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FLUOR

August 28, 2006

Fernald Closure Project
Letter No. C:CPD:2006-0180

Mr. Johnny W. Reising, Director
U. S. Department of Energy
Ohio Field Office – Fernald Closure Project
175 Tri-County Parkway
Cincinnati, Ohio 45246

Dear Mr. Reising:

CONTRACT DE-AC24-01OH20115, TRANSMITTAL OF THE FERNALD GROUNDWATER CERTIFICATION PLAN, REVISION 2

References: 1) Letter, J. Reising to J. Saric and T. Schneider, "Transmittal of Responses to Ohio Environmental Protection Agency Comments to Responses to Comments on the Fernald Groundwater Certification Plan," Revision 0, dated July 13, 2006.

2) Letter, T. Schneider to J. Reising, "Approval – Response to Comments on the Groundwater Certification Plan," dated August 3, 2006

3) Letter, J. Saric to J. Reising, "Groundwater Certification Report, Revision 1" dated June 2, 2006

This letter serves to transmit Revision 2 of the Fernald Groundwater Certification Plan for subsequent transmittal to the U. S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agencies (OEPA). Revision 2 incorporates changes based on responses to OEPA comments (Reference 1). The OEPA approved the responses and document changes in a letter dated August 3, 2006 (Reference 2). The EPA approved the Groundwater Certification Plan in a letter dated June 2, 2006 (Reference 3). Revision 2 has also been updated to reflect the installation of one new extraction well and six new monitoring wells in the former waste storage area.

If you have any questions or comments pertaining to this letter, please contact Jyh-Dong Chiou at 738-2834 or Bill Hertel at 648-3894.

Sincerely,

Cornelius M. Murphy
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Enclosure

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FERNALD GROUNDWATER CERTIFICATION PLAN

PROJECT NUMBER 51900-PL-0002

AUGUST 2006

Prepared by
Fluor Fernald, Inc.

Prepared for
U.S. Department of Energy

Under Contract DE-AC24-01OH20115

Revision 2
Final

Summary of changes made from Revision 1 to Revision 2

Location	Description of Changes	Driver
Figure 1-1 and Section 1.2	Revised to reflect the installation of a new extraction well in the Waste Storage Area since the issuance of Revision 1 in April 2006	Extraction Well 33347 was installed in July 2006.
Figure 3-2, Figure 3-3, Table 3-1 and Section 3.2	Revised to reflect the installation of a new extraction well and six new monitoring wells in the Waste Storage Area since the issuance of Revision 1 in April 2006	Extraction Well 33347 was installed in July 2006. Six new monitoring wells have been installed in the Waste Storage Area (83337, 83338, 83339, 83340, 83341, and 83346)
Section 4	Replaced page 4-3	Response to OEPA Original Comment # 4
Section 9	Replaced all	Response to OEPA Original Comment # 12

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ACRONYMS

ACA	Amended Consent Agreement
CAWWT	converted advanced wastewater treatment facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMT	continuous multi-channel tubing
COC	constituent of concern
D&D	demolition and disposal
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FRL	final remediation level
GMA	Great Miami Aquifer
gpm	gallons per minute
IEMP	Integrated Environmental Monitoring Plan
MCL	maximum contamination level
µg/L	micrograms per liter
NPDES	National Pollutant Discharge Elimination System
OEPA	Ohio Environmental Protection Agency
OMMP	Operations and Maintenance Master Plan for Aquifer Restoration and Wastewater Treatment
OSDF	on-site disposal facility
OU	operable unit
OU5 ROD	Operable Unit 5 Record of Decision
PPDD	Pilot Plant drainage ditch
RCRA	Resource Conservation and Recovery Act
SCQ	Sitewide CERCLA Quality Assurance Project Plan
SF	South Field
SP	South Plume
TI Waiver	Technical Impracticability Waiver
TIE	Technical Information Exchange
UCL	upper confidence limit
UTL	upper tolerance limit
WSA	waste storage area

1.0 INTRODUCTION

This Groundwater Certification Plan for the U.S. Department of Energy's (DOE's) Fernald site defines a programmatic strategy for certifying completion of the aquifer remedy. It was developed through a series of four Technical Information Exchange (TIE) meetings between the DOE, the U.S. Environmental Protection Agency (EPA), and the Ohio Environmental Protection Agency (OEPA) during the summer of 2005.

Development of this plan began with the issuance of the Draft Groundwater Remedy Certification Strategy on May 25, 2005 (DOE 2005a). The Draft Groundwater Remedy Certification Strategy provided a starting point for initiating discussions with regulators for developing this certification plan. Following issuance of the draft strategy, TIE meetings were held on May 31, 2005; July 6, 2005; August 4, 2005; and September 15, 2005. During each meeting, specific certification issues and technical approaches were identified, discussed, and the outline for this plan was developed.

1.1 OBJECTIVES AND SCOPE OF THE GROUNDWATER CERTIFICATION PLAN

The main objective of the Fernald Groundwater Certification Plan is to define a process for achieving and verifying completion of the aquifer remedy at the Fernald site. The preferred outcome is to certify that the Operable Unit 5 (OU5) Record of Decision (DOE 1996) remediation goals have been achieved using the pump-and-treat remediation system that is currently operating at the site. The plan also covers other potential contingencies and exit scenarios.

The Fernald Groundwater Certification Plan establishes the process that will be used to achieve groundwater restoration and conduct certification, but also relies on existing controlling documents for the implementation of that process:

- The Operations and Maintenance Master Plan for Aquifer Restoration and Wastewater Treatment (OMMP) is the controlling document for the operation of the aquifer remediation system. As of August 2006, the current version of the OMMP is Revision 2 (DOE 2005b).
- The Integrated Environmental Monitoring Plan (IEMP) is the controlling document for remedy performance groundwater monitoring. As of August 2006, the current version of the IEMP is Revision 4b (DOE 2006).

As identified in this plan, other documents and reports will be submitted throughout the groundwater certification process.

1.2 OVERVIEW OF THE GROUNDWATER REMEDY DESIGN

The Great Miami Aquifer is contaminated with uranium and other constituents from the Fernald site. An evaluation of the nature and extent of the contamination can be found in the Remedial Investigation Report for Operable Unit 5 (DOE 1995b). Uranium is the principal constituent of concern (COC).

A groundwater remediation strategy that relies on pump-and-treat technology is being used to conduct a concentration-based cleanup of the Great Miami Aquifer. The restoration strategy focuses primarily on the removal of uranium, but is also designed to:

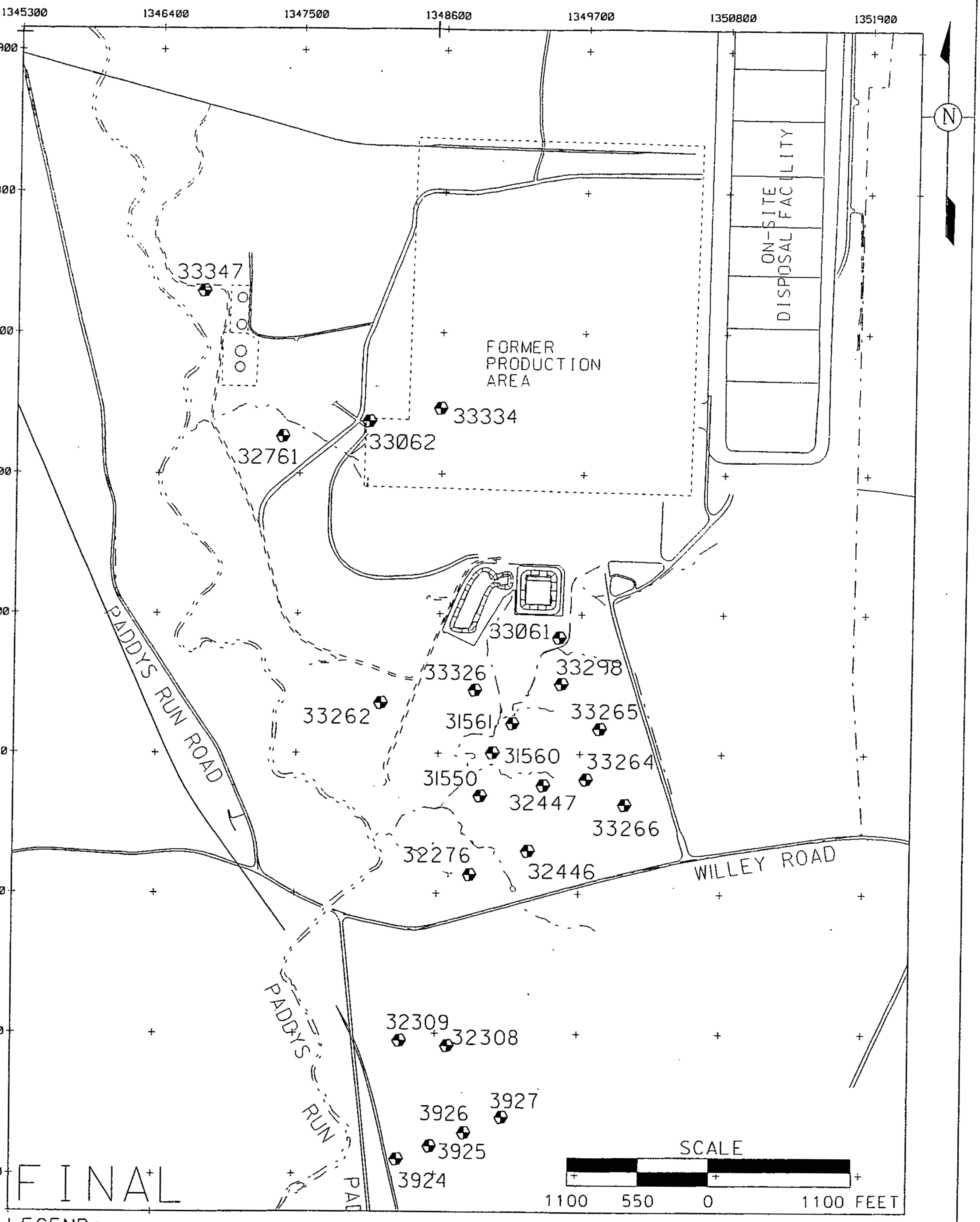
- Limit the further expansion of the plume
- Achieve removal of all targeted contaminants to concentrations below designated final remediation levels (FRLs)
- Prevent undesirable draw-down impacts beyond the Fernald site property
- Prevent pulling contamination from the Paddys Run Road Site Plume, which is located south of the Administrative Boundary for aquifer restoration (established in the OU5 Record of Decision).

The system of extraction wells being used to remediate the Great Miami Aquifer is divided into three area-specific aquifer remediation modules:

1. The South Plume Module
2. The South Field Module
3. The Waste Storage Area Module.

Figure 1-1 shows the location of the extraction wells that comprise these modules. The South Plume Module consists of six active extraction wells (3924, 3925, 3926, 3927, 32309, and 32308). The South Field Module consists of 13 active extraction wells (31550, 31560, 31561, 32276, 32446, 32447, 33061, 33262, 33264, 33266, 33265, 33326, and 33298). The Waste Storage Area Module consists of four active extraction wells (32761, 33062, 33334, and 33347). A summary of how the design of the aquifer remediation system was developed can be found in Section 3 of the IEMP. (A copy of Section 3 of the IEMP is provided in Appendix B.) A phased modular approach will be implemented for the groundwater certification process.

V:/5FGPI/DGN/CERTIFICATION/CERT-08.DGN



LEGEND:

—·—·— FERNALD SITE BOUNDARY

EXTRACTION WELL

STATE PLANAR COORDINATE SYSTEM 1983

15-AUG-2006

FIGURE 1-1. EXTRACTION WELL LOCATION MAP

1.3 DRIVERS AND CONTROLLING DOCUMENTS

Following are the current drivers and controlling documents for the groundwater remediation:

- The OU5 Record of Decision directs that "areas of the Great Miami Aquifer exceeding FRLs will be restored through extraction methods."
- The Waste Storage Area (Phase II) Design Report, Revision A (DOE 2005c), presents the current Aquifer Remedy System Design, Model Approach C.
- The most current version of the OMMP is the controlling document for operation of the aquifer remedy system.
- The most current version of the IEMP is the controlling document for groundwater remedy performance monitoring.
- The Sitewide CERCLA Quality Assurance Project Plan (SCQ) (DOE 2003), or its subsequent legacy management equivalent, will establish quality assurance guidelines for the aquifer remedy. As discussed in Section 3.5, the SCQ is currently being streamlined by removing all internal procedures.

1.4 ORGANIZATION OF THE GROUNDWATER CERTIFICATION PLAN

This certification plan is comprised of 11 sections and three appendices. The remaining sections and their contents are as follows:

Section 2.0 **Groundwater Certification Process and Stages.** Provides an overview each of the six stages defined for the groundwater certification process and presents the estimated time that will be required to complete the groundwater certification process.

Section 3.0 **General Certification Issues and Strategies.** Presents issues and strategies that were discussed at the May – September 2005 TIE meetings, culminating in the definition of the components and details of the certification plan. Discussion includes a definition of the aquifer remediation footprint, a description of the remediation infrastructure and monitoring network, reduced sampling list for Stage I, phased modular approach and use of transition monitoring, contingencies and exit strategies, data quality, and document review cycles.

Section 4.0 **Stage I – Pump-and-Treat Operations.** Presents the scope of Stage I of the certification process. Discussion includes objectives, issues and general strategies, an overview of the operations and system design, groundwater monitoring and reporting, decision-making criteria, contingencies and exit strategy.

Section 5.0 **Stage II – Post Pump-and-Treat Operations/Hydraulic Equilibrium State.** Presents the scope of Stage II of the certification process. Discussion includes objectives, issues and general strategies, time needed to document steady state, groundwater monitoring and reporting, and decision-making criteria.

Section 6.0 **Stage III – Certification/Attainment Monitoring.** Presents the scope of Stage III of the certification process. Discussion includes objectives, issues and general strategies, monitoring and reporting, and decision-making criteria.

Section 7.0	**Stage IV – Declaration and Transition Monitoring.** Presents the scope of Stage IV of the certification process. Discussion includes objectives, issues and general strategies, monitoring and reporting, and decision-making criteria.
Section 8.0	**Stage V – Demobilization.** Presents the scope of Stage V of the certification process. Presents plans for the D&D of infrastructure, well abandonment, soil excavation and certification, and the OU5 Final Remedial Action Report.
Section 9.0	**Stage VI – Long-Term Monitoring.** Presents the scope of Stage VI of the certification process. Discusses objectives, issues and general strategies, monitoring and reporting, decision making criteria, and contingencies and exit strategy.
Section 10.0	**Groundwater Certification Documents.** Presents an overview of the documentation that will be produced during the certification process. Discusses annual progress reports, module-specific declaration of completion/concurrence to precede letter reports, module-specific certification reports, and the OU5 Final Remedial Action Report.
Section 11.0	**References.** Presents references used in preparation of this plan.
Appendix A	**Groundwater FRL Constituent Monitoring Frequency Table**
Appendix B	**Sampling Protocol.** Presents a copy of Section 3 of the IEMP. The IEMP is the controlling document for groundwater sampling.
Appendix C	**Statistical Procedures.** Provides an overview of the statistical procedures that will be used for the groundwater certification process.
Appendix D	**Table of Contents for the Groundwater Certification Report.** Provides an outline for a table of contents for the future Groundwater Certification Report.

2.0 GROUNDWATER CERTIFICATION PROCESS AND STAGES

2.1 STAGES DEFINED FOR THE GROUNDWATER CERTIFICATION PROCESS

A six-stage modular groundwater certification process has been developed for Fernald and is illustrated in Figure 2-1. The six stages are:

- Stage I – Pump-and-Treat Operations
- Stage II – Post Pump-and-Treat Operations/Hydraulic Equilibrium State
- Stage III – Certification/Attainment Monitoring
- Stage IV – Declaration and Transition Monitoring
- Stage V – Demobilization
- Stage VI – Long-Term Monitoring.

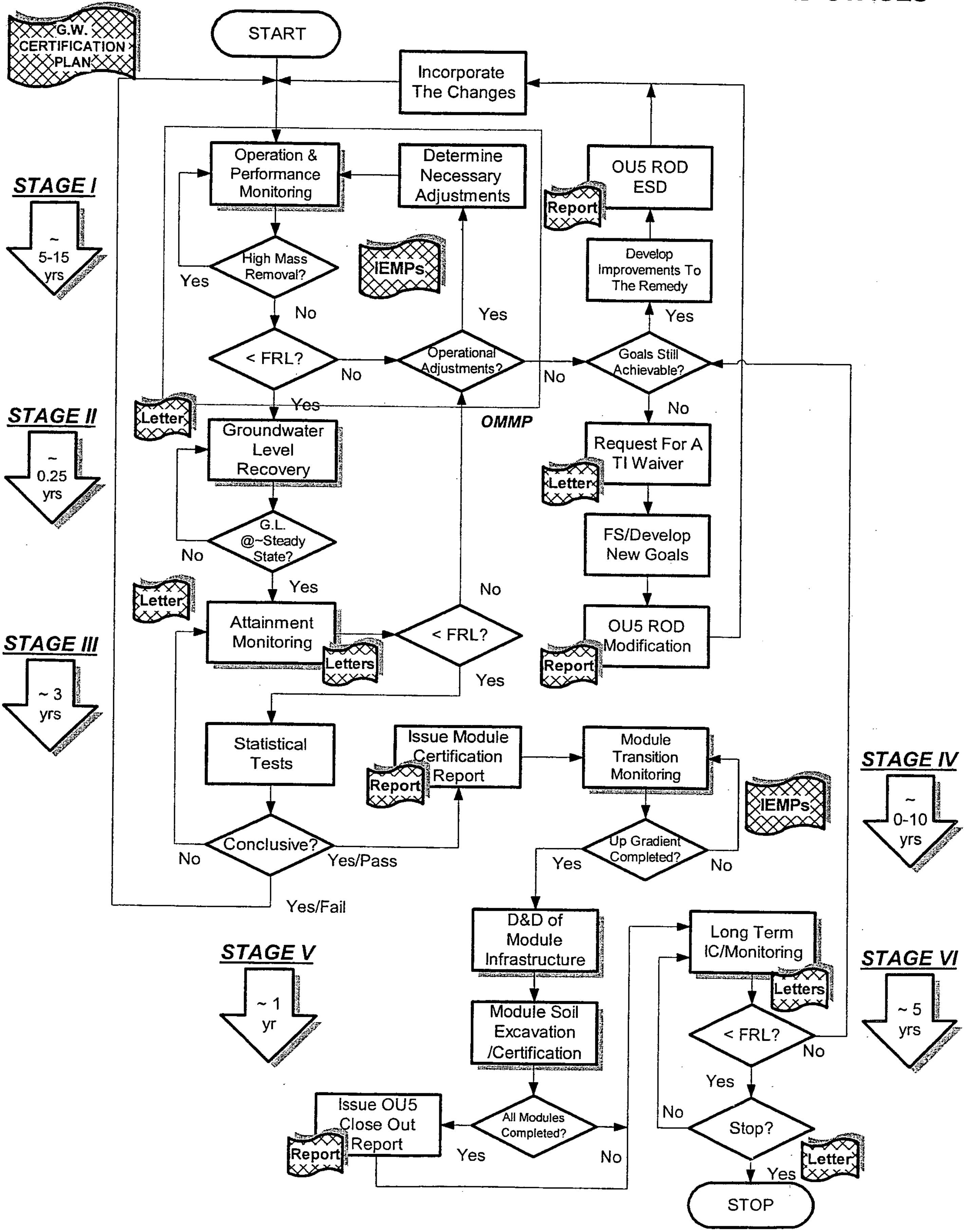
A brief description of each stage is provided below. Additional information concerning each stage is provided in Sections 4.0 through 9.0 of this plan.

A phased modular approach will be implemented for each stage of the certification process. The most current groundwater modeling is presented in the Waste Storage Area (Phase II) Design Report. Modeling Approach C indicates that extraction wells can be turned off in the South Plume Module first (in 2015), and in Waste Storage Area Module last (in 2023), assuming nominal water level boundary conditions.

Rather than wait until the entire aquifer remediation footprint is remediated in 2023 to begin Stage II of the certification process, a phased certification approach will be conducted, driven by the schedule predicted by the groundwater model for completion of Stage I at each module. Stage II for the off-property South Plume Module is predicted to begin first (in 2015). Stage II for the Waste Storage Area Module is predicted to begin in 2023.

This sequencing is a legacy of the OU5 Record of Decision objective to remediate the off-property uranium plume first. The off-property uranium plume is the most downgradient portion of the uranium plume and is being remediated by the South Plume Module. This means that upgradient uranium contamination will remain a potential threat to downgradient areas of the aquifer where FRL constituent concentrations have been achieved.

FIGURE 2-1 GROUNDWATER CERTIFICATION PROCESS AND STAGES



Transition monitoring will be conducted to address the potential threat posed by upgradient uranium contamination to uncontaminated downgradient areas of the aquifer that are past Stage I of the certification process or have achieved certification. In addition to the usual capture assessments that will continue for upgradient restoration modules where Stage I operations will still be progressing, a few groundwater monitoring wells will be selected along the upgradient edge of the clean module to monitor uranium concentrations. Increasing uranium concentrations will indicate that upgradient plume capture is not being achieved and that the downgradient clean module is in danger of being re-contaminated. Transition monitoring is further discussed in Section 7.0.

Stage I – Pump-and-Treat Operations

The aquifer remedy is currently in Stage I (Pump-and-Treat Operations). Stage I will continue until groundwater FRL constituent concentrations have been achieved. If it is determined that FRL objectives are not being met, then an adjustment to the operating system will be considered. The controlling document for operation of the aquifer remediation system is the OMMP. All operational adjustments will be implemented through the OMMP. If it is determined that operational adjustments are ineffective, then contingencies (e.g., a change in technology or to cleanup goals) may be pursued. Contingencies are further discussed in Section 3.4.

Groundwater extracted from the aquifer will be treated as necessary to achieve the discharge limits specified in the OU5 Record of Decision and National Pollutant Discharge Elimination System (NPDES) discharge limits. When discharge limits can be achieved without treatment, a request will be made to the EPA and OEPA to shut down and decommission the water treatment facility. Any request to permanently shut down the water treatment facility would include a continued commitment to maintain aggressive pumping rates in order to maximize mass removal from the aquifer and shorten remediation times.

Pump-and-treat operations are no longer supplemented with well-based re-injection. Efforts are underway to provide enhanced recharge to the aquifer through existing recharge pathways (e.g., basins, ditches, etc.).

Groundwater modeling predicts that the South Plume Module will complete Stage I of the certification process first, followed by the South Field Module, then the Waste Storage Area Module. It is estimated that completion of Stage I in the Waste Storage Area Module will take approximately 15 additional years. Additional information concerning Stage I can be found in Section 4.0.

Stage II – Post Pump-and-Treat Operations/Hydraulic Equilibrium State

Stage II monitoring will begin at a restoration module after pump-and-treat operations have stopped at that module. The objective of Stage II is to document that the aquifer has adjusted to steady-state, non-pumping conditions prior to proceeding to Stage III (Certification/Attainment Monitoring).

During Stage II, groundwater levels will be routinely measured to document that steady-state water level conditions have been achieved. Uranium concentrations will also be routinely measured. If uranium concentrations rebound to levels above the groundwater FRL during Stage II, the module will default to Stage I. If uranium concentrations remain below the groundwater FRL during Stage II and do not appear to be trending up toward the groundwater FRL, then the module will proceed to Stage III (Certification/ Attainment Monitoring). It is estimated that Stage II will last for about 0.25 years (i.e., three months) for each restoration module. If water levels have not reached steady-state conditions in three months, then Stage II will be extended until such a determination can be made. Additional information concerning Stage II can be found in Section 5.0.

Stage III – Certification/Attainment Monitoring

This is considered to be the most important stage of the certification process. Stage III monitoring will begin at a restoration module after the aquifer in the area of the module has achieved a hydraulic steady-state condition.

Groundwater monitoring will be conducted in all available wells located within the aquifer remediation footprint for the module undergoing certification (the aquifer remediation footprint is defined in Section 3.1). In addition to monitoring existing groundwater monitoring wells, direct-push sampling will be conducted to establish concentration profiles through the aquifer. Supplementing fixed monitoring wells with temporary direct-push sampling will address the issue of making sure that well screens are properly located to monitor the zones of highest residual dissolved contamination in the aquifer under non-pumping hydraulic steady-state conditions.

FRL concentration data will be collected quarterly over a three-year time period to document that OU5 Record of Decision aquifer remediation goals have been achieved, and that the goals will continue to be maintained in the future. Analysis of the data will include the use of statistics. Groundwater sampling will focus on the COCs included in the routine IEMP sampling program at the end of Stage I. The number of COCs being routinely sampled at the end of Stage I is expected to be significantly reduced from the number that is currently being sampled routinely. During the first quarter of the third year, all OU5 groundwater FRL COCs will be sampled as a final confirmation that no FRL exceedances remain. Additional information concerning Stage III can be found in Section 6.0.

Stage IV – Declaration and Transition Monitoring

The purpose of Stage IV is to identify that a certification report will be prepared for each aquifer remediation module that completes Stage III, and to document that the certified clean module area is not being re-contaminated by upgradient contamination.

Because certification is module-specific, additional groundwater monitoring will need to be conducted following completion of Stage III in the South Plume and South Field Modules to document that upgradient contamination is not entering the areas. This monitoring will take place in Stage IV. Three pre-selected groundwater monitoring wells will be monitored semiannually for uranium until the entire upgradient zone has been certified.

If contamination is detected in the certified clean module, pumping in the upgradient module can be adjusted to achieve effective capture. If necessary, extraction wells in the downgradient module can be re-activated to address the contamination. Additional information concerning Stage IV can be found in Section 7.0.

Stage V – Demobilization

Stage V covers such activities as the demolition and disposal (D&D) of infrastructure (which may include the converted advanced wastewater treatment facility [CAWWT], valve houses, and underground piping), well abandonment, soil excavation and certification, and closeout reporting. All extraction wells and monitoring wells will need to be plugged and abandoned following completion of Stage IV for the last module. Eighteen on-site disposal facility (OSDF) Great Miami Aquifer monitoring wells will remain.

As infrastructure is removed, soil excavation and certification around the infrastructure will need to be conducted. After the infrastructure has been removed, wells have been abandoned, and surrounding soil has been excavated and certified, the OU5 Final Remedial Action Report (referred to as OU5 Closeout Report in Figure 2-1) will be issued for the Aquifer Remediation Project. Additional information concerning Stage V can be found in Section 8.0.

Stage VI – Long-Term Monitoring

Long-term monitoring will be conducted to document that residual uranium contamination in the vadose zone does not cause groundwater FRL exceedances for uranium in the aquifer following the completion of the certification process.

The concern is that water levels in the aquifer could rise in the future, and possibly dissolve uranium that is fixed in the vadose zone located beneath former source areas, resulting in new FRL exceedances. Groundwater levels in former source areas will be monitored to determine if water levels rise to levels higher than what have been recorded during Stages II, III, and IV. High water levels would trigger sampling groundwater for uranium beneath former source areas using a direct-push sampling tool.

Water level monitoring will be conducted semiannually for five years as part of Stage VI, during the seasonal high and low water elevation time periods. Monitoring as part of Stage VI will stop after five years if the groundwater table remains low. If high water levels trigger monitoring beneath the former source areas, then monitoring will stop if uranium concentrations measured in the former source areas remain statistically below the groundwater FRL. Additional information concerning Stage VI can be found in Section 9.0.

2.2 ESTIMATED TIME REQUIRED TO COMPLETE GROUNDWATER CERTIFICATION

Using January 2006 as a referenced start date, the time required to complete certification of the aquifer remedy has been estimated to be from 26.25 years (2032) to 33.25 years (2039). Most of the uncertainty for completing the aquifer remedy resides in Stage I (Pump-and-Treat Operations).

Dates for completing Stage I are reported in the Waste Storage Area (Phase II) Design Report (via Groundwater Modeling Approach C) and are based on the type of boundary conditions used. The modeling results indicate the last groundwater module to complete Stage I will be the Waste Storage Area Module. Using wet water level boundary conditions, the Waste Storage Area Module is projected to complete Stage I by 2022. Using dry water level boundary conditions, the Waste Storage Area Module is projected to complete Stage I by 2031. Using nominal water level boundary conditions, the Waste Storage Area Module is projected to complete Stage I by 2023. For the purpose of this plan, nominal water level boundary conditions will be assumed, resulting in an estimated completion date for Stage I at all modules by 2023. The dates predicted for the completion of Stage I Pump and Treat Operations are subject to change should future model calibrations or field data indicate that the predictions are not correct.

Time estimates for the completion of Stage I are complicated by unknown aquifer responses to the pump-and-treat remediation such as contaminant concentration tailing and contaminant concentration rebounding. Tailing refers to the progressively slower rate of dissolved contaminant concentration decline observed with continued operation of the pump-and-treat system. These aquifer responses are common to pump-and-treat operations and are further discussed in the Section 4.0.

As shown in Figure 2-1, it is estimated that completion of Stages II through III will take about 3.25 years (Stage II–0.25 years; Stage III–3.0 years). These time estimates do not include time lags between the sampling event/round and when the data will actually be available for use. Stage IV will be ongoing as Stage I is completed. Therefore, certification of the last module, the Waste Storage Area Module, is projected to be completed in 2026.

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3.0 GENERAL CERTIFICATION ISSUES AND STRATEGIES

This section presents the key issues and strategies that were discussed and resolved at TIE meetings held between May 2005 and September 2005. Specifically, the issues include:

- Defining an aquifer remediation footprint (discussed in Section 3.1)
- Remediation infrastructure and monitoring network (discussed in Section 3.2)
- Reducing the sampling list of groundwater FRL constituents for Stage I remedy performance monitoring (discussed in Section 3.3)
- Contingencies and exit strategies (discussed in Section 3.4)
- Data quality (discussed in Section 3.5)
- Document review cycles (discussed in Section 3.6).

The selection and use of statistical procedures was also a key issue of the TIE meetings. Statistical procedures that will be used for the groundwater certification process are presented in Appendix C.

3.1 AQUIFER REMEDIATION FOOTPRINT

The aquifer remediation footprint was defined in the Draft Certification Strategy submitted to the EPA and OEPA on May 25, 2005, and presented to the EPA and OEPA at the March 9, 2005 TIE meeting at the Fernald site. Originally termed "impacted areas of the aquifer," the name was changed in response to a request made by the OEPA at the September 15, 2005 TIE meeting in Dayton.

The term "aquifer remediation footprint" is used to define those areas of the aquifer that will be targeted for the groundwater certification process. The OU5 Record of Decision establishes that "areas of the Great Miami Aquifer exceeding FRLs will be restored through extraction methods." Since the OU5 Record of Decision was issued, the areas of the aquifer being targeted for restoration have changed due to:

- Collecting additional characterization data to support module designs
- Changing the uranium FRL concentration for groundwater from 20 micrograms per liter (µg/L) to 30 µg/L.

A brief discussion of the changes is provided below, followed by a definition of the aquifer remediation footprint.

Continued groundwater monitoring and direct-push sampling conducted to support the design of individual aquifer modules during Stage I provided data that indicated that the area of the aquifer exceeding the groundwater FRL for uranium was larger than the area defined at the beginning of Stage I. The module designs that have been issued include the Waste Storage (Phase I) Module (DOE 2001a), South Field (Phase II) Module (DOE 2002) and the Waste Storage Area (Phase II) Module.

Changing the FRL limit for uranium in groundwater from 20 μg/L to 30 μg/L decreased the area of the aquifer that was defined as exceeding the groundwater FRL for uranium at the beginning of pump-and-treat operations. In 1996, when the OU5 Record of Decision was signed, the maximum contamination level (MCL) for uranium in drinking water had not been promulgated, but was proposed at 20 μg/L. The FRL for uranium for the groundwater remedy at the start of the remedy was defined as 20 μg/L to match this EPA proposal. In 2001, EPA finalized the MCL for uranium at 30 μg/L for drinking water. Through a Record of Decision Explanation of Significant Differences (ESD), the MCL became the FRL for total uranium in groundwater at the Fernald site.

To incorporate the changes presented above, the aquifer remediation footprint is conservatively defined as the areas contained within a composite of all previous 20-μg/L maximum uranium plume interpretations through 2000, and 30-μg/L maximum uranium plume interpretations subsequent to 2000, located north of the Administrative Boundary for aquifer restoration (established in the OU5 Record of Decision). The aquifer remediation footprint (updated through the second half of 2004) is shown in Figure 3-1. The footprint interpretation will be updated each year to reflect the annual updated maximum uranium plume map published yearly in the IEMP. The process used to update the maximum uranium plume map each year is defined in Section 3.0 of the IEMP.

3.2 REMEDIATION INFRASTRUCTURE AND MONITORING NETWORK

The remediation infrastructure and monitoring network consists of the CAWWT, valve houses, Parshall Flume, 208 groundwater monitoring wells owned by the site, 23 active extraction wells, and 17 inactive extraction and injection wells. Figure 3-2 is a location map for the monitoring wells and infrastructure. Figure 3-3 is a location map showing all active and inactive extraction and re-injection wells.

