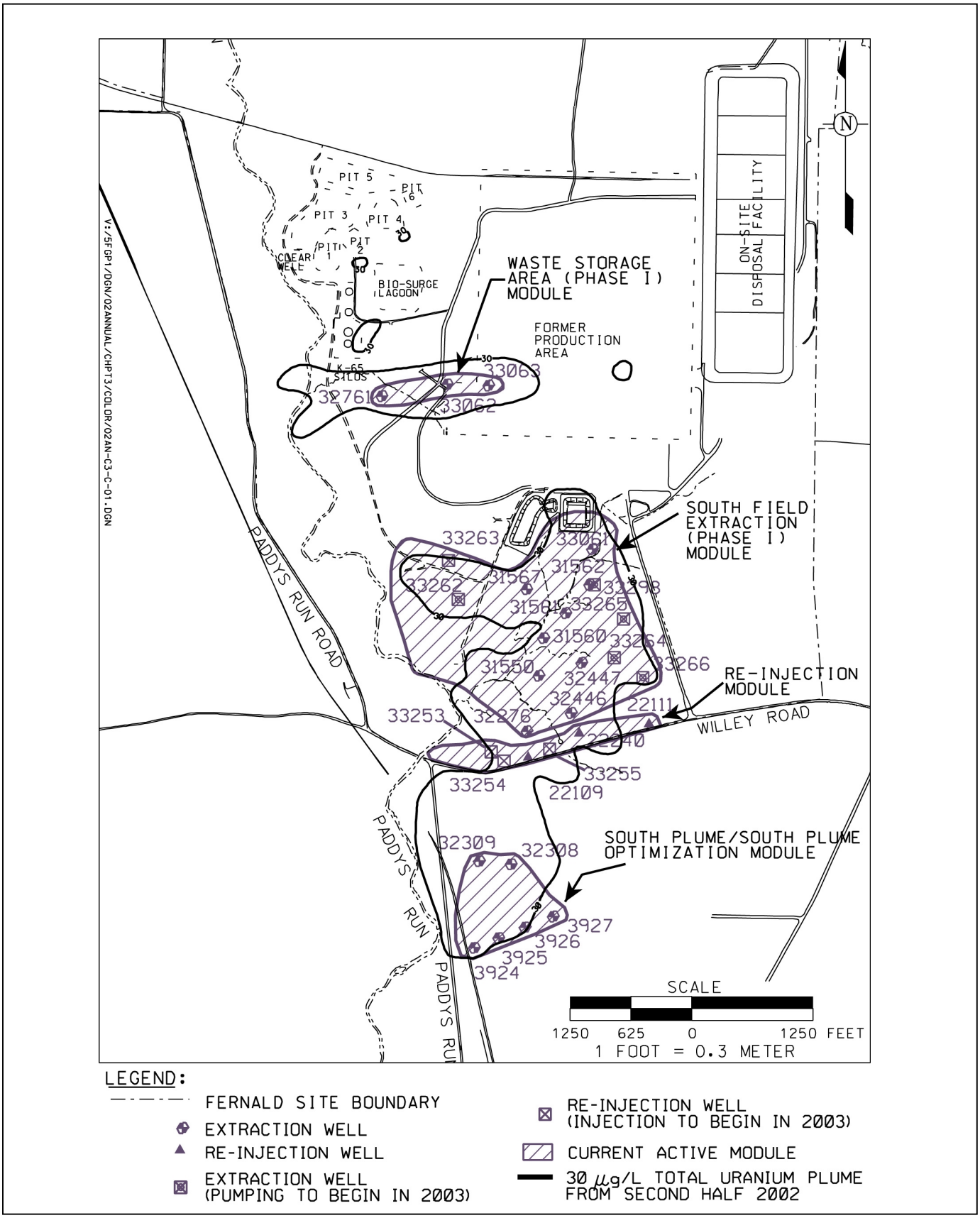

Figure 3-1. Current Extraction and Re-Injection Wells

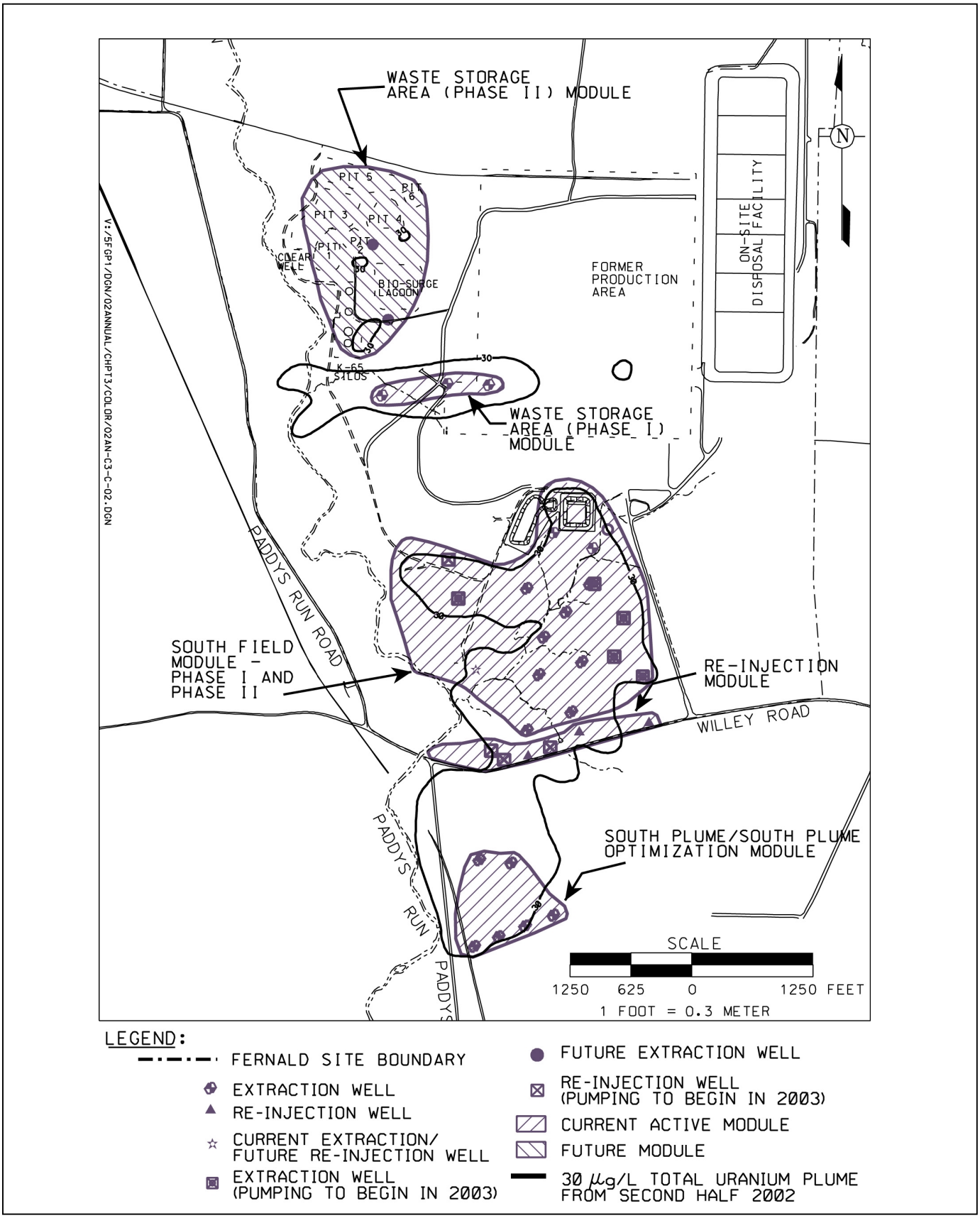

Figure 3-2. Current and Future Extraction and Re-Injection Wells for the Enhanced Groundwater Remedy

3.3 Groundwater Monitoring Highlights for 2002

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

The key elements of the Fernald site groundwater monitoring program design are described below:

- **Sampling** – Sample locations, frequency, and the constituents were selected to address operational assessment, restoration assessment, and compliance requirements. Selected wells are monitored for up to 50 groundwater FRL constituents. Monitoring is conducted to ascertain groundwater quality and groundwater flow direction. Figure 3-3 shows a typical groundwater monitoring well at the site and Figure 3-4 identifies the relative placement depths of groundwater monitoring wells at the site. As part of the comprehensive IEMP groundwater monitoring program, approximately 120 wells were monitored for water quality in 2002. Figure 3-5 identifies the location of the current IEMP water quality monitoring wells, including extraction wells. In addition to water quality monitoring, approximately 140 wells were monitored quarterly for groundwater elevations. Figure 3-6 depicts the IEMP routine water level (groundwater elevation) monitoring wells, including extraction wells.

