Attachment D

Integrated Environmental Monitoring Plan

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Appendix

Acronyms and Abbreviations

ALARA	as low as reasonably achievable
ARARs	applicable or relevant and appropriate requirements
ASL	analytical support level
BCG	biota concentration guide
CAWWT	Converted Advanced Wastewater Treatment Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CMT	continuous multichannel tubing
COC	contaminant of concern
DCF	dose conversion factor
DCG	derived concentration guideline
DOE	U.S. Department of Energy
LM	U.S. Department of Energy Office of Legacy Management
DOECAP	U.S. Department of Energy Consolidated Audit Program
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FFCA	Federal Facility Compliance Agreement
FMPC	Feed Material Production Center
FPQAPP	Fernald Preserve Quality Assurance Project Plan
FRL	final remediation level(s)
GEMS	Geospatial Environmental Mapping System
gpm	gallons per minute
GWLMP	Groundwater/Leak Detection and Leachate Monitoring Plan
IEMP	Integrated Environmental Monitoring Plan
kg	kilogram
LMICP	Comprehensive Legacy Management and Institutional Controls Plan
MeV	million electronc volts
MDC	minimum detectable concentration
Mrem/yr	millirem per year
m^3/min	cubic meters per minute
µg/L	micrograms per liter
µm	micrometer

mg/kg	milligram per kilogram
MS/MSD	matrix spike/matrix spike duplicate
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
OMMP	Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Project
OSL	optically stimulated luminescence
OSDF	On-Site Disposal Facility
OU	Operable Unit
pCi/kg	picocuries per kilogram
pCi/L	picocuries per liter
pCi/m^3	picocuries per cubic meter
PRG	preliminary remediation goal
PRRS	Paddys Run Road Site
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
SER	Site Environmental Report
SSOD	Storm Sewer Outfall Ditch
TLD	thermoluminescent dosimeter
VAM3D	Variability Saturated Analysis Model in 3 Dimensions

1.0 Introduction

The Integrated Environmental Monitoring Plan (IEMP) is the mechanism to assess the continued protectiveness of the remedial actions and comply with applicable DOE orders and environmental regulations. 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. The IEMP will delineate the Fernald Preserve's responsibilities for sitewide monitoring of surface water and sediment over the life of the remedy and ensure that final remediation levels (FRLs) are achieved at project completion. The IEMP will also serve as the primary vehicle for determining (to the satisfaction of the U.S. Environmental Protection Agency [EPA] and Ohio Environmental Protection Agency [Ohio EPA]) that remedial action objectives for the Great Miami Aquifer are being attained.

1.1 Background

The U.S. Department of Energy (DOE) Office of Legacy Management (LM) Fernald Preserve completed its remedial investigation/feasibility study obligations, and the final records of decision (RODs) for all five Fernald Preserve operable units (OUs) are in place. In 1997, in recognition of the increased focus on remedy implementation, DOE developed an integrated environmental monitoring strategy tailored to these cleanup actions. Between 1997 and 2006, the site's focus was on the safe and efficient execution of site remediation, including facility decontamination and dismantling, the design and construction of waste processing and disposal facilities, waste excavation and shipping, and the continuation of groundwater remediation.

Near the end of 2006, Declaration of Physical Completion (i.e., closure) was achieved. The on-site disposal facility (OSDF) was closed, the final cap was installed, and all site cleanup activities were completed, with the exception of the ongoing remediation of the Great Miami Aquifer. Even though the site met the closure criteria, the integrated environmental monitoring strategy will continue to ensure that environmental monitoring and reporting for all site media, including remedy performance monitoring, is a coordinated effort.

The basis for the current understanding of environmental conditions at the Fernald Preserve is the extensive site environmental data that have been collected. The data were collected over a 10-year period through the remedial investigation process required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, combined with 12 years of subsequent routine environmental monitoring data collected through the IEMP. Analysis of the remedial investigation data resulted in the selection of a final remedy for the Fernald Preserve's environmental media, with the issuance of the *Record of Decision for Remedial Actions at Operable Unit 5* (OU5 ROD) (DOE 1996a) in January of 1996. OU5 includes all environmental media, contaminant transport pathways, and environmental receptors (soil, groundwater, surface water, sediment, air, and biota) at and around the Fernald Preserve that have been affected by past uranium production operations. The remedy for OU5 defines final sitewide cleanup levels and establishes the general areal extent of on- and off-property actions necessary to mitigate the environmental effects of site production activities.

The IEMP is a formal remedial design deliverable required to fulfill Task 9 of the *Remedial Design Work Plan for Remedial Actions at Operable Unit 5* (DOE 1996b) and is an enforceable portion of the LMICP. The revision to the IEMP provides an update to the original IEMP (approved in August of 1997) as required by the *Remedial Design Work Plan and DOE Order 450.1A* (DOE 2008a).

1.2 Program Objectives and Scope

As post-closure and continued cleanup activities are conducted, the need for accurate, accessible, and manageable environmental monitoring information continues to be essential. The IEMP has been formulated to meet this need and will serve several comprehensive functions for the site by:

- Maintaining the commitment to a remediation-focused environmental surveillance monitoring program that is consistent with DOE Orders 450.1A, *Environmental Protection Program,* and 5400.5, *Radiation Protection of the Public and the Environment,* and that continues to address stakeholder concerns. Both orders are listed as "to be considered" criteria in the OU5 ROD and are, therefore, key drivers for the scope of the monitoring program.
- Fulfilling additional sitewide monitoring and reporting requirements activated by the CERCLA applicable or relevant and appropriate requirements (ARARs) for the OU5 ROD, including determining when environmental restoration activities are complete and cleanup standards have been achieved.
- Providing the mechanism for assessing the performance of the Great Miami Aquifer groundwater remedy, including determining when restoration activities are complete.
- Providing a reporting mechanism for many environmental regulatory compliance monitoring activities. These may include OSDF groundwater monitoring, Federal Facility Compliance Agreement (FFCA), and elements of the National Pollutant Discharge Elimination System (NPDES) discharge reporting.
- Providing a reporting interface for project-specific monitoring (i.e., OSDF), which is conducted under a separate attachment to the LMICP (Attachment C, "On-Site Disposal Facility Groundwater/Leak Detection and Leachate Monitoring Plan [GWLMP]").

Under the IEMP, data showing the environmental conditions at the Fernald Preserve are collected, maintained, and evaluated. Performance monitoring results associated with the Fernald Preserve are also evaluated and compared against established thresholds. DOE fulfills its obligation to document environmental monitoring information under the umbrella of the annual Site Environmental Report (SER).

The boundary conditions defined in the IEMP are as follows:

- The administrative boundary lies between remedial actions for groundwater south of the Fernald Preserve and those potential remedial actions associated with the Paddys Run Road Site (PRRS) plume. This boundary is shown in the *Feasibility Study Report for Operable Unit 5* (DOE 1995a) and the *Final Operable Unit 5 Proposed Plan* (DOE 1995b).
- The programmatic boundary refers to the differentiation between the scope and responsibility associated with the design, implementation, and documentation. OSDF monitoring activities are designated as project-specific monitoring. The designation is based on an evaluation of the pertinent regulatory drivers and DOE policies that have monitoring implications.

The IEMP monitoring programs measure the collective environmental impacts resulting from continued Fernald Preserve cleanup and monitoring activities.

1.3 Plan Organization

The IEMP is composed of six sections and one appendix. The remaining sections and their contents are as follows:

- Section 2.0—Post-Closure Strategy and Organization: Provides an overview of the post-closure monitoring strategy and a description of the post-closure organization.
- Section 3.0—Groundwater Monitoring Program: Provides a description of the monitoring activities necessary to track the progress of the restoration of the Great Miami Aquifer; discusses the groundwater monitoring activities necessary to maintain compliance with Resource Conservation and Recovery Act (RCRA) requirements as specified in the Ohio EPA Director’s Findings and Orders dated September 2000; and provides a description of the integration with the groundwater monitoring for the OSDF.
- Section 4.0—Surface Water, Treated Effluent, and Sediment Monitoring Program: Provides a description of the routine sitewide surface water monitoring required to maintain compliance with surface water and treated effluent discharge requirements. Additionally, this section provides a description of the sediment monitoring activities to independently verify the overall effectiveness of the sediment controls.
- Section 5.0—Dose Assessment Program: Provides a description of the sitewide external-radiation monitoring and dose calculations required to maintain compliance with DOE Order 5400.5.
- Section 6.0—Program Reporting: Provides a detailed accounting of the reporting elements included within the IEMP reporting framework.
- Appendix A—Natural Resource Monitoring Plan: Provides the regulatory requirements and strategy for the monitoring of ecological impacts to wetlands, threatened and endangered species, and terrestrial and aquatic habitats.

The IEMP is organized according to the principal environmental media and contaminant migration pathways routinely examined under the program. For each of the media constituting the program, evaluations of the regulatory drivers and pertinent DOE policies that govern environmental monitoring were conducted. The details and results of this evaluation are presented in Sections 3.0 through 5.0.

1.3.1 Plan Implementation

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

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

- Health and safety are the responsibility of all individuals working on this project scope. Qualified Health and Safety personnel shall participate on the project team to 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 evaluating and resolving all safety concerns. All activities will be conducted according to the *Health and Safety Manual* (DOE 2012).
- Quality Assurance personnel will participate on the project team, as necessary, to review project procedures and activities ensuring consistency with the requirements of the *Fernald Preserve Quality Assurance Project Plan* (DOE 2009) (FPQAPP) or other referenced standard and assist in evaluating and resolving all quality-related concerns.

1.3.2 Plan 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 is required, it will be completed in accordance with the FPQAPP. The variance 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 revisions to the IEMP, variances will be incorporated in the medium-specific sections.

If a change significantly affects the scope of the plan, approval would be requested through EPA and Ohio EPA. Afterward, a variance that documents the change and the justification for the change will be provided to EPA and Ohio EPA.

1.3.3 Health and Safety Considerations

The Fernald Preserve's Health and Safety personnel are responsible for the development and implementation of health and safety requirements for all medium-specific plans. Hazards (physical, radiological, chemical, and biological) typically encountered by personnel when performing the specified fieldwork will be addressed during team briefings. All involved personnel will receive adequate training in the health and safety requirements prior to implementation of the fieldwork required by this medium-specific plan. Health and safety requirements have been incorporated into *Fernald Preserve Environmental Monitoring Procedures* (DOE 2011a) and job safety analyses.

1.3.4 Data Management

Specific requirements for field and laboratory data documentation and validation are established to meet the IEMP data reporting and quality objectives and comply with the FPQAPP and the data validation procedure found in the *Environmental Procedures Catalog* (DOE 2011b).

Data documentation and validation requirements for data collected for the IEMP fall into two categories depending upon whether the data are field- or laboratory-generated. Field documentation review 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 medium-specific, plan-specified analytical support levels (ASLs).

Four ASLs (ASL A through ASL D) are defined for use at the Fernald Preserve. For groundwater, sediment, and surface water field data documentation will be at ASL A, and laboratory data documentation will be at ASL D, except for NPDES constituents carbonaceous biochemical oxygen demand, fluoride, total hardness, total phosphorus, total dissolved solids, and total suspended solids, which will be ASL C. Laboratory data validation will consist of verifying that data generated are in compliance with specified ASL D. ASL D provides quantitative data with some quality assurance/quality control checks.

Data will be entered into a controlled database using a double key or verification method to ensure accuracy. The hard-copy data will be managed in the project file in accordance with LM record-keeping requirements and DOE orders.

1.3.5 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 with 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 and FPQAPP requirements.

Recommended semiannual 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 Quality Assurance personnel. The project team leader and Quality Assurance personnel will coordinate assessment activities and comply with the FPQAPP. The project or Quality Assurance personnel shall have "stop work" authority if significant adverse effects to quality conditions are identified or work conditions are unsafe.

1.4 Role of the IEMP in Remedial Action Decision Making

The IEMP is the mechanism 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. The IEMP will delineate the Fernald Preserve's responsibilities for sitewide monitoring of surface water and sediment 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 (with concurrence from EPA and Ohio EPA) that remedial action objectives for the Great Miami Aquifer are being attained.

Subject matter experts are responsible for the ongoing review of media-specific monitoring data and the identification of any related environmental compliance issues. If the potential for an unacceptable future situation is identified, then options for addressing the problem will be identified. The options will be assessed with respect to their implications, and the results of the evaluations will be communicated as necessary to the Fernald Preserve's stakeholders, EPA, and Ohio EPA.

The medium-specific sections of this plan (Sections 3.0 through 5.0) identify monitoring requirements and ARARs for each environmental medium with the applicable compliance locations. Additionally, the medium-specific sections define the criteria to be used to identify trends in the data that could indicate an imminent unacceptable situation. Each of the medium-specific sections specifies the frequency of the data evaluations to satisfy the Fernald Preserve's overall planning and decision-making requirements. DOE will evaluate the data accordingly and will report the results according to the approach summarized below.