The groundwater monitoring network consists of five different monitoring well designs. These designs are illustrated in Figure 3-4. Type 2 groundwater monitoring wells are installed with 15-foot-long well screens. Type 6 groundwater monitoring wells are installed with either 10-foot or 15-foot-long screens. The other wells are installed with 10-foot-long well screens. Type 8 wells are continuous multi-channel tubing (CMT) wells; instead of having one screen, they have up to six individual screens in order to discretely

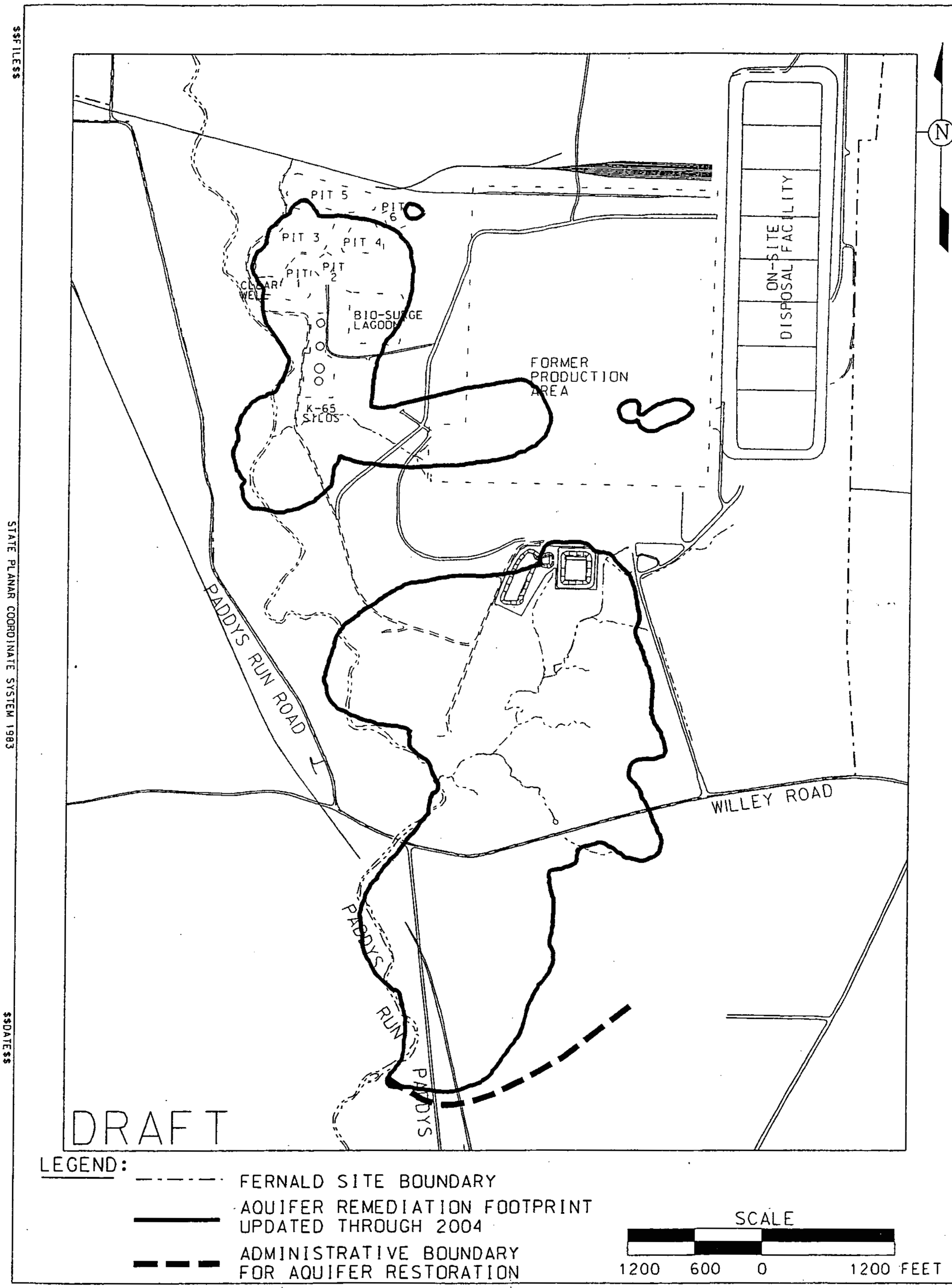

FIGURE 3-1. AQUIFER REMEDIATION FOOTPRINT

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STATE PLANAR COORDINATE SYSTEM 1983

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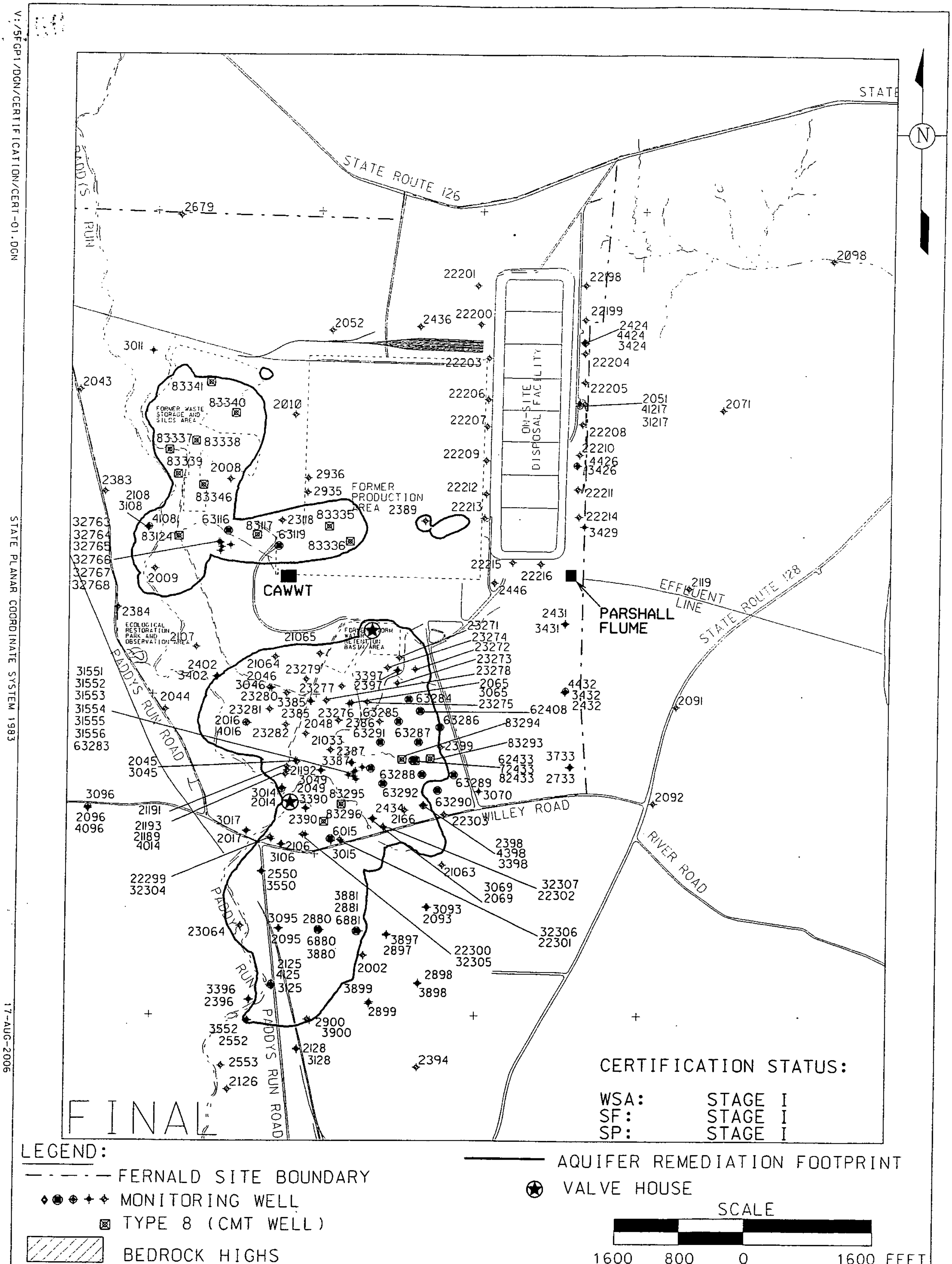
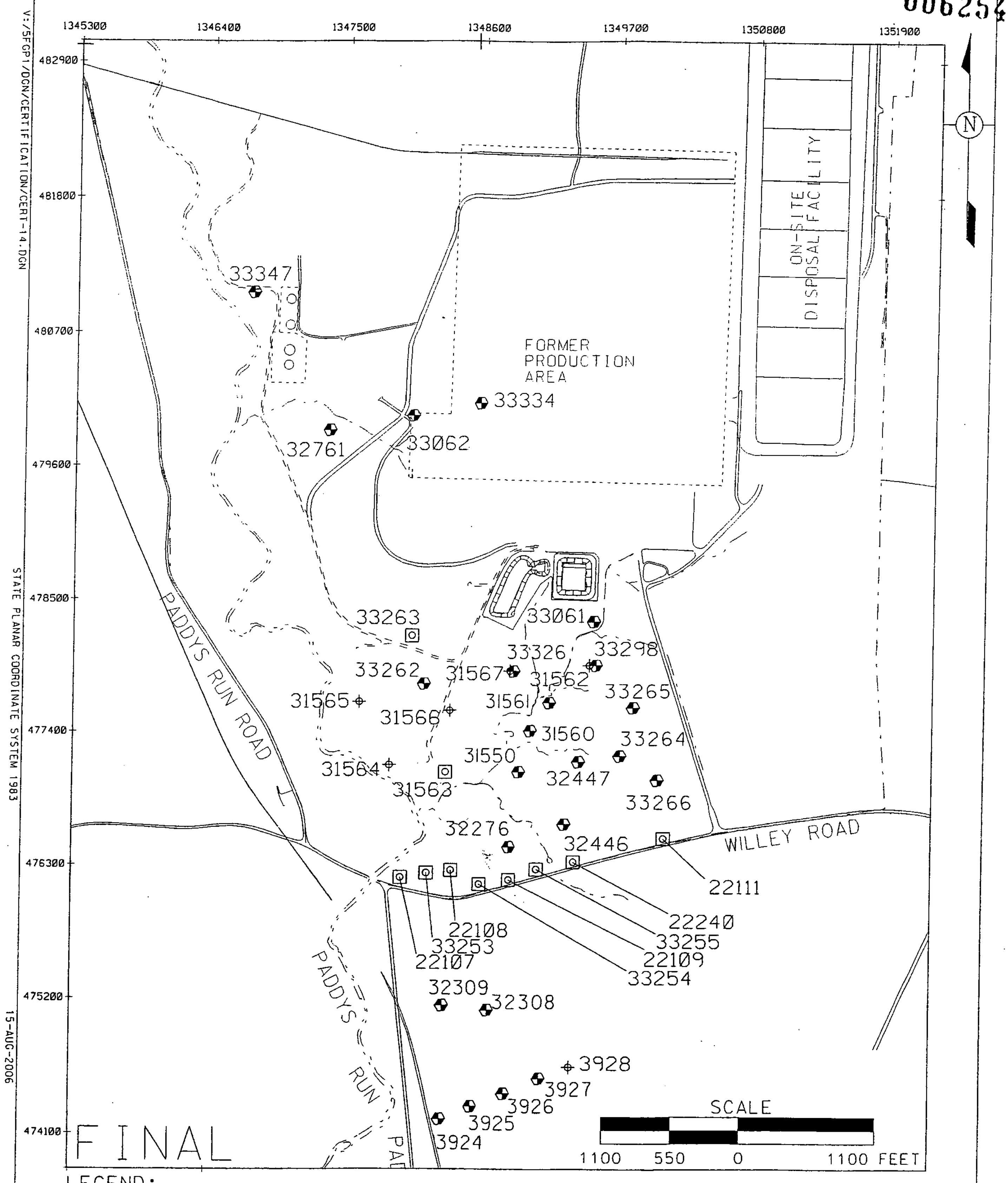


FIGURE 3-2. AVAILABLE GROUNDWATER MONITORING WELLS OWNED BY THE SITE AND SUPPORTING INFRASTRUCTURE



LEGEND:

- FERNALD SITE BOUNDARY
- ACTIVE EXTRACTION WELL
- INACTIVE EXTRACTION WELL
- INACTIVE INJECTION WELL

FIGURE 3-3. ACTIVE AND INACTIVE EXTRACTION AND INJECTION WELLS

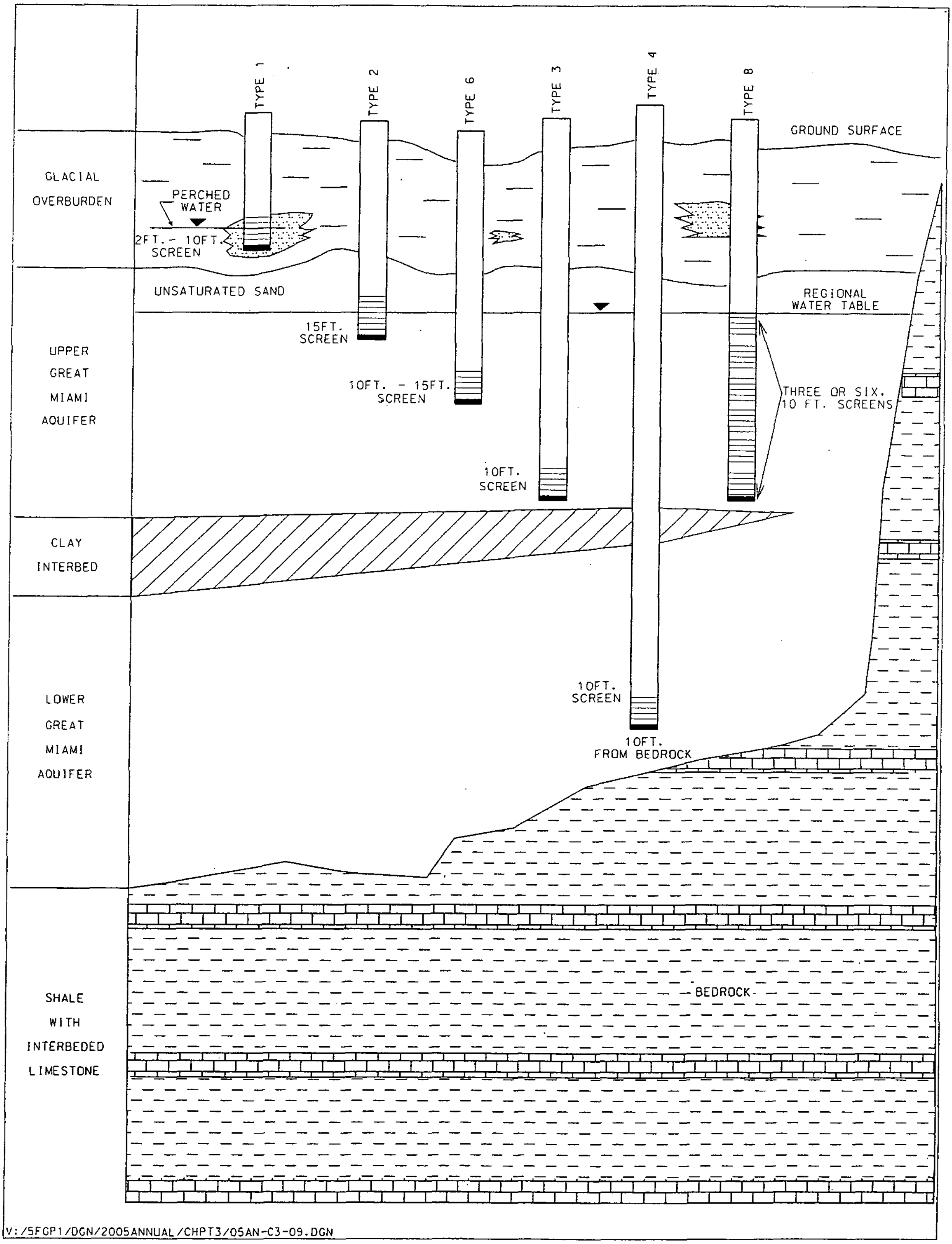


FIGURE 3-4. MONITORING WELL RELATIVE DEPTHS AND SCREEN LOCATIONS

monitor the entire vertical thickness of the plume. As illustrated in Figure 3-4, monitoring coverage is provided at several different depths in the aquifer.

Table 3-1 illustrates by well type the number of available groundwater monitoring wells (owned by the site) in each Aquifer Restoration Module. There are currently 208 available monitoring wells. The breakdown by module of available monitoring wells is as follows:

- The South Plume Module contains 31 monitoring wells.
- The South Field Module contains 96 monitoring wells.
- The Waste Storage Area Module contains 28 monitoring wells.

All of these wells or a subset of these wells will be used in the various stages of the groundwater certification process.

The number of available monitoring wells is expected to decrease over the course of the certification process. As a conservative step, monitoring wells in a restoration module will not be plugged and abandoned until transition monitoring is no longer required. Eventually, the only Great Miami Aquifer monitoring wells that will remain are the 18 OSDF Great Miami Aquifer monitoring wells.

3.3 REDUCED SAMPLING LIST FOR STAGE I

During the August 4, 2005 TIE meeting, an agreement was reached to reduce the Groundwater Monitoring Constituent List being used for groundwater remedy performance monitoring to the 14 groundwater FRL constituents that are identified for semiannual sampling in the IEMP, Revision 4. Details of the change and justification for the change will be provided through the IEMP reporting and revision process.

TABLE 3-1

AVAILABLE MONITORING WELLS AND ACTIVE EXTRACTION WELLS OWNED BY THE SITE

	Certification Wells					
Well Type	**South Plume Module**	**South Field Module**	**Waste Storage Area Module**	**OSDF**	**Other**	**Current Total**
Type 2	16	45	8	18	22	109
Type 3	12	29	7	0	8	56
Type 4	1	3	1	0	5	10
Type 6	2	14	2	0	0	18
Type 8	0	5	9	0	0	14
Total	**31**	**96**	**28**	**18**	**35**	**208**
Active Extraction Wells	6	13	4			23

The 14 groundwater FRL constituents that will continue to be monitored semiannually to support remedy performance monitoring as specified in the IEMP are:

- Antimony
- Arsenic
- Boron
- Carbon disulfide
- Fluoride
- Lead
- Manganese
- Molybdenum
- Nickel
- Nitrate/nitrite
- Technetium-99
- Trichloroethene
- Uranium
- Zinc

3.4 CONTINGENCIES AND EXIT STRATEGIES

The possibility that pump-and-treat technology will not achieve remediation goals has been factored into the groundwater certification process via contingencies and exit strategies. As illustrated in Figure 2-1, several contingencies and exit strategies are identified for the certification process, specifically, an ESD, a Technical Impracticability Waiver (TI Waiver), and a Record of Decision Amendment. These contingencies and exit strategies are linked to Stages I and VI of the certification process.

As stated earlier, the OMMP is the controlling document for operation of the aquifer remediation system. If it is determined that operational adjustments to the current system are no longer a viable option for achieving remediation goals, then contingencies (outside of the OMMP) will be considered. An OU5 Record of Decision ESD request may be made if it is determined that an improvement to the existing remedy is required. A TI Waiver may be requested if: (1) achievement of a remediation goal is shown to be impossible or impractical using the best available technology; and (2) it is shown that the design was proper, the system operated properly, and appropriate technology was used. The development of new remediation goals may be pursued through the preparation of an OU5 Record of Decision Modification (e.g., fact sheet, ESD, amendment).

If a contingency were deemed an appropriate course to pursue in the future, details concerning how best to proceed would need to be developed in cooperation with both the EPA and OEPA.

3.5 DATA QUALITY

Data quality requirements for Stage I of the aquifer remedy are currently defined in the IEMP. Table 3-2 presents the current strategy and requirements that are being followed for Stage I. These same objectives will be followed for Stage II, but as presented below, requirements will be stricter for Stage III.

Data quality requirements for Stage III (Certification/Attainment Monitoring) will increase compared to those that will be followed for Stages I and II. Table 3-2 highlights the changes. Specifically, the Analytical Support Level will increase to ASL D and validation requirements will increase to match what was done for soil certification.

The SCQ establishes minimum standards of performance for operational and analytical activities. The SCQ is being streamlined so that it will focus more on the continuing aquifer remedy, and be less redundant. Internal procedures are being removed as necessary from the SCQ so that the SCQ will become strictly a guidance document. The first draft of the streamlined SCQ is planned for June 2006.

3.6 DOCUMENT REVIEW CYCLES

The Amended Consent Agreement (ACA) will drive the review process for groundwater certification documents. Under the ACA, 60-day review cycles will be planned for groundwater certification documentation submitted to the EPA and OEPA for review.

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TABLE 3-2

DATA QUALITY OBJECTIVES, SAMPLE COLLECTION, AND DATA MANAGEMENT SUMMARY AND COMPARISON

TASK	CURRENT STRATEGY/REQUIREMENTS[a]	CERTIFICATION STRATEGY/REQUIREMENT
Project Phase	Remedial Design/Remedial Action	Certification (i.e., Stage III)
Analytical Support Level	In general, ASL B • Field screening at A • Chemical at B (full data package provided for metals and organics) • Radiological at E/D based on detection limits	D (E user-defined)
Validation	At Least 10 Percent Validated • Property Plume Boundary	100 Percent Validated • Same as soil certification • 10 percent to ASL D and 90 percent to ASL B
Sample Work Plan	IEMP	IEMP
Sample Collection Reference	SCQ and Standard Operating Procedures	Similar documents – being transitioned to LM
Field Quality Control Samples	Trip Blanks • For each sampling team on each day of sampling volatile organics Field Blanks • For each day of sampling organics Duplicates • Every 20 samples (or fraction thereof) Equipment Rinsate • Every 20 samples collected using non-dedicated equipment	Same as current
Laboratory Quality Control Samples	Method Blank Matrix Spike Matrix Spike Duplicate/Replicate Surrogate Spikes	Same as current
Detection Limits	1/10 of FRL, where possible	Same as current
Data Entry	Controlled Database • Double-key entry or other verification method to ensure accuracy	Same as current
Filtering	If turbidity is >5 NTU – use 5 μm or 0.45 μm filter until <5 NTU	Same as current

[a]Approach documented through the IEMP, Revision 4, Section 3 (Groundwater Monitoring Program).

4.0 STAGE I – PUMP-AND-TREAT OPERATIONS

All aquifer restoration modules are currently in Stage I of the certification process. Current modeling predictions indicate that the South Plume Module will complete Stage I first, followed by the South Field Module, and lastly the Waste Storage Area Module. The OU5 Record of Decision identifies 50 groundwater COCs that must be addressed by the pump-and-treat aquifer remedy. Uranium is the principal COC and is driving the remediation decision-making process.

4.1 OBJECTIVES

Objectives of the pump-and-treat operations are to:

- Achieve OU5 Record of Decision FRLs while maximizing mass removal
- Identify areas within the aquifer where tailing of FRL constituent concentrations are occurring (i.e., recalcitrant areas). Tailing refers to the progressively slower rate of dissolved contaminant concentration decline observed with continued operation of the pump-and-treat system.
- Identify areas within the aquifer that exhibit rebound when pumping is interrupted
- Provide treatment of groundwater such that the site maintains prescribed uranium discharge limits specified in the OU5 Record of Decision and NPDES discharge limits.
- Avoid increasing the size of the off property uranium plume
- Avoid allowing contaminants to flow southward off the property
- Avoid commingling the uranium plume with the Paddys Run Road Sites plume.

4.2 ISSUES AND GENERAL STRATEGIES

Issues concerning Stage I of the certification process include:

- Attainment of discharge limits and the use of the CAWWT.
- Role of injection.

4.2.1 Attainment of Discharge Limits and Use of the CAWWT

Based on historical data and experience, it is assumed that NPDES limits will be maintained during Stage I and subsequent certification stages. In addition, uranium has been an effective indicator parameter for other parameters such that adequate control of uranium will provide confidence that NPDES effluent limits will be maintained. DOE acknowledges that an NPDES permit will remain in effect for all groundwater discharges associated with the current remedy, and all effluent limits established in future permits will be evaluated and operations adjusted, if needed, to ensure compliance with those limits.

Groundwater will be treated to help meet uranium discharge limits specified in the OU5 Record of Decision until discharge limits can be achieved by blending untreated water alone. Eliminating groundwater treatment will not be pursued: (1) at the expense of compromising mass removal; or (2) if significant deviation from desired aggressive pumping rates is required. Any decision to operate by blending alone would be preceded by a request to the agencies that presents the impacts of such a change. Also, any decision to operate by blending alone will be made only after careful assessment has been made regarding the need to treat the high startup concentrations that may be experienced during the pulsed pumping operations. DOE will also consider discharging treated or blended water down the storm sewer outfall ditch instead of sending it to the Great Miami River in order to benefit from the potential aquifer re-charge that might be achieved through such an operation.

The test pump model is used to predict how long groundwater treatment will be required in order to meet uranium discharge limits. This model uses a spreadsheet to calculate a flow-weighted discharge concentration, based on pre-defined pumping rates of the extraction wells, pre-defined treatment capabilities, and uranium concentrations measured in water pumped from the extraction wells. The current prediction of how long treatment will be needed is based on constant pumping rates defined for Modeling Approach C, treatment capabilities defined in the OMMP, and uranium concentration data collected at the extraction wells through 2004. Following are two time predictions, one for 2007 and one for 2011.

The first prediction is based on trending actual concentration data collected at extraction wells. Based on the trended concentration data, the current predication is that groundwater treatment to meet uranium discharge limits will be required until the year 2007.

The second prediction is based on trending the 95 percent upper confidence level (UCL) of actual concentration data collected at extraction wells. Based on the trend of the 95 percent UCL of the uranium concentration data measured in water pumped from the extraction wells, groundwater treatment to meet uranium discharge limits will be required until the year 2011.

When labor, training, and maintenance costs are considered, it would not be cost effective to keep the CAWWT on standby. To be cost effective, the CAWWT either needs to operate or be shut down. Based on time predictions presented above, operating the CAWWT to meet uranium discharge limits will most likely no longer be required sometime between 2007 and 2011.

4.2.2 Role of Injection

As defined in the OU5 Record of Decision, innovative technologies will be pursued to supplement the pump-and-treat remedy. From 1998 through 2004, well-based re-injection was used to supplement the pump-and-treat remedy. Well-based re-injection was suspended in 2004 because it was no longer considered to be a cost-effective option. There are currently no plans to conduct future well-based re-injection.

An effort will be made for the remainder of the aquifer remedy to supplement pump-and-treat operations by directing as much clean surface water and/or groundwater as possible into all available practical pathways to the aquifer (i.e., the storm sewer outfall ditch, basins, Paddys Run). Enhanced infiltration to the aquifer through surface water features would be discontinued for one of two reasons. 1) A conclusion is reached that the process is not a cost effective benefit for improving the aquifer remedy. 2) Successful completion of Stage I in the module where induced infiltration is occurring.

A study was completed in 2005 that tested the feasibility of inducing recharge to the aquifer by pumping clean groundwater to the Storm Sewer Outfall Ditch (SSOD) in the South Field and allowing the water to infiltrate into the aquifer (DOE 2005d). Groundwater modeling predicts that such an action will shorten the time required to complete the aquifer remedy. The decision was made in early 2006 to proceed with pumping clean groundwater from existing construction wells located on the east side of the site into the SSOD as a supplement to natural flow of storm water entering the ditch in order to achieve up to a 500 gpm flow rate. Should the existing wells, pumps, and motors become unserviceable prior to a determination being made on the direct benefit being gained by the aquifer remedy because of he pumping, continuance of the pumping will be re-evaluated, and US EPA an Ohio EPA concurrence on a path forward will be obtained.

4.3 OVERVIEW OF OPERATIONS AND SYSTEM DESIGN

4.3.1 Operational Infrastructure and Design

As presented earlier, the pump-and-treat aquifer remediation system is divided into three restoration modules: the South Plume Module, the South Field Module, and the Waste Storage Area Module. The complete operational system is expected to consist of 23 active extraction wells. Six of these extraction wells are located off property, south of Willey Road (South Plume Module). Thirteen of the extraction wells are located in the South Field (South Field Module). Four of the extraction wells are located in the waste storage area (Waste Storage Area Module). Figure 1-1 shows the locations of the extraction wells. Operational pumping rates, as presented in the Waste Storage Area (Phase II) Design Report, are shown in Table 4-1. The total pumping rate being targeted for the system is approximately 4,775 gallons per minute (gpm) beginning April 1, 2006.

TABLE 4-1

GROUNDWATER REMEDY PUMPING SCHEDULE FOR MODELING APPROACH C

			PUMPING RATES (gpm)	
SYSTEM/WELL ID			04/01/06 to 04/01/15	04/01/15 to End
South Plume				
SP-1	RW-1	3924	200	0
SP-2	RW-2	3925	200	0
SP-3	RW-3	3926	200	0
SP-4	RW-4	3927	200	0
SP-6	RW-6	32308	200	0
SP-7	RW-7	32309	200	0
		Subtotal	1,200	0
South Field				
SF-31	EW-15a	33262	200	300
SF-17	EW-17a	31567	175	175
SF-18	EW-18	31550	100	100
SF-19	EW-19	31560	100	100
SF-20	EW-20	31561	100	400
SF-21	EW-21a	33298	200	300
SF-22	EW-22	32276	300	400
SF-23	EW-23	32447	300	400
SF-24	EW-24	32446	300	300
SF-25	EW-25	33061	100	100
SF-32	EW-30	33264	200	400
SF-33	EW-31	33265	300	400
SF-34	EW-32	33266	200	200
		Subtotal	2,575	3,575
Waste Storage Area				
WSA-1	EW-26	32761	300	500
WSA-2	EW-27	33062	200	200
WSA-4	EW-28	33063	200	200
WSA-5	EW-33	33330	300	300
		Subtotal	1,000	1,200
		Total Pumping	**4,775**	**4,775**

Pump-and-treat operations are expected to progress as follows:

- Pumping of the extraction wells will be constant until the entire remediation system is installed and anticipated tailing of uranium concentrations is encountered.
- Pulse pumping of extraction wells will be conducted to help mitigate tailing problems and to assess anticipated rebound when aquifer water levels rise near former source areas.
- Pumping will continue in a module until all monitoring wells and locations in the module are at or below FRL constituent concentrations.

Pulse pumping is being considered not only to help mitigate anticipated tailing of uranium concentrations, but to help address the concern of uranium contamination being left sorbed to soils in the vadose zone beneath former source areas. One option being considered is shutting down the entire system for approximately one month (with the exception of the South Plume barrier wells) to allow water levels in the aquifer to recover. Each spring/early summer, seasonal water levels in the aquifer are high due to seasonal recharge. Turning off the extraction wells each spring/early summer would boost the seasonal rise in water levels with the rise resulting from turning off the pumps. Pulse pumping operations would be controlled through the OMMP, which is the controlling document for operation of the remedy system.

4.3.2 Controlling Documents

The controlling document for pump-and-treat operations is and will continue to be the OMMP. The controlling document for remedy performance monitoring is and will continue to be the IEMP.

The design of the aquifer remedy system has evolved through the issuance of several different design documents:

- The Feasibility Study Report for Operable Unit 5 (DOE 1995a) presents the first aquifer remediation design.
- The Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) (DOE 1997) presents an improved remediation design that includes the design for the South Plume Optimization and South Field (Phase I) Modules.
- The Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas presents a new design that incorporates the waste storage area and eliminates the need for a restoration module in the Plant 6 area.
- The Design for Remediation of the Great Miami Aquifer, South Field (Phase II) Module presents an improved design that increases the number of wells in the South Field.
- The Waste Storage Area (Phase II) Design Report presents a final design for the Waste Storage Area Module.

4.4 MONITORING AND REPORTING

The groundwater monitoring network that is being used for Stage I remedy performance monitoring is and will continue to be defined in the IEMP. Remedy performance monitoring in the IEMP is organized around individual aquifer remediation modules.

4.4.1 Monitoring Network

Out of the available wells presented in Table 3-1, approximately 138 groundwater monitoring wells are currently being routinely sampled for FRL constituents under the IEMP, Revision 4 (refer to Figure 4-1), and water levels are being routinely measured at approximately 170 groundwater monitoring wells (refer to Figure 4-2). The number of wells being used for routine monitoring during Stage I is expected to remain fairly constant.

Concentration profile monitoring will be routinely conducted during Stage I via direct-push sampling at up to 10 locations per year in each aquifer remediation module. The purpose of the direct-push sampling is to update vertical plume profiles as the remedy progresses. As discussed in Sections 6.0 and 9.0, direct-push sampling will continue after Stage I has ended in order to document that certification/attainment samples are collected from areas of the aquifer that contain the maximum dissolved FRL constituent concentrations.

4.4.2 Sampling Lists, Frequency, and Duration

The sampling list used for each aquifer remediation module during Stage I is and will continue to be defined in the IEMP. Fourteen of the 50 FRL constituents have had FRL exceedances during the IEMP reporting period (1997 through 2004); refer to Section 3.3. These fourteen constituents will be sampled semiannually. The remaining 36 FRL constituents will not be sampled again until Stage III (Certification/Attainment Monitoring). It is anticipated that by the end of the Stage I, the list of FRL constituents being sampled semiannually will be significantly reduced. Any reduction in sampling lists would only be pursued with the approval of EPA and OEPA. A table that provides groundwater FRL constituent monitoring frequencies for all stages of the certification process is provided in Appendix A.

4.4.3 Controlling Documents

The controlling document for remedy performance monitoring during Stage I is and will continue to be the IEMP.

4.4.4 Reporting

The controlling document for remedy performance monitoring reporting is the IEMP. IEMP reporting protocols will continue to be followed during Stage I.

A Declaration of Completion/Concurrence to Proceed Letter will be issued at the end of Stage I for each aquifer remediation module. A certification report for each aquifer remediation module will also be issued. Reporting is further discussed in Section 10.0.

4.5 DECISION-MAKING CRITERIA

Criteria to modify, suspend, or stop operation of the aquifer remediation system will consider both the minimum mass recovery rate and target concentrations levels that are defined in the OMMP.

Stage I pumping will continue if:

- The uranium concentration of pumped groundwater at any extraction well, or any sampled location within the module, is greater than 30 μg/L
- The uranium concentration of pumped groundwater at any extraction well in the module, or sampled groundwater collected at any location in the module, rebounds to levels that are greater than 30 μg/L as a result of pulse pumping operations.

Stage I pumping will be discontinued or suspended if:

- The uranium concentration of pumped groundwater at all extraction wells in the module, or sampled groundwater collected at all monitoring locations in the module, is less than or equal to 30 μg/L
- The uranium concentration of pumped groundwater at all extraction wells in the module, or sampled groundwater collected at all locations in the module, doesn't rebound to levels that are greater than 30 μg/L as a result of pulse pumping operations
- Uranium mass removal efficiency indicates pumping is no longer efficient.

4.6 CONTINGENCIES AND EXIT STRATEGY

Contingencies and exit strategies would include:

- Operational adjustments
- ESDs
- TI Waiver.

Operational adjustments will be controlled though the OMMP. Any adjustments would use the existing pump-and-treat infrastructure and would not require changes to either the remedial action goals or the point of compliance.

An OU5 Record of Decision ESD would be required if it is decided to use a new technology such as bioremediation or natural attenuation.

A request for a TI Waiver would only be pursued if: (1) pump-and-treat operations have failed to achieve remediation goals; (2) the use of other promising technologies has been exhausted; and (3) it is shown that the design was proper, the system operated properly, and appropriated technology was used. Under a TI Waiver, new remediation goals or points of compliance may be pursued.