  Based on EPA and OEPA approval, beginning in July of 2002 the frequency of groundwater quality sampling went from quarterly to semiannually. Additional groundwater monitoring program changes were identified for implementation in 2003. All of the proposed changes are documented in Revision 3 of the IEMP, which became effective January 1, 2003.

- **Data Evaluation** – The integrated data evaluation process looks at the data collected from wells to determine: capture and restoration of the total 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 south of the Fernald site along Paddys Run Road resulting from independent industrial activities in the area).

- **Reporting** – All data are reported through the IEMP program mid-year data summary and annual site environmental reports.

3.3.1 Restoration Monitoring

In general, restoration monitoring tracks the progress of the groundwater remedy and water quality conditions. Restoration monitoring is discussed in the subsections that follow.

All operational modules were evaluated during the year to evaluate the progress of aquifer remediation. The evaluation was done by collecting and mapping groundwater quality and groundwater elevation data and then analyzing the results. Concentration maps are developed from analytical data and compared with groundwater elevation maps depicting the location of the capture zone.

More detailed information can be found in Appendix A of this report. Subsections that follow identify the specific Attachment of Appendix A where the detailed information can be found.

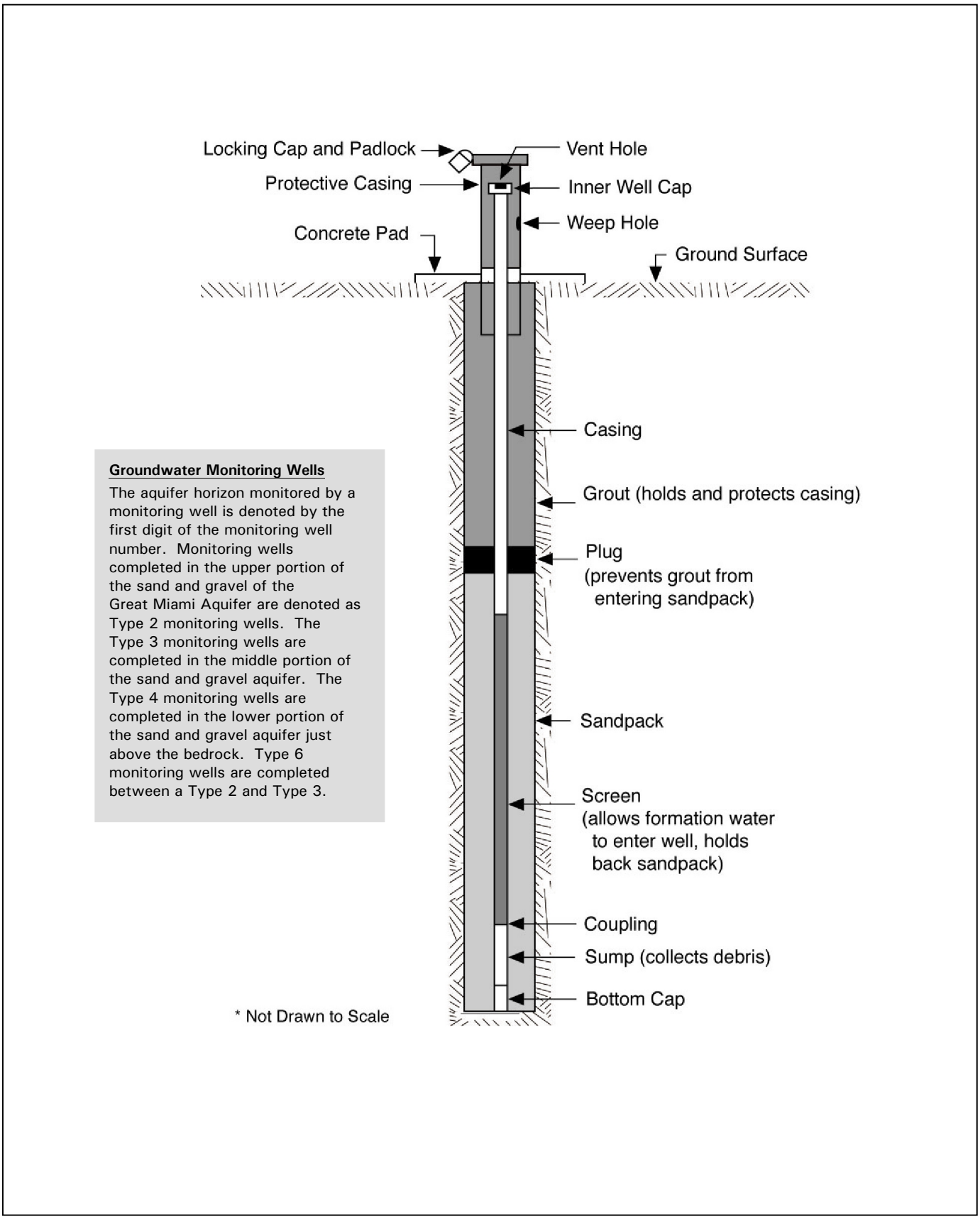

Figure 3-3. Typical Groundwater Monitoring Well Diagram

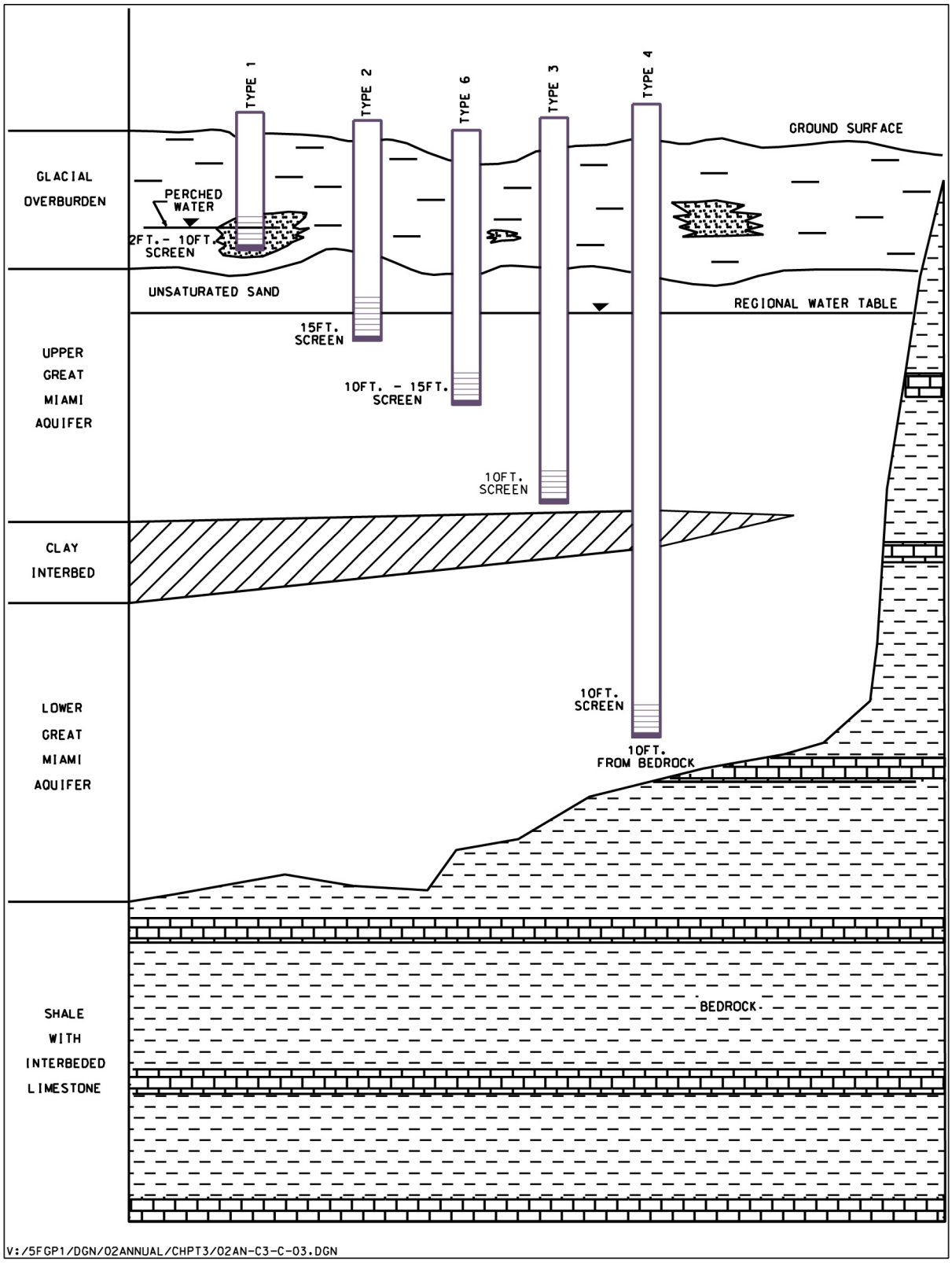

Figure 3-4. Monitoring Well Relative Depths and Screen Locations

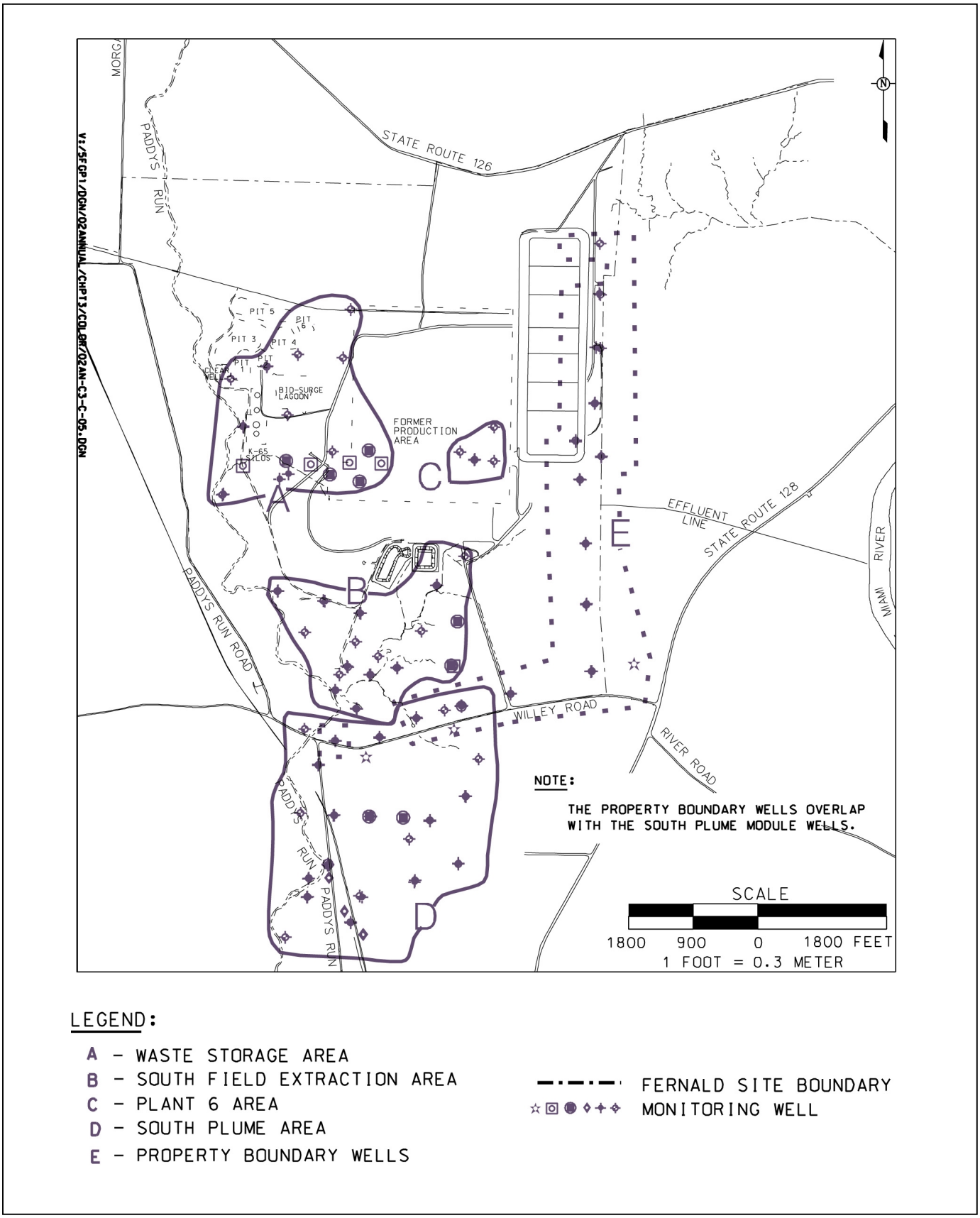

Figure 3-5. IEMP Water Quality Monitoring Wells

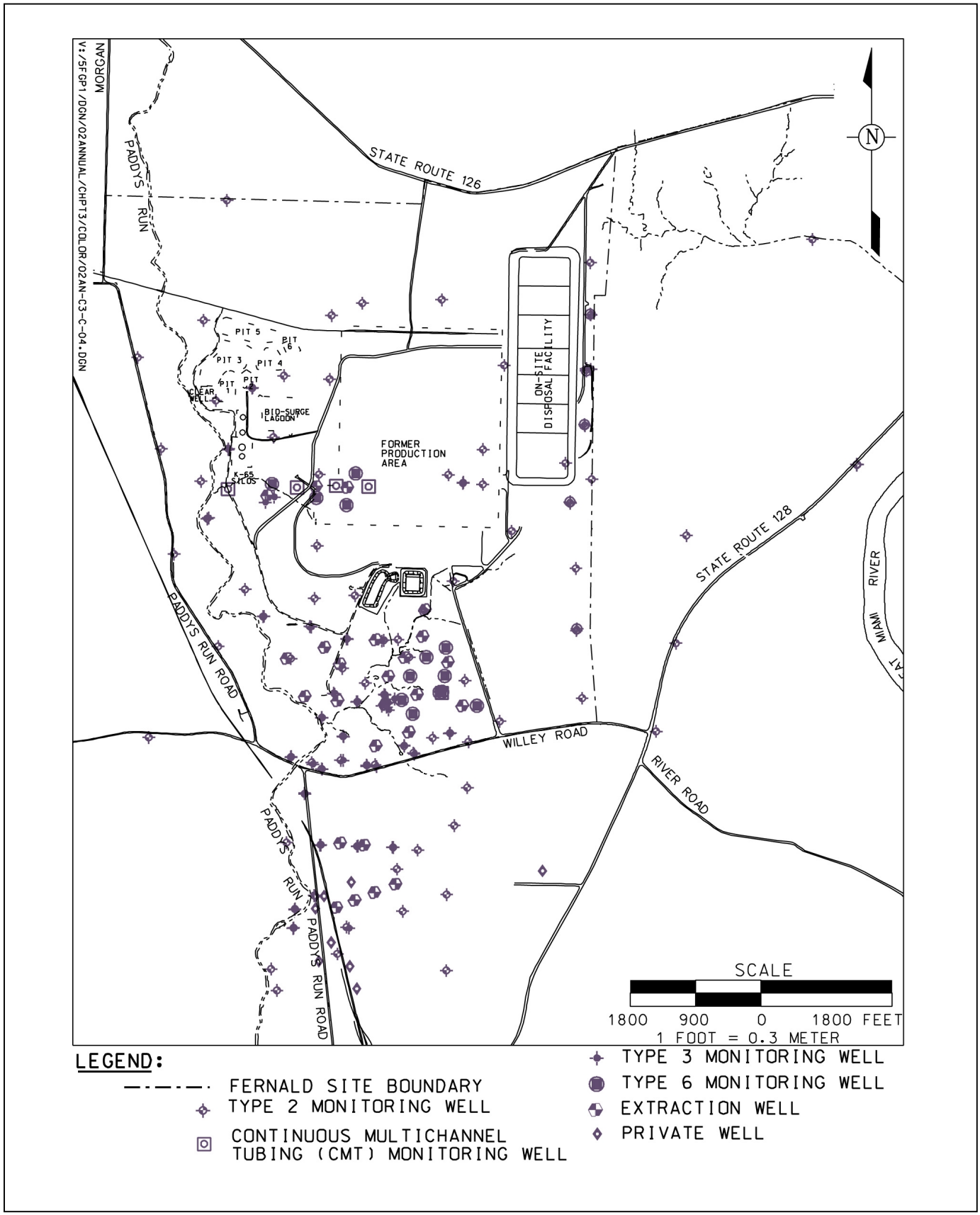

Figure 3-6. IEMP Groundwater Elevation Monitoring Wells

3.3.1.1 Operational Summary

Figure 3-1 shows the extraction and re-injection well locations associated with the current restoration modules. Table 3-1 summarizes the pounds of uranium removed and the amount of groundwater pumped by the active restoration modules during 2002. Figure 3-7 identifies the yearly and cumulative pounds of uranium removed from the Great Miami Aquifer from 1993 through 2002. Since 1993:

- 11,812 million gallons (44,708 million liters) of water have been pumped from the Great Miami Aquifer.
- 1,247 million gallons (4,720 million liters) of treated water have been re-injected into the Great Miami Aquifer.
- 4,448 net pounds (2,019 kg) of total uranium have been removed from the Great Miami Aquifer.

Appendix A, Attachment 1, of this report provides detailed operational information on each extraction and re-injection well, such as pumping and re-injection rates, uranium removal indices, and total uranium concentration graphs. The following subsections provide overview information on the individual modules.

TABLE 3-1
GROUNDWATER RESTORATION MODULE STATUS FOR 2002