Each medium section of this IEMP presents medium-specific reporting components, and Section 6.0 summarizes the overall reporting strategy for the IEMP. The annual SERs will be furnished to EPA and Ohio EPA in accordance with the provisions summarized in Section 6.0. The SERs will also be available for review by the Fernald Preserve's stakeholders at the Visitors Center and to selected stakeholders via mail.

2.0 Fernald Preserve Post-Closure Strategy and Organization

This section presents a description of the Fernald Preserve's post-closure strategy and organizational structure associated with post-closure activities, which includes the continuing OU5 (i.e., environmental media) remediation and monitoring efforts.

2.1 Post-Closure Strategy

The Fernald Preserve's post-closure strategy reflects the completion of the majority of CERCLA activities at the site. There have been extensive site characterization activities to determine the nature and extent of contamination, baseline risk assessments, and detailed evaluation and screening of remedial alternatives leading to a final remedy selection as documented in the ROD for each OU. The majority of all OU remediation activities were completed in 2006. The remaining OU with continuing remediation efforts is OU5. Table 2–1 provides a summary of the OU5 remedy overview.

Active remediation of the Great Miami Aquifer will continue during the post-closure period. Additionally, surface water surveillance monitoring (including NPDES monitoring), sediment surveillance monitoring, and natural resources restoration activities will continue.

2.2 Post-Closure Organization

The post-closure organizational structure is less complex than previous Fernald organizations. Adequate staff will remain at the site to continue to meet regulatory and OU5 commitments.

2.3 Post-Closure Status

In 2006, the contaminant sources that were at the Fernald Preserve were removed. Soil and on-property sediments were certified, with the exception of those areas indicated in Figure 2–1. Great Miami Aquifer restoration activities continue after closure as do surveillance monitoring for surface water and sediment. Natural resource restoration activities also continue after closure. Monitoring associated with the IEMP is mainly associated with these activities. Figure 2–2 shows the post-closure site configuration.

Table 2–1. OU5 Remedy Overview

OU	Description	Remedy Overview
OU5	Environmental Media • Groundwater • Surface water and sediments (on-property sediment cleanup completed) • Soil not included in the definitions of OU1 through OU4 (cleanup completed with the exception of those areas identified in Figure 2–1) • Flora and fauna	ROD Approved: January 1996 An Explanation of Significant Differences document was approved in November 2001, formally adopting EPA's Safe Drinking Water Act maximum contaminant level for uranium of 30 micrograms per liter as both the FRL for groundwater remediation and the monthly average uranium effluent discharge limit to the Great Miami River. Continued extraction of contaminated groundwater from the Great Miami Aquifer to meet FRLs at all affected areas of the aquifer. Treatment of contaminated groundwater, storm water, and wastewater to attain concentration and mass-based discharge limits and FRLs in the Great Miami River. Continued site restoration maintenance, institutional controls, and post-remediation maintenance. Completion of excavation of contaminated soil and sediment to meet FRLs. Excavation of contaminated soil containing perched water that presents an unacceptable threat, through contaminant migration, to the underlying aquifer. Completion of on-site disposal of contaminated soil and sediment that met the OSDF waste acceptance criteria. Soil and sediment that exceeded the waste acceptance criteria for the OSDF were treated, when possible, to meet the OSDF waste acceptance criteria or were disposed of at an off-site facility.

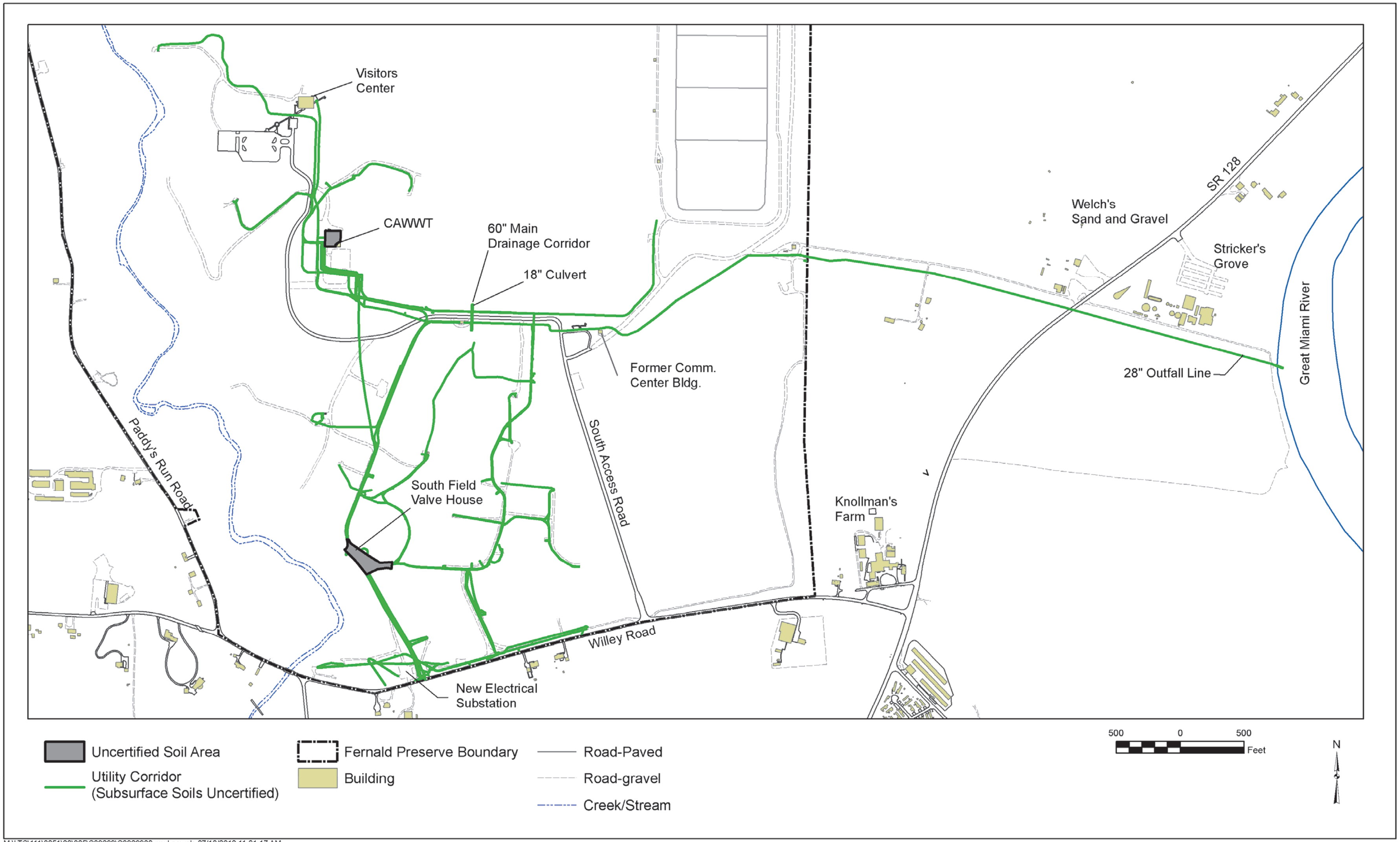

Figure 2–1. Uncertified Areas and Subgrade Utility Corridors

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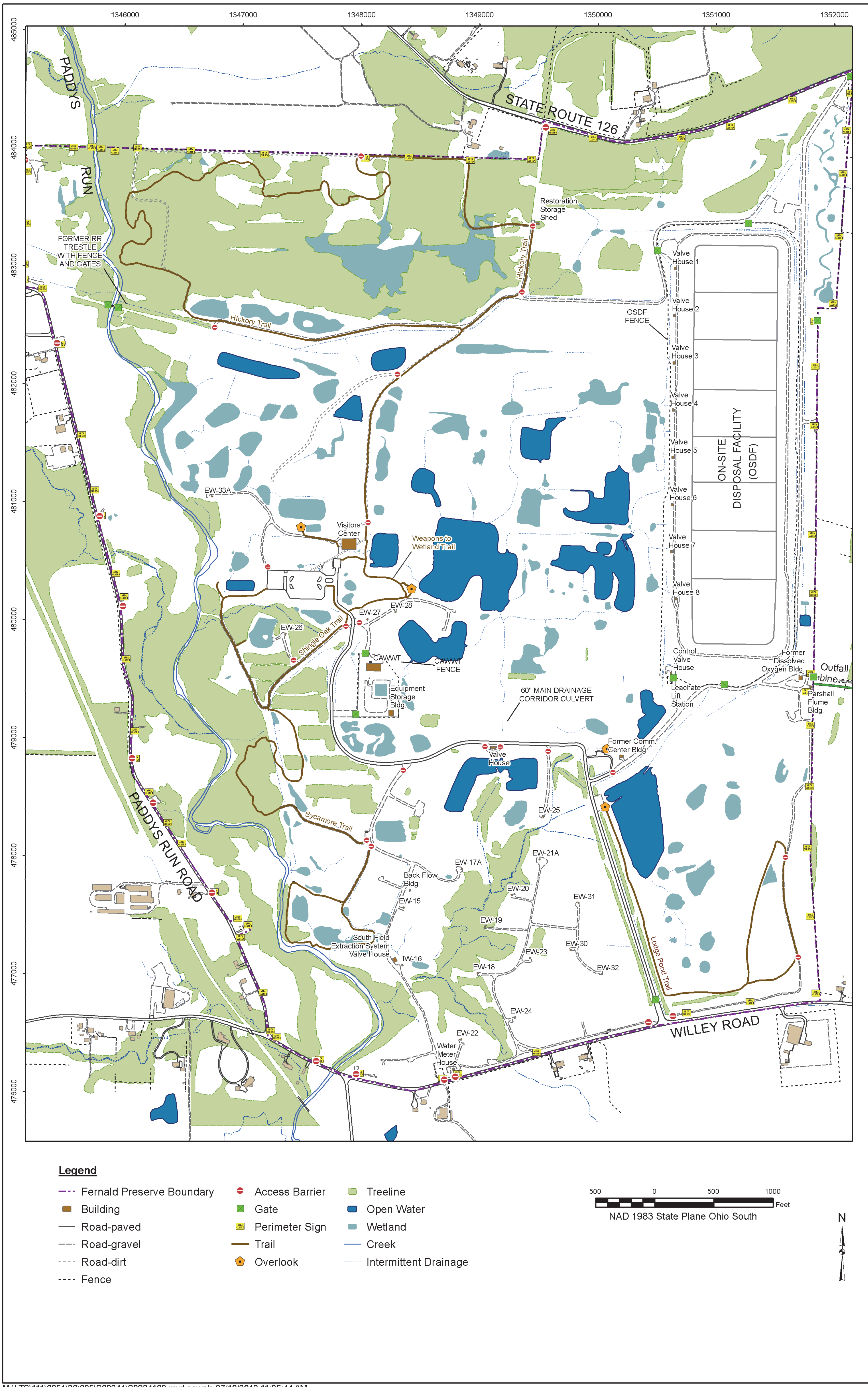

Figure 2–2. Fernald Preserve Site Configuration

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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 are outlined in Section 3.4, and the program design is presented in Section 3.5.

3.1 Integration Objectives for Groundwater

The IEMP serves to integrate several former compliance-based groundwater monitoring or protection programs:

- Ohio EPA Director's Findings and Orders (Ohio EPA 2000) for property boundary groundwater monitoring to satisfy RCRA facility groundwater monitoring requirements.
- Private well sampling.
- Groundwater protection management program plan.

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 OU5 groundwater remedy.

The *Fernald Groundwater Certification Plan* (DOE 2006a) defines a programmatic strategy for certifying the completion of the aquifer remedy. Remediation of the Great Miami Aquifer is being conducted using pump-and-treat technology, and it is progressing toward certification through a six-stage 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

The groundwater sampling specified in the IEMP tracks the performance of the aquifer remedy. The IEMP is the controlling document for groundwater remedy performance monitoring and is currently focused on groundwater monitoring to support Stage I (Pump-and-Treat Operations). Groundwater monitoring requirements for Stages II through VI of the groundwater certification process will be defined in future revisions of the IEMP. The following is a brief description of the certification stages listed above.

Stage I—Pump-and-Treat Operations

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

Remediation of the aquifer (operations and monitoring) is organized around three groundwater restoration modules:

- The South Plume Module
- The South Field (Phases I and II) Module
- The Waste Storage Area (Phases I and II) Module

Figure 3–1 identifies the locations of these modules.

Pump-and-treat operations will continue for each groundwater module until FRLs in the aquifer have been achieved or until the mass removal efficiency of the extraction system has decreased such that it is apparent that groundwater FRLs will not 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) (Attachment A). Ultimately, the IEMP will be used to document the approach to determine when the various modules complete pump-and-treat operations. Monitoring requirements needed to support later stages of the certification strategy will be incorporated into future revisions of the IEMP when deemed appropriate.