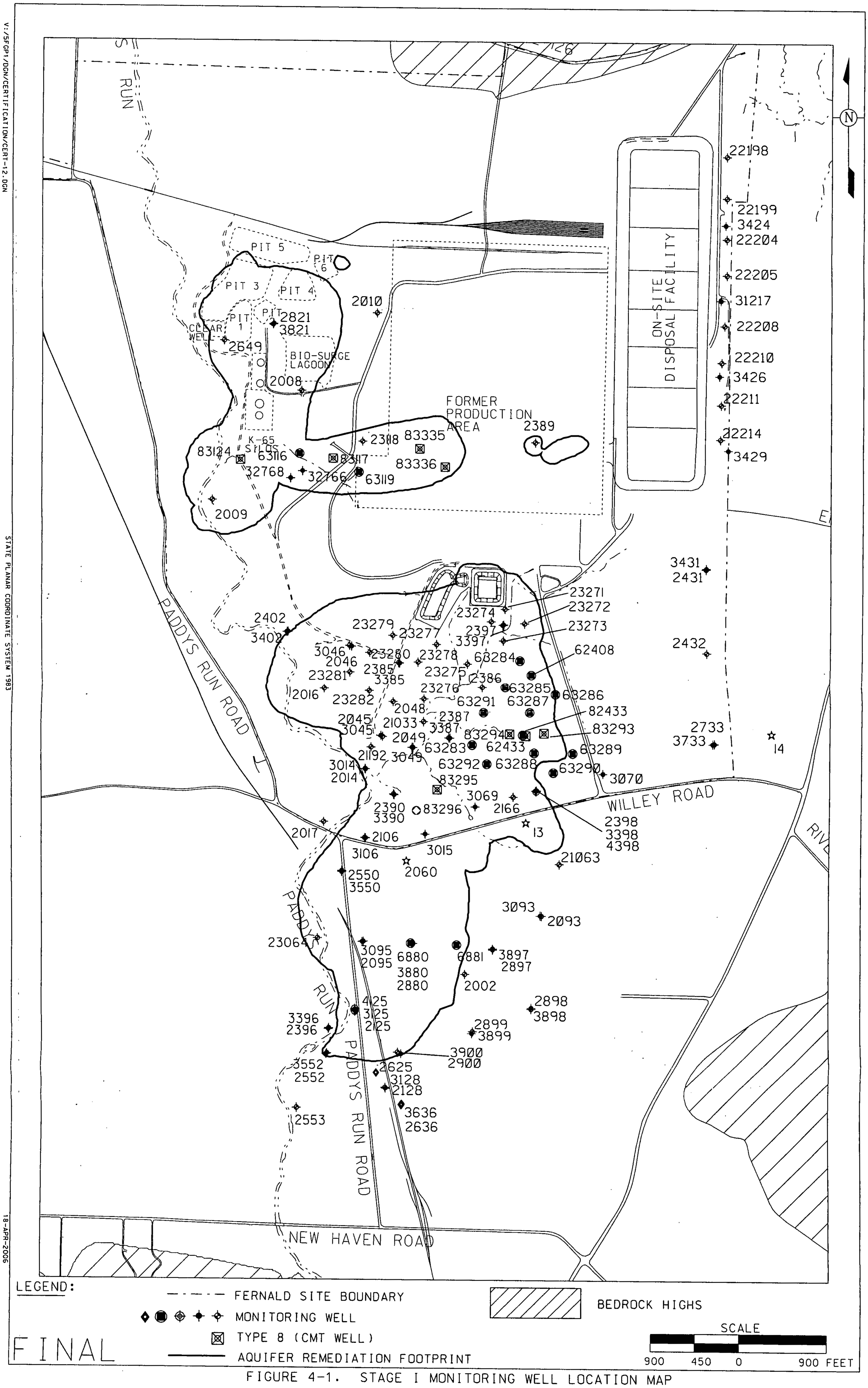

FIGURE 4-1. STAGE I MONITORING WELL LOCATION MAP

V:/5FGP1/DGN/CERTIFICATION/CERT-12.DGN

STATE PLANAR COORDINATE SYSTEM 1983

18-APR-2006

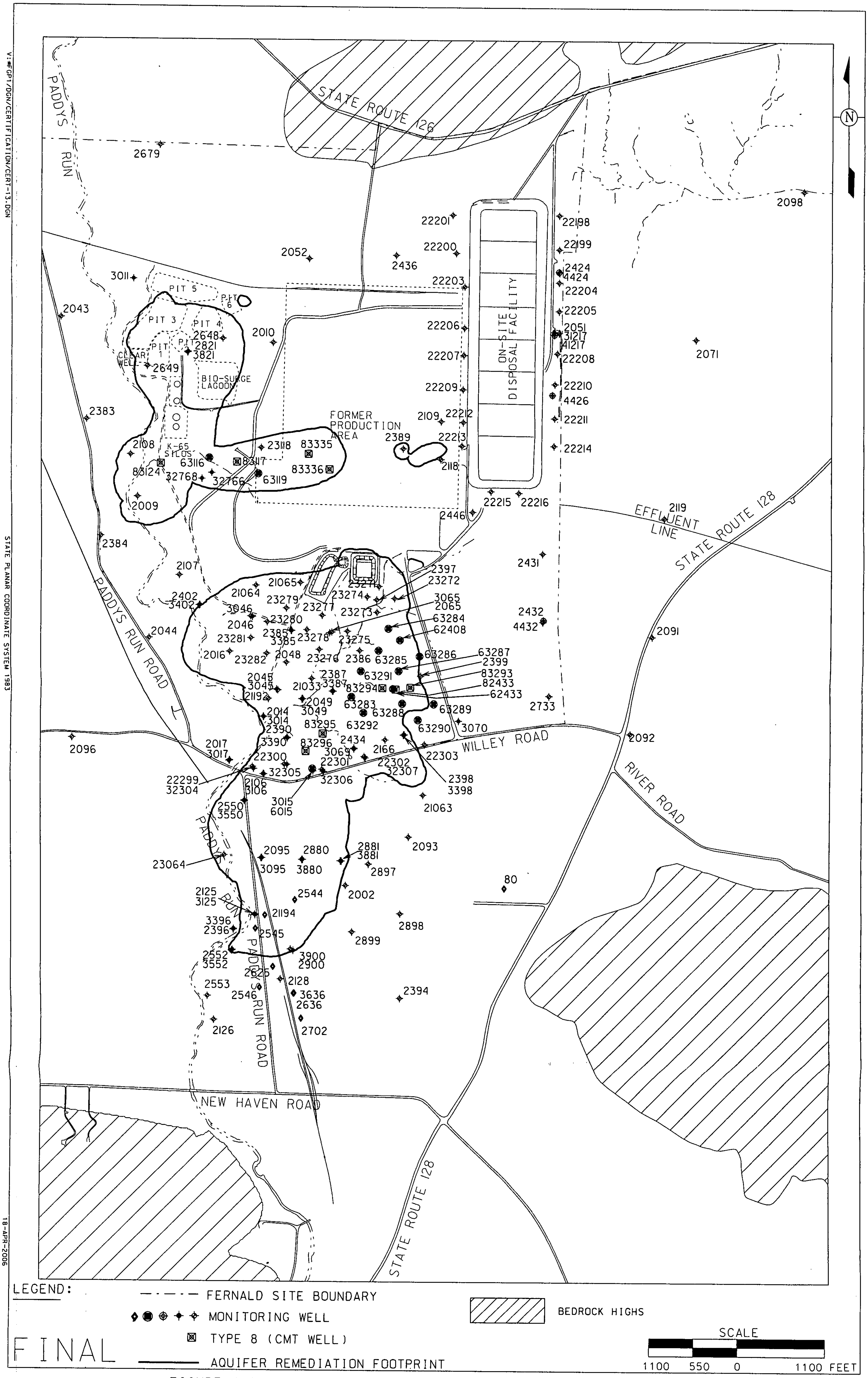

FIGURE 4-2. STAGE I WATER LEVEL MONITORING WELL LOCATION MAP

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5.0 STAGE II – POST PUMP-AND-TREAT OPERATIONS/ HYDRAULIC EQUILIBRIUM STATE

A phased modular approach will be taken to implement Stage II of the certification process. A Declaration of Completion/Concurrence to Proceed Letter requesting approval to initiate Stage II for each aquifer remediation module will be issued to the EPA and OEPA at the end of Stage I.

5.1 OBJECTIVES

The objectives of Stage II are to:

- Document that aquifer has reached steady-state hydraulic conditions after pump-and-treat extraction wells have been turned off
- Document uranium concentrations after pump-and-treat extraction wells have been turned off.

5.2 ISSUES AND GENERAL STRATEGIES

It is important that the aquifer be allowed to reach hydraulic steady-state conditions before proceeding to Stage III (Certification/Attainment Monitoring). As discussed below, it is anticipated that water levels will rebound almost instantaneously. FRL constituent concentrations, however, could continue to slowly rebound over a longer time period. Rather than remain in Stage II until FRL constituent concentrations have reached steady-state conditions, the decision has been made to proceed to Stage III if no uranium FRL exceedance occurs and groundwater elevation targets have been reached.

This strategy recognizes the possibility that Stage III efforts could fail if FRL constituent concentrations are still rebounding when Stage III data collection begins. Additional Stage III sampling may need to be conducted to compensate for uranium data collected under non-steady-state conditions.

5.2.1 Time Needed to Document Hydraulic Steady State

Water levels in a module area are expected to recovery rapidly after the pumping wells in that module are turned off. A seven-day pumping test was conducted in the Pilot Plant drainage ditch area in 2000, at a pumping rate of 750 gpm. Recovery of the water level in the aquifer was monitored after the pump was turned off. Water levels recovered to within one foot of static conditions after approximately one day (DOE 2001b). Water level versus time graphs will be prepared to illustrate how the elevations are trending. The asymptotic slope of the water level versus time curve will determine when elevation rebound has ended and steady-state hydraulic conditions have been achieved.

The steady-state elevations being targeted are those that are within the normal range of seasonal elevations without pumping. Water elevation data collected prior to the initiation of pump-and-treat operations will be used to define the normal range of seasonal elevations. Water table elevations measured during Stage II will be compared to water table elevations measured from 1988 to 1993. Elevations from 1988 to 1993 are documented in the OU5 Remedial Investigation Report. In addition to pre-pumping seasonal trends, regional trends will also be considered. Regional water level fluctuations for the Great Miami Aquifer are monitored by the Miami Conservancy District. It is probable that regional water levels in the future will be lower than they are now due to increased regional aquifer usage.

5.3 MONITORING AND REPORTING

5.3.1 Monitoring Network

The groundwater monitoring network used for Stage I remedy performance monitoring will also be used for Stage II steady-state assessment monitoring for water level measurements in all modules, and the collection of uranium concentration data in the South Plume Module and the Waste Storage Area Module. In the South Field Module, the collection of uranium concentration data will focus on recalcitrant areas using a subset of the available monitoring wells. It would be logistically impossible and unnecessary to monitor uranium in all available monitoring wells in the South Field during Stage II. The selection of South Field monitoring wells for uranium sampling in Stage II will be defined toward the end of Stage I when recalcitrant areas in the South Field are better defined. Selection of Stage II monitoring wells for uranium sampling in the South Field will be made with concurrence from the EPAs.

5.3.2 Sampling Lists, Frequency, and Duration

Stage II monitoring for water levels will be conducted biweekly for at least three months. Uranium concentration data will be collected monthly for at least three months. A table that provides groundwater FRL constituent monitoring frequencies for all stages of the certification process is provided in Appendix A.

5.3.3 Controlling Documents

The controlling document for Stage II will be the IEMP. The current version of the IEMP addresses Stage I monitoring. Details concerning Stage II monitoring will be added in future revisions of the IEMP through the normal IEMP revision process.

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5.3.4 Reporting

Data collected during Stage II monitoring will be reported through the IEMP reporting process.

A Declaration of Completion/Concurrence to Proceed Letter will be issued for each aquifer remediation module completing Stage II of the certification process. Reporting is further discussed in Section 10.0.

5.4 DECISION-MAKING CRITERIA

The decision to proceed to Stage III will be based on water level data reaching a steady state (i.e., no noticeable rising trend of groundwater elevations beyond seasonal fluctuations) and no detected groundwater FRL exceedances for uranium. If uranium concentrations rebound quickly (within one month) causing an FRL exceedance, the module will default to Stage I. If the trended data indicate that a groundwater FRL exceedance for uranium is likely within the next three years (the time period for Stage III monitoring), then the module will default to Stage I.

The probability of failing during Stage II will be better understood by the end of Stage I. It is anticipated that during Stage I, numerous pulse pumping operations will take place in an effort to increase mass removal efficiency (pounds of uranium removed) and to identify areas of concentration rebound. Areas of the plume that are identified as exhibiting seasonal concentration rebound in Stage I may be scheduled for routine pulse pumping operations during Stage I to try to reduce the amount of rebound that occurs with each successive pulse pumping episode. The objective would be to reduce rebound during Stage 1 down to levels that do not result in FRL exceedances in subsequent certification stages.

It is understood that moving to Stage III after three months of Stage II monitoring may result in the need to collect more data than what has been planned for in Stage III if it is determined that contaminant concentrations had not quite reached steady-state conditions before beginning Stage III.

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6.0 STAGE III – CERTIFICATION/ATTAINMENT MONITORING

A phased approach to certification/attainment monitoring will be implemented. Three aquifer remediation modules (South Plume Module, South Field Module, and Waste Storage Area Module) will be certified clean.

6.1 OBJECTIVES

The objective of Stage III is to collect groundwater FRL constituent concentration data to demonstrate that:

- No groundwater FRL exceedances are present at any monitored location.
- The 95 percent UCL on the mean of all FRL constituent concentrations at a particular monitoring location is less than or equal to the FRL.
- The future projected FRL constituent concentration at any monitored location will remain less than or equal to the FRL for up to 10 years.
- The upper tolerance level (UTL) of all monitoring results collected within the aquifer remediation module at the end of Stage III monitoring is less than or equal to the FRL.
- Trending of the module UTL indicates that it will remain less than or equal to the FRL in the future.

6.2 ISSUES AND GENERAL STRATEGIES

The major issue in Stage III (Certification/Attainment Monitoring) is choosing the statistical procedures and decision criteria. The strategy developed for using statistical procedures and decision criteria is illustrated in Figure 6-1. Further discussion on decision-making criteria is presented in Section 6.4

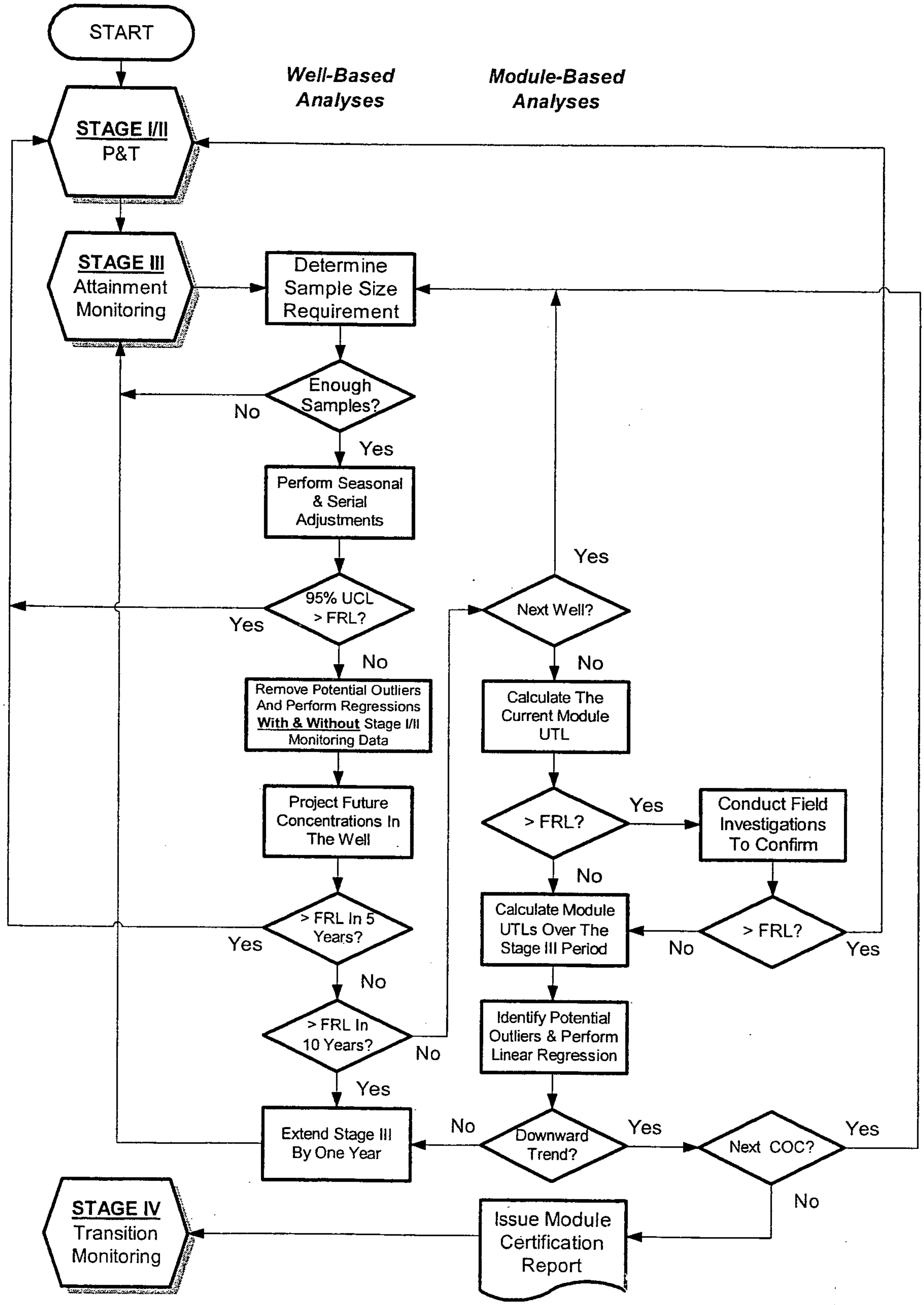
6.3 MONITORING AND REPORTING

6.3.1 Monitoring Network

The groundwater monitoring network used for Stage I and II monitoring will also be used during Stage III.

Concentration profile monitoring via direct-push sampling will also be conducted during Stage III. The purpose of the direct-push sampling will be to document that areas of the aquifer that contain the maximum dissolved FRL constituent concentrations are being properly monitored during Stage III. Sampling depths and locations will be adjusted if deemed appropriate based on the direct-push results.

FIGURE 6-1 GMA GROUNDWATER CERTIFICATION STATISTICAL PROCEDURES AND CRITERIA



6.3.2 Sampling Lists, Frequency, and Duration

Sampling will take place quarterly for a minimum of three years. This will provide a minimum of 12 sample points for statistical procedures. Sampling may continue longer than three years based on statistical needs. The list of groundwater FRL constituents routinely being sampled at the end of Stage I will also be used for Stage III. As discussed in Section 4.0, 14 groundwater FRL constituents are being routinely sampled for Stage I. It is anticipated that the number of FRL constituents being routinely sampled will be significantly reduced by the end of Stage I.

Full certification tests will be conducted for the remaining groundwater FRL constituents that were still being routinely sampled at the end of Stage I. A streamlined confirmation will be performed for all of the other groundwater FRL constituents. At a minimum the streamlined confirmation will include the 36 groundwater FRL constituents that are not being routinely sampled for Stage I Certification. All 50 groundwater FRL constituents are listed in Table A-1 of the IEMP. The 14 groundwater FRL constituents that are currently routinely sampled are listed in Section 3-3 of this plan. Dioxins are included in the list of constituents identified for streamlined confirmation. As directed in the Integrated Environmental Monitoring Plan, Rev. 3, Final, future dioxin sampling will be limited to locations in the waste storage area only. Therefore, streamlined confirmation for dioxin will only take place in the waste storage area. As necessary, those groundwater FRL constituents not being routinely sampled for at the end of Stage I will be sampled during the first quarter of the third year of certification/attainment monitoring to provide a comprehensive documentation on their FRL status. Additional sampling may be conducted if warranted based on the results of the comprehensive sampling. A table that provides groundwater FRL constituent monitoring frequencies for all stages of the certification process is provided in Appendix A.

6.3.3 Controlling Documents

The controlling document for Stage III (Certification/Attainment Monitoring) will be the IEMP. The current version of the IEMP addresses Stage I monitoring. Details concerning Stage II monitoring will be addressed through future revisions of the IEMP.

6.3.4 Reporting

Data collected during Stage III monitoring will be reported through the IEMP reporting process. It is anticipated that during Stage III monitoring, semiannual update letters will also be issued to the EPA and OEPA.

A Declaration of Completion/Concurrence to Proceed Letter will be issued at the end of Stage III for each aquifer remediation module. A certification report will also be issued for each aquifer remediation module at the end of Stage III. Reporting is further discussed in Section 10.0.

6.4 DECISION-MAKING CRITERIA

As presented in Figure 6-1, decision-making criteria for Stage III involves both well-based and module-based analyses.

6.4.1 Well-Based Analyses

If during Stage III any monitoring well sample result exceeds the groundwater FRL, and the exceedance is confirmed, then the module will default to Stage I. If an FRL exceedance is detected, it will need to be confirmed. The possibility of a data quality issue will be investigated, and the location will be re-sampled as soon as possible. If the FRL exceedance is not confirmed, the module will remain in Stage III, and the exceedance will be designated suspect and not be considered in statistical evaluations.

The 95 percent UCL on the mean at any monitoring location may also not exceed the groundwater FRL or the module will default to Stage I. Calculations for the 95 percent UCL will compensate for both serial correlations and seasonality. Even if seasonal effects are relatively small, it is recommended that the seasonal means be subtracted from the sample data (EPA 1992b). The data must pass an *a posteriori* sample size test to be valid. An alpha level of 5 percent will be used, and a beta level of 20 percent will be used.

If the criteria identified above are met, a linear regression of the three years' worth of Stage III concentration data will be performed. If the projection indicates that an FRL exceedance will occur within five years, the module will default to Stage I. If the projection indicates that an FRL exceedance will occur within 10 years (but beyond five years), the module will default to Stage I. If the projection indicates that no FRL exceedance will occur within the next 10 years, then the module may proceed to Stage IV, provided it also passes the module-based analyses described below.

6.4.2 Module-Based Analyses

The UTL for all the sampling results collected in the module during the last round of Stage III monitoring will be determined. If the UTL is greater than the FRL, then a field investigation will be conducted to confirm the exceedance.

The module UTL will also be trended using a linear regression. If the trend is flat or downward then the module may proceed to Stage IV. If the trend is upward, Stage III will be extended for one year and the analysis conducted again.

Specifics concerning statistical procedures can be found in Appendix C.

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7.0 STAGE IV – DECLARATION AND TRANSITION MONITORING

7.1 OBJECTIVES

Upon declaring that a module is certified clean, extra monitoring efforts will be implemented during Stage IV to document that the module is staying clean. The objective of Stage IV is to conduct transition monitoring upgradient of a certified clean module to document that contamination is not being allowed to re-enter the certified clean area.

7.2 ISSUES AND GENERAL STRATEGIES

Certifying on a modular basis adds the challenge of documenting that certified modules are not being re-contaminated from areas of the aquifer still undergoing remediation/certification. An objective of the aquifer remediation was to remediate the off-property portion of the uranium plume first. However, logistically the off-property portion of the plume is also the most downgradient portion. This means that upgradient contamination will still exist after the off-property plume has been remediated. Transition monitoring was developed to address this issue. A minimum of three monitoring wells will be selected upgradient of a clean module to document that contamination from the upgradient module is not being allowed to migrate into the certified clean area.

7.3 MONITORING AND REPORTING

7.3.1 Monitoring Network

The monitoring network for transition monitoring will consist of a minimum of three monitoring wells selected from the available monitoring wells in the upgradient portion of the module that has just been certified as clean. For the South Plume Module, Monitoring Wells 2106, 6015, and 13 are being targeted for transition monitoring (refer to Figure 7-1). For the South Field Module, Monitoring Wells 2402, 2046, and 2397 are being targeted for transition monitoring (refer to Figure 7-2).

7.3.2 Sampling Lists, Frequency, and Duration

Uranium will be sampled semiannually at the wells listed above until the upgradient module has also been certified clean. Transition monitoring in the South Plume will continue until the South Field Module has been certified clean. Transition monitoring in the South Field will continue until the waste storage area has been certified clean. A table that provides groundwater FRL constituent monitoring frequencies for all stages of the certification process is provided in Appendix A.

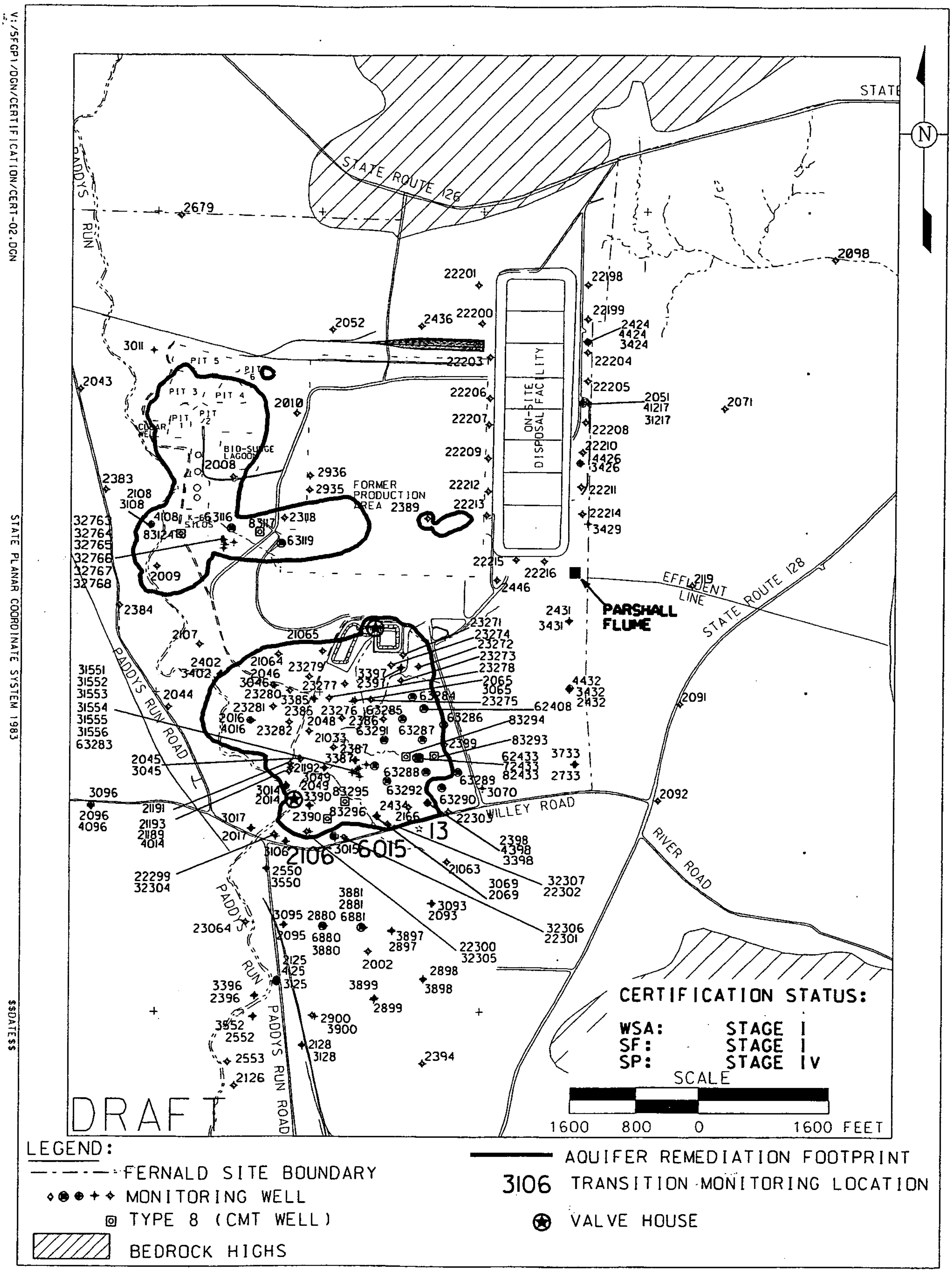

FIGURE 7-1. TRANSITION WELLS LOCATION MAP FOR THE SOUTH PLUME MODULE

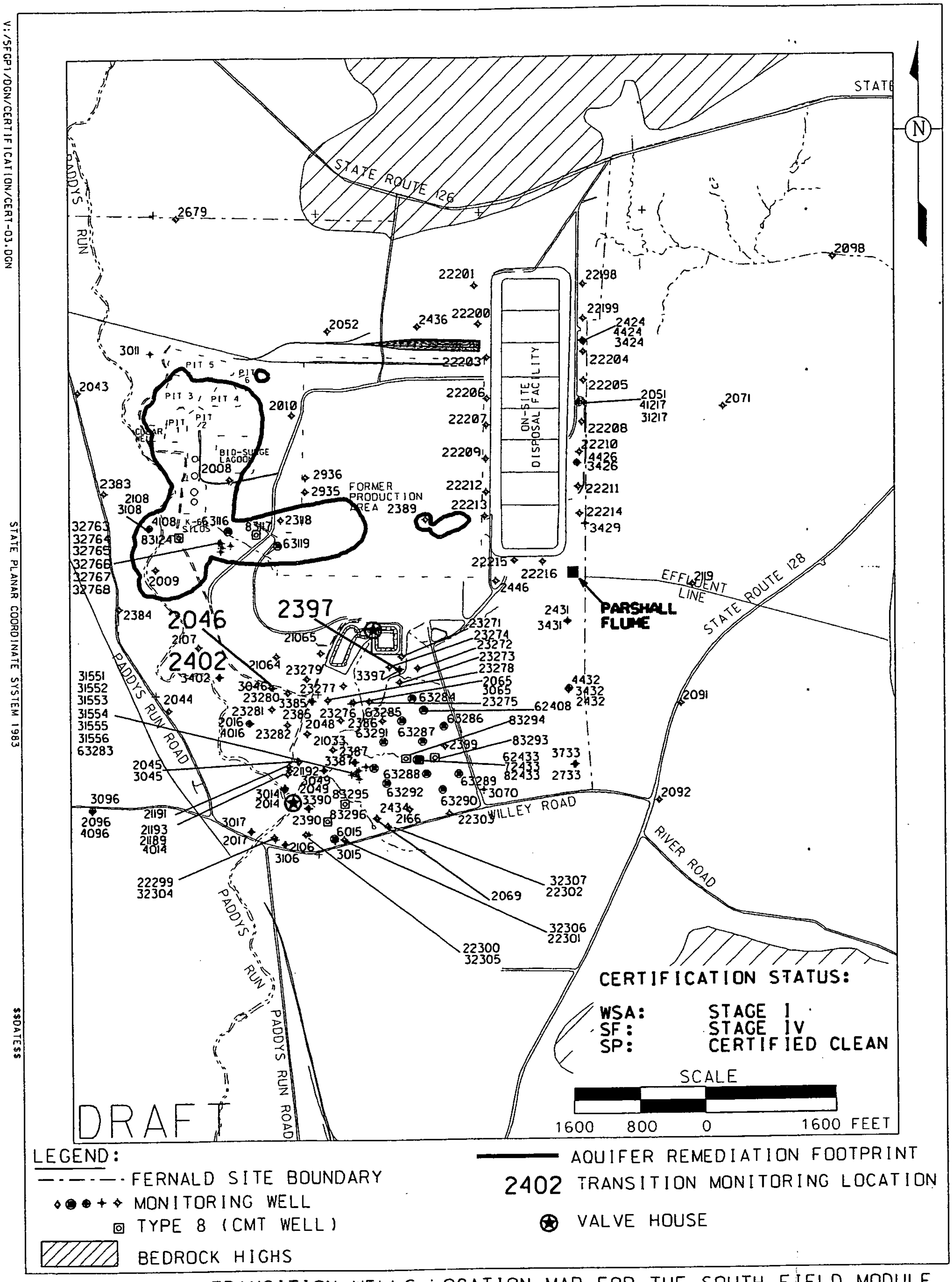

FIGURE 7-2. TRANSITION WELLS LOCATION MAP FOR THE SOUTH FIELD MODULE

7.3.3 Controlling Documents

The controlling document for transition monitoring will be the IEMP. The current version of the IEMP addresses Stage I monitoring. Details concerning Stage IV monitoring will be addressed through future revisions of the IEMP.

7.3.4 Reporting

Data collected during transition monitoring will be reported through the IEMP reporting process. The issuance of a certification report for each module will provide formal closure for the module. The contents for the module-specific certification report are presented in Section 10.0. It is anticipated that the first module-specific certification report to be issued will be for the South Plume Module. Assuming Stage I in the South Plume ends in 2015, and certification/attainment monitoring proceeds smoothly, the South Plume Module Certification Report will be issued in 2019.

7.4 DECISION-MAKING CRITERIA

The following decision-making criteria will be used:

- If an FRL exceedance is detected in a transition monitoring well, action will be taken to ensure that the downgradient certified clean area is not contaminated. If pumping is still taking place in the upgradient module, pumping rates in that module will be adjusted to gain effective capture of the contamination and keep it from entering the certified clean module area.
- If needed, the extraction wells in the certified clean module could be re-started to remediate the new contamination. If this course of action were taken, then the area affected by the new contamination would have to proceed through all stages of the certification process again.

A test for upward trend by regression analysis will also be conducted to determine if the future threat of an exceedance is probable. If a threat seems likely, operational adjustments in the upgradient module will be made to mitigate the threat.

8.0 STAGE V – DEMOBILIZATION

8.1 DEMOLITION AND DISPOSAL OF INFRASTRUCTURE

All structures, trailers, liners, pipes (except for the outfall line), and utilities dedicated for aquifer restoration and wastewater treatment will be removed properly and disposed of in a manner that is protective of the environment.

With the exception of the water treatment facility the D&D of infrastructure will not take place until the entire aquifer has been certified clean. This will provide the means to re-initiate pumping in any area of the aquifer that may require additional pumping prior to achieving final certification.

As discussed earlier, the water treatment facility will undergo D&D once it has been documented to EPA and OEPA that the facility is no longer needed to meet uranium discharge limits.

8.2 WELL ABANDONMENT

Following completion of the entire remedy, all extraction and monitoring wells will be plugged and abandoned in a manner that is protective of the environment. Guidelines for plugging and abandonment at the FCP are currently defined in Appendix J of the Sitewide CERCLA Quality Assurance Project Plan. These SCQ guidelines are consistent with State of Ohio plugging and abandonment regulations contained in Ohio Administrative Codes (OAC) 3701-28-07 and 2745-9-10, and guidelines found in Ohio EPA Technical Guidance for Ground Water Investigations. Compliance with these regulations and guidelines, and any future revisions, will continue for the life of the certification effort. OSDF Great Miami Aquifer monitoring wells will remain. During the life of the remedy, any well found not to be protective of the environment would be repaired or plugged and abandoned as soon as possible. The need for a replacement well will be determined at the time the abandonment is made. All state-mandated abandonment protocol and reporting requirements regarding the abandonment of monitoring wells will be followed.

8.3 SOIL EXCAVATION AND CERTIFICATION

All needed soil excavation and certification will be conducted according to Site-wide Excavation Plan requirements (DOE 1998).

8.4 OU5 FINAL REMEDIAL ACTION REPORT

Following completion of D&D of the aquifer remedy infrastructure, the OU5 Remedial Action Report (referred to OU5 Closeout Report in Figure 2-1) will be issued; it will reference the individual Groundwater Module Certification Reports, and the final OU5 Soil Certification Report. Additional information about this report can be found in Section 10.4.

9.0 STAGE VI – LONG-TERM MONITORING

Uranium contamination is sorbed onto the unsaturated aquifer sediments within the vadose zone beneath former source areas. This presence is due to groundwater levels being higher in the past when sources were active and due to source leaching and infiltration through the vadose zone.

9.1 OBJECTIVES

The objective of Stage VI is to monitor water levels in the former source areas as an indicator for the need to sample for dissolved uranium in the groundwater beneath those areas after certification has been achieved.

9.2 Monitoring and Reporting

9.2.1 Monitoring Network

The monitoring network will consist of the 5 Great Miami Aquifer groundwater-monitoring wells (Monitoring Wells 2649, 83124, 2046, 2389, and 83294), as shown in Figure 9-1. Any needed additional sampling in the former source areas would be accomplished using a direct-push sampling tool.

9.2.2 Monitoring List, Frequency, and Duration

Water level measurements will be taken semiannually for five years during July (when water levels are normally at seasonal high levels) and in January (when water levels are normally at seasonal low levels).

If water level data triggers the need to sample beneath the former source areas, groundwater samples would only be analyzed for uranium. A table that provides groundwater FRL constituent monitoring frequencies for all stages of the certification process is provided in Appendix A.

9.2.3 Controlling Documents

The controlling document for long-term monitoring will be the IEMP. The current version of the IEMP addresses Stage I monitoring. Details concerning Stage VI monitoring will be addressed through future revisions of the IEMP.