Module	Restoration Wells	Target Pumping Rate gpm	Target Pumping Rate Lpm	Gallons Pumped/ Re-Injected M gal	Gallons Pumped/ Re-Injected M liters	Uranium Removed/ Re-Injected lbs	Uranium Removed/ Re-Injected kg
South Plume/ South Plume Optimization Module	3924	1,500	5,700	924	3,497	241	109
	3925						
	3926						
	3927						
	32308	500	1,900				
	32309						
South Field Extraction (Phase I) Module	31550	2,040	7,200	1,037	3,925	634	288
	31560						
	31561						
	31562						
	31563[a]						
	31564[b]						
	31565[c]						
	31566[d]						
	31567						
	32276						
	32446						
	32447						
	33061						
Waste Storage Area Module	32761	1,000	3,800	326	1,234	361	164
	33062						
	33063						
Re-Injection Module	22107[e]	1,000	3,800	241	912	11.34	5.15
	33253[f]						
	22108[g]						
	33254[f]						
	22109						
	22111						
	22240						
Aquifer Restoration System Totals							
(pumped)		5,040	18,600	2,287	8,656	1,236	561
(re-injected)		1,000	3,800	241	912	11.34	5.15
(net)		4,040	14,800	2,046	7,744	1,225	556

[a]Extraction well removed from service in December 2002.
[b]Extraction well removed from service in December 2001.
[c]Extraction well removed from service in May 2001.
[d]Extraction well removed from service in August 1998.
[e]Re-injection well replaced by Well 33253 in November 2002.
[f]Re-injection well began operating in November 2002.
[g]Re-injection well replaced by Well 33254 in November 2002.

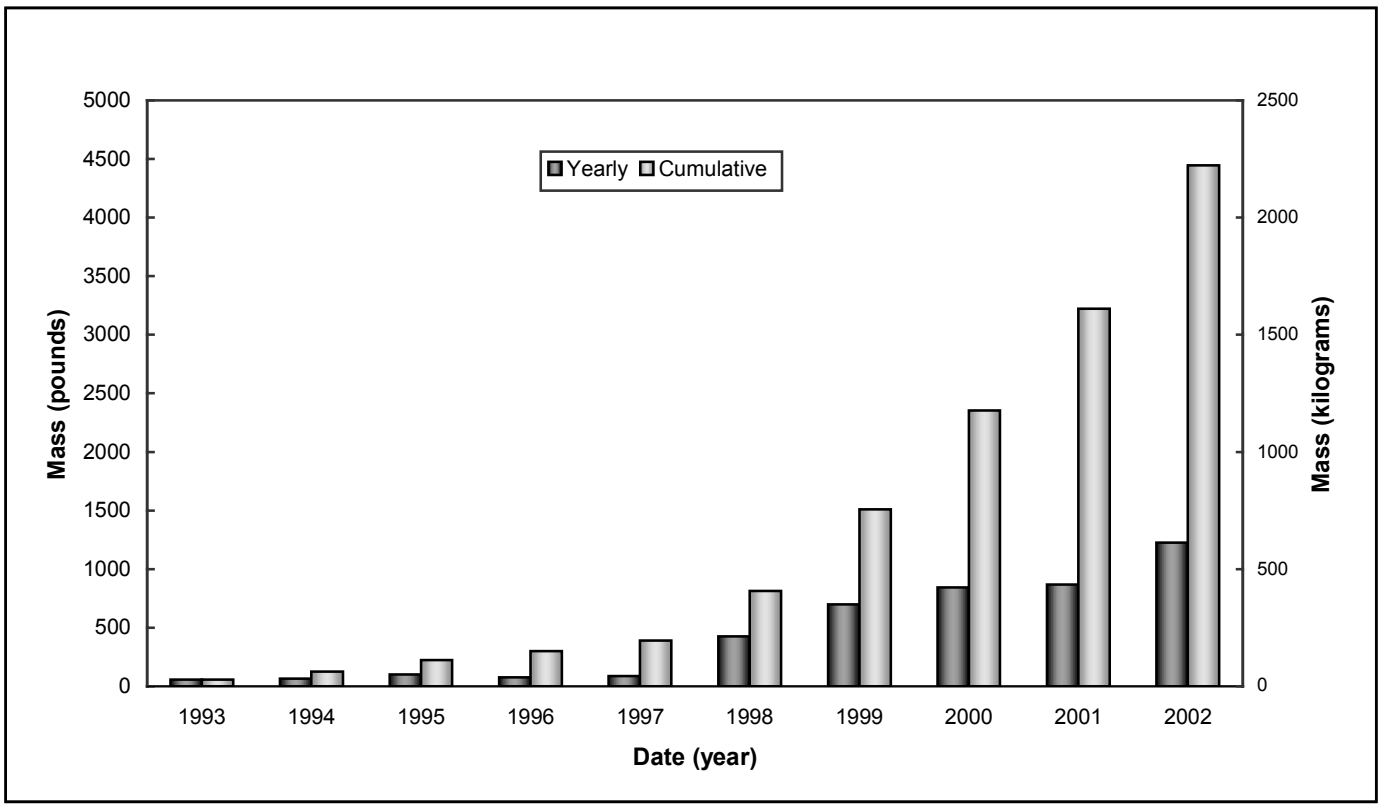

Figure 3-7. Net Pounds of Uranium Removed from the Great Miami Aquifer, 1993-2002