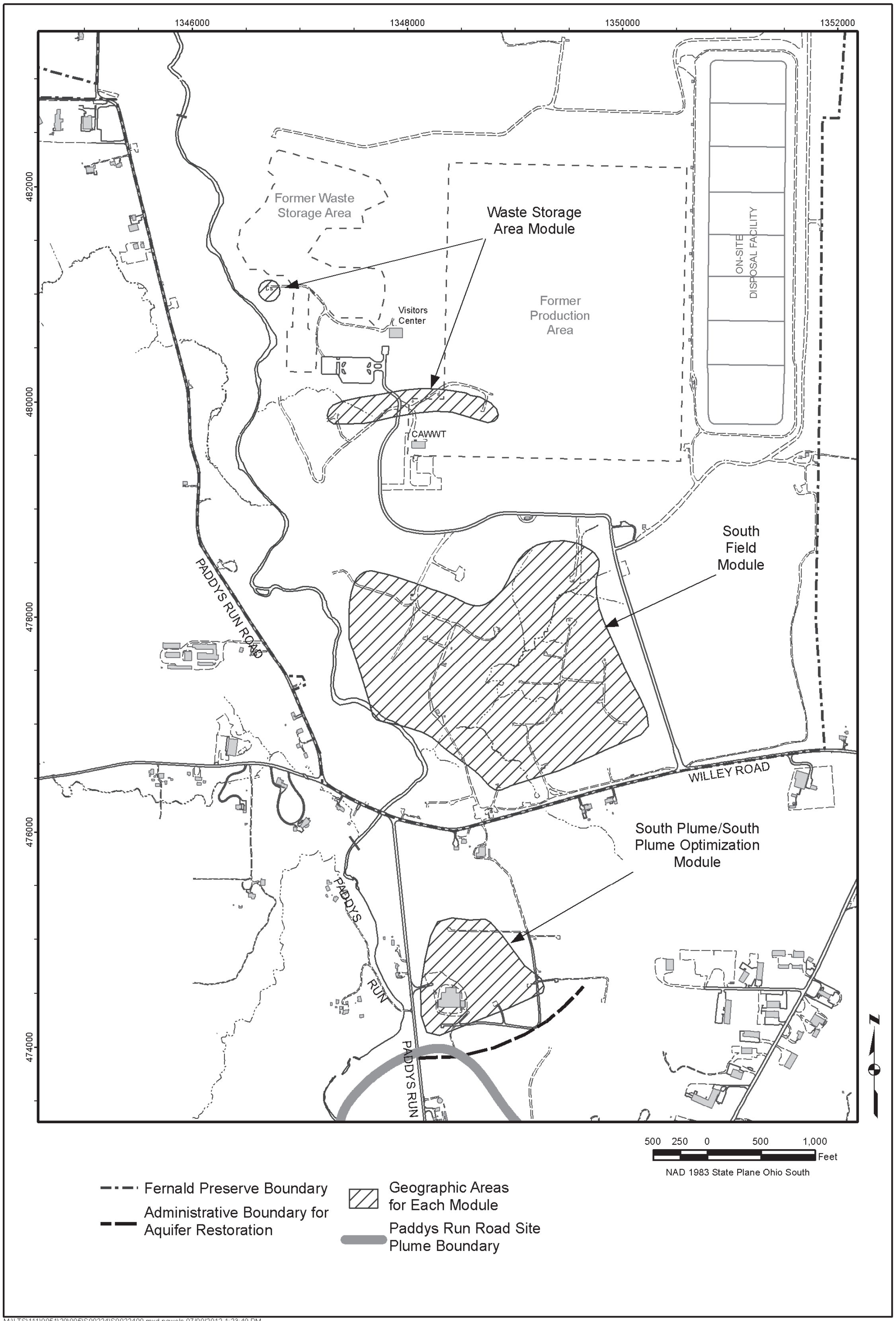

Figure 3–1. Location of Aquifer Restoration Modules

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

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 readjusted to steady-state nonpumping 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. Concentrations of groundwater FRL constituents 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). Stage II monitoring is estimated to take approximately 3 months.

Stage III—Certification/Attainment Monitoring

Certification/attainment monitoring will also be module specific. Data collected during Stage III 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 stay below FRLs.

Stage IV—Declaration and Transition Monitoring

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 estimated 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.

Stage V—Demobilization

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 decontamination and dismantling of infrastructure will not take place until the entire aquifer has been certified clean. This will provide the means to reinitiate 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 in former source areas after the last groundwater module is certified clean. If the water table rises to an elevation that exceeds what was previously recorded for a former source area, then groundwater monitoring beneath the former source area 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 Preserve–Specific Agreements

This section presents a summary evaluation of the regulatory-based requirements and policies governing the monitoring of the Great Miami Aquifer. The intent of the section is to identify the pertinent regulatory drivers, including 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 OU5 ROD and to achieve the intentions of other pertinent criteria, such as DOE orders and the Fernald Preserve's existing agreements that have a bearing on the scope of groundwater monitoring.

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 OU RODs to identify the subset with specific groundwater monitoring requirements. The Fernald Preserve's existing compliance agreements issued outside the CERCLA process 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 ROD for remedial actions at OU5 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, which are ARARs for groundwater remediation. For Fernald Preserve–related contaminants that do not have an established maximum contaminant level 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 noncarcinogens 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 OU5 ROD incorporates the requirements of the Fernald Preserve's existing CERCLA South Plume Removal Action, which was the regulatory driver for the former *South Plume Groundwater Recovery System Design, Monitoring, and Evaluation Program Plan* (DOE 1993).
- According to the *CERCLA Remedial Design Work Plan* (DOE 1996c) for remedial actions at OU5, 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. The IEMP will delineate the Fernald Preserve'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 Ohio EPA's satisfaction that remedial action objectives for the Great Miami Aquifer have been attained.

- The September 10, 1993, Ohio EPA Director's Final Findings and Orders required groundwater monitoring at the Fernald Preserve's property boundary to satisfy RCRA facility groundwater monitoring requirements (Ohio EPA 1993). The 1993 Final Findings and Orders were superseded by the September 7, 2000 Director's Final Findings and Orders (Ohio EPA 2000). The September 7, 2000, order specifies 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 450.1A, *Environmental Protection Program*, establishes the requirement for a groundwater protection management program plan for DOE facilities. The required informational elements of the plan are fulfilled by the *Remedial Investigation Report for Operable Unit 5* (DOE 1995c) and the *Feasibility Study Report for Operable Unit 5* (DOE 1995a). The groundwater monitoring program requirement is being fulfilled by the IEMP.
- DOE Order 5400.5, *Radiation Protection of the Public and the 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 Preserve'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 Preserve's private well sampling program for the Great Miami Aquifer (which was previously in the *Fernald Site Environmental Monitoring Plan* [DOE 1995d]) 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. Because a public water supply is now available, a dose assessment is no longer required.
- The 1986 Federal Facilities Compliance Agreement requires that the Fernald Preserve 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, Ohio EPA, 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 Ohio EPA in early 1996 with modifications documented in IEMP revisions. For groundwater, this agreement is specifically related to the South Plume well field 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, is listed in Table 3–1. Sections 3.7 and 6.0 outline the current and long-range plan for complying with the reporting requirements contained in the IEMP drivers.

Table 3–1. Fernald Preserve Groundwater Monitoring Regulatory Drivers and Responsibilities

	Driver	Action
IEMP	CERCLA ROD for OU5	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.
	Ohio EPA 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 450.1A, *Environmental Protection Program*. Also satisfies DOE Manual 435.1, which refers to DOE Order 5400.5	The IEMP describes routine monitoring to ensure remedy performance of the Great Miami Aquifer.
	Federal Facilities Compliance Agreement, Radiological Monitoring	The IEMP describes the routine sampling and reporting of well field performance in terms of the total volume extracted and the amount of uranium removed.

3.3 Groundwater Monitoring Administrative Boundaries

Administrative Boundary between the IEMP and Paddys Run Road Site Contaminant Plumes

As described in the remedial investigation report for OU5 (refer to Section 4.8.2), the PRRS 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 PRRS Remedial Investigation Report released in September 1992 documented releases to the Great Miami Aquifer of inorganic constituents, volatile organic compounds, and semivolatile organic compounds. The *Proposed Plan for OU5* (DOE 1995e) acknowledged that DOE's role and involvement, if any, in Ohio EPA's ongoing assessment and cleanup of the PRRS plume would be defined separately as part of the PRRS response obligations and in accordance with the PRRS 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 microgram per liter (µg/L)-total uranium plume south of the Administrative Boundary and the impact that pumping of the South Plume extraction wells has on the PRRS plume.

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 well-field operations and assess aquifer conditions. The expectations of the monitoring program 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 Preserve 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 PRRS plume.
- Continue to fulfill DOE Order 450.1A 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 historical operations at 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 constituent of concern (COC).

Figure 3–2 shows the maximum total uranium plume map (30 µg/L uranium or higher) as of the second half of 2011. These maps represent a compilation of several different monitoring depths within the aquifer, and they illustrate the maximum lateral extent of the plume at all depths. The top of the plume is usually 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 Restoration (Task 1)* (DOE 1997a); the *Conceptual Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2000); 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 2005a).

The primary sources of contamination that contributed to the present geometry of the uranium plume include (1) the former waste pits that were present in the waste storage area, (2) the former inactive fly ash 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 former Plant 1 pad and flowing west through the former 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 it has also been designed to limit the further expansion of the plume, remove targeted contaminants to concentrations below designated FRLs, and prevent undesirable drawdown impacts beyond the Fernald Preserve.

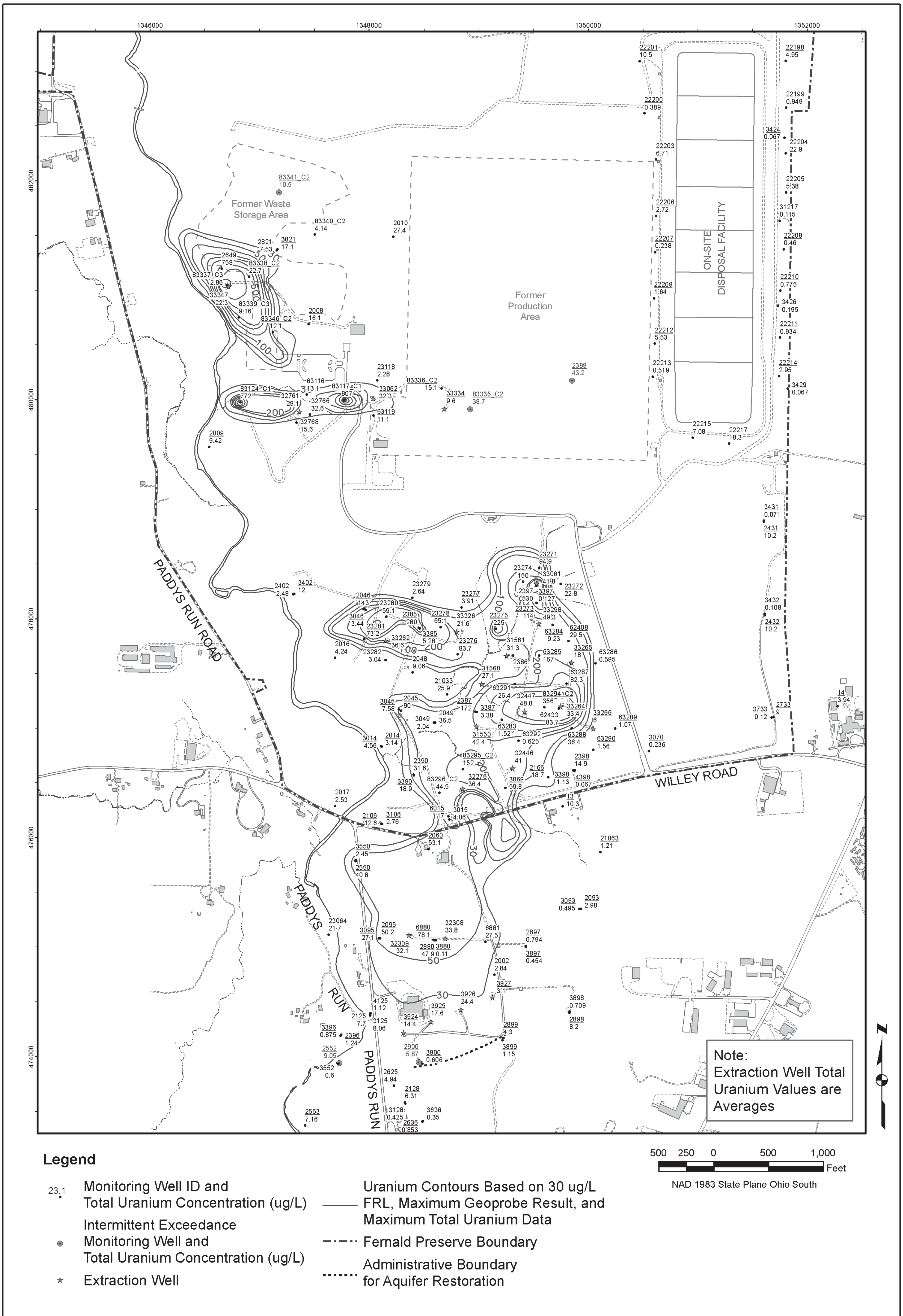

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Figure 3–2. Monitoring Well Data and Maximum Total Uranium Plume Through the Second Half of 2011

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The OU5 ROD establishes that “areas of the Great Miami Aquifer exceeding FRLs will be restored through extraction methods.” The aquifer’s “target certification footprint” is a term used to define those areas of the aquifer targeted for remediation.