9.2.4 Reporting

Annual letters will be issued to the EPA and OEPA.

9.3 DECISION-MAKING CRITERIA

If dissolved uranium concentrations beneath the former source areas appear to have increased higher than the concentration level documented at the time that certification was declared completed, then monitoring will continue and the need to install additional monitoring wells will be considered. Agency concurrence will be sought for any decision made concerning the need to install additional monitoring wells.

9.4 CONTINGENCIES AND EXIT STRATEGY

Long-term monitoring will stop after five years if the groundwater table remains low or uranium concentrations measured during higher groundwater table conditions remain statistically below the FRL.

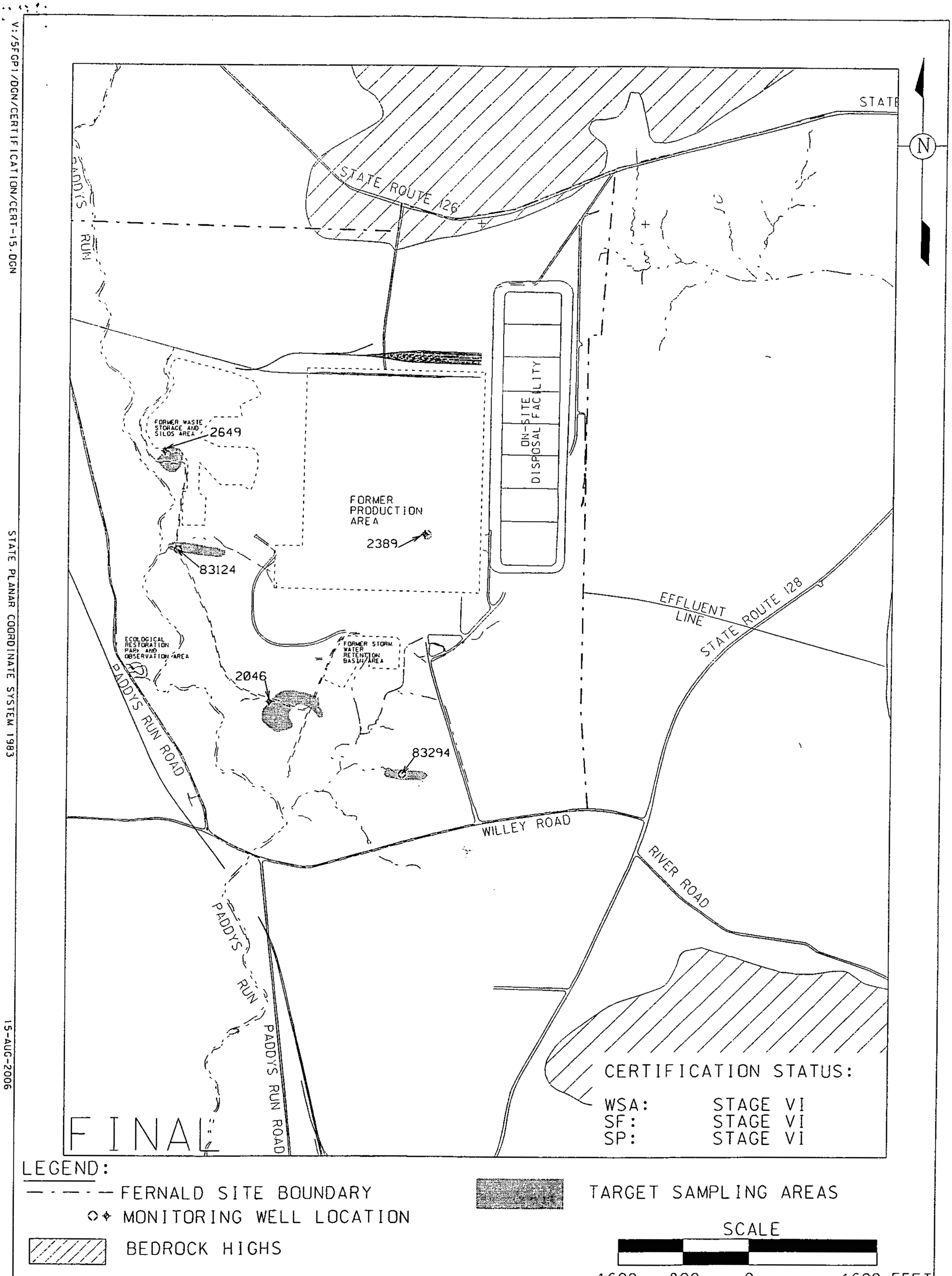

FIGURE 9-1. LONG-TERM MONITORING WELL LOCATION MAP

10.0 GROUNDWATER CERTIFICATION DOCUMENTS

Several different documents will be issued during the groundwater certification process:

- Annual progress reports
- Declaration of Completion/Concurrence to Proceed Letter Reports for Stages I, II, and III
- Module-specific certification reports
- OU5 Final Remedial Action Report that will reference the OU5 Interim Report, module-specific certification reports, and the Final OU5 Soil Certification Report.

As presented in Section 3.7, the ACA will drive the review process for these reports. Under the ACA, 60-day review cycles will be planned for any groundwater certification documentation submitted to the EPA and OEPA for review.

10.1 ANNUAL PROGRESS REPORTS

Annual progress reports on the aquifer remedy will continue to be issued through the normal IEMP reporting process. The annual Site Environmental Report presents a comprehensive look at environmental monitoring efforts for the entire Fernald site. Chapter 3 and its associated appendix from the Site Environmental Report describe groundwater remedy performance monitoring. The contents are as follows:

Chapter 3 – Groundwater Pathway
- 3.1 Summary of the Nature and Extent of Groundwater Contamination
- 3.2 Selection and Design of the Groundwater Remedy
- 3.3 Groundwater Monitoring Highlights for the Year
- 3.4 On-site Disposal Facility Monitoring

Appendix A – Supplemental Groundwater Information
- Attachment A.1 Operational Assessment
- Attachment A.2 Assessment of Total Uranium Results
- Attachment A.3 Groundwater Elevations and Capture Assessment
- Attachment A.4 Non-uranium Results
- Attachment A.5 On-site Disposal Facility Monitoring Results

As the South Plume Module approaches completion of Stage I, the contents of progress reports for future stages of the groundwater certification process will be developed through the normal IEMP revision process. It is anticipated that, with the exception of the operational assessment, the contents will be similar. EPA and OEPA concurrence on the details for future annual progress reports will be obtained through the IEMP revision process.

10.2 MODULE-SPECIFIC DECLARATION OF COMPLETION/CONCURRENCE TO PROCEED LETTERS

Module-Specific Declaration of Completion/Concurrence to Proceed Letters are planned in order to document the end of Stages I and II. The objective of the reports is to provide EPA and OEPA with enough information to decide whether to proceed to the next stage of the certification process. The reports will formalize the decision to end Stages I and II.

A Stage I Completion/Concurrence to Proceed Letter will present the data necessary to demonstrate that decision-making criteria have been met for discontinuing pumping and proceeding to Stage II. Specifics concerning the contents of the report will be addressed with both the EPA and OEPA one year prior to the expected submittal date.

A Stage II Completion/Concurrence to Proceed Letter will present the data necessary to demonstrate that decision-making criteria have been met for determining that the aquifer has achieved steady-state conditions. Specifics concerning the contents of the report will be addressed with both the EPA and OEPA at the same time that the contents of the Stage I completion/concurrence report for the same module are being finalized.

10.3 MODULE-SPECIFIC CERTIFICATION REPORTS

Module-specific certification reports will be prepared at the end of Stage III (Certification/Attainment Monitoring). The purpose of these reports will be to formalize the information needed to support a decision to declare a module certified clean. The report will also establish the steps that will be taken to protect the module from any upgradient areas of the aquifer that still might be undergoing remediation.

Specifics concerning the contents of a certification report will be finalized with both the EPA and OEPA at the start of Stage III monitoring. It is anticipated that the contents of the report will be similar to that presented in Appendix D. Module-specific certification reports will be referenced in the OU5 Final Remedial Action Report.

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10.4 OU5 FINAL REMEDIAL ACTION REPORT

In order to accommodate site closure in 2006 and the use of the Fernald site as an undeveloped park, an Interim Remedial Action Report is necessary for Operable Unit 5. The interim report will be developed and submitted for EPA approval once surface restoration activities are complete. An interim report is appropriate for OU5 at this stage because:

- The final groundwater remediation has not yet been achieved
- FRLs of surface water and sediment cannot be certified until groundwater discharges are complete
- There will be several areas where soil certification cannot be completed because of the remaining groundwater infrastructure
- The OSDF is required to undergo a continuing operation, maintenance, and monitoring requirement.

The OU5 Final Remedial Action Report will be prepared once the ground water remedy has been completed, all associated certifications have been approved, and D&D of the groundwater infrastructure has been completed. The OU5 Final Remedial Action Report will primarily update the information in the interim report and demonstrate completion of the outstanding actions.

Following completion of D&D of the aquifer infrastructure, the OU5 Final Remedial Action Report will be developed for agency approval. Following is a summary of the intended content of that report. Exact content details will be worked out with the EPA and OEPA prior to issue of the report.

Per EPA guidance, the information in an interim remedial action report can simply be amended to create a final remedial action report. With this strategy in mind, the following amendments and updates will be required for each of the three sections (aquifer, soils, OSDF) of the interim remedial action report:

Aquifer Section

- Provide reference to the OU5 Interim Remedial Action Report
- Provide reference to individual groundwater module-specific certification reports
- Provide reference to the OU5 Soil Certification Report
- Revise information relative to legal agreements
- Revise the summary of events to identify when groundwater module remediation ended and certification was attained
- Revise the summary of events to identify when surface water certification was attained
- Update the discussion on the performance of the remedy when all remediation is complete

- Update information relative to discharges to the Great Miami River (monthly concentrations and monthly mass)
- Update information on institutional controls
- Update the summary of project costs
- Update observations and lessons learned
- Update OU contact information
- Update remedy performance figures (amount of groundwater and uranium extracted)
- Update references.

Soils Section

- Provide reference to interim remedial action report
- Revise information relative to legal agreements
- Revise the summary of events to identify when groundwater module remediation ended the associated soils certification was attained
- Revise the summary of events to identify when surface water certification was attained and the associated sediments were certified
- Update information on institutional controls
- Update the summary of project costs
- Update the amounts of soils excavated and dispositioned
- Update observations and lessons learned
- Update OU contact information.

OSDF Section

- Provide reference to interim remedial action report
- Revise information relative to legal agreements
- Update information on institutional controls and status of post-closure care.

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APPENDIX A

GROUNDWATER FRL CONSTITUENT MONITORING FREQUENCIES

GROUNDWATER FRL CONSTITUENT MONITORING FREQUENCIES

50 Groundwater FRL Constituents [a]	Stage I	Stage II	Stage III [b]	Stage IV [c]	Stage VI [d]
	SP approx. 10 yrs. SF approx. 17 yrs. WSA approx. 18 yrs.	Approx ¼ yr All Modules	Minimum of 3 yrs. All Modules	SP approx. 7 yrs SF approx. 1 yr	5 yrs.
Uranium, Total	semiannual	monthly	quarterly	semiannual	if warranted
Zinc	semiannual		quarterly		
Manganese	semiannual		quarterly		
Nickel	semiannual		quarterly		
Technetium-99	semiannual		quarterly		
Nitrate[f]	semiannual		quarterly		
Lead	semiannual		quarterly		
Arsenic	semiannual		quarterly		
Molybdenum	semiannual		quarterly		
Boron	semiannual		quarterly		
Antimony	semiannual		quarterly		
Trichloroethene	semiannual		quarterly		
Carbon disulfide	semiannual		quarterly		
Fluoride	semiannual		quarterly		
Vanadium			Streamline		
1,1-Dichloroethane			Streamline		
1,1-Dichloroethene			Streamline		
1,2-Dichloroethane			Streamline		
2,3,7,8-Tetrachlorodibenzo-p-dioxin			Streamline		
4-Methylphenol			Streamline		
4-Nitrophenol			Streamline		
alpha-Chlordane			Streamline		
Aroclor-1254			Streamline		
Barium			Streamline		
Benzene			Streamline		
Beryllium			Streamline		
bis(2-Chloroisopropyl) ether			Streamline		
bis(2-Ethylhexyl)phthalate			Streamline		
Bromodichloromethane			Streamline		
Bromomethane			Streamline		
Cadmium			Streamline		
Carbazole			Streamline		
Chloroethane			Streamline		
Chloroform			Streamline		
Chromium VI			Streamline		
Cobalt			Streamline		
Copper			Streamline		
Mercury			Streamline		
Methylene chloride			Streamline		
Neptunium-237			Streamline		
Octachlorodibenzo-p-dioxin			Streamline		
Radium-226			Streamline		

GROUNDWATER FRL CONSTITUENT MONITORING FREQUENCIES

50 Groundwater FRL Constituents [a]	Stage I	Stage II	Stage III [b]	Stage IV [c]	Stage VI [d]
Radium-228			Streamline		
Selenium			Streamline		
Silver			Streamline		
Strontium-90			Streamline		
Thorium-228			Streamline		
Thorium-230			Streamline		
Thorium-232			**Streamline**		
Vinyl chloride			**Streamline**		

SP = South Plume
SF = South Field
WSA = Waste Storage Area

[a] 50 Groundwater FRL constituents are listed in Table 3-2 of the IEMP, Rev 4b, Draft Final. Non-Uranium groundwater FRL constituents that are sampled semiannually during Stage I are listed in Table 3-3 of the IEMP, Rev. 4b, Draft Final.

[b] During Stage III, those constituents that were being sampled semiannually at the end of Stage I will be sampled quarterly. Others will undergo a streamlined sampling program in that they will be sampled during the first quarter of the third year of Stage III monitoring to provide a comprehensive documentation of their FRL status. Additional sampling may be conducted if warranted, based on results of the streamlined sampling event.

[c] Stage IV sampling in the South Plume will continue until the South Field Module is certified clean. Stage IV sampling in the South Field will continue until the Waste Storage Area Module is certified clean.

[d] Sampling for uranium during Stage VI will be warranted if water levels in former source areas reach elevations higher than those recorded during Stages I through IV.

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APPENDIX B
SAMPLING PROTOCOL

APPENDIX B
SAMPLING PROTOCOL

Sampling protocol for the aquifer remedy is contained in the Integrated Environmental Monitoring Plan (IEMP). The IEMP is the controlling document for groundwater remedy performance monitoring. Following is Section 3 of the IEMP, Revision 4b, which pertains to groundwater monitoring.

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3.0 GROUNDWATER MONITORING PROGRAM

Section 3.0 presents the monitoring strategy for tracking the progress of the restoration of the Great Miami Aquifer and satisfying the site-specific commitments related to groundwater monitoring. A medium-specific plan for conducting all groundwater monitoring activities is provided. Program expectations for 2006 are outlined in Section 3.4, and the program design for 2006 is presented in Section 3.5.

3.1 INTEGRATION OBJECTIVES FOR GROUNDWATER

Remediation of the Great Miami Aquifer is being conducted using pump-and-treat technology, and is progressing toward certification through a staged process. The six stages are:

Stage I: Pump-and-Treat Operations
Stage II: Post Pump-and-Treat Operations/Hydraulic Equilibrium State
Stage III: Certification/Attainment Monitoring
Stage IV: Declaration and Transition Monitoring
Stage V: Demobilization
Stage VI: Long-Term Monitoring

The groundwater sampling specified in the IEMP tracks the performance of the Great Miami Aquifer groundwater restoration remedy being implemented under Operable Unit 5. The IEMP is the controlling document for groundwater remedy performance monitoring, and is currently focused on groundwater monitoring needed to support Stage I, Pump-and-Treat Operations, in 2006. Groundwater monitoring requirements for Stages II through VI of the groundwater certification process will be defined in future revision of the IEMP. The following is a brief description of the stages listed above:

Stage I – Pump-and-Treat Operations

The aquifer remedy is currently in Stage I. The principal contaminate of concern is uranium. Groundwater is being pumped from contaminated portions of the aquifer and treated for uranium.

A phased approach to remediation of the aquifer has been organized around three groundwater restoration modules:

1. The South Plume Module
2. The South Field Module
3. The Waste Storage Area Module

An overview of each aquifer restoration module is provided in Section 3.4, and Figure 3-1 identifies the location of these aquifer restoration modules. As discussed in Section 3.4, the aquifer remedy once included a re-injection module. Operation of the Re-injection Module was discontinued in 2004. Pump-and-treat operations will continue for each groundwater module until FRL concentrations in the aquifer have been achieved or mass removal efficiency of the extraction system has decreased such that it is apparent groundwater FRL concentration limits in the aquifer cannot be achieved. The controlling document for the operation of the pump and treat system is the Operations and Maintenance Master Plan for Aquifer Restoration and Wastewater Treatment (OMMP), Revision 2. Ultimately, the IEMP will be used to document the approach of determining when the various modules complete pump-and-treat operations. A Certification Strategy is currently being prepared that will explain how certification will progress for each active module in the aquifer remediation system. Once the Certification Strategy has been approved, monitoring requirements needed to support the strategy will be incorporated into future revisions of the IEMP as deemed appropriate.

The design of the groundwater monitoring program in 2006 was developed in recognition of:

- Operation of the South Field (Phases I and II) Module
- Operation of the South Plume Module
- Operation of the Waste Storage Area (Phases I and II) Module
- Soil excavation/certification activities in Areas 4B, 5, 6, and 7 including the silos area, and on-property stream corridors
- Continue and complete waste placement, closure, and capping activities at the on-site disposal facility
- Operation activities associated with the Operable Unit 4 Accelerated Waste Retrieval Project and Silo 3 Project treatment facility, and activities associated with the Silos 1 and 2 remediation facility.

Additional information concerning site remediation activities is contained in Section 2.0.

Along with this performance-based responsibility, the IEMP in 2006 serves to integrate several former compliance-based groundwater monitoring or protection programs:

- OEPA Director's Findings and Orders for property boundary groundwater monitoring to satisfy RCRA facility groundwater monitoring requirements
- Private well sampling
- Groundwater Protection Management Program Plan.

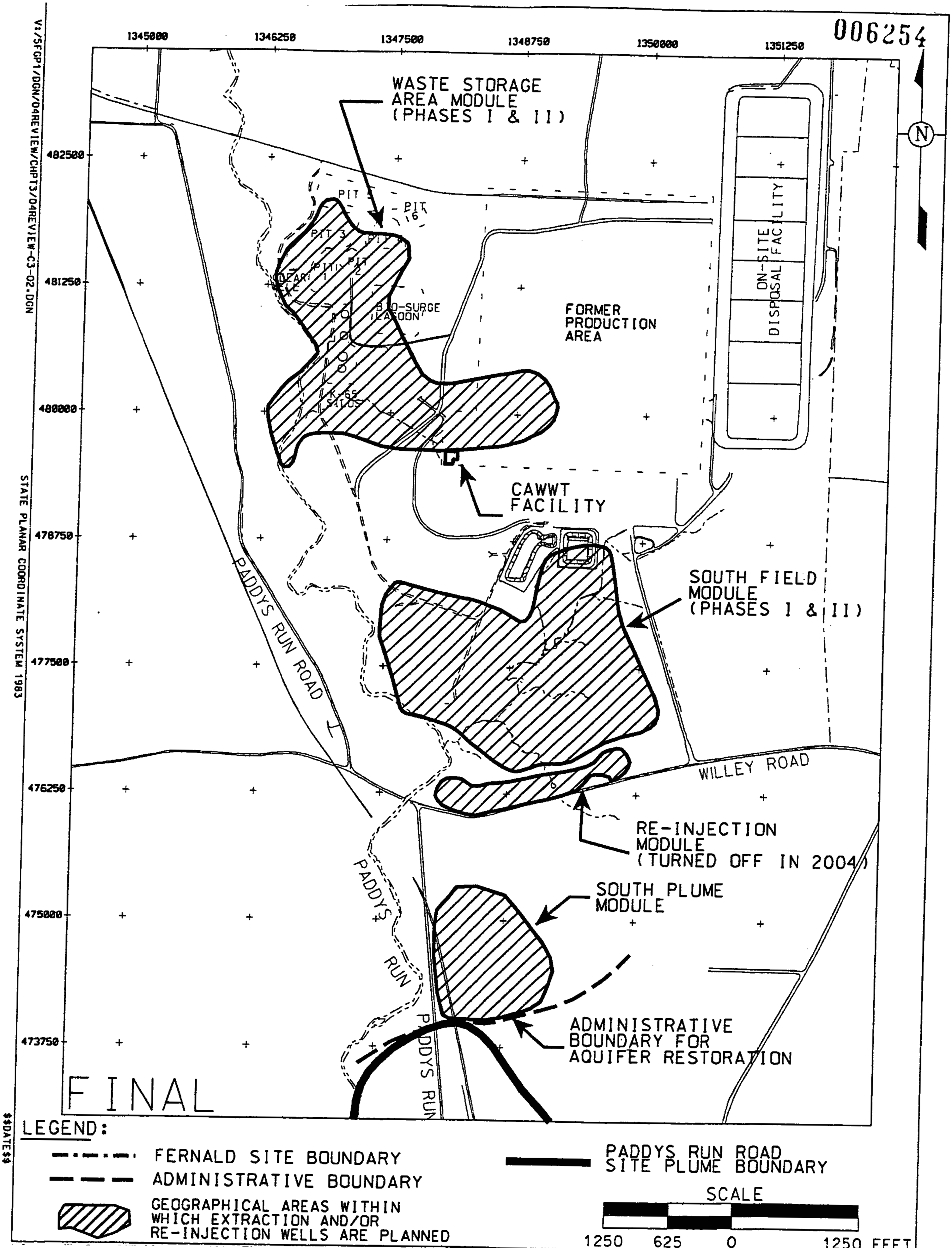

FIGURE 3-1. LOCATION OF AQUIFER RESTORATION MODULES

As discussed in Section 3.7, these activities were brought together under a single reporting structure to facilitate regulatory agency review of the progress of the Operable Unit 5 groundwater remedy.

<u>Stage II – Post Pump-and-Treat Operations/Hydraulic Equilibrium State</u>

Stage II monitoring will begin on a module-specific basis when pump-and-treat operations have stopped. The objective will be to document that the aquifer has re-adjusted to steady state non-pumping conditions prior to proceeding to Stage III, Attainment Monitoring. During Stage II, groundwater levels will be routinely measured to document that steady-state water level conditions have been achieved. Groundwater FRL constituent concentrations will also be routinely measured. If uranium concentrations rebound to levels above the groundwater FRL during the steady-state assessment, then pumping operations would resume. If uranium concentrations remain below the groundwater FRL during the steady-state assessment and do not appear to be trending up toward the groundwater FRL, then the certification process will proceed to Stage III, Certification/Attainment Monitoring. It is anticipated that Stage II monitoring will take approximately three months.

<u>Stage III – Certification/Attainment Monitoring</u>

Certification/attainment monitoring will also be module-specific. Data collected during Stage II will be used to document that remediation goals have been met, and that the goals will continue to be maintained in the future. Statistical tests will be used to predict the long-term ability to maintain below-FRL constituent concentrations.

<u>Stage IV – Declaration and Transition Monitoring</u>

Because certification is being approached on a module-specific basis, efforts need to be taken to ensure that upgradient plumes do not migrate into and re-contaminate downgradient areas where remediation goals have been achieved. A few monitoring wells will be positioned at the upgradient edge of the clean areas and will be monitored to document that the upgradient plume is not impacting the clean area. It is anticipated that Stage IV monitoring could be conducted for as long as 10 years, essentially the time when the groundwater model predicts that cleanup goals will be achieved in the South Plume Module versus the Waste Storage Area Module.

<u>Stage V – Demobilization</u>

Stage V identifies that all structures, trailers, liners, pipes (except the outfall line), and utilities dedicated for aquifer restoration and wastewater treatment will need to be properly decontaminated and dismantled in order to be protective of the environment. With the exception of the water treatment facility, the D&D of infrastructure will not take place until the entire aquifer has been certified clean. This will provide the means to re-initiate pumping in any area of the aquifer that may require additional pumping prior to achieving final certification.

Stage VI – Long-Term Monitoring

Long-term monitoring will be conducted after the last groundwater module area is certified clean. The monitoring will focus on the elevation of the water table in the area of the on-site disposal facility. If the water table rises to an elevation that exceeds what was previously recorded for the area, then groundwater monitoring beneath former source areas will be initiated to determine if any new sources have dissolved into the groundwater.

3.2 SUMMARY OF REGULATORY DRIVERS, DOE POLICIES, AND OTHER FERNALD SITE-SPECIFIC AGREEMENTS

This section presents a summary evaluation of the regulatory-based requirements and policies governing monitoring of the Great Miami Aquifer. The intent of the section is to identify the pertinent regulatory drivers, including applicable or relevant and appropriate requirements (ARARs) and to-be-considered requirements, for the scope and design of the Great Miami Aquifer groundwater monitoring system. These requirements are used to confirm that the program design satisfies the regulatory obligations for monitoring that have been activated by the Operable Unit 5 Record of Decision, and to achieve the intentions of other pertinent criteria, such as DOE Orders and the Fernald site's existing agreements that have a bearing on the scope of groundwater monitoring.

The results of the analysis are also used to define, as appropriate for these media, the administrative boundaries between the IEMP and the project-specific source control monitoring conducted by other organizations.

3.2.1 Approach

The analysis of the regulatory drivers and policies for groundwater monitoring was conducted by examining the suite of ARARs and to-be-considered requirements in the five approved CERCLA Operable Unit Records of Decision to identify the subset with specific groundwater monitoring requirements. The Fernald site's existing compliance agreements issued outside the CERCLA process (such as the September 10, 1993, OEPA Director's Findings and Orders [OEPA 1993]) were also reviewed.

3.2.2 Results

The following regulatory drivers, compliance agreements, and DOE policies were found to govern the monitoring scope and reporting requirements for remedy performance monitoring and general surveillance of the protectiveness of the Great Miami Aquifer groundwater remedy:

- The CERCLA Record of Decision for Remedial Actions at Operable Unit 5 requires the extraction and treatment of Great Miami Aquifer groundwater above FRLs until the full, beneficial use potential of the aquifer is achieved, including use as a drinking water source. The FRLs are established by considering chemical-specific ARARs, hazard indices, and background and detection limits for each contaminant. Many Great Miami Aquifer FRLs are based on established or proposed Safe Drinking Water Act maximum contaminant levels (MCLs), which are ARARs for groundwater remediation. For Fernald site-related contaminants that do not have an established MCL under the Safe Drinking Water Act, a concentration equivalent to an incremental lifetime cancer risk of 10^{-5} for carcinogens or a hazard quotient of 1 for non-carcinogens was used as the FRL, unless background concentrations or detection limits are such that health-based limits could not be attained. (In these cases the background or detection limit became the FRL.) The FRLs will be tracked throughout all affected areas of the aquifer and will be the basis for determining when the Great Miami Aquifer restoration objectives have been met. By definition, the Operable Unit 5 Record of Decision incorporates the requirements of the Fernald site's existing CERCLA South Plume Removal Action (which was the regulatory driver for the former Design Monitoring and Evaluation Program Plan and the Groundwater Monitoring and Reporting Program).
- Per the CERCLA Remedial Design Work Plan for Remedial Actions at Operable Unit 5, monitoring will be conducted following the completion of cleanup as required to assess the continued protectiveness of the remedial actions. The IEMP will specify the type and frequency of environmental monitoring activities to be conducted during remedy implementation and ultimately, following the cessation of remedial operations as appropriate. The IEMP will delineate the Fernald site's responsibilities for sitewide monitoring over the life of the remedy, and ensure that FRLs are achieved at project completion. The IEMP will also serve as the primary vehicle for determining to EPA and OEPA's satisfaction that remedial action objectives for the Great Miami Aquifer have been attained.
- The September 10, 1993, OEPA Director's Findings and Orders required groundwater monitoring at the Fernald site's property boundary to satisfy RCRA facility groundwater monitoring requirements, and have been superceded by Directors Final Findings and Orders, issued September 7, 2000. The September 7, 2000 Directors Final Findings and 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 without issuance of a new order.
- DOE Order 5400.1, General Environmental Protection Program establishes the requirement for a Groundwater Protection Management Program Plan (GPMPP) for DOE facilities. The required informational elements of a GPMPP are fulfilled by the Remedial Investigation (DOE 1995e) and Feasibility Study reports for Operable Unit 5. The groundwater monitoring program requirement is being fulfilled by the IEMP. This also satisfies DOE Manual 435.1 (DOE 2001c), which refers to DOE Order 5400.1.

- DOE Order 5400.5, Radiation Protection of the Public and Environment establishes radiological dose limits and guidelines for the protection of the public and environment. Demonstration of compliance with these limits and guidelines for radiological dose is based on calculations that make use of information obtained from the Fernald site's monitoring and surveillance program. This program is based on guidance in the Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance (DOE 1991). The Fernald site's private well sampling program for the Great Miami Aquifer (that was previously in the Fernald Site Environmental Monitoring Plan [DOE 1995c]) is conducted to satisfy the intention of this DOE Order with respect to groundwater. While most private well water users in the affected area are now provided with a public water supply, a limited private well sampling activity will be maintained to supplement the groundwater monitoring network provided by monitoring wells. A dose assessment is no longer required due to the availability of a public water supply.
- The 1986 Federal Facilities Compliance Agreement requires that the Fernald site maintain a sampling program for daily flow and uranium concentration of discharges to the Great Miami River and report the results quarterly to the EPA, OEPA, and Ohio Department of Health. The sampling program conducted to address this requirement has been modified over the years and is currently governed by an agreement reached with EPA and OEPA in early 1996 with modifications documented and approved through biennial IEMP revisions. For groundwater, this agreement is specifically related to the South Plume wellfield to quantify the amount of uranium removed and total volume of groundwater extracted.

The groundwater monitoring plan provided in this IEMP has been developed with full consideration of the regulatory drivers described above. Each of these drivers, and the associated monitoring conducted to comply with these drivers, are listed in Table 3-1. This table also lists each regulatory requirement for the on-site disposal facility groundwater monitoring program and the associated project-specific plan. Sections 3.7 and 7.0 outline the current and long-range plan for complying with the reporting requirements contained in the IEMP drivers.

Project-specific groundwater monitoring is required only for one project—the on-site disposal facility. The IEMP will not be used as the mechanism for conducting on-site disposal facility performance monitoring within the glacial overburden and the Great Miami Aquifer. A leak detection monitoring program plan, which includes both leachate and groundwater monitoring as part of a leak detection program, was submitted separately from the IEMP and approved by EPA and OEPA in 1997. The on-site disposal facility monitoring requirements include the regulatory drivers, the ARARs, and to-be-considered criteria that have a bearing on the design and execution of a groundwater monitoring program for the on-site disposal facility and are as follows:

- Ohio Solid Waste Disposal Facility Groundwater Monitoring Rules, Ohio Administrative Code (OAC) 3745-27-10 specify groundwater monitoring program requirements for sanitary landfills. These regulations describe a three-tiered program for detection, assessment, and corrective measures.

TABLE 3-1

FERNALD SITE GROUNDWATER MONITORING PROGRAM REGULATORY DRIVERS AND RESPONSIBILITIES

	DRIVER	ACTION
IEMP	CERCLA Record of Decision for Operable Unit 5	The IEMP describes routine monitoring to ensure remedy performance and to evaluate impacts of remediation activities to the Great Miami Aquifer. The IEMP will be modified toward completion of the remedial action to include a sampling plan to certify achievement of the FRLs.
	OEPA Director's Final Findings and Orders; RCRA/Hazardous Waste Facility Groundwater Monitoring	The IEMP describes routine monitoring at wells located at the property boundary to ensure remedy performance and to evaluate impacts of remediation activities to the Great Miami Aquifer.
	DOE Order 5400.1, Groundwater Protection Management Plan. Also satisfies DOE M 435.1 which refers to DOE Order 5400.1	The IEMP describes routine monitoring to ensure remedy performance and to evaluate impacts of remediation activities to the Great Miami Aquifer.
	DOE Order 5400.5, Radiation Protection of Public and Environment	No longer required.
	Federal Facilities Compliance Agreement, Radiological Monitoring	The IEMP describes the routine sampling and reporting of the South Plume wellfield in terms of the total volume extracted and the amount of uranium removed.

TABLE 3-1
(Continued)

	DRIVER	ACTION	PROJECT PLAN
PROJECT	OAC 3745-27-10, Ohio Solid Waste Disposal Facility Groundwater Monitoring	A leak detection monitoring program in the glacial overburden and the Great Miami Aquifer is being conducted for the on-site disposal facility.	Groundwater, leak detection, and leachate monitoring plan for the on-site disposal facility
	40 CFR 264.90-.99 (OAC 3745-54-90 through 99); 40 CFR 265.90-.94 (OAC 3745-65-90 through 94), RCRA/Ohio Hazardous Waste Disposal Facility Groundwater Monitoring	A leak detection monitoring program in the glacial overburden and the Great Miami Aquifer is being conducted for the on-site disposal facility.	Groundwater, leak detection, and leachate monitoring plan for the on-site disposal facility
	Uranium Mill Tailings Reclamation and Control Act Regulations Groundwater Monitoring for Disposal Facilities	A leak detection monitoring program in the Great Miami Aquifer is being conducted for the on-site disposal facility.	Groundwater, leak detection, and leachate monitoring plan for the on-site disposal facility
	OAC 3745-27-19(M)(4) and (5), Ohio Solid Waste Disposal Facility Leachate Detection and Collection Systems	Monitoring of on-site disposal facility leachate detection and collection systems is included in the on-site disposal facility leak detection monitoring program.	Groundwater, leak detection, and leachate monitoring plan for the on-site disposal facility

Note: Refer to Appendix A of the On-site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan (DOE 2006) for ARARs and other regulatory requirements.

- RCRA/Ohio Hazardous Waste Groundwater Monitoring Requirements for Regulated Units, 40 Code of Federal Regulations (CFR) 264.90 through .99 (OAC 3745-54-90 through 99) and 40 CFR 265.90 through .94 (OAC 3745-65-90 through 94), which specify groundwater monitoring program requirements for surface impoundments, landfills, and land treatment units that manage hazardous wastes. Because the Ohio regulations are at least as stringent, and in some cases more stringent, they are the controlling regulations.
- Uranium Mill Tailings Reclamation and Control Act Regulations, 40 CFR 192.32(A)(2), which specify standards for uranium byproduct materials in piles or impoundments. These regulations require conformance with the RCRA groundwater monitoring performance standard in 40 CFR 264.92. Compliance with RCRA/Ohio Hazardous Waste rules for groundwater monitoring will fulfill the substantive requirements for groundwater monitoring in the Uranium Mill Tailings Reclamation and Control Act regulations.
- Ohio Solid Waste Disposal Facility Rules, OAC 3745-27-19(M)(4) and (5), which require submittal of an annual operational report, including a summary of the quantity of leachate collected for treatment and disposal, location of leachate treatment, verification that the leachate management system is operating properly, and the results of analytical testing of an annual grab sample of leachate for groundwater monitoring constituents listed in Appendix I of OAC 3745-27-10.

Note: Refer to Appendix A of the On-site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan for ARARs and other regulatory requirements.