3.3.1.2 South Plume/South Plume Optimization Module Operational Summary

The four extraction wells of the South Plume Module include Extraction Wells 3924, 3925, 3926, and 3927, which began operating in August 1993. The two extraction wells of the South Plume Optimization Module (32308 and 32309) began operating in August 1998. Figure 3-8 illustrates capture zones associated with the South Plume/South Plume Optimization Module. Based on analysis of the data in 2002, the module continues to meet its primary objectives for the following reasons:

- Southward movement of the total uranium plume beyond the southern most extraction wells has not been detected.
- Active remediation of the central portion of the off-property total uranium plume continues.
- Paddys Run Road Site plume, located south of the extraction wells, is not being adversely affected by the pumping.

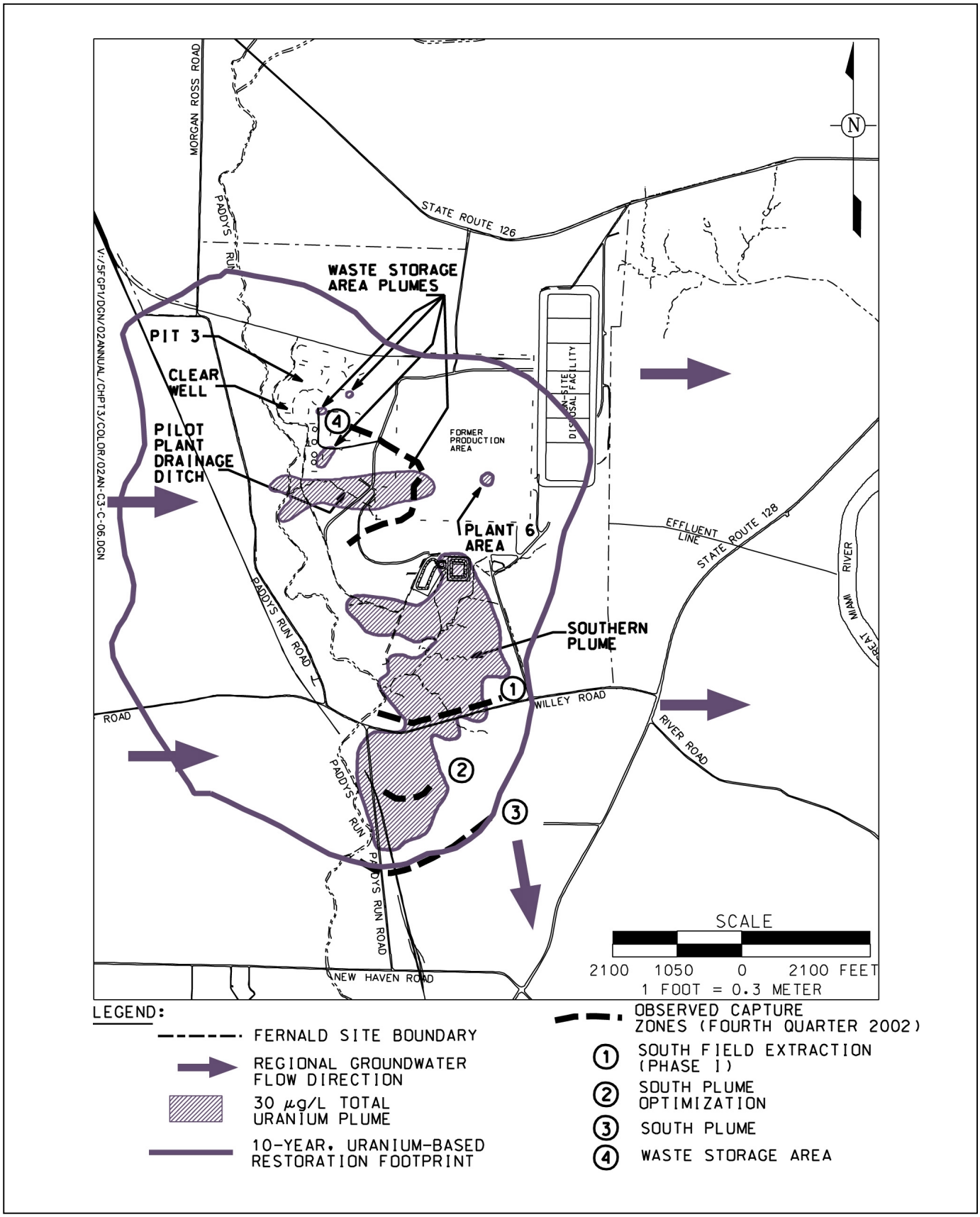

Figure 3-8. Total Uranium Plume in the Aquifer with Concentrations Greater than 30 µg/L at the End of 2002

3.3.1.3 South Field Extraction (Phase I) Module Operational Summary

The 10 original extraction wells of the South Field Extraction (Phase I) Module include 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276, which began operating on July 13, 1998. Since then, three new extraction wells have been added to the module (32446, 32447, and 33061) and four of the original wells have been shut down (31566, 31564, 31565, and 31563). With the exception of Extraction Well 31563, the extraction wells that were shutdown are all located upgradient of the plume where total uranium concentrations in the Great Miami Aquifer are now below the uranium FRL. Extraction Well 31563 is being converted to a re-injection well. Additionally, Extraction Wells 31564 and 31565 were removed from service to accommodate soil remedial activities in the vicinity of the wells. Extraction Well 31566 was removed from service in 1998, Extraction Well 31564 was removed from service in May 2001, Extraction Well 31565 was removed from service in December 2001, and Extraction Well 31563 was removed from service in December 2002.

The three new wells added to the South Field Module (32446, 32447, and 33061) were installed at locations where total uranium concentrations are considerably above the groundwater uranium FRL, in the eastern, downgradient portion of the South Field plume. Two of the three new wells (32446 and 32447) were installed in late 1999 and began pumping in February 2000. Extraction Well 33061 was installed in 2001 and became operational in 2002. Figure 3-8 illustrates the capture zone associated with the South Field Extraction (Phase I) Module.

The Design for Remediation of the Great Miami Aquifer, South Field (Phase II) Module was issued in May of 2002 (DOE 2002b). The design provides an updated characterization of the uranium plume in the Great Miami Aquifer beneath the southern portion of the Fernald site and a modeled design for the South Field (Phase II) Module located in that area. The modeled design consists of the following components:

- Four additional extraction wells, one in the southern waste unit area (33262), and three along the eastern edge of the on-property portion of the southern uranium plume (33264, 33265, and 33266).
- One additional re-injection well in the southern waste unit area (33263).
- Converting Extraction Well 31563 into a re-injection well.
- Installing and operating one active re-injection basin to flush treated groundwater back into the aquifer to supplement re-injection through re-injection wells.

The new wells specified in the South Field (Phase II) design were installed in 2002, and are scheduled to begin operating in 2003.