The target certification 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. The target certification footprint of the aquifer (updated through 2011) is shown in Figure 3–3. The interpretation will be updated each year in the SER 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 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:

- *Feasibility Study Report for Operable Unit 5* (DOE 1995a).
- *Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)* (DOE 1997a).
- *Conceptual Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2000).
- *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001).
- *Design for Remediation of the Great Miami Aquifer, South Field (Phase II) Module* (DOE 2002b).
- *Waste Storage Area Phase II Design Report* (DOE 2005a) and the *Addendum to the Waste Storage Area (Phase II) Design Report* (2005b).

Summaries of how the aquifer remediation system has evolved through the issuance of each of these design documents can be found in previous years’ IEMPs.

A test was conducted in 2005 to gauge seasonal flow of water in the storm sewer outfall ditch (SSOD) and to determine if recharge to the Great Miami Aquifer through the SSOD at a rate of 500 gallons per minute (gpm) was feasible (DOE 2005c). As reported in the *Groundwater Remedy Evaluation and Field Verification Plan* (DOE 2004), infiltration through the SSOD at a rate of 500 gpm was predicted to decrease the cleanup time by 1 year. The study concluded, though, that the operation would not be cost effective. Subsequent discussions with EPA and Ohio EPA in 2006 led to an agreement to proceed with a scaled-down version of the operation. Clean groundwater is being pumped into the SSOD to supplement natural storm water runoff in an attempt to accelerate remediation of the South Plume. Three existing wells on the east side of the site are being utilized to deliver as much clean groundwater as is needed to maintain a flow of approximately 500 gpm into the SSOD. This supplemental pumping will continue until the existing wells, pumps, or motors are no longer serviceable. At that time, the operation will be suspended, pending a determination that the remedy is benefiting from the operation.

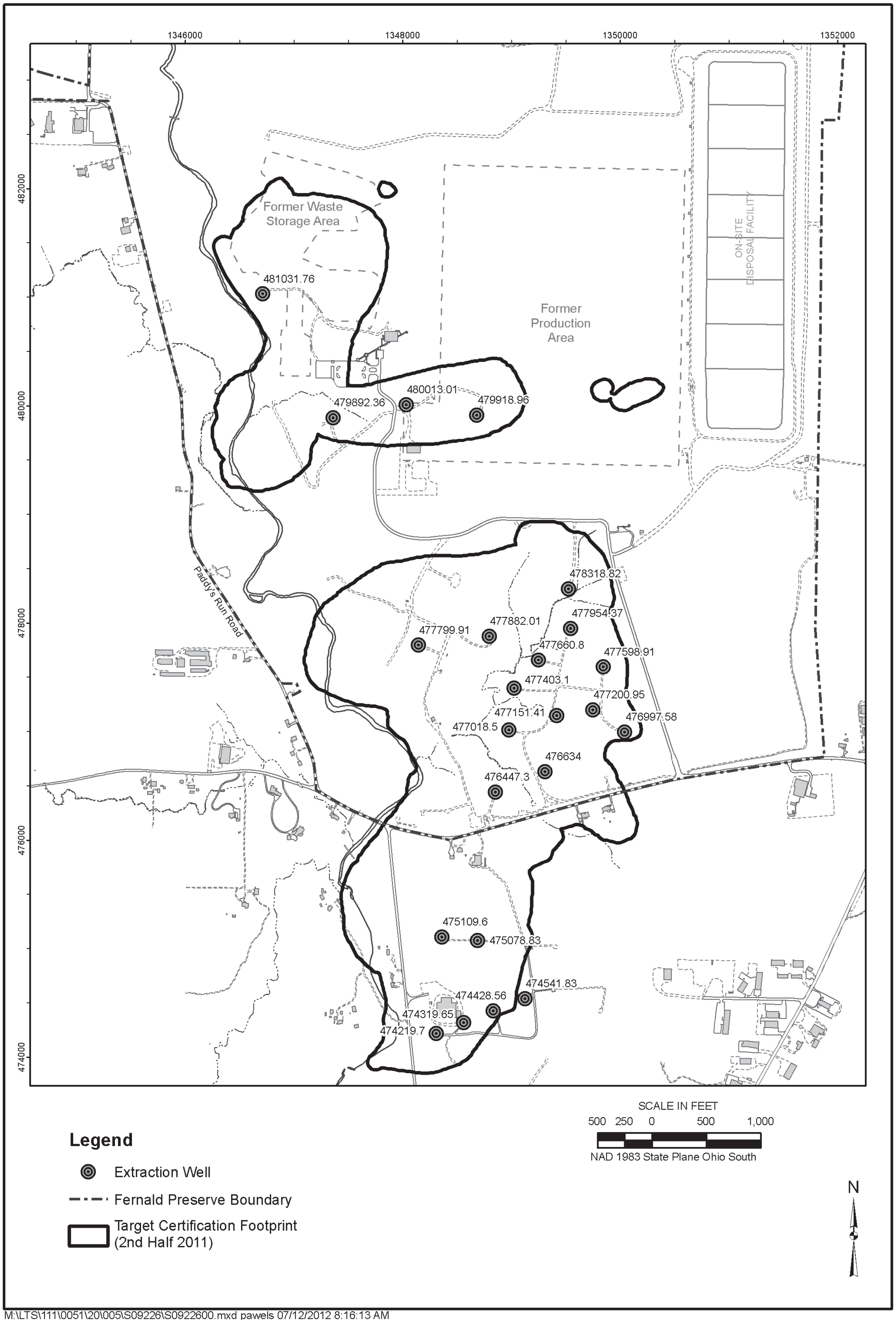

Figure 3–3. Extraction Well Locations

3.4.2.2 The Modular Approach to Aquifer Restoration

Restoration of the Great Miami Aquifer is being accomplished by operating 23 extraction wells in three area-specific groundwater restoration modules (South Plume Module, South Field Module, and Waste Storage Area Module) and a centralized water treatment facility (Figure 3–1). Figure 3–3 shows the locations of the extraction wells that these modules comprise.

<u>South Plume Module</u>
Six extraction wells (3924, 3925, 3926, 3927, 32308, and 32309).

<u>South Field Module</u>
Thirteen extraction wells (31550, 31560, 31561, 32276, 32446, 32447, 33061, 33262, 33264, 33265, 33266, 33298, and 33326).

<u>Waste Storage Area Module</u>
Four extraction wells (32761, 33062, 33334, and 33347).

For monitoring purposes, the aquifer is divided into five zones referred to as "aquifer zones" (see 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.

The locations of the extraction wells that constitute 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.

Reverse particle-path modeling predicts a hydraulic capture zone that is larger than the actual dimension of the 30-µg/L total uranium plume. The time-of-travel remediation footprint presented in this plan (see Figure 3–4) is based on the waste storage area (Phase II) design (2007 through 2023). This design remediation footprint was constructed using reverse, nonretarded, particle-path interpretations from the VAM3D Groundwater Model. The limits of most of the particle tracks are truncated because the particles reached the edge of the groundwater model domain.

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.

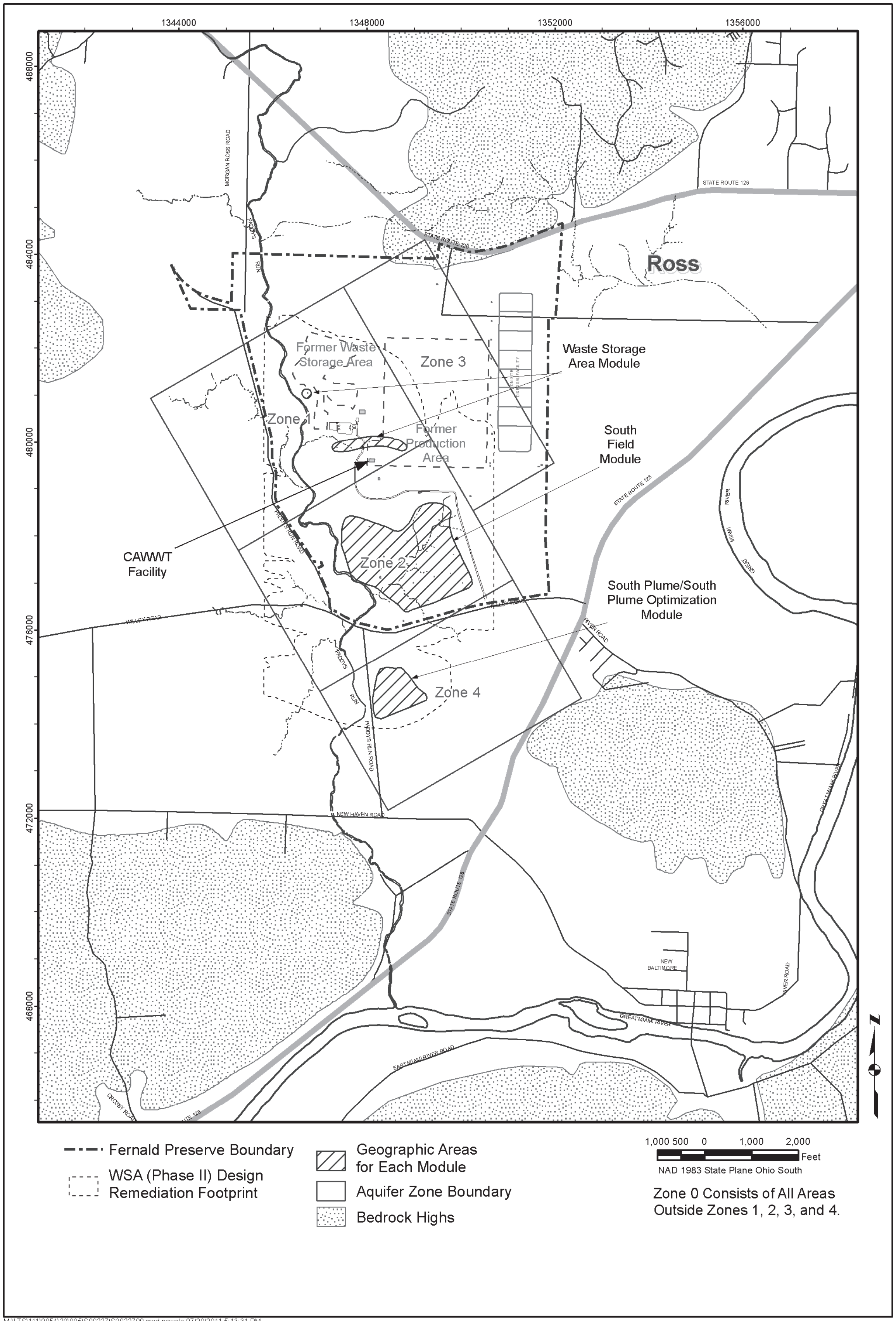

Figure 3–4. Groundwater Aquifer Zones and Design Remediation Footprint

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

- Monitor within the projected capture zone of the groundwater restoration operation unless an operational concern (e.g., the proximity of the South Plume extraction wells to the PRRS 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.
- 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.

142 wells at the Fernald Preserve are being sampled as identified in the following subsections.

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 have been presented in previous versions or the IEMP. Following is an overview.

Restoration of the aquifer will be verified against FRLs. The FRLs for the aquifer have been established in the OU5 ROD for 50 COCs. Groundwater monitoring focuses on these 50 FRL constituents to assess the progress of the aquifer remedy.

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 the inception of the IEMP. Constituents on the short list are monitored semiannually. Monitoring of 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 the IEMP program and contains the following information:

- Column 1 lists the 50 constituents for which FRLs were established in the OU5 ROD.
- Column 2 lists the FRL for each of the constituents.

- Column 3 identifies the basis for each FRL constituent (i.e., risk, ARAR, background, or detection limit) as defined in the OU5 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/OSDF wells along the eastern perimeter of the site and those wells along the eastern/southern boundary of the South Plume. The area identified as Property/Plume Boundary on Figure 3–5 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. 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 the area identified as Former Waste Storage Area on Figure 3–5 for the locations to be monitored in Zone 1.