3.3 PROGRAMMATIC BOUNDARY FOR THE GROUNDWATER MONITORING PROGRAM

This section identifies the programmatic boundaries that have been established between the IEMP and the project-specific activities to be conducted by others in 2006. The intent behind the boundary definition is to clearly delineate the scope and geographic extent of the IEMP's monitoring responsibility and to establish a recognized interface between the sitewide focus of the IEMP and the predominant emission control focus of project-specific monitoring.

The programmatic boundary for each environmental medium at the Fernald site will be unique, and for certain media, time-dependent. One or more of the following defines the medium-specific boundary:

- Regulatory monitoring requirements for the media
- Physical boundaries (i.e., geologic, hydrogeologic, or surface boundaries imposed by the remediation projects)
- Medium-specific monitoring requirements specifically assigned to the IEMP by administrative decisions.

Because of these unique considerations, the boundary definitions and responsibilities are provided for each medium in order to clearly convey the line of responsibility for that medium under the IEMP. For groundwater, three programmatic boundaries require definition for the IEMP:

- Responsibility for the Great Miami Aquifer and the soil/perched groundwater remediation efforts
- The Administrative Boundary between the Fernald site and the Paddys Run Road Site contaminant plumes (refer to Figure 3-1)
- Responsibility for construction and performance monitoring of the on-site disposal facility.

3.3.1 Responsibility for Great Miami Aquifer and Soil/Perched Groundwater Remediation Efforts

For the Fernald site's Great Miami Aquifer plume, all the geographic areas that are to be restored under the Operable Unit 5 Record of Decision (or routinely monitored beyond the restoration area) reside within the scope of the Aquifer Restoration/Water Management Project. Soil and perched groundwater remediation responsibilities also reside within the Demolition, Soil, and Disposal Project. The pre-certification and certification sampling activities that will accompany the excavation of affected soil and perched groundwater zones (to demonstrate the attainment of cross media-based soil FRLs) will be performed by the Demolition, Soil, and Disposal Project.

3.3.2 Administrative Boundary Between the IEMP and Paddys Run Road Site Contaminant Plumes

As described in the Remedial Investigation Report for Operable Unit 5 (refer to Section 4.8.2), the Paddys Run Road Site consists of two facilities: PCS Purified Phosphates (formerly Albright and Wilson Americas, Inc.) and Ruetgers-Nease Chemical Company, Inc. PCS Purified Phosphates occupies the northern portion of the site and manufactures phosphate compounds. Rutgers-Nease manufactures aromatic sulfonated compounds and occupies the southern portion of the site.

The Paddys Run Road Site Remedial Investigation Report released in September 1992 documented releases to the Great Miami Aquifer of inorganics, volatile organic compounds, and semi-volatile organic compounds. The Proposed Plan for Operable Unit 5 acknowledged that DOE's role and involvement, if any, in OEPA's ongoing assessment and cleanup of the Paddys Run Road Site plume would be separately defined as part of the Paddys Run Road Site response obligations and in accordance with the Paddys Run Road Site project schedule. Groundwater monitoring will continue south of the Administrative Boundary until certification of the off-property South Plume is complete. This monitoring will assess the nature of the 30-µg/L total uranium plume south of the Administrative Boundary and the impact that pumping of the South Plume extraction wells has on the Paddys Run Road Site plume.

3.3.3 Responsibility Boundary for Construction and Performance Monitoring at the On-Site Disposal Facility

The Demolition, Soil, and Disposal Project is responsible for construction, filling, capping, and maintenance of each cell of the on-site disposal facility. The Aquifer Restoration/Wastewater Project is responsible for leak detection monitoring for the on-site disposal facility; and for leachate monitoring, conveyance, and treatment.

On-site disposal facility monitoring results will be reported on the IEMP Data Information Site and in the annual site environmental report. Evaluation of baseline conditions will be provided through technical memoranda.

3.4 PROGRAM EXPECTATIONS AND DESIGN CONSIDERATIONS

3.4.1 Program Expectations

The IEMP groundwater monitoring program is designed to provide a comprehensive monitoring network that will track remedial wellfield operations and assess aquifer conditions. The expectations of the monitoring program in 2006 are to:

- Provide groundwater data to assess the capture and restoration of the 30-µg/L total uranium plume
- Provide groundwater data to assess the capture and restoration of non-uranium FRL constituents
- Provide groundwater data to assess groundwater quality at the downgradient Fernald site property boundary and off site at the leading edge of the 30-µg/L total uranium plume
- Provide groundwater data that are sufficient to assess how reasonable model predictions are over the long term
- Provide groundwater data to assess the impact that the aquifer restoration is having on the Paddys Run Road Site plume
- Continue to fulfill DOE Order 5400.1 requirements to maintain an environmental monitoring plan for groundwater
- Continue to address concerns of the community regarding the progress of the aquifer restoration.

3.4.2 Design Considerations

3.4.2.1 Background

The Great Miami Aquifer is contaminated with uranium and other constituents from the Fernald site. An evaluation of the nature and extent of contamination in the Great Miami Aquifer can be found in the Remedial Investigation Report for Operable Unit 5. Uranium is the principal COC.

Figures 3-2A and 3-2B show the maximum total uranium plume map (30 µg/L uranium or higher) as of the first half of 2005. These maps represent a compilation of several different monitoring depths within the aquifer, and illustrate the maximum lateral extent of the plume at all depths. The majority of the top of the plume is situated at the water table. In some regions of the aquifer, however, the top of the plume is situated below the water table. More detailed presentations of the geometry of the uranium plume can be found in Appendix G of the Baseline Remedial Strategy Report, Remedial Design for Aquifer

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STATE PLANAR COORDINATE SYSTEM 1983

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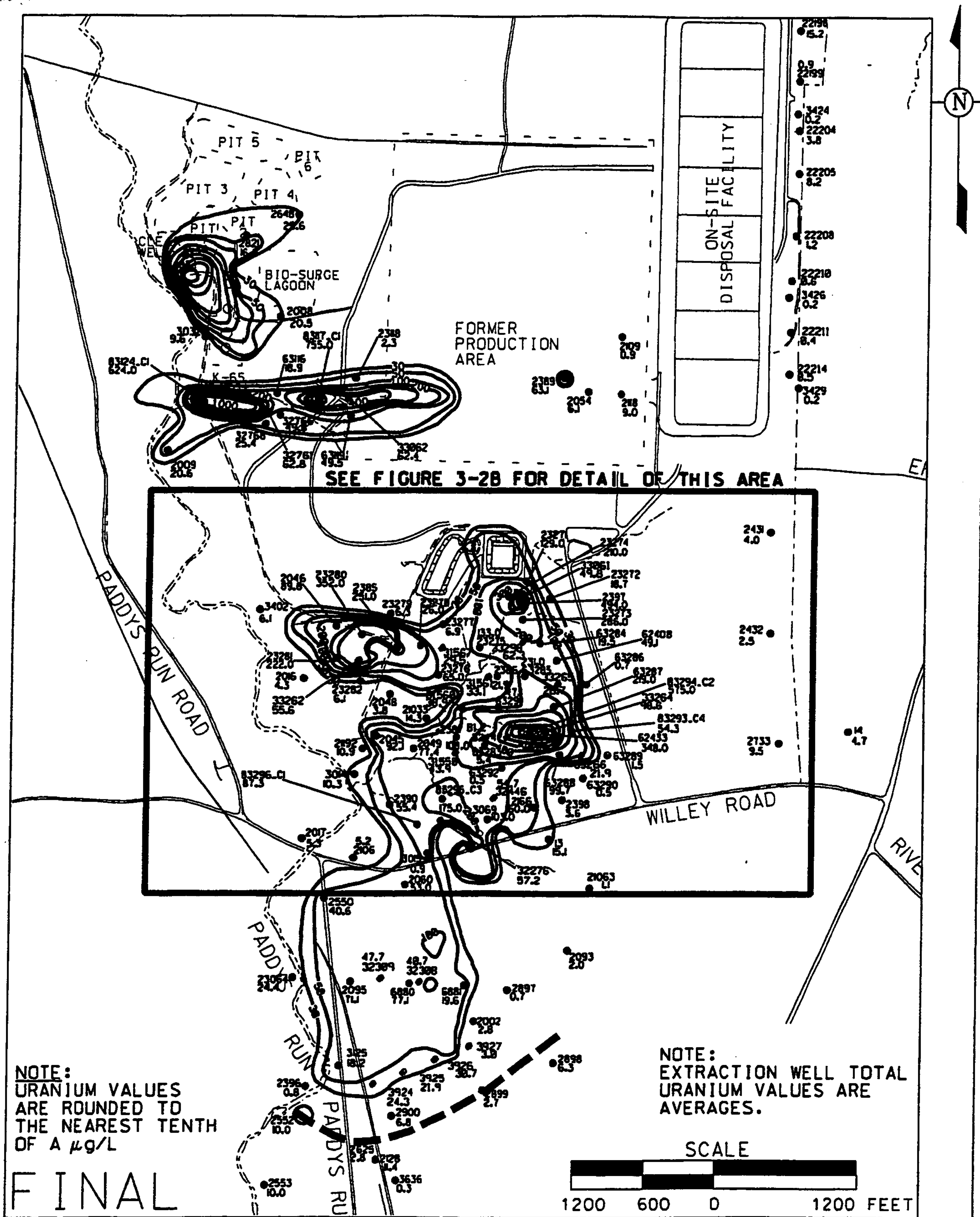


LEGEND:

- - - - FERNALD SITE BOUNDARY

5.J TOTAL URANIUM CONCENTRATION MEASURED IN THE FIRST HALF OF 2005

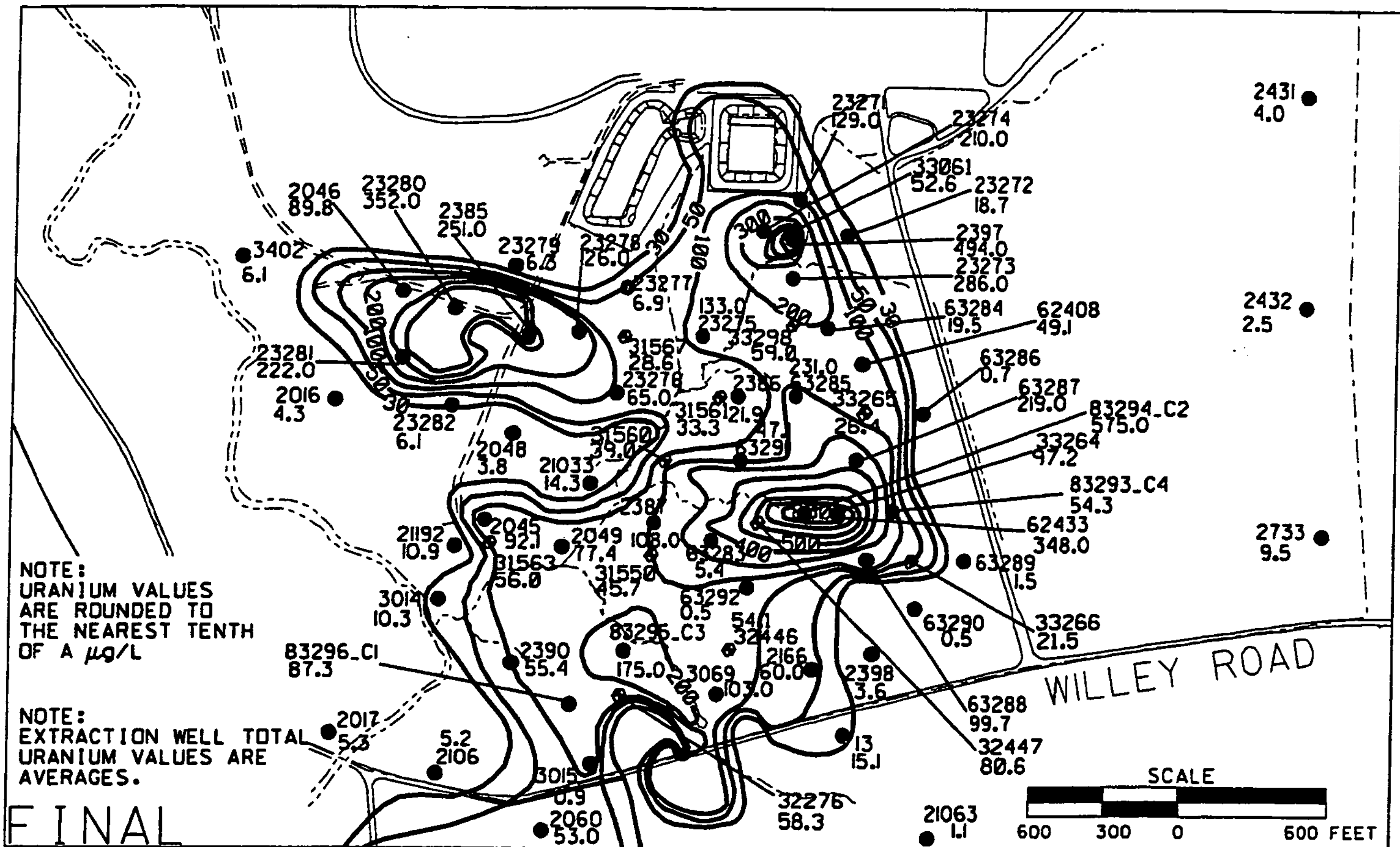
—— 30 —— URANIUM CONTOURS BASED ON 30 μg/L FRL, MAXIMUM, GEOPROBE RESULTS, AND MAXIMUM TOTAL URANIUM DATA THROUGH THE FIRST HALF OF 2005

▬ ▬ ▬ ADMINISTRATIVE BOUNDARY FOR AQUIFER RESTORATION

● MONITORING WELL

⊕ EXTRACTION WELL

FIGURE 3-2A. MONITORING WELL DATA AND MAXIMUM TOTAL URANIUM PLUME THROUGH THE FIRST HALF OF 2005



LEGEND:

- - - - FERNALD SITE BOUNDARY
● MONITORING WELL
⊗ EXTRACTION WELL
5.1 TOTAL URANIUM CONCENTRATION MEASURED IN THE FIRST HALF OF 2005
—30— URANIUM CONTOURS BASED ON 30 $\mu g/L$ FRL. MAXIMUM GEOPROBE RESULTS, AND MAXIMUM TOTAL URANIUM DATA THROUGH THE FIRST HALF OF 2005

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PLANAR COORDINATE SYSTEM 1983

FIGURE 3-2B. MONITORING WELL DATA AND MAXIMUM TOTAL URANIUM PLUME IN SOUTH FIELD THROUGH THE FIRST HALF OF 2005

$$DATE$$

Restoration (Task 1) (DOE 1997a); the Conceptual Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2000a); the Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module (DOE 2002b), and the Waste Storage Area (Phase II) Design Report (DOE 2005g).

The primary sources of contamination at the Fernald site that contributed to the present geometry of the uranium plume include: (1) the waste pits in the waste storage area; (2) the inactive flyash pile that was present in the South Field area; (3) former production activities; and (4) the previously uncontrolled surface water runoff from the former production area that had direct access to the aquifer through a former drainage originating near the Plant 1 Pad and flowing west through the waste storage area and the Pilot Plant drainage ditch.

A groundwater remediation strategy that relies on pump-and-treat technology is being used to conduct a concentration-based cleanup of the Great Miami Aquifer. The restoration strategy focuses primarily on the removal of uranium, but has also been designed to limit the further expansion of the plume, achieve removal of all targeted contaminants to concentrations below designated FRLs, and prevent undesirable draw-down impacts beyond the Fernald site.

The "remediation footprint" of the aquifer is a term used to define those areas of the aquifer that will be targeted for the remediation. The OU5 Record of Decision establishes that "areas of the Great Miami Aquifer exceeding FRLs will be restored through extraction methods." Over the course of the aquifer remedy, the areas of the aquifer being targeted for restoration have changed due to:

- The collection of additional characterization data to support modular designs
- Changing the uranium FRL concentration for groundwater from 20 μg/L to 30 μg/L.

Following is a brief discussion of the changes, along with the definition of "remediation footprint."

Continued groundwater monitoring and direct-push sampling conducted to support the design of individual aquifer modules provided data that indicated the area of the aquifer exceeding the groundwater FRL for uranium was larger than the area defined in the Operable Unit 5 Record of Decision.

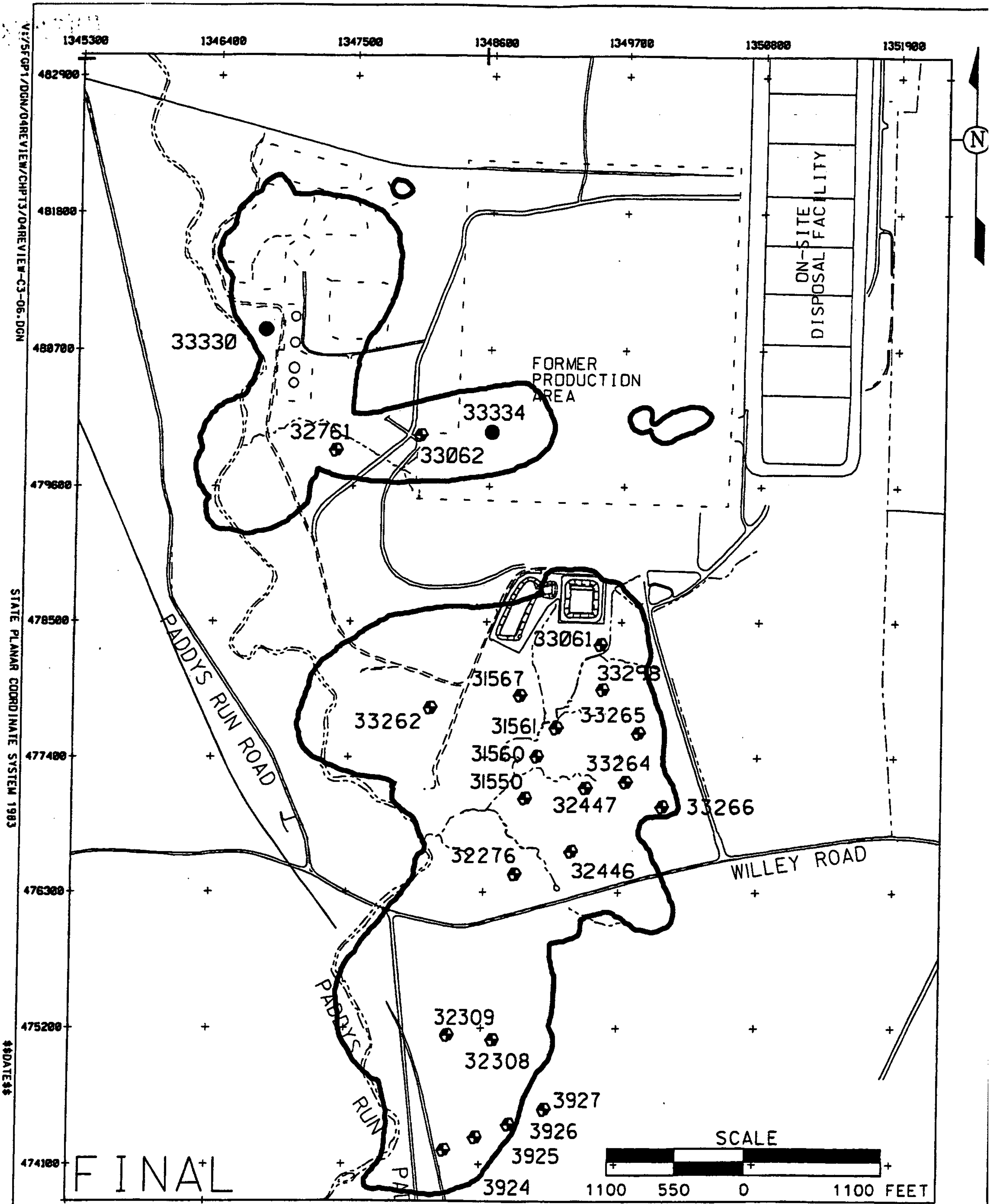
Changing the FRL concentration for uranium in groundwater from 20 μg/L to 30 μg/L decreased the area of the aquifer that was defined as exceeding the groundwater FRL for uranium in the Operable Unit 5 Record of Decision. In 1996, when the Operable Unit 5 Record of Decision was signed, the (MCL for uranium in drinking water had not been promulgated but was proposed as 20 μg/L. The FRL for uranium for the groundwater remedy was defined as 20 µg/L to match the proposed MCL. In 2001, EPA finalized the MCL for uranium at 30 µg/L for drinking water. Through a Record of Decision Explanation of Significant Differences (ESD), the MCL became the FRL for total uranium in groundwater at the Fernald site.

To incorporate the changes presented above, the remediation footprint of the aquifer is conservatively defined as the areas contained within a composite of all previous 20-µg/L maximum uranium plume interpretations through 2000, and 30-µg/L maximum uranium plume interpretations subsequent to 2000, located north of the Administrative Boundary for Aquifer Restoration. The remediation footprint of the aquifer (updated through 2004) is shown in Figure 3-3. The interpretation will be updated each year as new data are collected.

Pumping groundwater from the aquifer prior to the start of the actual groundwater remediation began in August 1993 with the startup of five extraction wells in the South Plume. The wells were installed and operated as part of a removal action to prevent the further southern migration of the uranium plume while the Remedial Investigation of the plume was being completed and a remediation system was being designed.

The design of the aquifer remediation system has evolved via the issuance of several different design documents. The first aquifer remediation design was presented in the Operable Unit 5 Feasibility Study. The design consisted of 28 extraction wells pumping for 27 years. It is this design that is contained in the Operable Unit 5 Record of Decision. A commitment was made in the Operable Unit 5 Record of Decision to pursue technological advances that might decrease the remediation time. A technology that was pursued was treated groundwater re-injection. Groundwater modeling was conducted to determine if adding re-injection wells to the remediation would facilitate a quicker cleanup. The groundwater modeling showed that a faster cleanup could be realized by using re-injection if several other actions were also realized. These other actions included:

- Other operable units completing their accelerated cleanup objectives so that surface access is available for aquifer remediation wells
- The accelerated removal of sources to allow extraction wells to be located closer to the center of uranium plumes
- Modeled geochemical and hydraulic parameters being consistent with aquifer conditions.



LEGEND:

- FERNALD SITE BOUNDARY
- EXTRACTION WELL
- REMEDIATION FOOTPRINT BOUNDARY
- EXTRACTION WELL BEING INSTALLED: OPERATION SCHEDULED IN 2006.

FIGURE 3-3. EXTRACTION WELL LOCATIONS

An aquifer remediation design, which included re-injection, was presented in the Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration. This design called for 37 pumping wells and 10 re-injection wells. The predicted cleanup time was modeled at 10 years. The pumping and re-injection wells were subdivided into five area specific restoration modules:

- The South Plume Module
- The South Field Module
- The Waste Storage Area Module
- The Plant 6 Module
- The Re-Injection Demonstration Module

Although groundwater modeling showed that re-injection expedited the cleanup, the technology was unproven at the Fernald site. Of concern was the cost of keeping the wells operational (industry experience showed that these wells tend to plug). A demonstration was needed to prove that the re-injection wells could be operated efficiently at the Fernald site. The decision was made to tie the demonstration into the remedy design presented in the Baseline Remedial Strategy Report. If successful, the impact to the remedy would be immediate.

In the summer of 1998, the first wells for the aquifer remediation became operational and marked implementation of the aquifer remedy design presented in the Baseline Remedial Strategy Report. Implementation of the Baseline Remedial Strategy Report design included a groundwater re-injection demonstration that was conducted from September 2, 1998, to September 2, 1999. At the request of the Fernald site, the evaluation of re-injection technology at the Fernald site was sponsored by DOE's Office of Science and Technology Subsurface Contaminants Focus Area. The re-injection demonstration was successful and re-injection was incorporated into the aquifer remedy.

Changes to the aquifer remedy design for the Waste Storage Area and Plant 6 modules were implemented in 2002 based on findings and groundwater modeling results presented in the Conceptual Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas. Characterization efforts conducted in support of the design showed that the uranium plume in the Plant 6 area had dissipated, eliminating the need for extraction wells in this area. Therefore, an aquifer restoration module is no longer planned for the Plant 6 area; however, groundwater monitoring in the Plant 6 area will continue until the Waste Storage Area Module, which is up gradient of the Plant 6 area, has been certified clean. In 2006, one monitoring well (Monitoring Well 2389) will be routinely monitored in the Plant 6 area.

Characterization efforts conducted in support of the waste storage area design also showed that the uranium plume in the waste storage area was smaller than what was characterized during the Remedial

Investigation/Feasibility Study, and that the waste storage area uranium plume in the vicinity of the confluence of Paddys Run and the Pilot Plant drainage ditch needed to be redefined and extended to the east. In light of these findings, a new restoration module for the waste storage area was modeled and designed. The number of wells needed in the design to remediate the waste storage area went from 10 (Baseline Remedial Strategy Report design) down to five (modified module design). The details concerning this design are presented in the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2001a). Three of the extraction wells began pumping in 2002.

Changes to the aquifer remedy design for the South Field module were implemented in 2003 based on findings presented in the Design for Remediation of the Great Miami Aquifer, South Field (Phase II) Module. Characterization efforts conducted to support the design showed that uranium concentrations beneath western portions of the Southern Waste Units were much lower than in previous years. The lower concentrations were attributed to source removal, natural flow of clean groundwater from the west into the area, the continued flushing of clean recharge water through Paddys Run to the underlying aquifer, increased flushing of clean recharge water through deep surface excavations in the inactive flyash pile, and remedial pumping of the extraction wells to the east of this area. The modified design for Phase II of the South Field Module went from nine new extraction wells and five new re-injection wells (Baseline Remedial Strategy Report design) down to four new extraction wells, one new re-injection well, conversion of an existing extraction well into an injection well, and an injection basin (modified module design).

In 2004, aquifer remedy design changes were implemented to address changing water treatment needs resulting from site closure and to stop well-based re-injection. Several water treatment flows were eliminated or reduced (e.g., remediation wastewater, sanitary wastewater, storm water runoff) from the scope of the treatment operation. Elimination or reduction of these flow streams provided an opportunity to reduce the size of the water treatment facility remaining to service the aquifer restoration after site closure. Reducing the size of the treatment facility prior to site closure in 2006 reduced the amount of impacted materials that needed future off-site disposal. In 2004, consensus was reached on a decision to "carve down" the AWWT into a smaller facility—the converted AWWT facility (CAWWT). During and after CAWWT construction, groundwater treatment capacity was limited so that treated groundwater was not available to support well-based re-injection or to continue to meet uranium discharge requirements. Therefore, in September 2004 well-based re-injection was stopped to facilitate construction of the CAWWT.

Groundwater modeling presented in the Comprehensive Groundwater Strategy Report (DOE 2003a) predicted that continued use of large-scale re-injection using existing re-injection wells would shorten the aquifer remedy by three years (comparison of Alternatives 1 and 6). These results indicated limited benefit to maintaining the infrastructure for large-scale, well-based re-injection (when viewed in relation to water treatment facility scale down activities) and supported the decision to stop re-injection. Therefore, the decision was also made in 2004 not to restart well-based re-injection once the CAWWT was operational.

Other operational strategies to enhance the aquifer remedy are being explored, such as inducing recharge to the Great Miami Aquifer through the storm sewer outfall ditch. A phased testing approach is being pursued that involves measuring induced flow rates and seasonal runoff flow into the storm sewer outfall ditch, and possibly conducting site-specific infiltration tests at key locations in the bed of the storm sewer outfall ditch. The phased testing will result in a decision to either incorporate the storm sewer outfall ditch recharge strategy into the site remedy, or to conduct further testing. A baseline flow test began on August 18, 2005 to determine if the storm sewer outfall ditch is capable of delivering an infiltration rate of 500 gallons per minute (gpm) to the aquifer. Clean groundwater is being pumped into the storm sewer outfall ditch from a construction well located on the east side of the Fernald site. This baseline test will be limited to the clean (northeast) branch of the storm sewer outfall ditch. If the baseline test is successful and plans are made to use the storm sewer outfall ditch strategy in the groundwater remedy, a flow rate higher than the 500 gpm will be considered, but logistics involving a source of clean water and meeting established discharge limits at the Parshall Flume will need to be evaluated also. A treatment capacity of 500 gpm is being reserved to treat storm water so it cannot be dedicated to re-injection. Water treatment priorities are defined in Section 5.2 of the draft Operations and Maintenance Master Plan for Aquifer Restoration and Wastewater Treatment (OMMP), Revision 2. At a minimum, additional flow measurements could be made to quantify how much water above the 500-gpm, induced flow the storm sewer outfall ditch will infiltrate into the aquifer from natural seasonal runoff. Site-specific infiltration tests through the bed of the storm sewer outfall ditch may also be conducted. If the baseline 500-gpm flow test is not successful, additional flow testing will be conducted. Additional flow testing in the storm sewer outfall ditch would involve both the northwest and northeast branches of the storm sewer outfall ditch. The flow rate for this additional testing will be a minimum of 500 gpm, but could be higher based on logistics involving an additional source of clean water, meeting established discharge limits at the Parshall Flume, and the ability of the storm sewer outfall ditch to accept the water. If this later flow testing is successful, then the storm sewer outfall ditch recharge strategy will be added to the aquifer remedy.

Changes to the remedy design for the waste storage area were implemented in 2005 based on findings presented in the Waste Storage Area (Phase II) Design. Characterization data collected to support the Phase II design were used to re-define the footprint of the 30-µg/L uranium plume. The data indicated that uranium concentrations in the aquifer near the former silos area were higher than what was mapped prior to the characterization, but that the footprint of the plume was smaller than previously mapped. Because the uranium plume footprint was smaller only one additional extraction well is needed to remediate it. This new extraction well is scheduled for installation in early 2006, and will be operational in 2006.

3.4.2.2 The Modular Approach to Aquifer Restoration

Restoration of the Great Miami Aquifer is being accomplished by using a series of area-specific groundwater restoration modules and a centralized water treatment facility (refer to Figure 3-1).

In 2006, the South Field Module, South Plume Module, and Waste Storage Area Module will all be operational. Figure 3-3 shows the location of the extraction wells that comprise these modules.

South Plume Module

Six extraction wells (3924, 3925, 3926, 3927, 32308, and 32309) will be operational in the South Plume Module in 2006. Extraction Wells 3924, 3925, 3926, and 3927, which were originally called the South Plume Module, have been in operation since 1993 as part of a removal action. Located at the southern edge of the total uranium plume, the initial South Plume Module, as reported in the Work Plan for the South Contaminated Plume Removal Action (DOE 1992), was installed to create a hydraulic barrier and to prevent further southern migration of the uranium plume. In 1998, two additional extraction wells (32308 and 32309) became operational just north of the four original South Plume Module wells. These two wells were installed under a project known as the South Plume Optimization Module. The term "South Plume Module" is used to refer to both the original extraction wells installed under the South Plume Module and those installed under the South Plume Optimization Module.

South Field Module

Thirteen extraction wells (31550, 31560, 31561, 32276, 32446, 32447, 33061, 33262, 33264, 33265, 33266, 33298, and 33326) will be operational in the South Field Module in 2006. Restoration of the aquifer in the South Field area began in 1998 when 10 extraction wells (31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276) began pumping around the excavation area near the storm sewer outfall ditch (South Field Extraction [Phase I] Module). Six of the original ten extraction wells (31562, 31563, 31564, 31565, 31566, and 31567) are no longer operating:

- Extraction Well 31562 was shut down in 2003 and replaced by a new well (33298)
- Extraction Well 31563 was shut down in 2002 and converted to a re-injection well as part of the South Field (Phase II) project
- Extraction Wells 31564 and 31565 were shut down in 2001 so that additional soil remediation could be conducted in the area. The decision was made not to re-start pumping at these wells because they are no longer situated in locations that will provide a pumping benefit to the aquifer remedy.
- Extraction Well 31566 was shut down in 1998 to minimize the potential for pulling contamination into a region of the aquifer with finer grain sediment.
- Extraction Well 31567 was shut down in 2005 due to excessive plugging of the well screen; it was replaced by a new well (33326).

The South Field Module was expanded in 1999 and 2002. In 1999, Extraction Wells 32446 and 32447 were added and began operating in 2000. Extraction Well 33061 was added and became operational in 2002. In 2003, the module was modified again, this time as part of Phase II. Four new extraction wells (33262, 33264, 33265, 33266), one replacement well (33298), two re-injection wells (33263, 31563), and one injection basin became operational. Because of the decision in 2004 to stop well-based re-injection, the two re-injection wells (33263 and 31563) are no longer operating. Also, the injection basin has become a passive feature in that water is not being actively pumped to the basin. Figure 3-3 shows the location of the extraction wells that will be operational in 2006.

Waste Storage Area Module

In 2006, four extraction wells (32761, 33062, 33334, and 33330) will be operating in the Waste Storage Area Module. Two of the extraction wells (32761 and 33062) were installed as part of the Waste Storage Area (Phase I) Module. A third extraction well (well 33063) installed as part of the Waste Storage Area (Phase I) Module was plugged and abandoned in 2004 to facilitate surface excavation activities. A replacement well (Well 33334) will be operational in 2006. Extraction Well 33330 is part of the Waste Storage Area (Phase II) Design. It is scheduled for installation in early 2006, and will be operational in 2006.

The groundwater monitoring program for 2006 is designed to track remedy performance of the modules presented above. For monitoring purposes, the aquifer is divided into five zones referred to as "aquifer zones" (refer to Figure 3-4). These aquifer zones are used to evaluate the predicted performance (both individually and collectively) at the aquifer restoration modules. Aquifer Zones 1, 2, and 4 contain aquifer remediation modules. Aquifer Zone 0 (the fifth zone) is the area outside the other four aquifer zones.