3.3.1.4 Re-Injection Module Operational Summary

A groundwater re-injection demonstration test was conducted at the Fernald site from September 2, 1998 to September 2, 1999. The Re-Injection Module consisted of Re-Injection Wells 22107, 22108, 22109, 22111, and 22240. After this demonstration in September of 1999, it was decided to incorporate re-injection technology into the aquifer remedy. The Re-Injection Demonstration Test Report detailing the demonstration was issued to EPA and OEPA on May 30, 2000.

The evaluation indicated that the testing results were favorable regarding the viability of re-injection at the Fernald site, that a reliable source of injection water could be maintained, and that an acceptable injection rate could be sustained without negative effects on the plume or aquifer. However, residual plugging of the re-injection wells became a concern in the last half of 2000. During 2001 the re-injection wells were subjected to the new treatment method and this new process was economically viable in three of the five wells (Re-Injection Wells 22111, 22240, and 22109). It was determined that it was more cost effective to replace the other two wells rather than attempt another treatment.

Re-Injection Well 22107 was replaced by Re-Injection Well 33253. Re-Injection Well 22108 was replaced by Re-Injection Well 33254. These two new replacement wells began operating for a brief period in November 2002. On November 21 all re-injection wells were shut down and remained off-line for the rest of the year to help ensure compliance with the site's monthly average uranium discharge limit. In addition to the two new replacement wells, a sixth re-injection well was added to the module (Re-Injection Well 33255). The new re-injection well is located half way between Re-Injection Wells 22109 and 22240, and is scheduled to become operational in 2003.

3.3.1.5 Waste Storage Area (Phase I) Operational Summary

The Waste Storage Area Module became operational on May 8, 2002, nearly 17 months ahead of the Operable Unit 5 Remedial Action Work Plan established start date of October 1, 2003. The module consists 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 2001a).

3.3.1.6 Monitoring Results for Total Uranium

Total uranium is the primary FRL constituent because it is the most prevalent site contaminant and has impacted the largest area of the aquifer.

Figure 3-8 shows general groundwater flow directions and the interpretation of the total uranium plume in the aquifer, and is updated with data collected through 2002. The shaded areas represent the interpreted size of the total uranium plume that is above the 30 µg/L groundwater FRL for total uranium. Capture zones observed during the second half of 2002 for the active restoration modules are also identified on Figure 3-8. These capture zones indicate that the southern 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 that the total uranium concentrations greater than the FRL are within the 10-year, uranium-based restoration footprint which was defined in the 1997 Baseline Remedial Strategy Report.

Geoprobe®

The Geoprobe®, a hydraulically powered, direct-push sampling tool, is used at the Fernald site 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 to push into the ground without drilling (or cutting) to displace soil in the tool's path. The FCP 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.

Waste Storage Area - Nine new monitoring wells were installed in the Pilot Plant Drainage Ditch area to monitor the remediation of the uranium plume around the three new extraction wells. Installation of the new monitoring wells was completed on January 17, 2002. Sampling of these new wells indicated the presence of uranium concentrations that were higher than previously recorded in the area by direct-push sampling. The impact that these higher uranium concentrations will have on the modeled cleanup time predictions is being examined. Results are scheduled to be available in 2003. The higher uranium concentrations found in 2002 did not have much effect on the size and shape of the 30 µg/L total uranium plume boundary depicted in Figure 3-8.

South Field and South Plume Areas – Twenty-five different locations were sampled in 2002 using direct-push methods in the South Field and off-property South Plume areas to update uranium plume interpretations (22 locations in the portion of the South Plume and three locations in the South Field). Results from the off-property locations were also used to evaluate the need to install an additional extraction well. The results indicated that an additional extraction well is not needed at this time in the off-property portion of the uranium plume to achieve modeled cleanup predictions.

Data indicated that the western edge of the 30 µg/L total uranium plume boundary, just north of Willey Road, has shifted to the east, indicated by a decrease in uranium concentrations. This reduction is attributed to a combination of re-injection along Willey Road, recharge of clean water through Paddys Run, and pumping in the South Plume and South Field. As a result, the trailing edge of the 30 µg/L plume has moved to the east. Reduced uranium concentrations were measured all along Willey Road just downgradient of the re-injection wells. As re-injection continues, it is anticipated that the plume will eventually be cut in half near the re-injection wells along Willey Road. Uranium contamination south of the re-injection wells will move toward the South Plume extraction wells, uranium contamination north of the re-injection wells will move toward the South Field extraction wells.

Appendix A, Attachment 2, of this report provides individual monitoring well total uranium results and two total uranium plume maps for 2002. Appendix A, Attachment 3, of this report provides capture zone evaluations based on groundwater flow directions interpreted from groundwater elevation data. It includes quarterly groundwater elevation maps and graphical displays of groundwater elevation data.

3.3.1.7 Monitoring Results for Non-Uranium Constituents

Although the enhanced groundwater remedy is primarily targeting remediation of the total uranium plume, other FRL constituents contained within the total uranium plume are also being monitored.

Table 3-2 summarizes the results of monitoring for non-uranium FRL exceedances, and Figure 3-9 identifies the locations of the wells that had non-uranium FRL exceedances. Table 3-2 shows the number of wells exceeding the FRL in 2002, the range of 2002 data above the FRL from wells inside or outside this footprint, and the number of wells with 2002 FRL exceedances outside the Baseline Remedial Strategy Report 10-year, uranium-based restoration footprint.

TABLE 3-2
NON-URANIUM CONSTITUENTS WITH RESULTS ABOVE FINAL REMEDIATION LEVELS DURING 2002

Constituent	Number of Wells Exceeding the FRL	Number of Wells Exceeding the FRL Outside the BRSR[a] 10-Year, Uranium-Based Restoration Footprint	Groundwater FRL	Range of 2002 Data Inside the BRSR[a] 10-Year, Uranium-Based Restoration Footprint above the FRL[b]	Range of 2002 Data Outside the BRSR[a] 10-Year, Uranium-Based Restoration Footprint above the FRL[b]
General Chemistry			**(mg/L)**	**(mg/L)**	**(mg/L)**
Nitrate/Nitrite	2	0	11[c]	12.7 to 76.4	NA
Inorganics					
Arsenic	1	1	0.050	NA	0.0791
Boron	1	0	0.33	0.478	NA
Lead	1	1	0.015	NA	0.0173
Manganese	8	5	0.90	1.33 to 2.86	1 to 2.29
Mercury	1	0	0.0020	NA	0.0167
Molybdenum	1	0	0.10	0.423	NA
Nickel	1	0	0.10	0.134	NA
Zinc	3	1	0.021	0.0212 to 0.0317	0.0282
Volatile Organics			**(µg/L)**	**(µg/L)**	**(µg/L)**
Trichloroethene	1	0	5.0	78	NA
Radionuclides			**(pCi/L)**	**(pCi/L)**	**(pCi/L)**
Technetium-99	2	0	94	103 to 1120	NA

[a]Baseline Remedial Strategy Report (DOE 1997a)
[b]NA = not applicable
[c]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4; however, the sampling results are for nitrate/nitrite.