Table 3–2. Groundwater FRL Exceedances Based on Samples and Locations Since IEMP Inception (from August 1997 through 2011)

(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	6536	1712	26.19%	1(21) 2(38) 3(3) 4(17)	30.13 J/2433 -
Zinc	0.021 mg/L	B	1714	92	5.37%	0(11) 1(5) 2(14) 3(5) 4(4)	0.0212 NV/13.6 –
Manganese	0.90 mg/L	B	2125	162	7.62%	0(6) 1(14) 2(10) 3(5) 4(4)	0.913 J/105 J
Nickel	0.10 mg/L	A	1947	23	1.18%	0(1) 1(3) 2(7) 3(1)	0.101 –/1.54 –
Technetium-99	94 pCi/L	R*	1758	90	5.12%	1(5)	98.2 –/1660 –
Nitrate[f]	11 mg/L	B	2156	108	5.01%	1(8) 2(1)[g]	11.4 –/331 NV
Lead	0.015 mg/L	A	1534	15	0.98%	0(3) 1(2) 2(4) 3(2)	0.0154 –/0.201 -
Arsenic	0.050 mg/L	A	1941	15	0.77%	0(1) 1(1) 2(1) 4(4)	0.051 –/0.125 –
Molybdenum	0.10 mg/L	A	1034	22	2.13%	1(1)	0.178 –/0.794 –
Boron	0.33 mg/L	R	2335	15	0.64%	2(2)	0.331 –/1.16 –
Antimony	0.0060 mg/L	A	1635	35	2.14%	0(15) 1(1) 2(6)4(2)	0.00601 –/0.0334 –
Trichloroethene	0.0050 mg/L	A	1454	29	1.99%	0(1)[h] 1(3) 4(1)[h]	0.00604 –/0.120 –
Carbon disulfide	0.0055 mg/L	A	1063	6	0.56%	0(1)[h] 1(3) 2(1)[h]	0.006 –/0.014 –
Fluoride	4 mg/L	A	1855	4	0.22%	0(2) 1(1) 3(1)	5.3 –/12.3 –
Vanadium	0.038 mg/L	R	955	1	0.10%	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	586	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	792	0	0%	NA	NA
Aroclor-1254	0.00020 mg/L	D	86	0	0%	NA	NA
Barium	2.0 mg/L	A	227	0	0%	NA	NA
Benzene	0.0050 mg/L	A	1056	0	0%	NA	NA
Beryllium	0.0040 mg/L	A	877	0	0%	NA	NA
Bis(2-chloroisopropyl) ether	0.0050 mg/L	D	480	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	792	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
Carbazole	0.011 mg/L	R	459	0	0%	NA	NA

Table 3–2 (continued). Groundwater FRL Exceedances Based on Samples and Locations Since IEMP Inception (from August 1997 through 2011)

(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]
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	967	0	0%	NA	NA
Copper	1.3 mg/L	A	119	0	0%	NA	NA
Mercury	0.0020 mg/L	A	2133	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	1080	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	792	0	0%	NA	NA

[a]From OU5 ROD, Table 9–4.
[b]From OU5 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 2011 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).
[h]Since the IEMP inception, there has been one isolated exceedance at two locations.
[i]Since the IEMP inception, there has been only one vanadium exceedance at well 2426 (in 1998).
[j]Of the 86 samples analyzed for bis(2-ethylhexyl)phthalate, a common laboratory containment, five had results above the FRL. The above-FRL results are all considered suspect due to laboratory analysis issues, laboratory blank and field blank contamination, or field duplicate results being nondetected. 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 matrix spike/matrix spike duplicate (MS/MSD) recoveries. In fact, the MS/MSD (i.e., spiked samples) results were both much less than the original sample result.

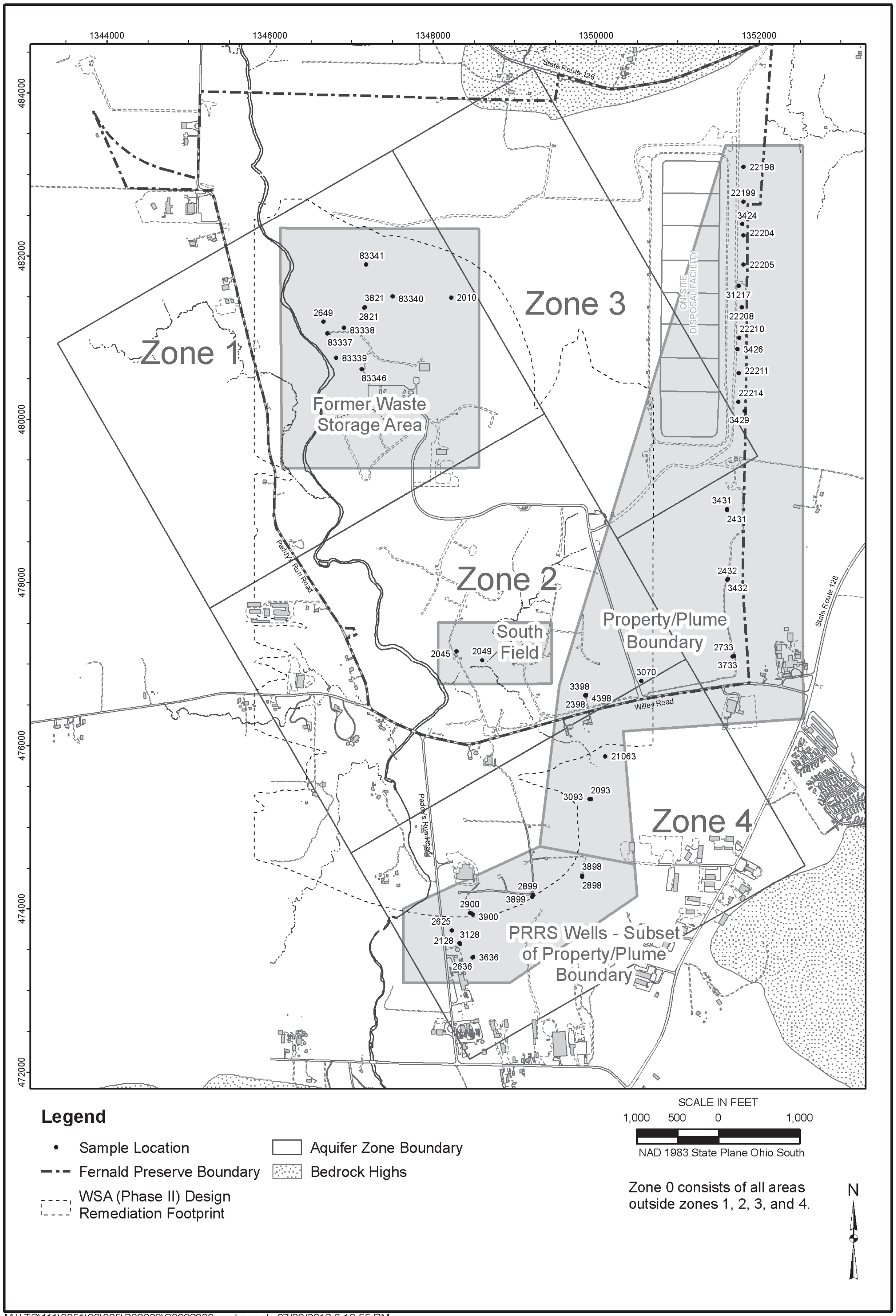

Figure 3–5. Locations for Semiannual Monitoring for Property/Plume Boundary, South Field, and Waste Storage Area

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.

   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 had 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 (Table 3–3).

3.5 Design of the IEMP Groundwater Monitoring Program

Monitoring 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.

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 startup 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.

<u>Annual Well Field Shutdown</u>
A 1- to 4-week shutdown of all extraction wells (with the exception of the four leading-edge South Plume recovery wells) will be conducted each year when water levels in the aquifer are seasonally high. Water levels in the aquifer are seasonally at their highest in late spring/early summer. Shutting down the extraction wells during this time period will allow water levels in the aquifer to rise as high as possible, resulting in the saturation of as much of the aquifer sediments as possible. The well field shutdown period will also be utilized to conduct well field and water treatment system maintenance.

Uranium concentrations will be measured at six monitoring wells (2045, 2046, 23274, 83124, 83294, and 83337) to support the shutdown activity. First-half of the year total uranium measurements will serve as pre-shutdown concentrations for the six wells. The six wells will be sampled just prior to restarting the extraction wells. Type 8 wells will be sampled in both Channel 1 and Channel 2.

The extraction wells will be sampled just prior to shutdown, and once a week during the shutdown. Wells will be operated for approximately 10 minutes prior to the collection of a groundwater sample. The extraction wells will be sampled daily for up to 4 days following restart of the extraction wells.

During the annual shutdowns, water level measurements will be recorded at selected locations using downhole pressure transducers. The transducers will be set to record a water level every hour on the top of the hour. Selected locations will be identified in the annual SER along with the collected data.

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]Manganese has consistent/recent exceedances 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

		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					

Table 3–4 (continued). List of IEMP Groundwater Monitoring Wells

		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
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	2649				2649	
38	2733	2733				
39	2821				2821	
40	2880					
41	2897					
42	2898	2898		2898		
43	2899	2899		2899		
44	2900	2900		2900		
45	3014					
46	3015					
47	3045					
48	3046					
49	3049					
50	3069					
51	3070	3070				
52	3093	3093				
53	3095					
54	3106					
55	3125					
56	3128	3128		3128		
57	3385					
58	3387					
59	3390					
60	3396					
61	3397					
62	3398	3398				
63	3402					
64	3424	3424				
65	3426	3426				
66	3429	3429				
67	3431	3431				

Table 3–4 (continued). List of IEMP Groundwater Monitoring Wells

		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**
68	3432	3432				
69	3550					
70	3552					
71	3636	3636		3636		
72	3733	3733				
73	3821				3821	
74	3880					
75	3897					
76	3898	3898		3898		
77	3899	3899		3899		
78	3900	3900		3900		
79	4125					
80	4398	4398				
81	6015					
82	6880					
83	6881					
84	21033					
85	21063	21063				
86	21192					
87	22198	22198	22198			
88	22199	22199	22199			
89	22204	22204	22204			
90	22205	22205	22205			
91	22208	22208	22208			
92	22210	22210	22210			
93	22211	22211	22211			
94	22214	22214	22214			
95	23064					
96	23118					
97	23271					
98	23272					
99	23273					
100	23274					
101	23275					
102	23276					
103	23277					
104	23278					
105	23279					
106	23280					
107	23281					
108	23282					
109	31217	31217				
110	32766					
111	32768					
112	62408					

Table 3–4 (continued). List of IEMP Groundwater Monitoring Wells

		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**
113	62433					
114	63116					
115	63119					
116	63283					
117	63284					
118	63285					
119	63286					
120	63287					
121	63288					
122	63289					
123	63290					
124	63291					
125	63292					
126	82433					
127	83117					
128	83124					
129	83293					
130	83294					
131	83295					
132	83296					
133	83335					
134	83336					
135	83337				83337[d]	
136	83338				83338[d]	
137	83339				83339[d]	
138	83340				83340[d]	
139	83341				83341[d]	
140	83346				83346[d]	
141	82369					
142	82372					

[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 PRRS monitoring wells.
[d] Volatile organic compounds are not sampled in Type 8 wells.

Table 3–5. IEMP Monitoring Requirements[a]

1. Total Uranium

2. Waste Storage Area

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

3. South Field

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

4. Property/Plume Boundary for FRL Exceedances

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

5. Property/Plume Boundary for PRRS
(These wells are also monitored for Property/Plume Boundary for FRL exceedances constituents)

General Chemistry	Inorganic	Radionuclides and Uranium	Organic
Phosphorous	Arsenic[d] Potassium Sodium	NA[c]	Benzene Ethylbenzene Isopropylbenzene Toluene Total xylenes

[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 in this IEMP are consistent with the requirements of the FPQAPP as the primary document that describes procedures and protocols for monitoring the Fernald Preserve.

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 Groundwater 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 the FPQAPP.

3.6.1.1 Total Uranium Monitoring

142 monitoring wells will be sampled semiannually for total uranium. 48 of these wells will be sampled for additional constituents as described in Sections 3.6.1.2 through 3.6.1.4. A list of the wells to be sampled for only total uranium is provided in Table 3–6 and shown in Figure 3–6. The wells extend across all aquifer zones and provide monitoring coverage in all restoration module areas. Figure 3–6 shows the locations of the monitoring wells.

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	6015	63289
2389	6880	63290
2390	6881	63291
2396	21033	63292
2397	21192	82369
2402	23064	82372
2550	23118	82433
2552	23271	83117
2553	23272	83124
2880	23273	83293
2897	23274	83294
3014	23275	83295
3015	23276	83296
3045	23277	83335
		83336

Note: The channel completed in the plume interval with the highest measured uranium concentration will be sampled every 6 months. The other channels will be sampled once a year to document any changes in the plume concentration profile.