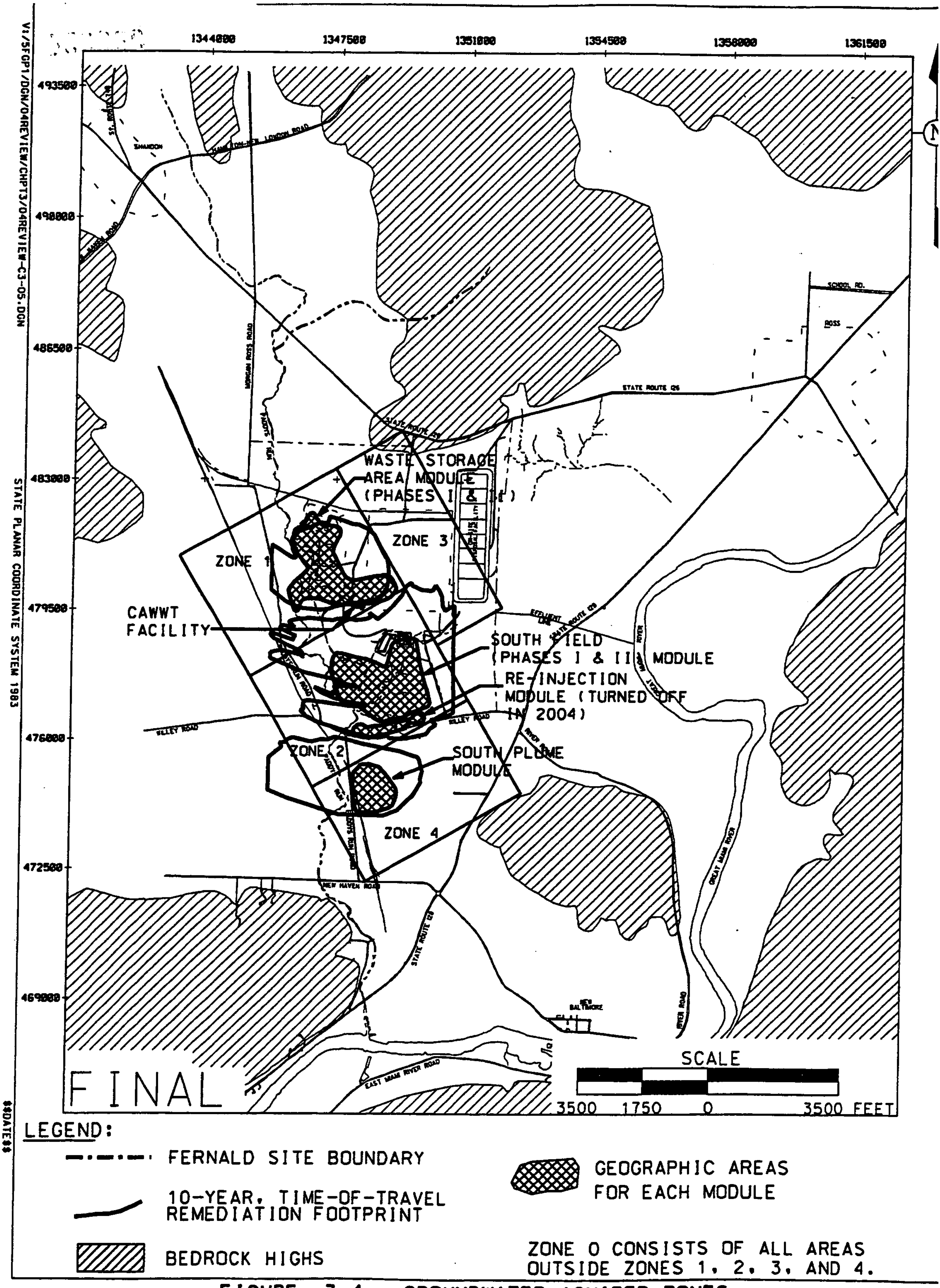


FIGURE 3-4. GROUNDWATER AQUIFER ZONES AND AQUIFER RESTORATION FOOTPRINT

The locations of the extraction wells comprising the restoration modules are as follows:

- The South Plume Module is located in Aquifer Zone 4
- The South Field Module (Phases I and II) is located in Aquifer Zone 2
- The Waste Storage Area Module (Phases I and II) is located in Aquifer Zone 1.

Groundwater modeling predicts that aquifer remedy pumping will create a hydraulic capture zone that is larger than the actual dimension of the 30-µg/L total uranium plume. In previous plans, the extent of this capture zone was called the 10-year, uranium-based restoration footprint. The 10-year time reference originated from the 1997 modeling done for the Baseline Remedial Strategy Report that predicted a 10-year cleanup time. As discussed earlier, the current design is modified from the Baseline Remedial Strategy Report Design; therefore, the 10-year aquifer restoration footprint originating from the Baseline Remedial Strategy Report is no longer applicable to the remedy. A new 10-year, time-of-travel footprint that does not include well-based re-injection operations was presented in the final Groundwater Remedy Evaluation and Field Verification Plan, Revision 0. Information concerning how this new footprint was constructed is also presented in that report. The new 10-year, time-of-travel remediation footprint is shown in Figure 3-4 in order to show its relationship to the aquifer zones.

3.4.2.3 Well Selection Criteria

Geologic and hydrogeologic properties, predicted and actual groundwater flow, and contaminant distribution within the Great Miami Aquifer (before and during remediation) serve as input to the design and modification of the IEMP groundwater monitoring network. Field measurements and computer simulations were conducted to support initial design efforts.

All available information is reviewed to select appropriate monitoring well locations. The monitoring well locations for the IEMP are selected according to the following criteria:

- Monitor within the projected capture zone of the groundwater restoration operation unless an operational concern (e.g., the close proximity of the South Plume extraction wells to the Paddys Run Road Site plume) requires a monitoring location to be outside of the capture zone. Note: Pumping rates may change to optimize the operation through time; therefore, the capture zone may also change.
- Use existing monitoring wells in the remediation footprint of the aquifer and avoid installing new monitoring wells unless determined necessary based on operational knowledge, which will be used to help select new locations
- Provide adequate areal coverage across each remediation module area
- Include monitoring wells that are needed to meet site-specific monitoring commitments

- Avoid selecting monitoring well locations that would interfere with surface remediation activities such as soil excavations. Note: This criterion is becoming less of a concern because most of the planned monitoring wells are already in place. At issue, however, is the loss of monitoring wells should excavation activities expand into areas that contain existing monitoring wells. If wells are lost due to surface operations, replacement wells will be installed if deemed appropriate at the time.
- Select monitoring well locations that will provide data needed to determine how reasonable model predictions are over the long term
- Select monitoring well locations in consideration of landowner concerns. In the off-property portion of the South Plume, landowner access concerns have, and will continue to have, a bearing on the location and number of monitoring wells in that area. Generally, location of monitoring wells is limited to peripheral areas along the edges of the farm fields. This monitoring well limitation is being addressed through supplemental use of direct push sampling that can be conducted during the times of the year when the fields are not being used for crops.

During 2006, approximately 130 wells at the Fernald site will be sampled as identified in the subsections that follow.

3.4.2.4 Constituent Selection Criteria

The groundwater sampling constituent selection criteria are based on evaluation of the groundwater data that have been collected since the inception of the IEMP. Rationale and information concerning constituent selection is presented in Appendix A. Following is an overview.

Restoration of the aquifer will be verified against FRLs. FRLs for the aquifer have been established in the Operable Unit 5 Record of Decision for 50 COCs. Groundwater monitoring focuses on these 50 FRL constituents to assess the progress of the aquifer remedy.

As presented in Appendix A, a short list of constituents has been established for monitoring purposes and is based on where and whether constituents have had FRL exceedances in the aquifer since inception of the IEMP. Constituents on the short list are monitored semiannually. Monitoring of those constituents not on the short list will be addressed during Stage III, Certification/Attainment Monitoring, as necessary.

Table 3-2 summarizes groundwater sampling results since the inception of IEMP program and contains the following information:

- Column 1 lists the 50 constituents for which FRLs were established in the Operable Unit 5 Record of Decision
- Column 2 lists the respective FRL concentration for each of the constituents

TABLE 3-2

GROUNDWATER FRL EXCEEDANCES BASED ON SAMPLES AND LOCATIONS SINCE IEMP INCEPTION (FROM AUGUST 1997 THROUGH 2004)

(1) Constituent	(2) Groundwater FRL[a]	(3) Basis for FRL[b]	(4) No. of Samples[c]	(5) No. of Samples >FRL[c,d]	(6) Percent of Samples >FRL	(7) Zones with FRL Exceedances (No. of Wells with exceedances in each Aquifer Zone)[c,d,e]	(8) Range above FRL[c,d,e]
Uranium, Total	30 µg/L	A	3778	957	25.33%	1(15) 2(38) 3(3) 4(16)	30.13 J/1160 NV
Zinc	0.021 mg/L	B	1129	78	6.91%	0(10) 1(5) 2(14) 3(5) 4(2)	0.0212 NV/13.6 -
Manganese	0.90 mg/L	B	1316	84	6.38%	0(5) 1(6) 2(10) 3(5) 4(4)	0.916 -/105 J
Nickel	0.10 mg/L	A	1138	20	1.76%	0(1) 1(1) 2(7) 3(1)	0.101 -/1.54 -
Technetium-99	94 pCi/L	R*	1459	28	1.92%	1(3)	101.08 -/1352.266 J
Nitrate[f]	11 mg/L	B	1898	31	1.63%	1(5) 2(1)[g]	11.4 -/331 NV
Lead	0.015 mg/L	A	1138	13	1.14%	0(2) 1(2) 2(4) 3(2)	0.0157 -/0.201 -
Arsenic	0.050 mg/L	A	1356	14	1.03%	0(1) 1(1) 2(1) 4(4)	0.051 -/0.125 -
Molybdenum	0.10 mg/L	A	810	10	1.23%	1(1)	0.207 -/0.69 -
Boron	0.33 mg/L	R	1947	15	0.77%	2(2)	0.331 -/1.16 -
Antimony	0.0060 mg/L	A	1139	8	0.70%	0(4) 1(1) 2(2)4(1)	0.00601 -/0.0196 J
Trichloroethene	0.0050 mg/L	A	1325	10	0.75%	1(2)	0.0207 -/0.120 -
Carbon disulfide	0.0055 mg/L	A	1004	6	0.60%	0(1)[h] 1(3) 2(1)[h]	0.006 -/0.014 -
Fluoride	4 mg/L	A	1359	4	0.29%	0(2) 1(1) 3(1)	5.3 -/12.3 -
Vanadium	0.038 mg/L	R	951	1	0.11%	0(1)	0.0664 J[i].
1,1-Dichloroethane	0.28 mg/L	A	86	0	0%	NA	NA
1,1-Dichloroethene	0.0070 mg/L	A	517	0	0%	NA	NA
1,2-Dichloroethane	0.0050 mg/L	A	704	0	0%	NA	NA
2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.000010 mg/L	D	19	0	0%	NA	NA
4-Methylphenol	0.029 mg/L	R	86	0	0%	NA	NA
4-Nitrophenol	0.32 mg/L	R	86	0	0%	NA	NA
alpha-Chlordane	0.0020 mg/L	A	724	0	0%	NA	NA
Aroclor-1254	0.00020 mg/L	D	86	0	0%	NA	NA
Barium	2.0 mg/L	A	194	0	0%	NA	NA
Benzene	0.0050 mg/L	A	905	0	0%	NA	NA
Beryllium	0.0040 mg/L	A	877	0	0%	NA	NA
bis(2-Chloroisopropyl) ether	0.0050 mg/L	D	411	0	0%	NA	NA
bis(2-Ethylhexyl)phthalate	0.0060 mg/L	A	86	0[j]	0%	NA[j]	NA
Bromodichloromethane	0.10 mg/L	A	723	0	0%	NA	NA
Bromomethane	0.0021 mg/L	R	86	0	0%	NA	NA
Cadmium	0.014 mg/L	B	994	0	0%	NA	NA

TABLE 3-2
(Continued)

(1) Constituents	(2) Groundwater FRL[a]	(3) Basis for FRL[b]	(4) No. of Samples[c]	(5) No. of Samples >FRL[c,d]	(6) Percent of Samples >FRL	(7) Zones with FRL Exceedances (No. of Wells with exceedances in each Aquifer Zone)[c,d,e]	(8) Range above FRL[c,d,e]
Carbazole	0.011 mg/L	R	411	0	0%	NA	NA
Chloroethane	0.0010 mg/L	D	86	0	0%	NA	NA
Chloroform	0.10 mg/L	A	86	0	0%	NA	NA
Chromium VI	0.022 mg/L	R	16	0	0%	NA	NA
Cobalt	0.17 mg/L	R	878	0	0%	NA	NA
Copper	1.3 mg/L	A	86	0	0%	NA	NA
Mercury	0.0020 mg/L	A	2064	0[k]	0%	NA	NA
Methylene chloride	0.0050 mg/L	A	84	0	0%	NA	NA
Neptunium-237	1.0 pCi/L	R*	1606	0	0%	NA	NA
Octachlorodibenzo-p-dioxin	1.0E-7 mg/L	D	19	0	0%	NA	NA
Radium-226	20 pCi/L	A	194	0	0%	NA	NA
Radium-228	20 pCi/L	A	86	0	0%	NA	NA
Selenium	0.050 mg/L	A	991	0	0%	NA	NA
Silver	0.050 mg/L	A	856	0	0%	NA	NA
Strontium-90	8.0 pCi/L	A	1394	0	0%	NA	NA
Thorium-228	4.0 pCi/L	R*	992	0	0%	NA	NA
Thorium-230	15 pCi/L	R*	86	0	0%	NA	NA
Thorium-232	1.2 pCi/L	R*	902	0	0%	NA	NA
Vinyl chloride	0.0020 mg/L	A	723	0	0%	NA	NA

[a]From Operable Unit 5 Record of Decision, Table 9-4.
[b]From Operable Unit 5 Feasibility Study, Table 2-16:
A = ARAR-based
B = Based on 95th percentile background concentrations
D = Based on lowest achievable detection limit
R = Risk-based Preliminary Remediation Goal (PRG)
R* = Risk-based Preliminary Remediation Level includes the radionuclide risk-based PRG plus its 95th percentile background concentration.
[c]Based on filtered and unfiltered samples from the August 1997 through 2004 IEMP groundwater data.
[d]Sample results having a -, J, or NV qualifier were used:
- = result is confident as reported
J = result is quantitatively estimated
NV = result is not validated
[e]NA = not applicable
[f]Nitrate/nitrite results are evaluated with respect to the nitrate FRL.
[g]Since the IEMP inception, there has been only one nitrate/nitrite exceedance at Well 2017 (in 1998) (refer to Figure A-12).
[h]Since the IEMP inception, there has been one isolated exceedance for carbon disulfide at two locations (refer to Figure A-5).
[i]Since the IEMP inception, there has been only one vanadium exceedance at Well 2426 (in 1998) (refer to Figure A-16).
[j]Of the 86 samples analyzed for bis(2-Ethylhexyl)phthalate, a common laboratory containment, five had results above the FRL. The FRL results above are all considered suspect due to laboratory analysis issues, laboratory blank and field blank contamination, or field duplicate results being non-detected. The five exceedances are as follows: 0.014J mg/L, Well 2398 and 0.010J mg/L, Well 3390 in Aquifer Zone 2; 0.016J mg/L, Well 2109 in Aquifer Zone 3; and 0.008J mg/L, Well 2125 and 0.13J mg/L, Well 3095 in Aquifer Zone 4.
[k]The mercury exceedance is suspect, due to negative MS/MSD recoveries. In fact, the MS/MSD (i.e., spiked samples) results were both extremely below the original sample result.

- Column 3 identifies the basis for each FRL constituent (i.e., risk, ARAR, background, or detection limit) as defined in the Operable Unit 5 Feasibility Study Report
- Column 4 documents the number of samples that have been analyzed for each constituent since the start of IEMP sampling
- Column 5 notes the number of samples that have had a concentration greater than the FRL for each constituent
- Column 6 notes the percent of the samples for each constituent that have had a concentration greater than the FRL
- Column 7 identifies the zones where FRL exceedances have been observed and the number of wells in each zone that had exceedances
- Column 8 shows the above FRL concentration range for each constituent that had FRL exceedances.

As shown in Table 3-2, 35 of the 50 groundwater FRL constituents have not had an FRL exceedance. Excluding uranium, the groundwater FRL constituents that did have recorded exceedances were from a limited number of wells. The spatial distribution of these wells indicates that many of the non-uranium FRL exceedances are not associated with a plume.

Groundwater monitoring focuses on the short list of 15 groundwater FRL constituents. The following monitoring will be conducted:

1. Uranium, which is the primary COC and has the greatest number of wells with exceedances, will be monitored semiannually.

2. Constituents that have FRL exceedances in multiple zones (i.e., antimony, arsenic, fluoride, lead, manganese, nickel, and zinc) will be monitored semiannually as follows:

   - At a minimum, all constituents will be monitored at downgradient wells including existing property boundary/on-site disposal facility wells along the eastern perimeter of the site and those wells along the eastern/southern boundary of the South Plume. Area C on Figure A-19 shows the configuration of this monitoring network, which lies in Zones 0, 2, 3, and 4, and for the most part outside of the restoration footprint. Monitoring at these locations will document that above-FRL contaminants are not migrating beyond the expected capture zone.

     Note: Carbon disulfide and nitrate/nitrite are considered to have legitimate exceedances in only one zone (Zone 1) and are discussed below (refer to item #3).

   - In addition to being monitored in Zones 0, 2, 3, and 4, constituents that have exceedances in multiple zones were evaluated with respect to Zone 1 to determine if monitoring is conducted to address consistent/recent exceedances in this area. Monitoring will be addressed in this zone, in addition to the monitoring at the Property/Plume Boundary, to ensure that the constituents exhibiting consistent/recent exceedances are being monitored near potential sources. From review of Table A-2 (in Appendix A), manganese in Zone 1 appears to have consistent/recent exceedances. Therefore, it will be monitored in this zone at wells that have exceedances. In addition to manganese, nickel had an exceedance in 2002. Nickel will also be monitored in Zone 1. Refer to Area A on Figure A-19 for the locations to be monitored in Zone 1.

3. Constituents that have FRL exceedances in only one zone will be monitored semiannually solely in that zone. The monitoring will consist of the following: carbon disulfide, molybdenum, nitrate/nitrite, technetium-99, and trichloroethene in Zone 1 (waste storage area), and boron in Zone 2 (South Field). Specific monitoring locations will be based on the wells that have exceedances.

   Note: Carbon disulfide has exceedances primarily in Zone 1. The two wells that have exceedances outside Zone 1 were Property Boundary Wells 2432 and 3069. These wells were sampled quarterly and exceedances were slightly above the FRL (6 μg/L with respect to the 5.5 μg/L FRL). For Well 2432, there have been no additional exceedances since the occurrence during first quarter 1999. With regard to the one exceedance for Well 3069 that occurred during fourth quarter 2001, a duplicate result during the sampling event was below the FRL (refer to Figure A-5). No additional exceedances for carbon disulfide have occurred at Well 3069 since 2001.

   Nitrate/nitrite has exceedances primarily in Zone 1. One well (2017), which is located in Zone 2, had a one-time exceedance in 1998.

4. Vanadium has a one-time exceedance in 1998 during quarterly sampling at one well (2426). This constituent will be monitored less than semiannually due to the lack of exceedances. Monitoring for this constituent is addressed in Section A.3.2. Vanadium will be addressed during Stage III, Certification/Attainment Monitoring.

Based on the above four criteria, 13 non-uranium groundwater FRL constituents are on the "short list" and are monitored semiannually (refer to Table 3-3).

3.5 DESIGN OF THE IEMP GROUNDWATER MONITORING PROGRAM

The monitoring approach for 2006 focuses on IEMP data and specifically calls for semiannual monitoring of groundwater FRL constituents with exceedances. A list of IEMP groundwater monitoring wells is provided in Table 3-4. Table 3-5 provides a list of the monitoring requirements. Justification for the monitoring approach is provided in Appendix A.

The monitoring strategy and technical approach will be revised as necessary in subsequent revisions to the IEMP to encompass operational changes over the life of the remedy. A start-up monitoring, project-specific plan or variance to an existing plan will be developed to supplement the IEMP each time a new extraction well begins to operate for the first time.

TABLE 3-3

IEMP CONSTITUENTS WITH FRL EXCEEDANCES, LOCATION OF EXCEEDANCES, AND REVISED MONITORING PROGRAM

Parameter	Aquifer Zones with Exceedances	Monitoring Program
Antimony	Multiple Zones	Property/Plume Boundary
Arsenic	Multiple Zones	Property/Plume Boundary
Boron	Aquifer Zone 2 (South Field)	South Field
Carbon Disulfide	Aquifer Zone 1 (Waste Storage Area)	Waste Storage Area
Fluoride	Multiple Zones	Property/Plume Boundary
Lead	Multiple Zones	Property/Plume Boundary
Manganese	Multiple Zones[a]	Property/Plume Boundary, Waste Storage Area
Molybdenum	Aquifer Zone 1 (Waste Storage Area)	Waste Storage Area
Nickel	Multiple Zones	Property/Plume Boundary, Waste Storage Area
Nitrate/Nitrite	Aquifer Zone 1 (Waste Storage Area)	Waste Storage Area
Technetium-99	Aquifer Zone 1 (Waste Storage Area)	Waste Storage Area
Trichloroethene	Aquifer Zone 1 (Waste Storage Area)	Waste Storage Area
Zinc	Multiple Zones	Property/Plume Boundary

[a]There are consistent/recent exceedances of manganese in Zone 1; therefore, this constituent will be monitored in the waste storage area and along the Property/Plume Boundary.

TABLE 3-4

LIST OF IEMP GROUNDWATER MONITORING WELLS[a]

		Property/Plume Boundary Monitoring				
Number[a]	Total Uranium Monitoring	Monitor FRL Exceedances	Monitor OSDF Constituents[b]	Monitor PRRS Constituents[c]	Waste Storage Area Monitoring - FRL Exceedances	South Field Monitoring - FRL Exceedances
1	13					
2	14					
3	2002					
4	2008					
5	2009					
6	2010				2010	
7	2014					
8	2016					
9	2017					
10	2045					2045
11	2046					
12	2048					
13	2049					2049
14	2060 (12)					
15	2093	2093				
16	2095					
17	2106					
18	2125					
19	2128	2128		2128		
20	2166					
21	2385					
22	2386					
23	2387					
24	2389					
25	2390					
26	2396					
27	2397					
28	2398	2398				
29	2402					
30	2431	2431				
31	2432	2432				
32	2550					
33	2552					
34	2553					
35	2625	2625		2625		
36	2636	2636		2636		
37	2648				2648	

TABLE 3-4
(Continued)

Number[a]	Total Uranium Monitoring	Property/Plume Boundary Monitoring: Monitor FRL Exceedances	Property/Plume Boundary Monitoring: Monitor OSDF Constituents[b]	Property/Plume Boundary Monitoring: Monitor PRRS Constituents[c]	Waste Storage Area Monitoring - FRL Exceedances	South Field Monitoring - FRL Exceedances
38	2649				2649	
39	2733	2733				
40	2821				2821	
41	2880					
42	2897					
43	2898	2898		2898		
44	2899	2899		2899		
45	2900	2900		2900		
46	3014					
47	3015					
48	3045					
49	3046					
50	3049					
51	3069					
52	3070	3070				
53	3093	3093				
54	3095					
55	3106					
56	3125					
57	3128	3128		3128		
58	3385					
59	3387					
60	3390					
61	3396					
62	3397					
63	3398	3398				
64	3402					
65	3424	3424				
66	3426	3426				
67	3429	3429				
68	3431	3431				
69	3432	3432				
70	3550					
71	3552					
72	3636	3636		3636		
73	3733	3733				
74	3821				3821	
75	3880					
76	3897					
77	3898	3898		3898		
78	3899	3899		3899		
79	3900	3900		3900		
80	4125					

TABLE 3-4
(Continued)

Number[a]	Total Uranium Monitoring	Property/Plume Boundary Monitoring: Monitor FRL Exceedances	Property/Plume Boundary Monitoring: Monitor OSDF Constituents[b]	Property/Plume Boundary Monitoring: Monitor PRRS Constituents[c]	Waste Storage Area Monitoring - FRL Exceedances	South Field Monitoring - FRL Exceedances
81	4398	4398				
82	6015					
83	6880					
84	6881					
85	21033					
86	21063	21063				
87	21192					
88	22198	22198	22198			
89	22199	22199	22199			
90	22204	22204	22204			
91	22205	22205	22205			
92	22208	22208	22208			
93	22210	22210	22210			
94	22211	22211	22211			
95	22214	22214	22214			
96	23064					
97	23118					
98	23271					
99	23272					
100	23273					
101	23274					
102	23275					
103	23276					
104	23277					
105	23278					
106	23279					
107	23280					
108	23281					
109	23282					
110	31217	31217				
111	32766					
112	32768					
113	62408					
114	62433					
115	63116					
116	63119					
117	63283					
118	63284					
119	63285					
120	63286					
121	63287					
122	63288					
123	63289					

TABLE 3-4
(Continued)

		Property/Plume Boundary Monitoring				
Number[a]	Total Uranium Monitoring	Monitor FRL Exceedances	Monitor OSDF Constituents[b]	Monitor PRRS Constituents[c]	Waste Storage Area Monitoring - FRL Exceedances	South Field Monitoring - FRL Exceedances
124	63290					
125	63291					
126	63292					
127	82433					
128	83117					
129	83124					
130	83293					
131	83294					
132	83295					
133	83296					
134	83335					
135	83336					

[a]The number in Column 1 is used to identify the number of wells in the program. The individual monitoring well identification numbers are provided in Columns 2-7 as appropriate.
[b]List of total uranium monitoring wells and Property/Plume Boundary monitoring wells that overlap with OSDF monitoring wells.
[c]List of total uranium monitoring wells and Property/Plume Boundary monitoring wells that overlap with Paddys Run Road Site monitoring wells.

TABLE 3-5

MONITORING REQUIREMENTS[a]

1. TOTAL URANIUM

2. WASTE STORAGE AREA

General Chemistry	Inorganic	Radionuclide	Organic
Nitrate/Nitrite	Manganese	Technetium-99	Carbon Disulfide
	Molybdenum	Total Uranium[b]	Trichloroethene
	Nickel		

3. SOUTH FIELD

General Chemistry	Inorganic	Radionuclide	Organic
NA[c]	Boron	Total Uranium[b]	NA[c]

4. PROPERTY/PLUME BOUNDARY FOR FRL EXCEEDANCES

General Chemistry	Inorganic	Radionuclide	Organic
Fluoride	Antimony	Total Uranium[b]	NA[c]
	Arsenic		
	Lead		
	Manganese		
	Nickel		
	Zinc		

5. PROPERTY/PLUME BOUNDARY FOR PRRS

General Chemistry	Inorganic	Radionuclide	Organic
Phosphorous	Arsenic[d]	NA[c]	Benzene
	Potassium		Ethyl benzene
	Sodium		Isopropyl benzene
			Toluene
			Total xylene

[a]Monitoring will be conducted semiannually.
[b]Total uranium is monitored as part of the sitewide uranium monitoring.
[c]NA = not applicable
[d]Arsenic is also monitored with respect to FRL exceedances as part of the Property/Plume Boundary.

3.6 MEDIUM-SPECIFIC PLAN FOR GROUNDWATER MONITORING

This section serves as the medium-specific plan for implementation of the sampling, analysis, and data management activities associated with the sitewide groundwater remedy performance monitoring program. The program expectations and design presented in Section 3.4 were used as the framework for developing the monitoring approach presented in this section. The activities described in this medium-specific plan have been designed to provide groundwater data of sufficient quality to meet the program expectations as defined in Section 3.4.1. All sampling procedures and analytical protocols described or referenced herein are consistent with the requirements of the Sitewide CERCLA Quality Assurance Project Plan (SCQ) (DOE 2003g).

Subsequent sections of this medium-specific plan define the following:

- Project organization and associated responsibilities
- Sampling program
- Change control
- Health and safety
- Data management
- Project quality assurance.

3.6.1 Project Organization

A multi-disciplined project organization has been established to effectively implement and manage the project planning, sample collection and analysis, and data management activities directed in this medium-specific plan. The key positions and associated responsibilities required for successful implementation are as follows:

The project team leader will have full responsibility and authority for the implementation of this medium-specific plan in compliance with all regulatory specifications and sitewide programmatic requirements. Integration and coordination of all medium-specific plan activities defined herein with other project organizations are also key responsibilities. All changes to these activities must be approved by the team leader or designee.

Health and safety are the responsibility of all individuals working on this project scope. Qualified health and safety specialists shall participate on the project team to provide radiation protection and industrial hygiene support, and assist in preparing and obtaining all applicable permits. In addition, safety specialists shall periodically review and update the specific health and safety documents and operating procedures; conduct pertinent safety briefings; and assist in evaluation and resolution of all safety concerns.

Quality assurance specialists will participate on the project team, as necessary, to review project procedures and activities ensuring consistency with the requirements of the SCQ or other referenced standards, and assist in evaluating and resolving all quality related concerns.

3.6.2 Sampling Program

The information derived from the groundwater monitoring program should produce a clear understanding of groundwater quality in the Great Miami Aquifer. The groundwater sampling process will be controlled so that collected samples are representative of groundwater quality. All procedures for monitoring well development, sample collection, and shipment will be performed in accordance with directives established in the SCQ.

3.6.2.1 Total Uranium Monitoring

One hundred thirty-five monitoring wells will be sampled semiannually for total uranium. Forty-three of these wells will be sampled for additional constituents as described in Sections 3.6.2.2 through 3.6.2.4. A list of the wells to be sampled for total uranium only is provided in Table 3-6 and shown in Figure 3-5.

The wells extend across all aquifer zones and provide monitoring coverage in all restoration module areas. Figure 3-5 shows the locations of the monitoring wells.

This semiannual total uranium sampling activity will address the following remediation sampling needs:

- The need to interpret changes to the total uranium plume over time due to remediation activities
- The need to interpret the extent of capture in relation to the total uranium plume
- The need to interpret the effectiveness of the aquifer remedy in maintaining a hydraulic barrier that limits the further southern migration of the total uranium plume and to document the area of uranium contamination (above 30 μg/L) south of the Administrative Boundary
- Continued tracking of uranium concentrations at three off-property private monitoring wells.

Up to 27 locations will also be sampled each year for total uranium using a direct-push sampling tool. Direct-push sampling will provide vertical profile concentration data. The vertical profile data will be used to supplement the fixed monitoring well data in order to produce more robust plume interpretations. Exact locations for the direct-push sampling will be selected each year based on monitoring well data, modeling needs, and data interpretation needs.

TABLE 3-6

LIST OF GROUNDWATER WELLS TO BE SAMPLED FOR TOTAL URANIUM ONLY

13	3046	23278
14	3049	23279
2002	3069	23280
2008	3095	23281
2009	3106	23282
2014	3125	32766
2016	3385	32768
2017	3387	62408
2046	3390	62433
2048	3396	63116
2060 (12)	3397	63119
2095	3402	63283
2106	3550	63284
2125	3552	63285
2166	3880	63286
2385	3897	63287
2386	4125	63288
2387	6880	63289
2389	6015	63290
2390	6881	63291
2396	21033	63292
2397	21192	82433
2402	23064	83117
2550	23118	83124
2552	23271	83293
2553	23272	83294
2880	23273	83295
2897	23274	83296
3014	23275	83335
3015	23276	83336
3045	23277	

Note: Six of the seven available channels in a continuous multi-channel tubing (CMT) well are available for water quality sampling. The seventh channel is used only for water level measurements. The channel completed in the plume interval with the highest measured uranium concentration will be sampled every six months. The other five channels will be sampled once a year to document any changes in the plume concentration profile.

STATE PLANAR COORDINATE SYSTEM 1983

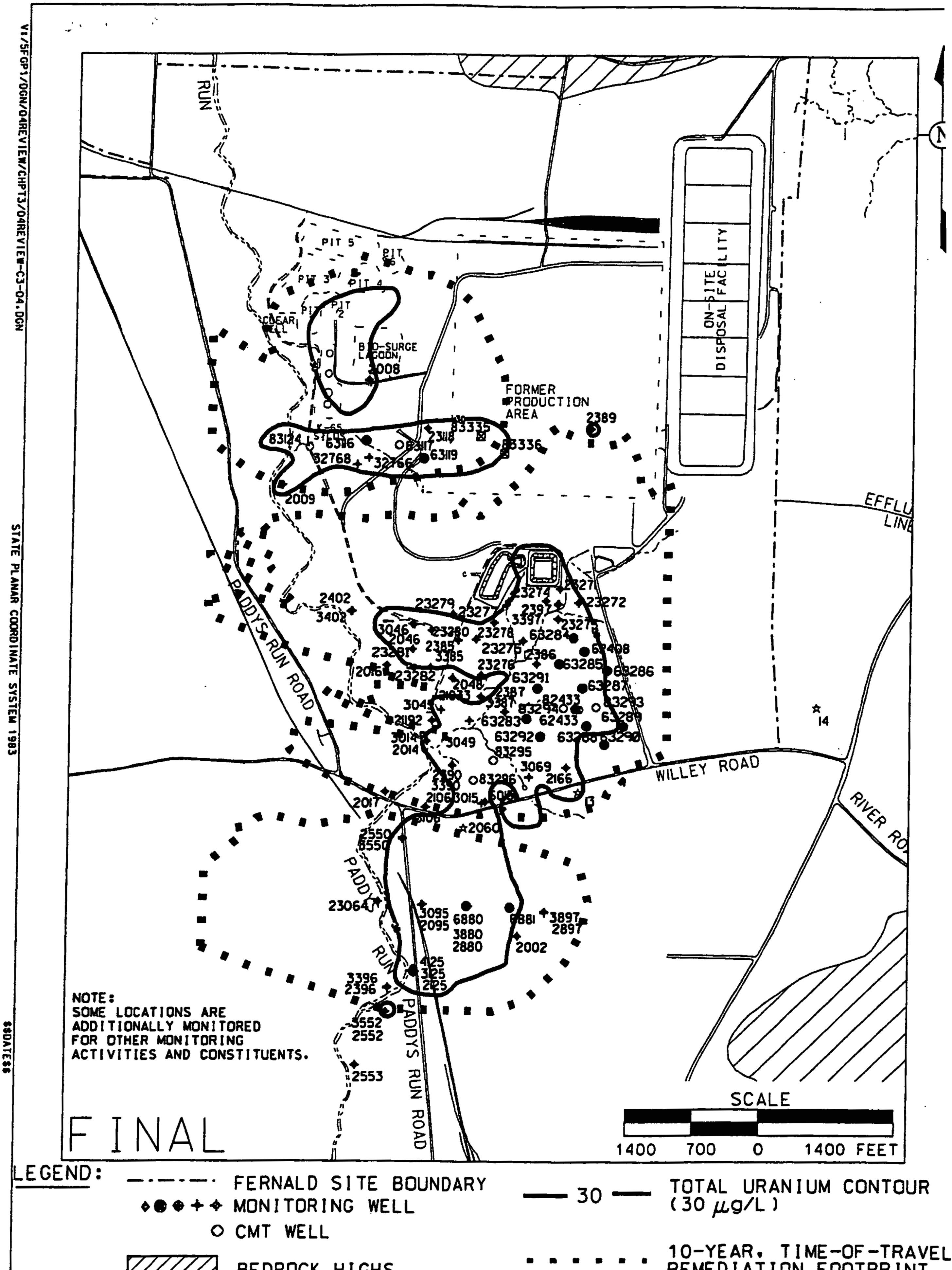


FIGURE 3-5. LOCATIONS FOR SEMIANNUAL TOTAL URANIUM MONITORING ONLY

$$DATE$$

Three private wells (12, 13, and 14) will also be sampled for total uranium. Figure 3-5 shows the location of these three wells (Private Well 12 is also identified as Monitoring Well 2060). Continuing to add to the historical database at these three private well locations is beneficial for facilitating discussions with area stakeholders on the progress of the aquifer restoration. The three locations are situated immediately downgradient of the Fernald site property boundary.

3.6.2.2 South Field Monitoring

The South Field is located in Aquifer Zone 2 (refer to Figure 3-4). Thirteen extraction wells (South Field [Phases I and II] Module) are scheduled to be operating in the South Field in 2006.

In addition to the monitoring wells being sampled in the South Field for total uranium only (refer to Section 3.6.2.1), two monitoring wells (2045 and 2049) will be sampled semiannually for boron and total uranium. The rationale for the selection of these wells and this constituent is presented in Section 3.4 and Appendix A. Figure 3-6 shows the locations of these two wells. Following is the monitoring table:

SOUTH FIELD MONITORING TABLE
SEMIANNUAL SAMPLING FREQUENCY

General Chemistry	Inorganic	Radionuclide	Organic
NA	Boron	Total Uranium	NA

Direct-push sampling has been conducted annually at seven wells (12367, 12368, 12369, 12370, 12371, 12372, and 12373) along and south of Willey Road since the Re-injection Demonstration. Figure 3-7 shows these locations. This annual direct-push sampling will continue in order to track remediation progress. At each direct-push location, a groundwater sample will be collected at 10-foot intervals beneath the water table, and analyzed for uranium only until it can be verified that the entire thickness of the 30-µg/L total uranium plume has been sampled.