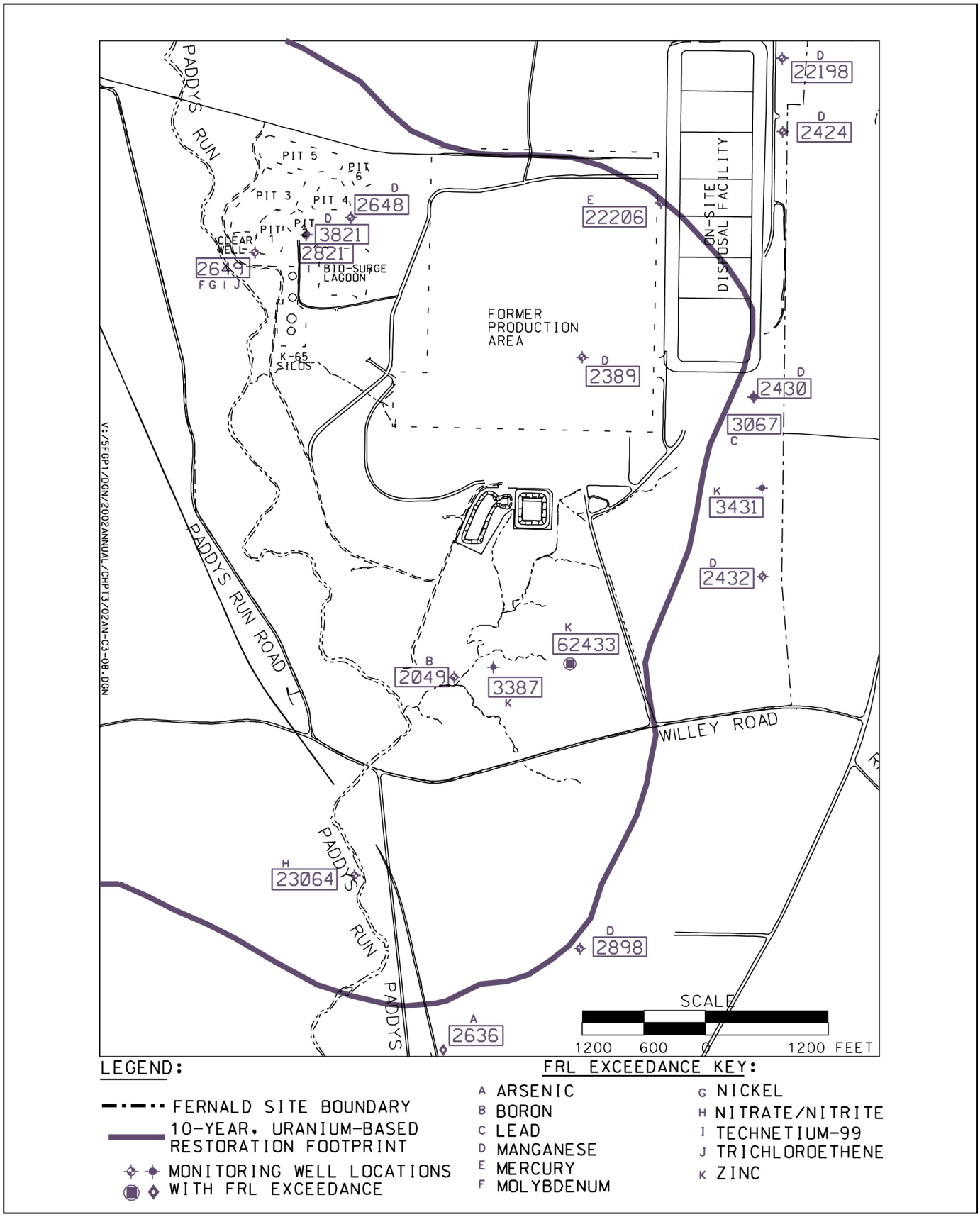

Figure 3-9. Non-Uranium Constituents with 2002 Results Above Final Remediation Levels

During 2002 non-uranium FRL exceedances were observed at 18 monitoring well locations as shown in Figure 3-9. A total of 11 non-uranium FRL constituents exceeded FRLs in 2002. All these exceedances were within the Baseline Remedial Strategy Report 10-year, uranium-based restoration footprint, except the following: one exceedance for arsenic in the Paddys Run Road Site area; one exceedance each for lead and zinc along the eastern property boundary; and five exceedances for manganese along the eastern restoration footprint perimeter (refer to Figure 3-9). No plumes for the above-FRL constituents at the locations outside the 10-year, uranium-based restoration footprint were identified in the extensive groundwater characterization efforts evaluated as part of the Remedial Investigation Report for Operable Unit 5.

The constituents with FRL exceedances at the well locations outside the 10-year, uranium-based restoration footprint were further evaluated to determine if they were random events or if they were persistent according to criteria discussed in Appendix A, Attachment 4, of this report. None of the exceedances in 2002 were classified as persistent. All former exceedances that were classified as persistent have disappeared with subsequent sampling.

Appendix A, Attachment 4, of this report provides detailed information of non-uranium FRL exceedances and the persistence of these exceedances.

3.3.2 Other Monitoring Commitments

Two other groundwater monitoring activities are included in the IEMP:

- Private Well Monitoring.
- 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 below provides additional details on the two compliance monitoring activities.

The three private wells (Monitoring Wells 2060 [12], 13, and 14) located along Willey Road are monitored under the IEMP to assist in the evaluation of the total uranium plume migration (refer to Appendix A, Attachment A.2, Figure A.2-1 for well locations). It was at one of these private wells that off-property groundwater contamination was initially detected in 1981. Monitoring at other private wells in 1997 because a DOE-sponsored public water supply became available to Fernald site neighbors who have been affected by off-property groundwater contamination.

The availability of the public water supply resulted in the plugging and abandonment of many private wells in the affected off-property areas where groundwater is being remediated. Data from the three private wells sampled under the IEMP were incorporated into the total uranium plume map shown in Figure 3-8.

During 2002 Property Boundary Monitoring was comprised of 33 monitoring wells located downgradient of the Fernald site, along the eastern and southern portions of the property boundary. Twenty-seven Type 2 and 3 wells were monitored for 27 of the most mobile FRL constituents in order to determine if contaminant excursions at the property boundary are occurring during the remediation process. During 2000 the frequency of monitoring the six property boundary Type 4 wells was decreased to once every five years due to lack of contamination in the aquifer at the depth these wells monitor. Data from the property boundary wells were integrated with other IEMP data for 2002 and were incorporated into the total uranium plume map shown in Figure 3-8. Non-uranium data from these wells were included above in the section on monitoring results for non-uranium constituents.

Director's Findings and Orders were issued by OEPA 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 throughout the duration of remedial actions.

3.4 On-Site Disposal Facility Monitoring

Groundwater monitoring for the cells of the on-site disposal facility is conducted in the glacial till (perched water) and in the Great Miami Aquifer. Groundwater monitoring in support of the on-site disposal facility continued in 2002. This monitoring program is designed to accomplish the following:

- Establish a baseline of groundwater conditions in both the perched groundwater and the Great Miami Aquifer beneath each cell of the on-site disposal facility. The baseline data will be used to evaluate future changes in perched groundwater and Great Miami Aquifer groundwater quality to help determine if the changes are due to on-site disposal facility operations.

- Continue routine groundwater sampling following waste placement and cell capping as part of the comprehensive leak detection monitoring program for the on-site disposal facility. This information will be used to help verify the ongoing performance and integrity of the on-site disposal facility.

Table 3-3 summarizes the groundwater monitoring information associated with the on-site disposal facility. Table 3-3 also summarizes leachate collection system and leak detection system monitoring information. Sampling of the leachate collection system and the leak detection system is generally initiated after waste placement, while groundwater sampling is initiated before waste is placed in a particular cell. Table 3-3 provides information for Cells 1 through 6 along with sample information and range of total uranium concentrations. With respect to samples collected from the horizontal till wells and Great Miami Aquifer wells, there was only one exceedance for a groundwater FRL during 2002. This exceedance was for mercury at Monitoring Well 22206, which monitors the aquifer beneath Cell 4.

During 2002 the Technical Memorandum for establishing baseline groundwater conditions for Cells 1 through 3 was issued and approved by the OEPA and EPA. Data in the memorandum establish initial groundwater conditions to be compared with future sampling results as part of the leak detection data evaluation process. As part of the memorandum process, changes to the sampling protocol for Cells 1 through 3 were recommended. The new sampling protocol for these cells was approved and implemented in the second half of 2002. Additionally in 2002, baseline sampling for Cells 4 and 5 continued and sampling for Cell 6 was initiated in December 2002 in the Great Miami Aquifer wells.