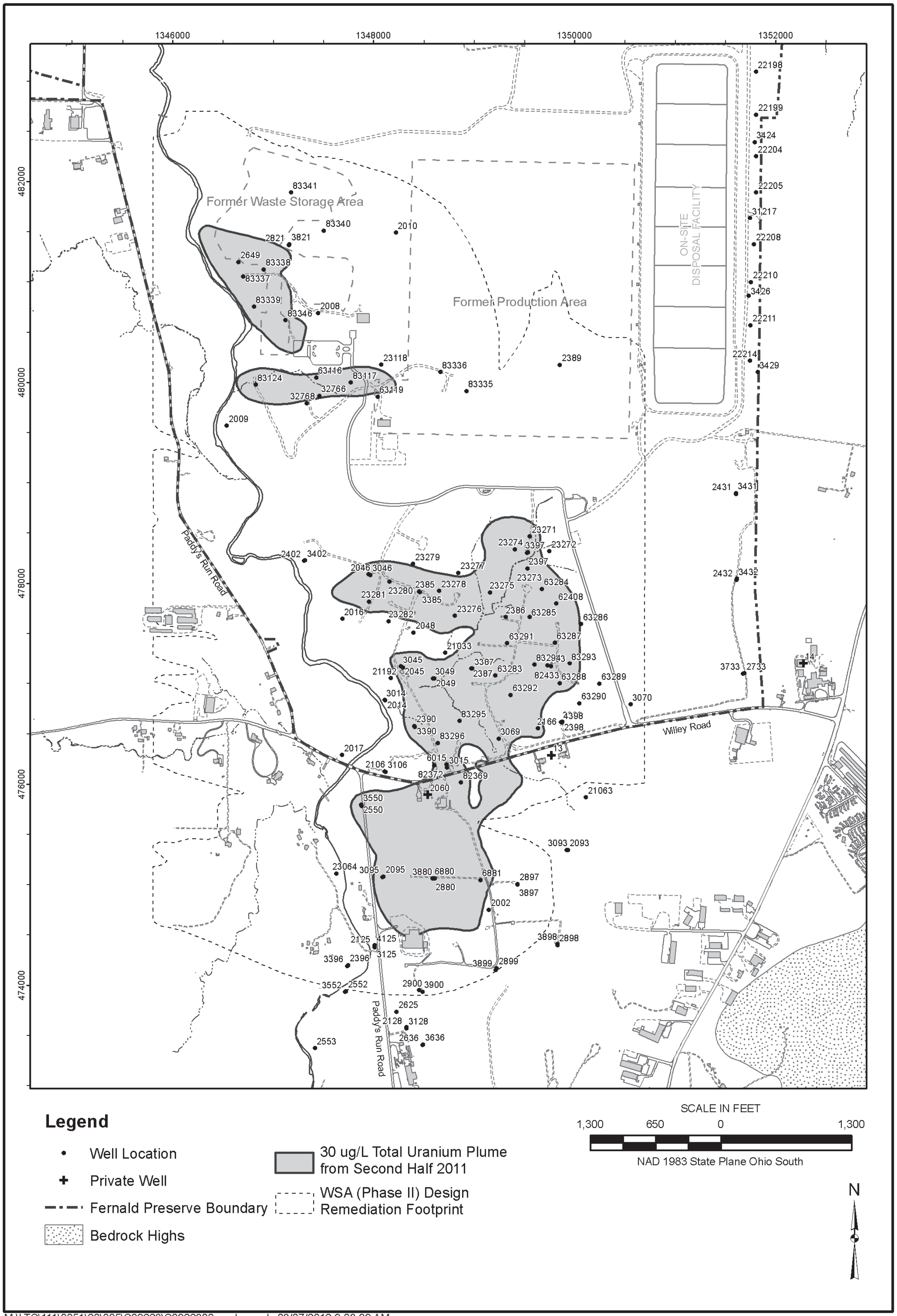

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Figure 3–6. *Locations for Semiannual Total Uranium Monitoring Only*

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 further southern migration of the total uranium plume, and the need 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 and identified in the SER. The selection process is based on monitoring well data, modeling needs, and data-interpretation needs.

Three private wells (2060 [12], 13, and 14) will be sampled for total uranium. Figure 3–6 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 immediately downgradient of the Fernald Preserve property boundary.

3.6.1.2 South Field Monitoring

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

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 as well as total uranium. The rationale for the selection of these wells and this additional constituent is presented in Section 3.4. Figure 3–5 shows the locations of these two wells. Following is the monitoring table:

South Field Monitoring Project Table
Semiannual Sampling Frequency

General Chemistry	Inorganic	Radionuclides and Uranium	Organic
NA	Boron	Total Uranium	NA

Up until 2011, direct-push sampling was conducted annually at five locations (12368, 12369, 12370, 12372, and 12373) along and south of Willey Road. These 5 locations were included in the 27 locations sampled yearly using direct-push technology. Figure 3–7 shows these locations. This annual direct-push sampling was used to help track remediation progress. At each direct-push location, a groundwater sample was collected at 10-foot intervals beneath the water table and analyzed for only uranium until it can be verified that the entire thickness of the 30-µg/L total uranium plume has been sampled.

Annual sampling of these locations was creating a problem in the field, in that it was becoming hard to find a location free of grout from multiple previous sampling efforts. Over the years, the plume has decreased so that currently only two locations remain within the 30 ug/L uranium plume (Locations 12372 and 12369). DOE installed multi-level monitoring wells at these two locations (82369 and 82372). The other locations that are no longer in the 30 ug/L uranium plume (Locations 12373, 12368, and 12370) will not be sampled again until the south plume certification stage of the groundwater remedy, unless it is deemed necessary to do so.

3.6.1.3 Waste Storage Area Monitoring

The waste storage area is located in Aquifer Zone 1 (refer to Figure 3–4). Four extraction wells (32761, 33062, 33347, and 33334) are operating in the waste storage area. Figure 3–3 shows the locations of these four wells.

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 10 wells listed below will be sampled semiannually (refer to Figure 3–5 for the locations of these 10 wells).

Monitoring Wells to Be Monitored Semiannually
In the Waste Storage Area

2010	2649	2821	3821	83337
83338	83339	83340	83341	83346

The four Type 2 and Type 3 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. The six Type 8 wells will also be sampled for the constituents listed in the table below, with the exception of the organics. Type 8 wells will not be used to sample for organics. The six Type 8 wells listed above for the waste storage area are three-channel CMT wells. All three channels will be sampled semiannually.

Waste Storage Area Monitoring Project Table
Semiannual Sampling Frequency

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

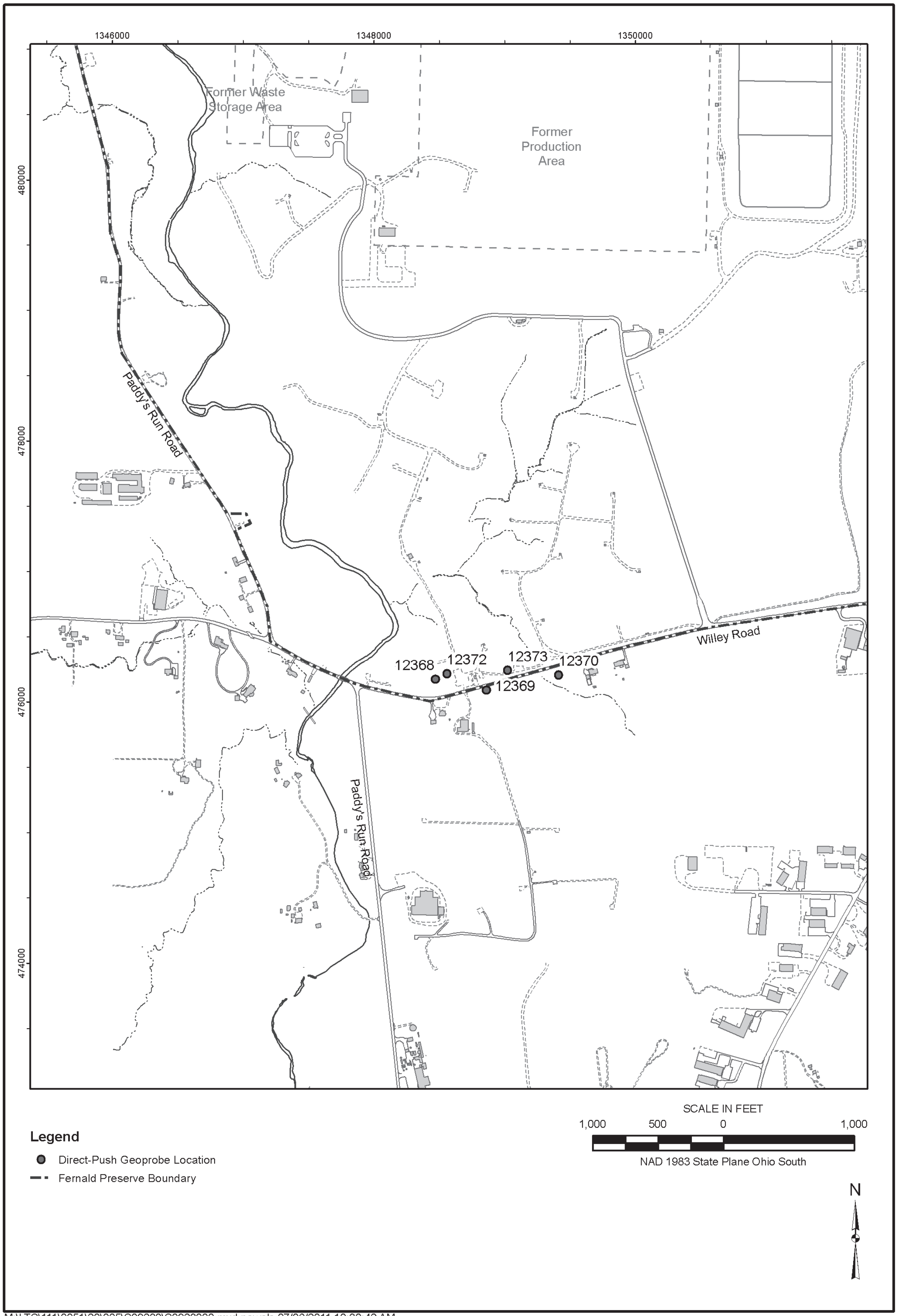

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Figure 3–7. Direct Push Sampling Locations

As explained in Section 3.6.1.7, filtering of groundwater samples at monitoring wells may take place on a case-by-case basis if deemed appropriate.

> Note: *Filtering of groundwater samples using a 0.45-micrometer (µm) filter was deemed appropriate for monitoring well 2010 because the well had shown evidence of being biofouled in the past. A discussion of the biofouling problem at monitoring well 2010 is presented in the Addendum to the Waste Storage Area (Phase II) Design Report (DOE 2005b). The pump was replaced in monitoring well 2010 in 2009, and the turbidity of the well decreased dramatically. With the new pump, filtering of the samples is no longer required.*

Locations may also be sampled in the waste storage area, 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 to produce more robust plume interpretations. Direct-push locations in the waste storage area will be sampled for the waste storage area monitoring semiannual constituents listed below, excluding the organic constituents. Location numbers and collected data will be provided in each annual SER.

A direct-push sample will be collected prior to any filtering and will be analyzed for nitrate/nitrite. The remainder of the samples (manganese, molybdenum, nickel, total uranium, and technetium-99) will, at a minimum, be filtered through a 5-µm filter.

If the turbidity of the 5-µm filter direct-push sample is below 5 nephelometric turbidity units (NTUs), the remaining five constituents will be sampled. If the turbidity of the 5-µm filtered direct-push sample is above 5 NTUs, the sample will be further filtered through a 0.45-µm filter. Both the 5-µm and the 0.45-µm filtered sample will be analyzed for total uranium, and the four remaining constituents will be analyzed from the 0.45-µm filtered sample only.

3.6.1.4 Property/Plume Boundary Monitoring

The focus of the Property/Plume Boundary Groundwater Monitoring project 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 Preserve property.

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 PRRS plume will be documented. Monitoring will also reduce redundancy with OSDF monitoring prescribed in the GWLMP.

<u>Property/Plume Boundary Monitoring for FRL Exceedances</u>
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 3–5 shows the locations of the wells.

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.

Eight of the 25 monitoring wells (22204, 22205, 22208, 22198, 22211, 22214, 22210, and 22199) are also sampled for OSDF constituents listed in the GWLMP.

Property/Plume Boundary Monitoring Wells to be Monitored for FRL Exceedances Only

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

Property Plume Boundary Monitoring Table for FRL Exceedances, Semiannual Sampling Frequency

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

Property/Plume Boundary Monitoring for Paddys Run Road Site Constituents

Groundwater is being pumped from the aquifer immediately north of the PRRS (extraction wells 3924, 3925, 3926, and 3927); it remains important to document the influence (or lack of influence) that the pumping has on the PRRS plume. Groundwater samples will be collected semiannually from 11 monitoring wells (refer to Figure 3–5).

The 11 wells are:

2128	2899	3898
2625	2900	3899
2636	3128	3900
2898	3636	

These 11 wells will be analyzed for PRRS constituents as well as for IEMP FRL exceedance constituents. The PRRS constituents listed below are 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	Radionuclides and Uranium	Organic
Fluoride	Antimony	Total Uranium	Benzene
Phosphorous	Arsenic		Ethylbenzene
	Lead		Isopropylbenzene
	Manganese		Toluene
	Nickel		Total Xylenes
	Potassium		
	Sodium		
	Zinc		

If pumping rates of wells in the South Plume Module are increased above rates established in 1998 (maximum pumping rates listed in Table 5–1 of the OMMP under the objective of minimizing the impact to the PRRS plume), then arsenic sampling will be conducted weekly in monitoring wells 2128, 2625, 2636, and 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 PRRS plume. The weekly sampling will be done for a minimum of 3 weeks after a pumping rate increase; if no changes in arsenic concentration trends are observed, the increased arsenic sampling will be discontinued. Figure 3–5 identifies the locations of these monitoring wells.

3.6.1.5 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.