3.6.2.3 Waste Storage Area Monitoring

The waste storage area is located in Aquifer Zone 1 (refer to Figure 3-4). Four extraction wells (32761,33062, 33330, and 33334) will be operating in the waste storage area in 2006. Figure 3-3 shows the locations of these four wells Additional monitoring wells are planned for the waste storage area to supplement the new extraction well that is being installed as part of the Waste Storage Area (Phase II) Design. These new monitoring wells will be added to the list of groundwater wells being monitored in the waste storage area as they become available.

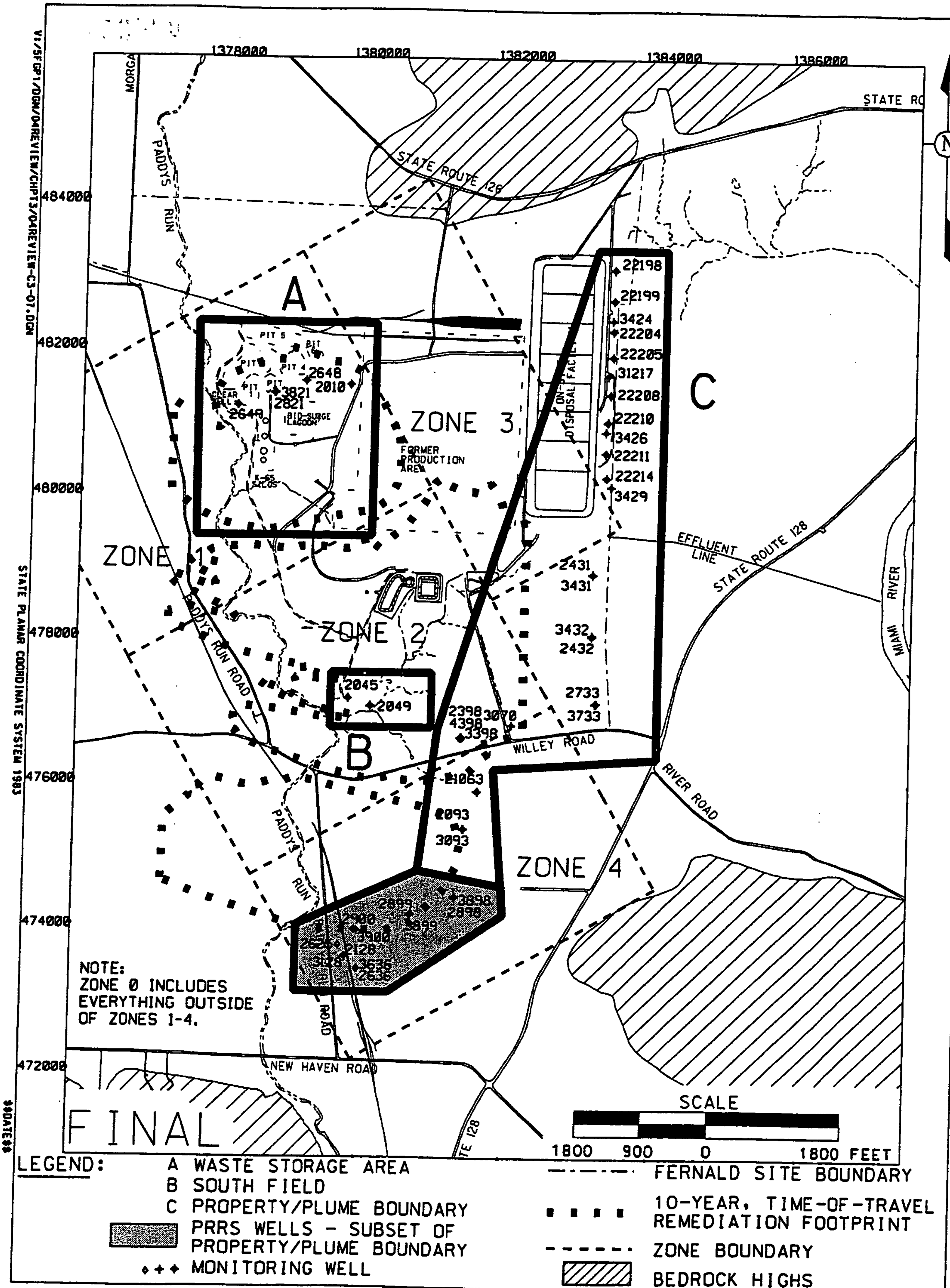


FIGURE 3-6. LOCATIONS FOR SEMIANNUAL MONITORING FOR PROPERTY/PLUME BOUNDARY, SOUTH FIELD, AND WASTE STORAGE AREA

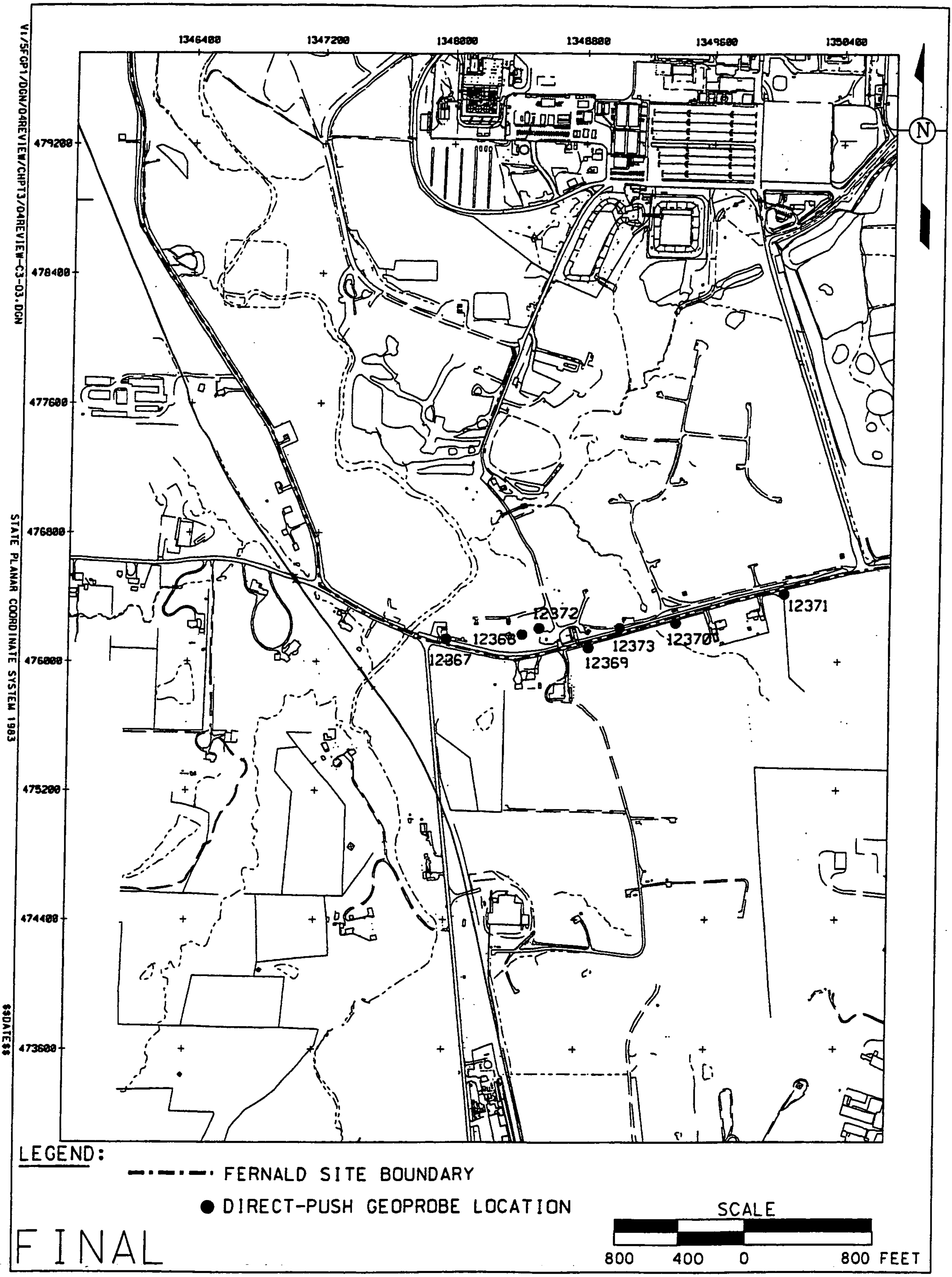


FIGURE 3-7. DIRECT-PUSH SAMPLING LOCATIONS

In addition to the monitoring wells being sampled in the waste storage area for total uranium only (refer to Section 3.6.2.1), the five wells listed below will be sampled semiannually (refer to Figure 3-6 for the locations of these five wells).

FIVE MONITORING WELLS TO BE MONITORED SEMIANNUALLY IN THE WASTE STORAGE AREA

2010	2649	2821	3821	2648

These five wells will be sampled semiannually for the constituents listed in the table below. The rationale for the selection of these wells and these constituents is presented in Section 3.4 and Appendix A.

WASTE STORAGE AREA MONITORING TABLE SEMIANNUAL SAMPLING FREQUENCY

General Chemistry	Inorganic	Radionuclide	Organic
Nitrate/Nitrite	Manganese	Technetium-99	Carbon Disulfide
	Molybdenum	Total Uranium	Trichloroethene
	Nickel		

3.6.2.4 Property/Plume Boundary Monitoring

The focus of the Property/Plume Boundary Groundwater Monitoring activity is to detect and assess potential changes in groundwater conditions along the eastern property boundary and downgradient of the leading edge of the 30-µg/L total uranium plume south of the Fernald site property.

In 2006, monitoring will be conducted along the property boundary and downgradient uranium plume boundary for FRL exceedances; the influence (or lack of influence) that pumping is having on the Paddys Run Road Site Plume will be documented. Monitoring in 2006 will also reduce redundancy with on-site disposal facility monitoring.

Property/Plume Boundary Monitoring for FRL Exceedances

Twenty-five monitoring wells along the eastern property boundary and the leading edge of the off-site total uranium plume will be sampled semiannually (refer to the table that follows). Figure 3-6 is a map showing the locations of the wells.

PROPERTY/PLUME BOUNDARY MONITORING WELLS TO BE MONITORED FOR FRL EXCEEDANCES ONLY

2093	3424	22198
2398	3426	22199
2431	3429	22204
2432	3431	22205
2733	3432	22208
3070	3733	22211
3093	4398	22214
3398	21063	22210
		31217

The 25 monitoring wells will be sampled semiannually for the constituents listed below. All of these constituents have had FRL exceedances. The rationale for the selection of these constituents and the monitoring schedule are presented in Section 3.4 and Appendix A.

PROPERTY PLUME BOUNDARY MONITORING TABLE FOR FRL EXCEEDANCES SEMIANNUAL SAMPLING FREQUENCY

General Chemistry	Inorganic	Radionuclide	Organic
Fluoride	Antimony Arsenic Lead Manganese Nickel Zinc	Total Uranium	NA

Eight of the 25 monitoring wells (22204, 22205, 22208, 22198, 22211, 22214, 22210, and 22199) will be sampled for on-site disposal facility constituents. The data collected will then be used to satisfy both needs. The on-site disposal facility monitoring wells will continue to be sampled quarterly as specified in the On-site Disposal Facility Groundwater/Leak Detection and Leak Monitoring Plan (DOE 2006).

Property/Plume Boundary Monitoring for Paddys Run Road Site Constituents

Groundwater is being pumped from the aquifer immediately north of the Paddys Run Road Site (Extraction Wells 3924, 3925, 3926, and 3927); it remains important to document the influence (of lack of influence) that the pumping has on the Paddys Run Road Site plume. In 2006, groundwater samples will be collected semiannually from 11 monitoring wells (refer to Figure 3-6).

The 11 wells are:

2128	2899	3898
2625	2900	3899
2636	3128	3900
2898	3636	

These 11 wells will be analyzed for Paddys Run Road Site constituents as well as for IEMP FRL exceedance constituents. The Paddys Run Road Site constituent list used in 2005 will be carried over into 2006. The following list shows the constituents to be monitored:

PROPERTY PLUME BOUNDARY MONITORING TABLE FOR FRL EXCEEDANCES AND PADDYS RUN ROAD SITE CONSTITUENTS SEMIANNUAL SAMPLING FREQUENCY

General Chemistry	Inorganic	Radionuclide	Organic
Fluoride	Antimony	Total Uranium	Benzene
Phosphorous	Arsenic		Ethyl benzene
	Lead		Isopropyl benzene
	Manganese		Toluene
	Nickel		Total Xylene
	Potassium		
	Sodium		
	Zinc		

If pumping rates of wells in the South Plume Module are increased above rates established in 1998, then arsenic sampling will be conducted weekly in Monitoring Wells 2128, 2625, 2636, 2900, and in Extraction Wells 3924 and 3925. The arsenic sampling will be used to determine if the increased pumping rates have adversely impacted the Paddys Run Road Site plume. The weekly sampling will be done for a minimum of three weeks after a pumping rate increase; if no changes in arsenic concentration trends are observed, the increased arsenic sampling will be discontinued. Figure 3-6 identifies the locations of these monitoring wells.

3.6.2.5 Monitoring Non-Uranium Groundwater FRL Constituents without IEMP FRL Exceedances

Monitoring for non-uranium groundwater FRL constituents that have not had an FRL exceedance since the inception of the IEMP, will be addressed during Stage III, Certification/Attainment Monitoring, as necessary.

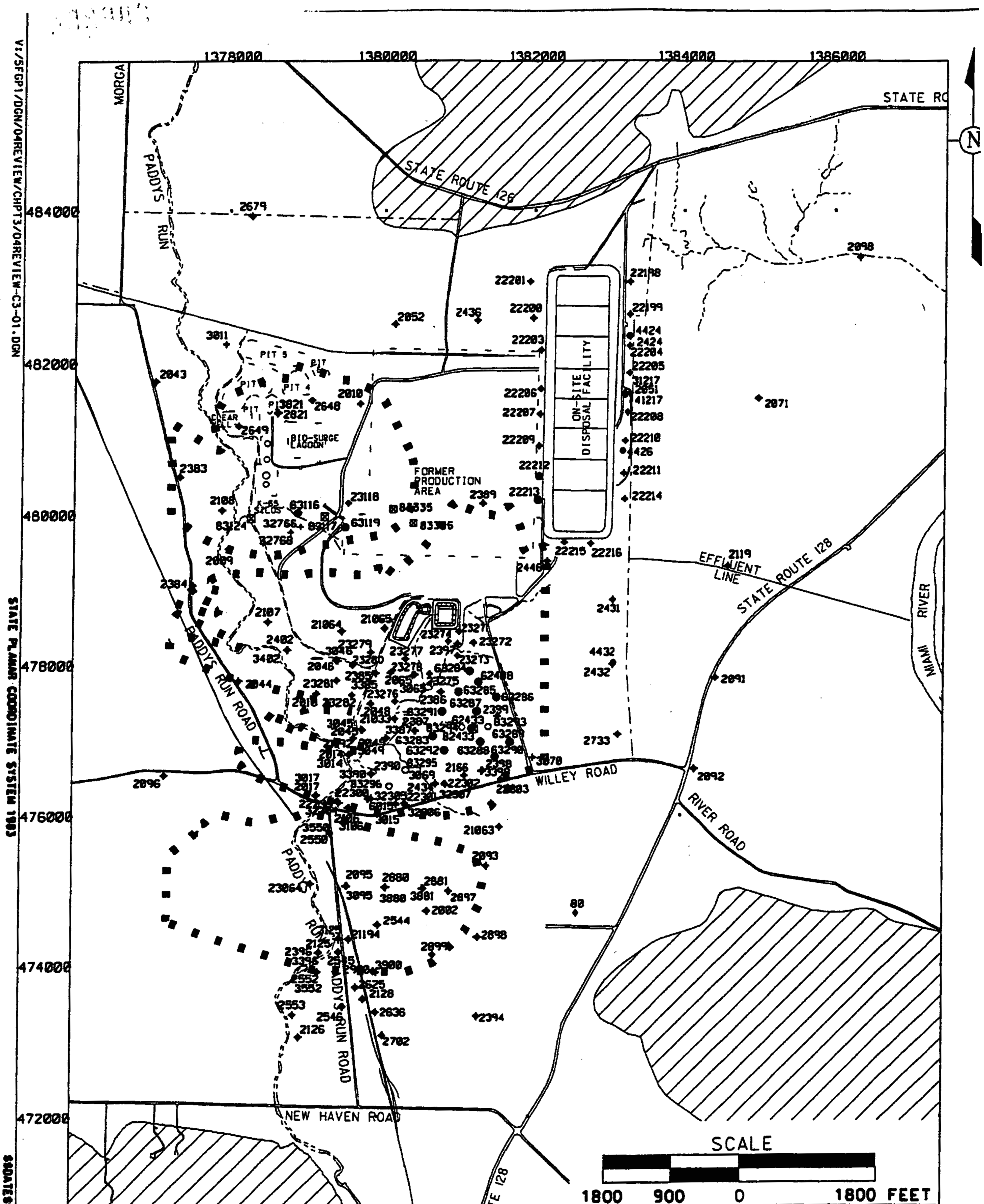
3.6.2.6 Routine Water Level Monitoring

The water table in the Great Miami Aquifer and its response to seasonal fluctuations has been well characterized in the Remedial Investigation Report for Operable Unit 5. Water level data have been routinely collected at the Fernald site since 1988. Water level data are used to evaluate seasonal variations and interpret groundwater flow directions. This is accomplished by preparing hydrographs and maps of the water table in the Great Miami Aquifer. During the remediation phase of the CERCLA process, water levels will be monitored across the site to assess the effects of extraction operations on the water table and flow conditions within the Great Miami Aquifer.

The Great Miami Aquifer is an unconfined aquifer and responds rapidly to recharge events. Data collected at the Fernald site and reported in the Operable Unit 5 Remedial Investigation Report document that no strong vertical gradients exist in the area of the Fernald site. Water level monitoring will rely mostly on data from Type 2 wells, which will be supplemented as necessary with data from Type 3, Type 6, and Type 8 wells. Type 8 wells will have water level measurements taken in Channels 1 and 6. If Channel 1 is dry, a measurement will be collected from the next deeper channel that is not dry.

Approximately 170 monitoring wells were selected for water level monitoring in 2006; they are shown in Figure 3-8 and listed below. Additional monitoring wells are being planned for the waste storage area to supplement the new extraction well that is being installed as part of the Waste Storage Area (Phase II) Design. These new monitoring wells will be added to the list of groundwater elevation monitoring wells as they become available.

Groundwater elevation monitoring locations were selected to provide areal coverage across all areas of the Fernald site with an increasing density of wells in areas surrounding active aquifer restoration wells. Groundwater elevations will be measured quarterly in these wells to provide data for construction of water table elevation maps. These maps will be used to interpret the location of flow divides, capture zones, and stagnation zones created by the operation of remediation wells. Additional monitoring wells and more frequent measurement intervals may be used near aquifer remediation modules as they become operational and as sensitive capture zones or stagnation zones are identified, or if unpredicted fluctuations in contaminant concentrations are observed.



LEGEND:

- FEMP BOUNDARY
- 2046 TYPE 2 MONITORING WELL
- 3046 TYPE 3 MONITORING WELL
- 4046 TYPE 4 MONITORING WELL
- 6046 TYPE 6 MONITORING WELL
- 88 PRIVATE WELL
- 82433 MULTI-LEVEL MONITORING WELL
- 10-YEAR, TIME-OF-TRAVEL REMEDIATION FOOTPRINT
- BEDROCK HIGHS

FINAL

FIGURE 3-8. GROUNDWATER ELEVATION MONITORING WELLS

LIST OF GROUNDWATER ELEVATION MONITORING WELLS

80	2387	3011	22198	23281
2002	2389	3014	22199	23282
2009	2390	3015	22200	31217
2010	2394	3017	22201	32304
2014	2396	3045	22203	32305
2016	2397	3046	22204	32306
2017	2398	3049	22205	32307
2043	2399	3065	22206	32766
2044	2402	3069	22207	32768
2045	2424	3070	22208	41217
2046	2431	3095	22209	62408
2048	2432	3106	22210	62433
2049	2434	3125	22211	63116
2051	2436	3385	22212	63119
2052	2446	3387	22213	63283
2065	2544	3390	22214	63284
2071	2545	3396	22215	63285
2091	2546	3398	22216	63286
2092	2550	3402	22299	63287
2093	2552	3550	22300	63288
2095	2553	3552	22301	63289
2096	2625	3821	22302	63290
2098	2636	3880	22303	63291
2106	2648	3881	23064	63292
2107	2649	3900	23118	82433
2108	2679	4424	23271	83117
2119	2702	4426	23272	83124
2125	2733	4432	23273	83293
2126	2821	6015	23274	83294
2128	2880	21033	23275	83295
2166	2881	21063	23276	83296
2383	2897	21064	23277	83335
2384	2898	21065	23278	83336
2385	2899	21192	23279	
2386	2900	21194	23280	

3.6.2.7 Sampling Procedures

Sample analysis will be performed at the on-site laboratory or a contract laboratory, depending on specific analyses required, laboratory capacity, turnaround time, and performance of the laboratory. The laboratories used for analytical testing must be approved in accordance with the criteria specified in Sections 3.1.5 and 12.4, and Appendix E of the SCQ. These criteria include meeting the requirements for performance evaluation samples, pre-acceptance audits, performance audits, and an internal quality assurance program. A list of approved laboratories and the current status of each is maintained by the Fernald site's Quality Assurance organization.

All monitoring wells will be purged and sampled using the guidelines specified in Sections 6.2 and K.4.2 of the SCQ, which have been incorporated into the standard operating procedures used for conducting groundwater sampling. The applicable SCQ sections and operating procedures pertaining to groundwater sampling are as follows:

Standard Operating Procedures	
SMPL-02	Liquid Sampling for Water Monitoring (DOE 2004f)
SMPL-05	Groundwater Level/Total Depth Measurements (DOE 2005c)
SMPL-21	Collection of Field Quality Control Samples (DOE 2002a)
ADM-02	Field Project Prerequisites (DOE 2005b)
ADM-03	Water Sample Shipment (DOE 2004g)
EQT-02	Water Quality Meters (DOE 2005h)
EW-0002	Chain of Custody/Request for Analysis Record for Sample Control (DOE 2004c)

Sitewide CERCLA Quality (SCQ) Assurance Project Plan	
Section 4	Quality Assurance Objectives
Section 5	Field Activities
Section 6	Sampling Requirements
Section 7	Sample Custody
Section 8	Calibration Procedures and Frequency
Appendix I	Field Calibration Requirements
Appendix J	Field Activity Methods
Appendix K	Sampling Methods

Table 3-7 summarizes the field sampling information by analytical constituent groups and includes the analytical support level (ASL), holding time, preservative, container requirement, and analytical method. The volume of purge water to be removed from monitoring and extraction wells is specified in Liquid Sampling for Water Monitoring.

TABLE 3-7
ANALYTICAL REQUIREMENTS FOR THE GROUNDWATER MONITORING PROGRAM

Constituent	Method	Sample Type	ASL[a]	Holding Time[b]	Preservative[b]	Container[b,c]
General Chemistry:						
Fluoride	300.0[d], 340.2[d], or 4500C[e]	Grab	B	28 days	None	Plastic
Nitrate/Nitrite	353.1[d], 353.2[d], 4500D[e], or 4500E[e]	Grab	B	28 days	Cool to 4°C, H_2SO_4 to pH <2	Plastic or glass
Phosphorus	365.(all)[d] or 4500E[e]	Grab	B	28 days	Cool to 4°C, H_2SO_4 to pH <2	Plastic or glass
Inorganics:						
Metals	6020[f], 7000A[f], or 6010B[f]	Grab	B	6 months	HNO_3 to pH <2	Plastic or glass
Radionuclides: (All Radiological)	SCQ[g]	Grab	B	Six months or 5x half-life, whichever is less	HNO_3 to pH <2	Plastic or glass
Volatile Organics:	8260B[f]	Grab	B	7 days	Cool to 4°C	Glass vial with Teflon-lined septum cap
		Grab	B	14 days	Cool to 4°C H_2SO_4, HCl, or solid $NaHSO_4$ to pH <2	Glass vial with Teflon-lined septum cap
Field Parameters[h]:	SCQ[i]	Grab	A	NA[j]	NA[j]	NA[j]

[a]The ASL may become more conservative if it is necessary to meet detection limits or data quality objectives.
[b]Appropriate preservative, holding time, and container will be used for the corresponding method.
[c]Container size is left to the discretion of the individual laboratory.
[d]Methods for Chemical Analysis of Water and Wastes (EPA 1983)
[e]Standard Methods for the Examination of Water and Wastewater (APHA 1989)
[f]Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (EPA 1998b)
[g]Radionuclide analyses do not have standard methods; however, the analytical specifications for these constituents are provided in Appendix G of the SCQ.
[h]Field parameters include dissolved oxygen, pH, specific conductance, temperature, and turbidity.
[i]Appendix K of the SCQ provides field analytical methods.
[j]NA = not applicable

An objective of the IEMP groundwater monitoring program is to collect and analyze representative groundwater samples. The sample analysis for metals and radionuclides should quantify species that are dissolved, occur as mobile precipitates, or are adsorbed onto mobile particles. If immobile particles to which metals are bound are allowed to remain in field-acidified samples, then the laboratory analysis will overstate the true concentration of mobile species present in the sample because acidification dissolves precipitates or causes adsorbed metals to desorb. Turbidity readings and the use of filtration to obtain a representative sample are therefore important field concerns for collection of groundwater samples.

Consistent with OEPA guidelines, 5 nephelometric turbidity units (NTU) will serve as the cut-off for a representative groundwater sample and for determining when filtration of the sample to be analyzed for metals/radionuclides is required. Routine filtration will be avoided at the Fernald site whenever possible. Proper well construction and maintenance will be practiced in order to help keep the turbidity of unfiltered groundwater samples at or below 5 NTU. If, after properly purging a monitoring well, the sample turbidity is greater than 5 NTU, then the sample will be filtered through a 5-micron filter. If the turbidity of the 5-micron filtered sample is still above 5 NTU, then the 5-micron filtered sample will be additionally filtered through a 0.45-micron filter. Both the unfiltered and final filtered uranium sample will be analyzed. The final filtered sample will be analyzed for metals and radionuclides only.

3.6.2.8 Quality Control Sampling Requirements

Field quality control samples will be collected to assess the accuracy and precision of field and laboratory methods as outlined in Section 4.1.1 of the SCQ. These samples will be collected and analyzed in order to evaluate the possibility that some controllable practice, such as decontamination, sampling technique, or analytical method may be responsible for introducing bias in the analytical results. The following types of quality control samples will be collected: sampling equipment rinsates, trip blanks, field blanks, and duplicate samples, as outlined in Section 4 and Appendix A of the SCQ. Each quality control sample is preserved using the same method for groundwater samples. The quality control sample frequencies will be tracked to ensure the proper frequency requirements are met as follows:

- Trip blanks will be prepared for each sampling team on each day of sampling when organic compounds are included in the respective analytical program
- Equipment rinsates will be collected for every 20 groundwater samples that are collected using reusable sampling equipment. If a specific sampling activity consists of less than 20 groundwater samples, then a rinsate sample will still be required. Rinsates are not required when dedicated well equipment or disposable sampling equipment is used.
- Field blanks will be collected for each day of groundwater sampling when organic compounds are included in the respective analytical program
- Field duplicates will be collected for every 20 groundwater samples (or fraction thereof) if the specific sampling program consists of fewer than 20 samples.

The groundwater samples associated with each quality control sample also will be tracked to ensure traceability in the event that contaminants are detected in the quality control samples.

3.6.2.9 Decontamination

In general, decontamination of equipment is minimized due to limited use of reusable equipment during sample collection. However, if decontamination is required, then equipment will be cleaned between sample locations. The decontamination shall be Level II as referenced in Section K.11 of the SCQ. The specific details are outlined in Liquid Sampling for Water Monitoring.

3.6.2.10 Waste Disposition

Wastes that will be generated during sampling activities are purge water and decontamination solutions, and contact wastes. The following subsections provide the proposed disposition methodology for each type of waste generated.

Purge Water and Decontamination Solutions

Groundwater purged from the wells and solutions used to decontaminate sampling equipment will be containerized for proper disposal. For each batch of wastewater, a Wastewater Discharge Request form is submitted to the Fernald site's Compliance organization for direction and approval for disposition. This wastewater is routinely disposed of at the Storm Water Retention Basin or the advanced wastewater treatment plant, depending on the point of origin.

Contact Wastes

Contact wastes, such as personal protective equipment, paper towels, and other solid, investigation-derived wastes, will be placed in plastic bags and placed in dumpsters. Contact wastes generated inside a radiologically controlled or contamination area will be dispositioned to a controlled waste container in the respective area.

3.6.2.11 Monitoring Well Maintenance

During the restoration of the Fernald site, surface cleanup activities will create adverse conditions around several groundwater monitoring wells. Extra effort will be taken on the part of Fernald site personnel to safeguard and inspect groundwater monitoring wells during site restoration. Monitoring well maintenance will center around two questions:

1. Is the monitoring well protective of the subsurface environment in its current condition?
2. Does the monitoring well yield a representative groundwater sample?

Well Maintenance Inspections

Routine inspections of Great Miami Aquifer groundwater monitoring wells will be conducted during sampling or collection of water levels (at a minimum of once a year if the well is not being routinely sampled) to determine if the well is protective of the environment based on the inspection criteria below. Wells may be inspected more frequently if they are located in an area of active surface restoration. All assessment and maintenance activities will be recorded on applicable field data forms. The inspections include, but are not limited to, the following:

- Ensuring that the well identification number is painted or welded on the top of the lid
- Inspecting the ground surrounding the well for depressions and channels that allow surface water to collect and flow toward the wellhead; and for debris and foreign material that could leach contaminants into the subsurface or otherwise interfere with well sampling
- Ensuring visibility and accessibility to the well
- Inspecting locking lids and padlocks to check for rust and ease of operation
- Inspecting the exposed (protective) well casing to ensure that it is free of cracks and signs of corrosion; it is reasonably plumb with the ground surface; it is painted bright orange; the drain hole is clear; it is free of debris; and the well casing has no sharp edges
- Removing and inspecting the well cap to ensure that it is free of debris, fits securely, and the vent hole is clear; and if equipped with a ground-flush cap, ensuring that it is water-tight to prevent surface water from entering the well
- Inspecting concrete surface seals for settling and cracking
- If exterior guards are used to protect the well, then periodically inspecting the guards for visibility and damage and repaint, if necessary.

Well Evaluation

If the turbidity and amount of sediment measured in the well, or the visual inspection indicates a potential problem with the well, then the following work may be performed to evaluate the cause of the sedimentation or other problems:

- Review existing well installation documentation
- Review well history and historical water quality data to identify whether it produces consistently clear or turbid samples
- Review groundwater sampling field records
- Conduct a downhole camera survey to inspect the integrity of the screen and casing.

At least once a year, an assessment will be made of wells that are sampled as to whether or not the well is yielding a representative sample. This assessment includes, but is not limited to, the following:

- Determining how much sediment has entered the well screen and accumulated in the well; and review historical depth records. This will be done by measuring the depths of those wells that do not have dedicated packers.
- Determining if any foreign material is present in the well (e.g., bentonite grout)
- Determining if the groundwater color has changed over time (e.g., due to iron bacteria)
- Evaluating turbidity within the sample.

Well Maintenance Corrective Actions

Corrective actions to address problems identified in the well maintenance inspections will be conducted as soon as feasible. Corrective maintenance to address excessive turbidity will include removal of sediment from the well through redevelopment of the well.

It is possible that minerals can precipitate on well screens. If it is determined that minerals have precipitated in the well or on the well screen, and they are affecting the representativeness of the groundwater sample, then the limited use of chemicals (e.g., chlorine, hydrochloric acid, etc.) to remove the mineral build-up may be considered. It is understood that chemicals have a very limited application in the rehabilitation of monitoring wells because the chemicals can cause changes such that the well will no longer yield a representative sample (EPA 1991). Changes resulting from the use of chemicals could last for a short time or could be permanent. Therefore, if chemical rehabilitation is attempted, it will only be attempted as a last resort. Water quality parameters (such as Eh (redox potential), pH, temperature, and conductivity) will be measured prior to the application of the chemicals and following the use of the chemicals. These measurements will serve as values for comparison of water quality before and after well maintenance.

If a groundwater monitoring well has been damaged in such a way that it is no longer protective of the subsurface environment and it cannot be repaired, then the well will be plugged and abandoned. If it is determined that the well is not yielding a representative groundwater sample and rehabilitation efforts are not effective in correcting the condition, then the well will be considered for plugging and abandonment. If the well is still protective of the subsurface environment, then it might be used for the collection of water level data even though it does not yield representative groundwater samples. Wells designated for plugging and abandonment may be sampled one last time for a subset of water quality parameters listed in Table 3-5.

The exact parameter list selected for the sampling will be based on the location of the well. CMT wells being plugged and abandoned may have each available channel sampled for total uranium (or any groundwater FRL constituent) prior to being plugged and abandoned, as deemed appropriate.

3.6.3 Change Control

Changes to the medium-specific plan will be at the discretion of the project team leader. Prior to implementation of field changes, the project team leader or designee shall be informed of the proposed changes and circumstances substantiating the changes. Any changes to the medium-specific plan must have written approval by the project team leader or designee, Quality Assurance representative, and the field manager prior to implementation. If a Variance/Field Change Notice is required, it will be completed in accordance with Section 15.3 of the SCQ. The Variance/Field Change Notice form shall be issued as controlled distribution to team members and will be included in the field data package to become part of the project record. During biennial revisions to the IEMP, Variance/Field Change Notices will be incorporated to update the medium-specific plan.

3.6.4 Health and Safety Considerations

The Fernald site's Health and Safety organization is responsible for the development and implementation of health and safety requirements for this medium-specific plan. Hazards (such as physical, radiological, chemical, and biological) typically encountered by personnel when performing the specified field work will be addressed during team briefings.

All involved personnel will receive adequate training to the health and safety requirements prior to implementation of the field work required by this medium-specific plan. Safety meetings will be conducted prior to beginning field work to address specific health and safety issues. All Fluor Fernald employees and subcontractor personnel who will be performing field work required by this medium-specific plan are required to have completed applicable training.

For areas that are subject to more restrictive radiological controls where the potential for exposure is greater, radiation work permits are necessary and will be obtained prior to the field work being performed in those areas. A radiological control technician will be assigned to each field crew performing any activities in an area requiring a radiation work permit.

3.6.5 Data Management

Field documentation and analytical results will meet the IEMP data reporting and quality objectives, comply with appropriate sections and appendices of the SCQ, and comply with specific Fernald site procedures such as the Data Validation Procedure (DOE 2003c).