Placement of contaminated soil and debris in Cell 1 concluded at the end of December 2000 (Cell 1 was 100 percent full), and cap material was placed on Cell 1 through November 2001. Placement of contaminated soil and debris in Cell 2 concluded at the end of October 2002 (Cell 2 was 100 percent full). Soil and debris placement continued in Cell 3, and began in Cells 4 and 5 during 2002. At the end of December 2002, Cell 3 was approximately 51 percent full, Cell 4 was approximately nine percent full, and Cell 5 was approximately three percent full. Waste placement in Cells 4 and 5 was initiated in November 2002. Based on 2002 leak detection flow monitoring data associated with the on-site disposal facility, the liner systems for Cells 1 through 5 are performing within the specifications outlined in the approved cell design.

Figure 3-10 identifies the on-site disposal facility footprint and monitoring well locations for Cells 1 through 6. (Additional cells will be activated at the on-site disposal facility, and will be monitored similar to Cells 1 through 6.) For additional information on the groundwater, leak detection and leachate sampling results for the on-site disposal facility, refer to Appendix A, Attachment 5, of this report.

TABLE 3-3
ON-SITE DISPOSAL FACILITY GROUNDWATER, LEACHATE, AND LEAK DETECTION SYSTEM MONITORING SUMMARY

Cell (Waste Placement Start Date)[a]	Monitoring Location	Monitoring Zone	Date Sampling Started	Total Number of Samples	Range of Total Uranium Concentrations[a] (μg/L)
Cell 1 (December 1997)	22201	Great Miami Aquifer	March 31, 1997	35	ND – 8.33
	22198	Great Miami Aquifer	March 31, 1997	53	0.557 – 8.474
	12338	Glacial Till	October 30, 1997	40	ND – 19
	12338C	Leachate Collection System	February 17, 1998	20	ND – 142.186
	12338D	Leak Detection System	February 18, 1998	19	1.5 – 23.2
Cell 2 (November 1998)	22200	Great Miami Aquifer	June 30, 1997	30	ND – 1.11
	22199	Great Miami Aquifer	June 25, 1997	30	0.259 – 12.1
	12339	Glacial Till	June 29, 1998	39	ND – 6.56
	12339C	Leachate Collection System	November 23, 1998	17	4.51 – 68.6
	12339D	Leak Detection System	December 14, 1998	17	8.69 – 71[b]
Cell 3 (November 1999)	22203	Great Miami Aquifer	August 24, 1998	28	ND – 7.92
	22204	Great Miami Aquifer	August 24, 1998	28	ND – 5.924
	12340	Glacial Till	July 28, 1998	32	ND – 25.4
	12340C	Leachate Collection System	October 13, 1999	14	9.27 – 83.7
	12340D	Leak Detection System	August 26, 2002	2	15.1 – 27.3
Cell 4 (November 2002)	22205	Great Miami Aquifer	November 5, 2001	13	0.446 – 19.7
	22206	Great Miami Aquifer	November 6, 2001	13	0.335 – 5.78
	12341	Glacial Till	February 26, 2002	9	11.1 – 21.1
	12341C	Leachate Collection System	November 4, 2002	1	4.41
	12341D	Leak Detection System	November 4, 2002	1	5.74
Cell 5 (November 2002)	22207	Great Miami Aquifer	November 6, 2001	13	0.3 – 4.48
	22208	Great Miami Aquifer	November 5, 2001	13	ND – 0.514
	12342	Glacial Till	February 26, 2002	6	0.557 – 8.474
	12342C	Leachate Collection System	November 4, 2002	1	3.39
	12342D	Leak Detection System	November 4, 2002	1	2.93
Cell 6 (NA)	22209	Great Miami Aquifer	December 16, 2002	1	0.407
	22210	Great Miami Aquifer	December 16, 2002	1	0.447

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

[b]Data not considered representative of true leak detection system 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 resultant mixing of individual flows.

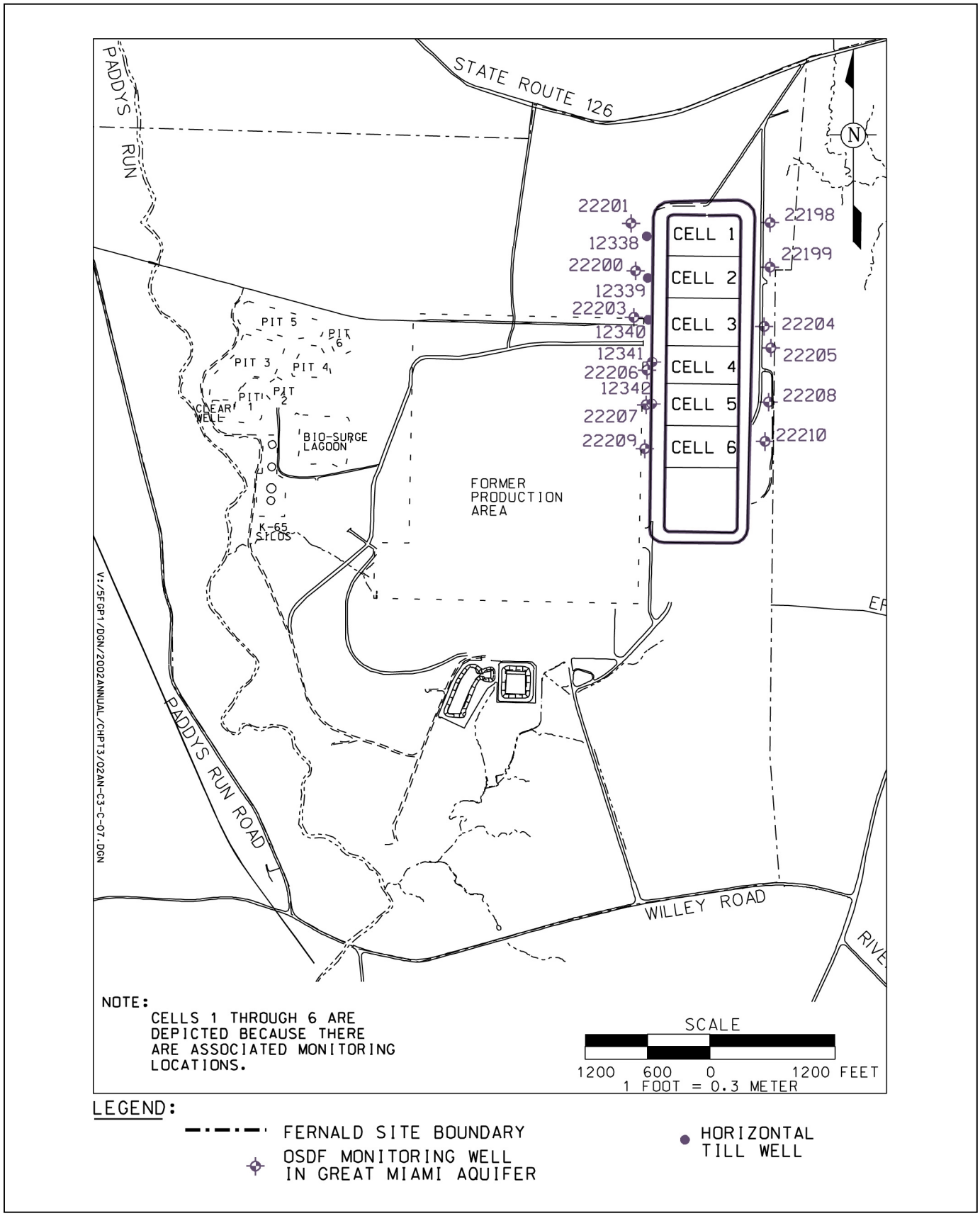

Figure 3-10. On-Site Disposal Facility Footprint and Monitoring Well Locations