3.6.1.6 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 OU5. Water level data have been routinely collected at the Fernald Preserve 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. 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 Preserve and reported in the OU5 Remedial Investigation Report (DOE 1995c) document that no strong vertical gradients exist in the area of the Fernald Preserve. 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 the top and bottom channels. If the top channel is dry, a measurement will be collected from the next deeper channel that is not dry.

179 monitoring wells are available for measurement, as shown in Figure 3–8 and are listed in Table 3−7. In the second quarter of each year, water levels at all 179 wells will be measured, for the other three quarters 102 of 179 wells will be measured. The 102 wells are identified in Table 3–7 (bold font and shading). Groundwater elevation monitoring locations were selected to provide areal coverage across the Fernald Preserve with an increasing density of wells in areas surrounding active aquifer restoration wells. Groundwater elevations will be measured quarterly 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 if sensitive capture zones or stagnation zones are identified, or if unpredicted fluctuations in contaminant concentrations are observed.

3.6.1.7 Sampling Procedures

Sample analysis will be performed either on site or at off-site contract laboratories, depending on specific analyses required, laboratory capacity, turnaround time, and performance of the laboratory. The laboratories used for analytical testing have been audited to ensure that Department of Energy Consolidated Audit Program (DOECAP) or equivalent process requirements have been met as specified in the FPQAPP. These criteria include meeting the requirements for performance evaluation samples, pre-acceptance audits, performance audits, and an internal quality assurance program.

All monitoring wells will be purged and sampled using the requirements specified in the FPQAPP, which have been incorporated into the *Fernald Preserve Environmental Monitoring Procedures* (DOE 2011a).

Table 3–8 summarizes the field sampling information by analytical constituent groups and includes the analytical support level (ASL), holding times, preservatives, container requirements, and analytical methods. Groundwater samples collected at monitoring wells are not routinely filtered.

Not filtering groundwater samples collected at monitoring wells is a conservative (and EPA-recommended) approach to determining the true mobility of metals and uranium in groundwater. Filtering of groundwater samples at monitoring wells may take place on a case-by-case basis if deemed appropriate.

If filtering is conducted, the reasons for filtering will be provided to the EPA and Ohio EPA as soon as possible and will be documented annually in the SER.

Table 3–7. List of Groundwater Elevation Monitoring Wells[a]

80	**2389**	**3045**	22204	32307
81	**2390**	3046	22205	**32766**
2002	**2394**	3049	22206	**32768**
2009	2396	3065	**22207**	41217
2010	2397	3069	**22208**	62408
2014	2398	**3070**	22209	**62433**
2016	2399	3095	22210	**63116**
2017	**2402**	3106	22211	**63119**
2043	2424	3125	22212	63283
2044	**2431**	3385	**22213**	**63284**
2045	**2432**	3387	**22214**	63285
2046	2434	3390	22215	**63286**
2048	**2436**	3396	22217	63287
2049	**2544**	3398	22299	63288
2051	**2545**	3402	22300	63289
2052	**2546**	3550	22301	63290
2065	**2550**	3552	**22302**	**63291**
2071	**2552**	3821	**22303**	**63292**
2091	**2553**	**3880**	**23064**	**82369**[b]
2092	**2625**	**3881**	**23118**	**82372**[b]
2093	**2636**	3900	**23271**	82433[b]
2095	**2649**	4424	23272	**83117**[b]
2096	**2679**	4426	23273	**83124**[b]
2106	**2702**	4432	23274	**83293**[b]
2107	**2733**	**6015**	**23275**	83294[b]
2108	**2821**	21033	23276	**83295**[b]
2119	2880	**21063**	23277	83296[b]
2125	2881	**21064**	23278	**83335**[b]
2126	**2897**	**21065**	**23279**	**83336**[b]
2128	**2898**	**21192**	23280	**83337**[b]
2166	**2899**	21194	**23281**	**83338**[b]
2383	**2900**	22198	**23282**	**83339**[b]
2384	**3011**	22199	31217	**83340**[b]
2385	**3014**	22200	**32304**	**83341**[b]
2386	3015	**22201**	32305	**83346**[b]
2387	3017	22203	32306	

[a] Bold font and shading identifies the subset of 102 wells measured the first, third, and fourth quarters of each year.
[b] Multichannel wells will have water level measurements taken in the top and bottom channels. If the top channel is dry, a measurement will be collected from the next deeper channel that is not dry.

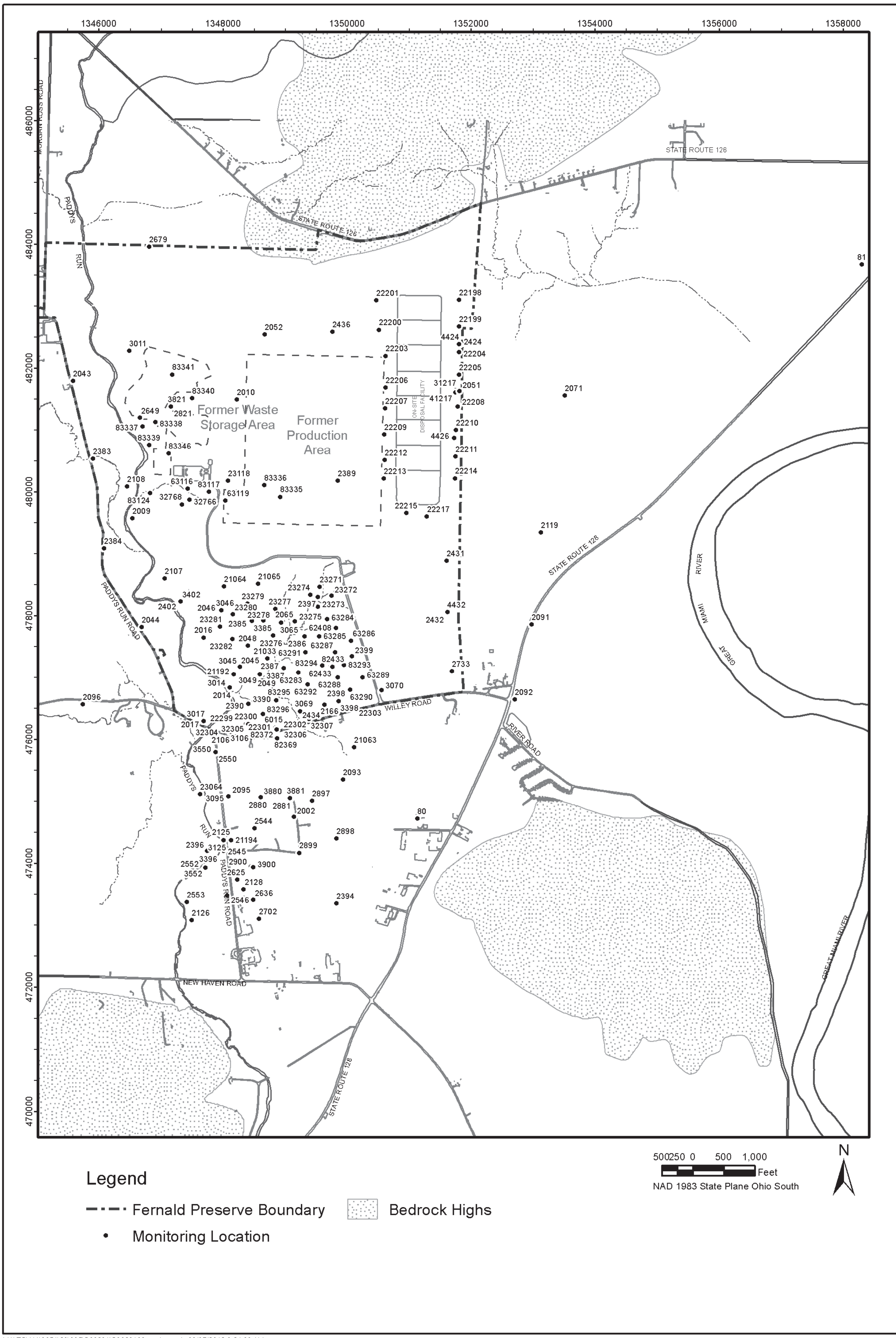

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Figure 3–8. Groundwater Elevation Monitoring Wells

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Table 3–8. Analytical Requirements for the Groundwater Monitoring Program

Constituent	Analytical Method	Sample Type	ASL	Holding Time[a]	Preservative[a]	Container[a,b]
General Chemistry:						
Fluoride	300.0[c], 340.2[c], 4500C[d], or 9056[e]	Grab	D	28 days	None	Plastic
Nitrate/Nitrite	353.1[c], 353.2[c], or 4500D,E,H[e]	Grab	D	28 days	Cool to 4°C, H_2S0_4 to pH <2	Plastic or glass
Phosphorus	365.(all)[c] or 4500E[d]	Grab	D	28 days	Cool to 4°C, H_2S0_4 to pH <2	Plastic or glass
Inorganics:						
Metals	6020[e], 7000A[e], or 6010B[e]	Grab	D	6 months	HNO_3 to pH <2	Plastic or glass
Radionuclides and Uranium:						
Technetium-99	DOE-EML HASL 300†	Grab	D	6 months or 5 × half-life, whichever is less	HNO_3 to pH <2	Plastic or glass
Total Uranium	6020[e]	Grab	D	6 months	HNO_3 to pH <2	Plastic or glass
Volatile Organics[h]:	8260B[e]	Grab	D	NA[i]	Cool to 4°C	NA[i]
		Grab	D	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[g]:	FPQAPP[h]	Grab	A	NA[i]	NA[i]	NA[i]

Note: The analytical site-specific contract identifies the specific method.

[a] Appropriate preservative, holding time, and container will be used for the corresponding method.
[b] Container size is left to the discretion of the individual laboratory.
[c] *Methods for Chemical Analysis of Water and Wastes* (EPA 1983).
[d] *Standard Methods for the Examination of Water and Wastewater* (APHA 1989).
[e] *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA 1998).
[f] *Procedures Manual of the Environmental Measurements Laboratory* (DOE 1997b).
[g] Field parameters are dissolved oxygen, pH, oxidation-reduction potential, specific conductance, temperature, and turbidity.
[h] The FPQAPP provides field analytical methods.
[i] NA = not applicable.

Due to the temporary nature of direct-push sampling locations and the smaller amount of development that takes place compared to a monitoring well, direct-push samples are often turbid. Therefore, direct-push groundwater samples are routinely filtered through a 5-µm filter. Past experience has shown that measured uranium concentrations in direct-push samples are consistently similar regardless of whether the sample was filtered using a 5-µm filter or a 0.45-µm filter. Therefore, direct-push samples for uranium analysis are routinely filtered through a 5-µm filter only. Exceptions to this filtering procedure include the collection of waste storage area parameters as discussed in Section 3.6.2.3.

3.6.1.8 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 the FPQAPP. These samples will be collected and analyzed to evaluate the possibility that some controllable practice, such as equipment 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 rinsate blanks, trip blanks, and duplicate samples. Each quality control sample is preserved using the same method as groundwater samples.

The quality control sample frequencies will be tracked to ensure that 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. They will be prepared before the sampling containers enter the field and will be taken into the field and handled along with the collected samples. Trip blanks will not be opened in the field.
- Equipment rinsate blanks 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. Rinsate blanks are not required when dedicated well equipment or disposable sampling equipment is used.
- Field duplicates will be collected for every 20 or fewer groundwater samples if the specific sampling program consists of fewer than 20 samples. For direct-push sampling locations, one duplicate will be collected at a chosen depth per location.

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

3.6.1.9 Decontamination

In general, decontamination of equipment is minimized by limited use of reusable equipment during sample collection. However, if decontamination is required, then sampling equipment will be cleaned between sample locations. The decontamination requirements are identified in the FPQAPP.

3.6.1.10 Waste Disposition

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

<u>Purge Water and Decontamination Solutions:</u> All decontamination wastewater and purge water will be containerized and disposed of through the Converted Advanced Wastewater Treatment Facility (CAWWT) for treatment. The point of entry into the CAWWT will be either the CAWWT backwash basin or the OSDF permanent lift station.

<u>Contact Wastes:</u> Contact wastes, such as personal protective equipment, paper towels, and other solid waste is typically not contaminated with radiological constituents and is placed in plastic bags and disposed of through the normal sanitary waste stream.

3.6.1.11 Monitoring Well Maintenance

Monitoring wells at the Fernald Preserve will be maintained to keep them in a condition that is protective of the subsurface environment and to ensure that representative groundwater samples can be obtained. Two types of activities are recognized: well maintenance inspections and well evaluations.

<u>Well Maintenance Inspections</u>
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. 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.
- 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; 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.
- Inspecting concrete surface seals for settling and cracking.
- Inspecting the exterior guards for visibility and damage, and repainting if necessary.