Data documentation and validation requirements for data collected in 2006 for the IEMP fall into two categories depending upon whether the data are field- or laboratory-generated. Field data validation will consist of verifying medium-specific plan compliance and appropriate documentation of field activities. Laboratory data validation will consist of verifying that data generated are in compliance with ASLs specified in the medium-specific plan. Specific requirements for field data documentation and validation, and laboratory data documentation and validation will be in accordance with SCQ and Fernald site procedures.

There are five analytical levels (ASL A through ASL E) defined for the Fernald site in Section 2 of the SCQ. For groundwater in 2006, field data documentation will be at ASL A, and laboratory data documentation, in general, will be at ASL B. A more conservative ASL may be required for laboratory data in order to meet required detection limits or in order to ensure data quality objectives. ASL B is appropriate for laboratory-generated data collected in 2006 because the data are being used for surveillance during site restoration. ASL B provides qualitative, semi-qualitative, and quantitative data with some quality assurance/quality control checks.

At a minimum, 10 percent of the IEMP field and analytical data will undergo validation to ensure that analytical data are in compliance with the ASL method criteria being requested and in order to meet data quality objectives. The percentage of data validated could increase in order to meet data quality objectives.

Data will be entered into a controlled database using a double-key or other verification method to ensure accuracy. The hard copy data will be managed in the project file according to Fernald site record keeping procedures and DOE Orders.

3.6.6 Quality Assurance

Assessments of work processes shall be conducted to verify quality of performance, and may include audits, surveillances, inspections, tests, data verification, field validation, and peer reviews. Assessments shall include performance-based evaluation of compliance to technical and procedural requirements and corrective action effectiveness necessary to prevent defects in data quality. Assessments may be conducted at any point in the life of the project. Assessment documentation shall verify that work was conducted in accordance with IEMP, SCQ, and Quality Assurance Program (DOE 2003f) requirements. Recommended quarterly quality assurance assessments or surveillances shall be performed on tasks specified in the medium-specific plan. These assessments may be in the form of independent assessments or self-assessments, with at least one independent assessment conducted annually. Independent assessments are the responsibility of designated project Quality Assurance personnel. Self-assessments are performed by project personnel in order to evaluate the overall quality of work performance. The project team leader and the Quality Assurance group will coordinate assessment activities and comply with Section 12 of the SCQ. The project personnel or Quality Assurance representative shall have "stop work" authority if significant adverse effects to quality conditions are identified or work conditions are unsafe.

Only laboratories on the approved laboratory list will be used for sample analyses in accordance with Section 12 and Appendix E of the SCQ.

3.7 IEMP GROUNDWATER MONITORING DATA EVALUATION AND REPORTING

This section provides the methods to be used in analyzing the data generated by the IEMP groundwater sampling program in 2006. It summarizes the data evaluation process and actions associated with various monitoring results. The planned reporting structure for IEMP-generated groundwater data, including specific information to be reported in the annual site environmental report, is also provided.

3.7.1 Data Evaluation

Data resulting from the IEMP groundwater program will be evaluated to meet the program expectations identified in Section 3.4.1. Data evaluation will look at both the operational efficiency and the operational effectiveness of the groundwater remediation system (EPA 1992). Operational efficiency refers to implementing the most efficient remedy possible. The objectives are to minimize downtimes, conduct stable operations, meet planned performance goals, and operate a cost-effective system. Operational efficiency will be assessed by tracking the following:

- Pumping rates for individual wells and modules
- Gallons of water pumped
- Extraction well total hours of operation during the year
- The volume of treated water
- Planned versus actual gallons of water pumped.

Operational effectiveness refers to the evaluation of the degree of contamination cleanup achieved. Operational effectiveness will be assessed by tracking the following:

- Planned versus actual pounds of uranium removed from the Great Miami Aquifer
- Pounds of uranium removed per million gallons of water pumped (uranium removal index)
- Running cumulative pounds of uranium removed from the Great Miami Aquifer versus predicted running cumulative pounds of uranium removed from the Great Miami Aquifer
- Total uranium concentration data collected from extraction wells
- Total uranium concentration data collected from monitoring wells
- Water level data collected from monitoring wells
- Interpretations of capture zones
- Regression curves of uranium concentration data at extraction wells
- Regression curves of uranium concentration data at groundwater monitoring wells (starting in 2005 and then every five years). Regression curves of uranium concentration data at groundwater monitoring wells will be prepared every five years because only two data points a year will be added to the database used to generate the curves.

Most of the data will be tabulated, presented in graphs, or presented in maps and evaluated in the following manner:

- Concentration versus time plots for specific constituents
- Tables identifying wells with constituents above FRL concentrations
- Mann-Kendall trend analyses for specific constituents
- Concentration contour maps.

Large quantities of data will be collected and evaluated each year. In order to evaluate the results of the sampling, the data collected for the IEMP will be presented and evaluated using the formats above. The findings of data evaluations will be shared with project personnel. The EPA and OEPA have identified that this is a successful method of evaluating and presenting the data. Groundwater monitoring program data will be evaluated to:

- Assess progress in capturing and restoring the area containing the >30-µg/L total uranium plume
- Assess progress in capturing and restoring the areas affected by non-uranium FRL exceedances
- Assess water quality at the downgradient Fernald site property boundary
- Assess model predictions
- Assess the impact that the aquifer restoration is having on the Paddys Run Road Site plume
- Meet other monitoring commitments
- Address community concerns.

The aquifer restoration system is being designed to reduce the concentration of uranium and non-uranium FRL constituents in the aquifer to concentrations that are at or below their FRL. Because uranium is the principal COC, the aquifer restoration system has been designed to capture the 30-µg/L total uranium plume, with the understanding that the system may need to be modified in the future to capture and remediate non-uranium FRL constituents.

Extraction wells have been positioned within each restoration module to capture the uranium plume. Operational decisions and pumping changes will focus on the capture of the uranium plume in 2006. Operational changes to meet non-uranium FRL concentrations are considered to be a secondary objective. However, evaluation of the need for an operational change to address non-uranium FRL constituents will be ongoing throughout aquifer remediation and is expected to gain in importance as the achievement of the uranium objective approaches.

Following is a discussion of how each of the groundwater program expectations are intended to be met through evaluation of IEMP groundwater data.

Capturing and Restoring the Area Containing the >30-µg/L Total Uranium Plume

Capture and restoration of the area containing the >30-µg/L total uranium plume will be evaluated using groundwater elevation data and the most current maximum total uranium plume interpretation. Groundwater elevation maps with capture zone and flow divide interpretations will be prepared to evaluate the extent of capture.

Remediation of the 30-µg/L total uranium plume will be assessed by monitoring total uranium concentrations over time. The 30-µg/L maximum total uranium plume will be mapped and compared to previous maps to determine how the plume has changed in response to remediation. Direct-push sampling data will be used throughout the remedy to supplement fixed monitoring well location data by providing vertical profile concentration data.

If a new total uranium FRL exceedance is detected in the aquifer, then an attempt will be made to determine the cause of the exceedance. Considerations will include:

- Movement of known total uranium contamination in response to pumping, or natural migration
- New contamination reaching the aquifer as a result of restoration activity
- Previously undetected uranium contamination that has now moved into a monitoring zone as a result of pumping, or natural migration.

When a new extraction well begins operating, water levels will be collected more frequently until conditions have stabilized. Once conditions have stabilized, monitoring will fall back to the regular IEMP monitoring schedule. Individual start-up plans will provide specifics on the frequency of water level and water quality data collection during the start-up time period.

Capturing and Restoring the Areas Affected by Non-uranium FRL Exceedances

The Operable Unit 5 Record of Decision identifies 49 FRL constituents, other than total uranium, that also need to be tracked as part of the aquifer restoration. These 49 constituents are collectively referred to as the non-uranium FRL constituents. During the aquifer restoration, groundwater monitoring will take place for the non-uranium FRL constituents. Constituents that have been detected in the aquifer above their respective FRL will be monitored semiannually.

Non-uranium FRL concentration trends in the Great Miami Aquifer will be assessed through trend analysis when sufficient data have been obtained. The Mann-Kendall statistical test for trend will be used to facilitate the trending interpretation. Concentrations versus time plots may be used to illustrate how the concentrations are trending.

If a new non-uranium FRL exceedance is detected in the aquifer, then an attempt will be made to determine the cause of the exceedance. Considerations will include:

- Movement of known contamination in response to pumping or natural migration
- New contamination reaching the aquifer as a result of restoration activity
- Previously undetected contamination that has now moved into a monitoring zone as a result of pumping or natural migration.

Any FRL exceedance detected at a property boundary/plume boundary well location will be evaluated using the same data evaluation protocol that was approved for the Restoration Area Verification Sampling Program, Project-Specific Plan (DOE 1997d) in order to determine if additional action is required. The constituent concentration data over time will be graphed. If two or more sampling events following an FRL exceedance indicate that the concentrations are below the FRL, then the location will not be considered for remediation or further monitoring above and beyond what is already prescribed by the IEMP. If sampling following the initial FRL exceedance indicates that the exceedance was not just a one-time occurrence, and the exceedance is judged to be the result of Fernald site activities (either historical or current), then action will be taken to address the exceedance.

Meeting Other Monitoring Commitments

Other groundwater monitoring commitments that need to be addressed are private well sampling; property boundary monitoring; and fulfillment of DOE Order 5400.1 requirements to maintain an environmental monitoring program for groundwater.

Total uranium data collected at private wells will be graphed to illustrate changes and will be used in the preparation of total uranium contour maps. Data collected from the Fernald site property/plume boundary monitoring system will be compared to FRLs. This will facilitate the detection and monitoring of FRL exceedances and will determine if interim actions are warranted, in addition to implementing the sitewide aquifer restoration. Lastly, this groundwater monitoring program presented in the IEMP, along with the groundwater data reporting in IEMP annual integrated site environmental reports, fulfills DOE Order 5400.1 requirements.

Groundwater Modeling

Groundwater uranium concentration data and water level data obtained through the life of the remedy will be compared against model-predicted concentrations and water levels to evaluate how reasonable the predictions are over the long term. Individual well residuals (model-predicted concentration versus actual measured concentrations) will be determined without running the model. A mean residual calculation for each monitoring event will also be determined. Determination of a residual will be model layer-specific. The model layer that contains the highest uranium concentration will be used. Monitoring wells in the remediation footprint of the aquifer with well screens installed at the same elevation as the selected model layer, will be included in the residual exercise. Results of the first assessment will be provided in the 2005 Site Environmental Report. The assessment may be continued every five years if it is determined to be beneficial. A brief summary of background information on the groundwater model follows.

Since modeling was conducted for the Remedial Investigation/Feasibility Study and Baseline Remedial Strategy reports, the model has undergone several changes in order to improve its capability for making water level and uranium concentration predictions. DOE has changed from the Sandia Waste Isolation Flow and Transport (SWIFT) groundwater modeling code to the Variably Saturated Analysis Model in 3 Dimensions (VAM3D) modeling code for all site groundwater modeling operations. This transition has been documented in detail in Development and Verification of VAM3DF, a Numerical Flow and Transport Modeling Code (HydroGeologic 1998).

The groundwater modeling grid used in the SWIFT model was retained for the VAM3D model. However, vertical discretization of the model was increased in the VAM3D model to 12 vertical layers instead of the six layers used in the SWIFT model.

The groundwater model was recalibrated for flow to address observed changes in water level conditions and to address seasonal changes in water levels prior to it being used to support the design of the Waste Storage Area Module in 2001, the South Field (Phase II) Module in 2002, and the Waste Storage Area (Phase II) Module in 2005. The 12-layer VAM3D model was recalibrated to current groundwater elevations in May 2000 with calibration activities detailed in the Great Miami Aquifer VAM3D Flow Model Recalibration Report (DOE 2000b). With increased vertical resolution in the VAM3D ZOOM model (14 layers compared to 12 layers in the original VAM3D model), predicted wellhead concentrations for total uranium more closely match observed wellhead concentrations. Wellhead concentration decline curves were published in the 2004 Site Environmental Report (DOE 2005e) comparing modeled versus observed wellhead concentrations for total uranium. These comparisons will continue and will be published in future site environmental reports.

In the past, initial conditions in the fate and transport portion of the groundwater model have been routinely updated. Until recently, the update of initial conditions was considered necessary to incorporate additional characterization data collected during the design of the planned groundwater restoration modules (South Plume Module, South Field [Phases I and II] Module, and Waste Storage Area [Phases I and II] Module). Without the update of initial conditions, the module designs would not have reflected the most up-to-date plume conditions. Because the last planned aquifer restoration module design was recently completed (Waste Storage Area [Phase II] Design), the process of routinely updating initial conditions in the fate and transport portion of the groundwater model can be stopped.

Because of significant seasonal changes in Great Miami Aquifer groundwater elevations, three sets of steady-state flow model boundary conditions were developed for the VAM3D model as a result of the recalibration effort. These three steady-state flow model boundary conditions correspond to nominal groundwater elevations, and minimum and maximum groundwater elevations observed during the wet and dry seasons of the year, respectively. The wet and dry boundary condition data sets will be used in future groundwater modeling activities to predict aquifer remedy performance under those conditions. To facilitate computational efficiency, a local VAM3D ZOOM model was designed covering a smaller area than the 12-layer VAM3D model. The VAM3D ZOOM model contains 14 layers and covers an area just large enough to encompass the total uranium plume and the extraction wells in the aquifer remedy. The VAM3D ZOOM model design is documented in Integration of Data Fusion Modeling (DFM) with VAM3DF Contaminant Transport Code (HydroGeologic 2000).

Because the ZOOM model boundaries are near some of the aquifer remedy extraction wells, ZOOM model steady-state flow boundaries must be derived from the larger 12-layer VAM3D model to avoid model boundary effects impacting flow model predictions of remedy performance. For all current and future operational flow modeling activities, aquifer remedy pumping scenarios are first run to steady state in the large 12-layer VAM3D model then ZOOM model boundary values are derived from the output of the 12-layer flow model run. This technique is described in more detail in Design for Remediation of the Great Miami Aquifer, South Field (Phase II) Module.

It is understood that the groundwater model may need to be recalibrated for flow if measured water levels and model predictions are not adequate for managing the remedy. If future flow model calibration efforts are performed, the large 12-layer VAM3D model will be recalibrated to observed groundwater elevation data; then VAM3D ZOOM model boundary conditions will be derived from the large 12-layer VAM3D model. Calibration standards will be the same as those used to calibrate the SWIFT model.

The basic strategy for assessing flow predictions will be as follows:

- Model-predicted water level values will be compared to actual field measured values. The decision to recalibrate the groundwater model will be based on how close the model predictions are to field measured values.
- The difference between the maximum and minimum measured groundwater elevation over time will be used to define a water level elevation range for a particular well. The water level range is the result of seasonal variations and long-term water level trends within the aquifer. A range of water levels over time has been established for each water level monitoring well identified in the IEMP.
- If the difference between measured elevations and modeled predictions is greater than 5 feet for more than one-third of the monitoring wells within the capture zone of the extraction system, or for a significant local area of the model domain, then the need to implement model recalibration for the affected area of the model will be evaluated. All relevant groundwater data acquired since the previous flow model calibration will be considered in future flow model calibrations. Comparisons will recognize that modeled predictions represent average conditions within a model block and monitoring wells are not usually located at the center of a model block. One solution might be to compare the surrounding eight model blocks to the actual measured elevation.

Assess the Impact that the Aquifer Restoration Has on the Paddys Run Road Site Plume

As was done from 1997 to 2005, concentration data collected in 2006 for key Paddys Run Road Site constituents will be evaluated using trend analysis. Water level maps will be produced to determine where capture is occurring due to pumping in the South Plume Module.

Adequately Address Community Concerns

The IEMP fulfills the informational needs of the Fernald community by preparing groundwater environmental results in the annual site environmental report. DOE makes these reports available to the public at the Public Environmental Information Center. Comments received over the life of the IEMP program regarding the IEMP groundwater program will be considered for future revisions to the IEMP.

Groundwater Certification Process and Stages

Efforts are underway to develop a Groundwater Certification Plan for the Groundwater Remedy. The objective of the Certification Plan is to document the process that will be followed to certify the aquifer remedy objectives have been met. As explained below, pump-and-treat operations are currently in progress at the Fernald site. The IEMP is the controlling document for remedy performance monitoring during the pump-and-treat operational period. The IEMP will continue to be the controlling document for all groundwater monitoring needed to support the certification process following completion of pump-and-treat operations.

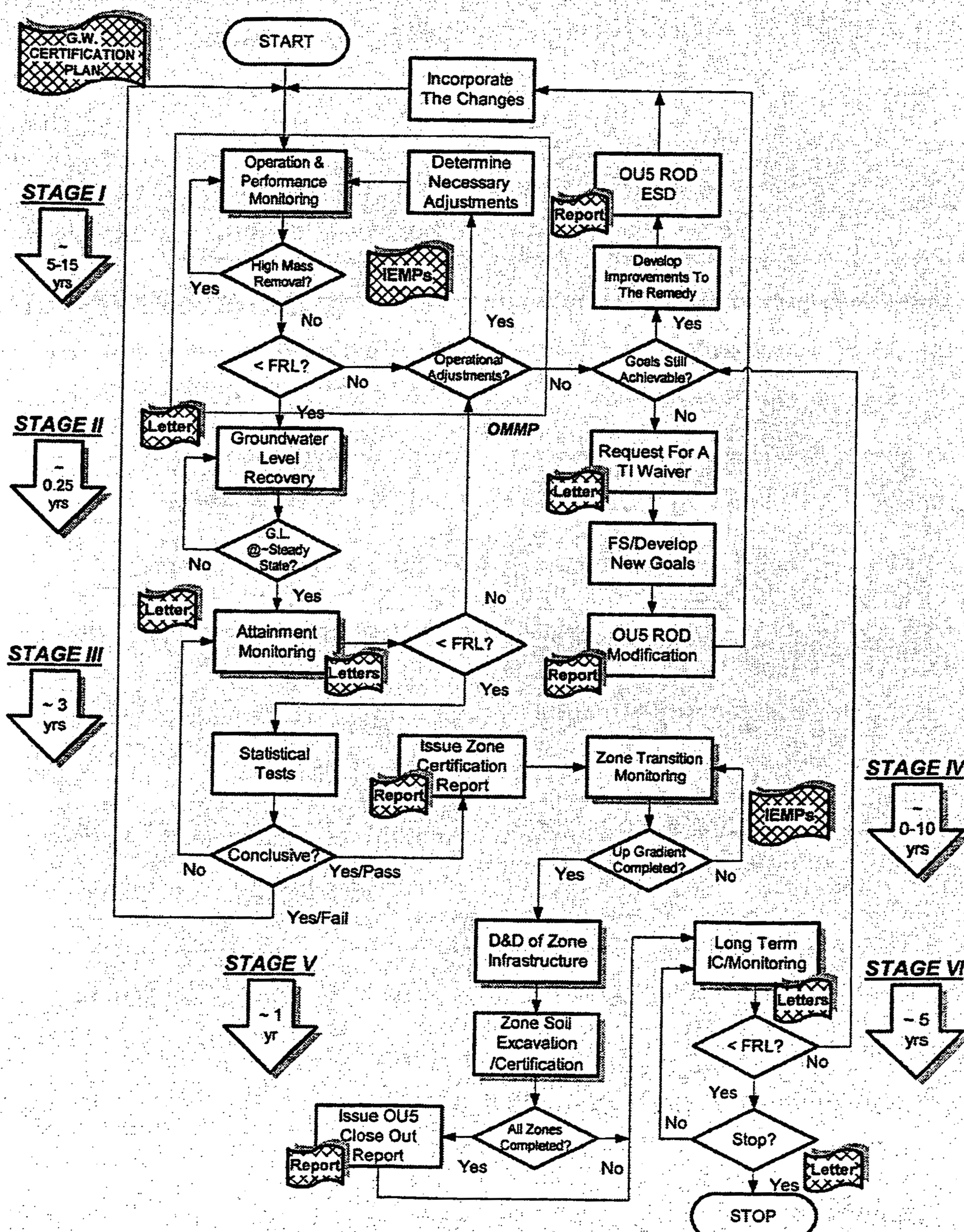
Figure 3-9 illustrates the groundwater certification process. Six stages have been identified for the certification process:

- Stage I: Pump-and-Treat Operations
- Stage II: Post Pump-and-Treat Operations/Hydraulic Equilibrium State
- Stage III: Certification/Attainment Monitoring
- Stage IV: Declaration and Transition Monitoring
- Stage V: Demobilization
- Stage VI: Long-Term Monitoring

In 2006, remedy performance monitoring will continue to support pump-and-treat operations. As illustrated in Figure 3-9, remedy performance monitoring is conducted to assess the efficiency of mass removal and to gauge performance in meeting FRL objectives. If it is determined that high mass removal is not being maintained, or FRL goals are not being achieved, then the need for operational adjustment will be evaluated and implemented if deemed appropriate. A change to the operation of the aquifer restoration system would be implemented through the Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project (DOE 1997c). A groundwater monitoring change, if found to be necessary, would be implemented through the IEMP. If additional characterization data are needed beyond the current scope of the IEMP then a separate sampling plan will be prepared. Additional sampling activities may use other sampling techniques, such as a direct-push sampling tool, which has been successfully used at the Fernald site to obtain groundwater samples without the use of a permanent monitoring well.

FIGURE 3-9

GROUNDWATER CERTIFICATION PROCESS AND STAGES



The IEMP will be used to document the approach for determining when various modules can be removed from service and groundwater monitoring can focus on subsequent stages of the groundwater certification process.

3.7.2 Reporting

The IEMP groundwater program data in 2006 will be reported on the IEMP Data Information Site, and in the annual site environmental report. Groundwater data that support the On-site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan will be provided in the same manner. Additional information on IEMP data reporting is provided in Section 7.3.3.

Data pertaining to the groundwater program will be provided on the IEMP Data Information Site. The data will be in the format of searchable data sets and/or downloadable data files. This site will be updated every 2 to 4 weeks, as data become available.

The annual site environmental report will be issued each June for the previous calendar year. This comprehensive report discusses a year of IEMP data previously reported on the IEMP Data Information Site. The report includes the following:

Operational Assessment

- The set point pumping rates for each extraction well during the year
- The uranium removal rate of individual wells
- Extraction well total hours of operation during the year
- The volume of treated groundwater
- Extraction well operating time expressed as a percentage of total available operating time
- The volume of water pumped from each extraction well during the year
- Planned versus actual gallons of water pumped
- The net water balance
- Total pounds of uranium removed during the year
- Total pounds of uranium removed from the aquifer since the start of remediation
- Planned versus actual pounds of uranium removed from the Great Miami Aquifer
- Running cumulative pounds of uranium removed from the Great Miami aquifer versus predicted running cumulative pounds of uranium removed from the Great Miami Aquifer
- Total uranium concentration data collected from extraction wells

- Total uranium concentration data collected from monitoring wells
- Water level data collected from monitoring wells
- The maximum, minimum, and average uranium concentration sent to treatment during the last year
- The monthly average uranium concentration in water discharged to the Great Miami River during the year
- Pumping rate figures for each extraction well
- Regression curves of uranium concentration data at extraction wells
- Regression curves of uranium concentration data at groundwater monitoring wells (every 5 years).

Aquifer Conditions

- The area of capture during the year
- A description of the geometry of the total uranium plume during the year
- The effect that restoration had (i.e., pumping) on the Paddys Run Road Site plume during the year
- The status of non-uranium FRL exceedances, including any newly detected FRL exceedances
- Identification of any new areas of FRL exceedances
- A comparison of groundwater restoration performance with respect to model predictions established in the Baseline Remedial Strategy Report
- Any changes that may have been made to the operation or design.

Data that Support the On-site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan

- Status information pertaining to the on-site disposal facility wells along with baseline data summaries
- Leachate volumes and concentrations from the leachate collection system and from the leak detection system for the on-site disposal facility
- Results of quarterly groundwater sampling initiated after waste is placed in a cell of the on-site disposal facility.

In addition, the annual site environmental report will include trend analysis of the data collected from the on-site disposal facility.

Because the IEMP is a living document, annual reviews and two-year revisions have been instituted. The annual review cycle provides the mechanism for identifying and initiating any groundwater program modifications (e.g., changes in constituents, locations, or frequencies) that are necessary to align the IEMP with the current mix of near-term remediation activities. Any program modifications that may be warranted prior to the annual review would be communicated to EPA and OEPA.

APPENDIX C
STATISTICAL PROCEDURES

APPENDIX C
STATISTICAL PROCEDURES

This appendix presents the statistical procedures that will be used to address groundwater certification.

C.1 STATISTICAL PROCEDURES FOR GROUNDWATER CERTIFICATION

The statistical procedures selected for the groundwater certification require a minimum of 12 data points. Certification/attainment monitoring data will be collected quarterly for a minimum of three years to satisfy this requirement.

The groundwater certification process is divided into two parts:

1. Well-based analyses
2. Module-based analyses.

C.2 WELL-BASED ANALYSES

Well-based analyses will consist of two parts:

Part 1 Determine if the average concentration is below the final remediation level (FRL)
Part 2 Determine the trend of the data.

C.2.1 Determine If the Average Concentration is Below the FRL

This analysis determines if there is statistically significant evidence to show that the average concentration of a given groundwater FRL constituent is below its respective FRL. The upper confidence level (UCL) of the mean concentration will be compared to the FRL. If the UCL of the mean concentration is less than the FRL, then it will be concluded that, at the specified confidence level, it is certified that the mean groundwater FRL constituent concentration is below its respective FRL.

An important factor in the calculation of UCLs is the assumed underlying data distribution. The two most common distributions are normal and lognormal. The equations presented below will be used to determine the UCL depending on the assumed distribution. Distribution testing will be accomplished using the Shapiro-Wilk test for normality. The test for the lognormal distribution will be accomplished by testing the natural log-transformed data using the Shapiro-Wilk test (Madansky 1988). The distribution assumption (normal or lognormal) will be based on the test that yields the highest p-value as an indication of "best" fit to the data.

An *a posteriori* sample size test will be performed to determine if enough data were taken to make the determination of certification. A calculated sample size that exceeds the actual sample size will indicate that insufficient data were collected to make the certification determination. The formula to be used is also presented below.

Groundwater data often exhibit a seasonal effect as well as serial correlation. U.S. Environmental Protection Agency (EPA) guidelines recommend that even if the data do not show significant levels of seasonality or serial correlation, it is best to account for these effects in the calculations (EPA 1992a). In order to accommodate these effects, a modification to standard error of the mean term in the UCL formula will be used.

C.2.1.1 Normal Distribution Formula

C.2.1.1.1 Upper Confidence Limit on the Mean

The UCL on the mean will be calculated as

$$UCL_{.95} = \overline{x} + t_{1-\alpha,df} s_{\overline{x}}$$

where

$$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

and adjusting for serial correlation and seasonality,

$$s_{\overline{x}} = \sqrt{\frac{\sum_{i=2}^{N} (e_i - e_{i-1})^2}{2n(n-1)}}$$

where e_i is the sample residual after correcting for seasonality.

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The sample residual is calculated by first determining the seasonal average:

$$\bar{x}_j = \frac{1}{m} \sum_{k=1}^{m_j} x_{jk}$$

where m_j is the number of non-missing observations for season j.

The sample residual is then calculated by

$$e_{jk} = x_{jk} - \bar{x}_j$$

The degrees of freedom, *df*, used in the UCL calculation above is approximately equal to

$$\frac{2(N-n)}{3}$$

where *n* is the number of seasons. In the equation, to be conservative, the *df* will be chosen as the greatest integer less then $\frac{2(N-n)}{3}$.

C.2.1.1.2 *A Posteriori* Sample Size Determination

It will be determined that enough samples have been taken if

$$n \geq S^2 \left(\frac{z_{1-\beta} + z_{1-\alpha}}{FRL - \bar{x}} \right)^2$$

where α is the Type I error rate of 0.05 and β is the Type II error rate of 0.20.

C.2.1.2 Lognormal Distribution

C.2.1.2.1 UCL on the Mean

The UCL on the mean will be calculated as

$$UCL_{.95} = \exp\left(\bar{y} + \frac{S_y^2}{2} + \frac{S_y H_{1-\alpha}}{\sqrt{n-1}} \right)$$

where

$$\bar{y} = \frac{\sum_{i=1}^{n} y_i}{n}$$

$$y_i = \ln(x_i)$$

and $H_{1-\alpha}$ is the tabled multiplier factor for computing the one-sided upper $1-\alpha$ percent confidence limit on a lognormal mean. (The tables are reprinted as Tables A10 through A13 in Gilbert 1987.)

The same adjustment for serial correlation and seasonality needs to be made the lognormal equations. The adjusted standard error, $S_{\bar{y}}$, is calculated as in the normal case, except that the sample results, y_i, are the natural log-transformed results. The UCL formula for the lognormal assumption shown above uses the standard deviation of the data, not the standard error, so the equation must be modified to use the adjusted standard error. The derivation of the adjustment is as follows:

Starting with the UCL formula,

$$UCL_{.95} = \exp\left(\bar{y} + \frac{S_y^2}{2} + \frac{S_y H_{1-\alpha}}{\sqrt{n-1}} \right)$$

the adjusted standard deviation and variance are back calculated from the adjusted standard error where 006254

$$S_{\bar{y}} = \frac{S_y}{\sqrt{n}}$$

so the standard deviation is calculated as

$$S_y = S_{\bar{y}} \times \sqrt{n}$$

and, therefore, the variance is calculated as

$$S_y^2 = [S_{\bar{y}}]^2 \times n$$

Substituting these values back into the UCL equation we get

$$UCL_{.95} = \exp\left(\bar{y} + \frac{S_{\bar{y}}^2 \times n}{2} + \frac{S_{\bar{y}} \times \sqrt{n} \times H_{1-\alpha}}{\sqrt{n-1}} \right)$$

C.2.1.2.2 <u>*A Posteriori* Sample Size Determination – Lognormal Assumption</u>

The *a posteriori* test for sample size under the lognormal assumption is calculated similarly to the normal assumption. The exception is that the log-mean and log-variance are used and the FRL term is replaced by the natural log-transformed FRL [ln(FRL)]. It will be determined that enough samples have been taken if

$$n \geq S_y^2 \left(\frac{z_{1-\beta} + z_{1-\alpha}}{\ln(FRL) - \bar{y}} \right)^2$$

where α is the Type I error rate of 0.05 and β is the Type II error rate of 0.20.

B.2.2 <u>Determine the Trend of the Data</u>

Subsequent to Stage I, the trend of the data should be determined; groundwater FRL constituent concentrations should not exhibit an upward trend over time. The expectation is that the data will exhibit no trend, but a statistically significant downward trend is not a concern. Linear regression analysis will be used to assess the direction and significance of potential trends in groundwater FRL constituent concentrations per well. Two statistical outputs will be generated:

1. Is there a significant upward trend?
2. If so, will a 10-year future projection of the trend result in an FRL exceedance?

There may be situations where the linear model is judged to be a poor fit and where another model is judged to fit the observed data better. The determination of "better" will be based primarily on the R-Squared value of the models. If another model has at least a 20 percent relative increase in the R-Squared value when compared to the linear model, then this alternate model will be considered for the assessment of the concentration trend.

The simple linear regression model is given as

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i$$

where

y_i is the predicted contaminant concentration for the i^{th} time period
x_i is the value of the i^{th} time period
β_0 is the y-intercept (a constant)
β_1 is the regression slope
ε_i is the random error term.

The first assessment of trend will be to determine if the slope of the regression model is significant. This information will be obtained from the Analysis of Variance (ANOVA) table associated with the regression as the p-value of the slope. The ANOVA table can be generated from any statistical software package as well as other analytical software such as Microsoft Excel. A p-value of less than 0.05 will be considered significant evidence of a slope for certification purposes, while a value between 0.05 and 0.10 will be considered marginally significant evidence. The sign of the slope coefficient indicates the direction: negative indicates a downward slope or trend and positive means an upward slope.

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Additional models that will be considered include:

Exponential

$$y_i = e^{(\beta_0 + \beta_1 x_i)}$$

Reciprocal-Y

$$y_i = 1/(\beta_0 + \beta_1 x_i)$$

Reciprocal-X

$$y_i = \beta_0 + \frac{\beta_1}{x_i}$$

Double Reciprocal

$$y_i = 1/\left(\beta_0 + \frac{\beta_1}{x_i}\right)$$

Multiplicative

$$y_i = \beta_0 x_i^{\beta_1}$$

C.3 MODULE-BASED ANALYSES

Module-based analyses will represent a snapshot in time. They will consist of two parts:

1. Calculate the UTL
2. Determine if quarterly UTLs are trending upward toward the FRL

C.3.1 Calculate the UTL

The first step in the module-based analyses is to determine, within a specified level of confidence, if the 95th percentile of all sample concentrations measured during the current quarter within the module is below the FRL. This upper confidence limit on an upper percentile is often referred to as an upper tolerance limit (UTL).

Calculation of the UTL will be based on the discussion and formulas presented in Section 4.1 of the Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities – Addendum to Interim Final Guidance. It has been observed that the UTL calculation as presented in the original guidance usually yields coverage in excess of 98 percent. The modified formula yields an average coverage of 95 percent, which is the intent of the test procedure. An additional benefit of the modified procedure is that the κ multiplier can be directly computed with the aid of a more readily available Student's t-distribution table. The other method requires the use of a specialized table.

As with the UCL calculations above, the formulas used depend on the assumed underlying distribution. Again, the Shapiro-Wilk tests will be used to assess the distribution type. The formula for the UTL is similar to the standard UTL formula except that the κ multiplier is calculated instead of taken from a table of values.

C.3.1.1 Normal Assumption UTL Formula

The normal assumption UTL formula is

$$UTL = \bar{x} + s\kappa_{1-\alpha}$$

where

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

and

$$s = \sqrt{\frac{\sum_{i=1}^{N} x_i^2 - \frac{\left(\sum_{i=1}^{N} x_i\right)^2}{n}}{n-1}}$$

and

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$$K_{1-\alpha} = \left(t_{N-1,0.05}\right)\sqrt{1-\frac{1}{N}}$$

and $t_{n-1,0.05}$ is the 95th percentile of Student's t-distribution with N-1 degrees of freedom.

C.3.1.2 Lognormal Assumption

The UTL formula under the lognormal assumption is given as

$$UTL = e^{\left(\bar{y}+s_y K_{1-\alpha}\right)}$$

where $\bar{y}$ is the mean of the natural log-transformed data and S_y is the standard deviation of the natural log-transformed data. The $K_{1-\alpha}$ multiplier is defined as above.

C.3.2 Determine If Quarterly UTLs are Trending Upward Toward the FRL

The second part of module-based analyses is a trend analysis of the quarterly UTLs. It will be assumed that after Stage I operations have ended and steady-state hydraulic conditions have been achieved in the aquifer, then groundwater constituent concentrations within the module will either continue to drop or reach steady-state conditions. To test this assumption, a trend analysis of the quarterly UTLs will be performed. A statistically significant upward trend will indicate that at one or more locations within the module there is a potential FRL exceedance problem. This could trigger a more intense study that could include geostatical analysis or modeling and direct-push sampling in order to locate areas where FRL exceedances might be occurring.

The trend analysis will be performed in a similar manner to that of the individual wells as described above. In this case, however, the parameter being studied is the quarterly UTL. As stated above, the linear model will be assumed unless there is sufficient reason to switch to another model.

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