<u>Well Evaluation</u>
A monitoring well evaluation will be initiated if there is an indication that the monitoring well may no longer be yielding a representative groundwater sample. A monitoring well may no longer be yielding a representative groundwater sample for several reasons. The well's integrity

may be compromised, as determined through the well maintenance inspections discussed above. The downhole integrity of the monitoring well may be compromised, as evidenced through an increase in the turbidity of the collected sample or the amount of sediment measured in the bottom of the well. The bioaccumulation of metals around the well screen may be occurring as evidenced by the cloudiness or coloration of the collected water sample or the odor of the collected sample. If a problem is suspected, then the following work may be performed to evaluate the cause:

- 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 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 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.
- Noting if an odor that could be associated with biofouling (i.e., rotten-egg or fish odor) is present.

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 or that metals can bioaccumulate around well screens. If it is determined that minerals have precipitated in the well or on the well screen, or that metals have bioaccumulated around the well screen, and the representativeness of the groundwater sample is being impacted, then the limited use of chemicals (e.g., chlorine, hydrochloric acid) to remove the mineral build-up or alleviate the biofouling may be considered. CMT wells could probably not be rehabilitated due to the small diameters of the sampling channels. 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 [oxidation-reduction 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. A replacement monitoring well will only be installed if the monitoring well that was plugged and abandoned was being actively monitored for either water quality or water levels. Any preliminary decision not to replace a monitoring well will be discussed with the EPA and Ohio EPA prior to finalizing the decision.

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. 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 SER, 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.

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 sampling results, 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. EPA and Ohio EPA have indicated 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 Preserve property boundary.
- Assess model predictions.
- Assess the impact that the aquifer restoration is having on the PRRS plume.
- Meet other monitoring commitments.
- Address community concerns.

The aquifer restoration system is designed to reduce the concentration of uranium and non-uranium FRL constituents in the aquifer to concentrations that are at or below their FRLs. 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. Operational changes to meet non-uranium FRLs 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 the aquifer remediation period 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 is 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.
- 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 startup plans will provide specifics on the frequency of water level and water quality data collection during the startup time period.

Capturing and Restoring the Areas Affected by Non-uranium FRL Exceedances
The OU5 ROD 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 FRLs will be monitored semiannually.

Non-uranium FRL constituent 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. Concentration 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.
- 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 1997c) 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 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 Preserve activities (either historical or current), then action will be taken to address the exceedance.

<u>Meeting Other Monitoring Commitments</u>
Other groundwater monitoring commitments that need to be addressed are private well sampling, property boundary monitoring, and fulfillment of DOE Order 450.1A 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 Preserve 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 SERs, fulfills DOE Order 231.1 requirements.

<u>Groundwater Modeling</u>
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. Monitoring wells in the remediation footprint of the aquifer will be included in the residuals exercise. Assessments will be conducted every five years. Results of the first assessment were provided in the *2005 Fernald Preserve Site Environmental Report (DOE 2006b)*. Results of the second assessment were provided in the *2010 Fernald Preserve Site Environmental Report* (DOE 2011c). A brief summary of background information on the groundwater model can be found in previous versions of the IEMP.

<u>Assess the Impact that the Aquifer Restoration Has on the Paddys Run Road Site Plume</u>
As was done since 1997, concentration data collected for key PRRS 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.

<u>Adequately Address Community Concerns</u>
The IEMP fulfills the informational needs of the Fernald community by preparing groundwater environmental results in the annual SER. DOE makes these reports available to the public. 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

A Groundwater Certification Plan has been prepared for the groundwater remedy. The objective of the Certification Plan is to document the process that will be followed to certify that aquifer remedy objectives have been met. As explained below, pump-and-treat operations are currently in progress at the Fernald Preserve. 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

Remedy performance monitoring is currently supporting 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 OMMP. 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 Preserve to obtain groundwater samples without the use of a permanent monitoring well.

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.

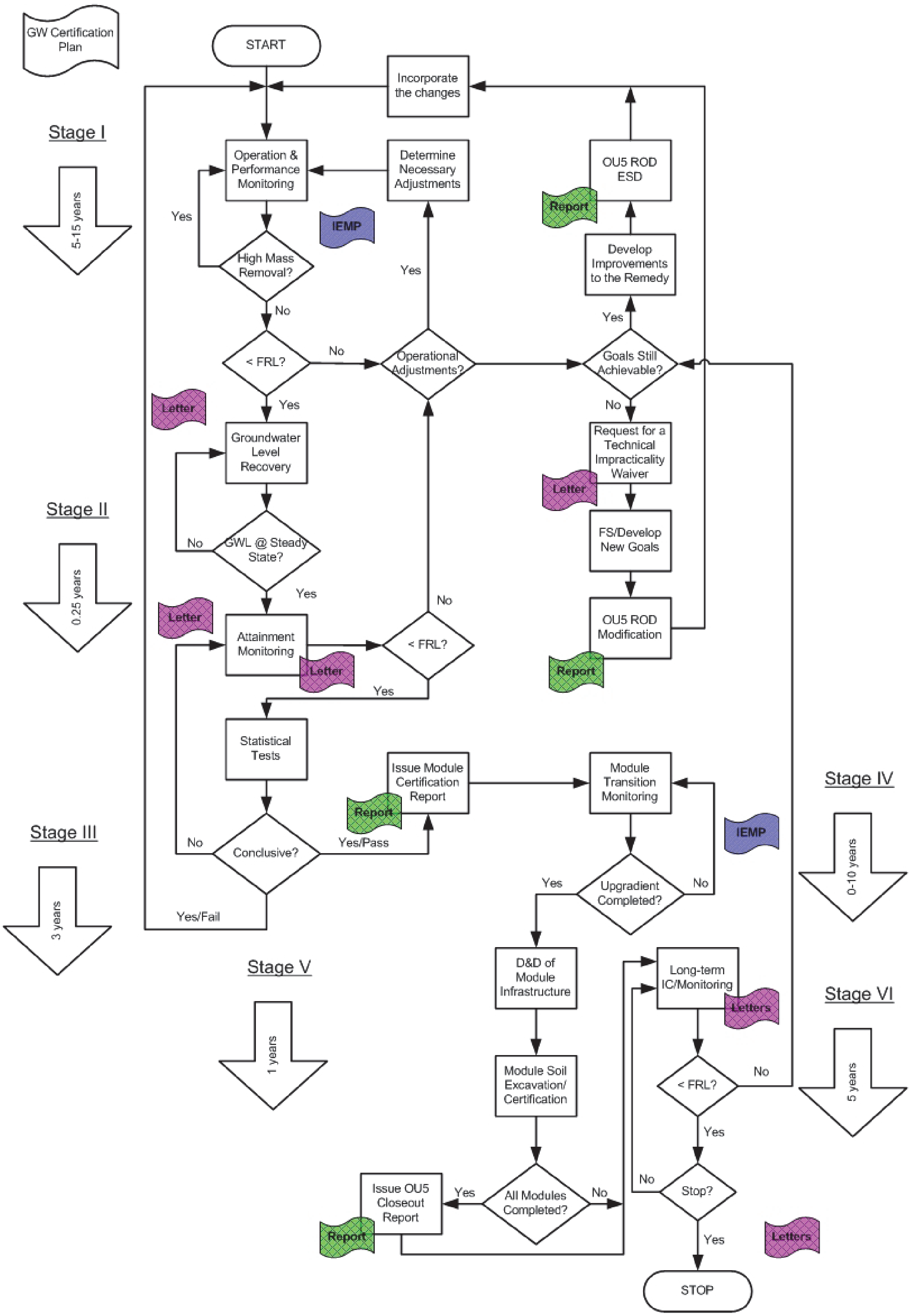

Figure 3–9. Groundwater Certification Process and Stages

3.7.2 Reporting

The IEMP groundwater program data will be reported in the annual SER and posted on the LM website at http://www.lm.doe.gov/fernald/Sites.aspx. Data on the website will be in the format of searchable data sets and downloadable data files. Additional information on IEMP data reporting is provided in Section 6.0.

The annual SER will be issued each June for the previous calendar year. This comprehensive report discusses a year of IEMP data previously reported on the LM website. The report includes the following:

<u>Operational Assessment</u>

- 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.

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 pumping had on the PRRS 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* (DOE 1997a).
- Any changes that may have been made to the operation or design.

Data that Support the OSDF Groundwater/Leak Detection and Leachate Monitoring Plan

- Status information pertaining to the OSDF wells along with baseline data summaries.
- Leachate volumes and concentrations from the leachate collection system and from the leak detection system for the OSDF.
- Results of quarterly groundwater sampling.

In addition, the annual SER will include trend analysis of the data collected from the OSDF.

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 activities. Any program modifications that may be warranted prior to the annual review would be communicated to EPA and Ohio EPA.

4.0 Surface Water, Treated Effluent, and Sediment Monitoring Program

Section 4.0 discusses the monitoring strategy for assessing sitewide surface water, treated effluent, and sediment. The strategy includes compliance-based monitoring and reporting obligations, a medium-specific plan, sampling design, and data evaluation.

4.1 Integration Objectives for Surface Water, Treated Effluent, and Sediment

The IEMP is the designated mechanism for conducting the sitewide surface water, treated effluent, and sediment surveillance and compliance monitoring. In this role, the IEMP serves to integrate several compliance-based monitoring and reporting programs currently in existence for the Fernald Preserve:

- The discharge monitoring and reporting program related to the site's NPDES permit.
- The radiological monitoring of and reporting for the treated effluent mandated by the OU5 ROD.
- The IEMP Characterization Program, which combines portions of the former Environmental Monitoring Program that has been ongoing at the Fernald Preserve since the 1950s and was updated in Revision 0 of the IEMP (DOE 1997d), to accommodate surface water monitoring during the post-closure period.
- The radiological monitoring of and reporting for off-property sediment mandated by the OU5 ROD.

4.2 Analysis of Regulatory Drivers, DOE Policies, and Other Fernald Preserve Site-Specific Agreements

This section presents a summary evaluation of the regulatory drivers governing the monitoring of the Fernald Preserve's point-source and non-point-source discharges to Paddys Run and the Great Miami River and also includes post-closure sediment monitoring. The intent of this section is to identify the pertinent regulatory requirements for the scope and design of the surface water, treated effluent, and sediment monitoring program. These requirements will be used to confirm that the program satisfies the regulatory obligations for monitoring that have been activated by the RODs and will achieve the intentions of other pertinent criteria, such as DOE orders and the Fernald Preserve's existing agreements and permits, as appropriate, that have a bearing on the scope of surface water, treated effluent, and sediment monitoring.

4.2.1 Approach

The analysis of the regulatory drivers and policies for surface water, treated effluent, and sediment monitoring was conducted by examining the ARARs and CERCLA RODs to identify subsets with specific environmental monitoring requirements. The Fernald Preserve's existing compliance agreements issued outside the CERCLA process were also reviewed.

4.2.2 Results

The surface water, treated effluent, and sediment monitoring program described in this IEMP has been developed with full consideration of the regulatory drivers and policies. Table 4–1 lists each of these IEMP drivers and the associated actions conducted to comply with them. A brief summary of regulatory drivers and policies has been provided in previous IEMPs. Sections 4.5 and 6.0 provide the Fernald Preserve's current and long-range plan for complying with the reporting requirements invoked by these drivers.

Table 4–1. Fernald Preserve Surface Water, Treated Effluent, and Sediment Monitoring Program Regulatory Drivers and Actions

	Driver	Action
IEMP	DOE Order 450.1A, environmental monitoring plan for all media	The IEMP describes treated effluent and surveillance monitoring as required by DOE Order 450.1A.
	DOE Order 5400.5, *Radiation Protection of Public and Environment*	The IEMP includes a description for routine sampling of Paddys Run and on-site drainage ditches for radiological constituents.
	CERCLA Remedial Design Work Plan (DOE 1996c)	The IEMP describes treated effluent and surveillance monitoring as required by DOE Order 450.1A.
	OU5 ROD	The IEMP will be modified toward completion of the remedial action to include surface water sampling to certify FRL achievement. The IEMP includes monitoring for performance-based uranium discharge limits.
	OU5 Feasibility Study/OU5 ROD	The IEMP will be modified toward completion of the remedial actions to include sediment sampling to verify FRL achievement.
	NPDES Permit	The IEMP describes routine sampling of permit-designated treated effluent discharges and storm water drainage points for NPDES permit constituents.
	Federal Facilities Compliance Agreement Radiological Monitoring	The IEMP describes the routine sampling at the Parshall Flume (PF 4001) for radiological constituents.

Note: Soil and sediment at the Fernald Preserve have been certified, with the exception of those areas identified in Figures 2–1 and 2–2. Therefore, it is not expected that FRL exceedances will occur in association with uncontrolled runoff.

4.3 Program Expectations and Design Considerations

4.3.1 Program Expectations

The expectations for the surface water and treated effluent monitoring program are to:

- Provide an ongoing assessment of the potential for cross-medium impacts from surface water to the underlying Great Miami Aquifer at locations near the point where the protective glacial overburden has been breached by site drainages.
- Document whether the sporadic exceedances of FRLs in various site drainages (noted in IEMP reports) continue to occur at key on-site locations, at the property boundary on Paddys Run, and in the Great Miami River outside the mixing zone, and determine if monitoring can be reduced based on surface water data results.

- Provide an assessment of impacts to surface water due to uncontrolled runoff.
- Provide additional data at background locations on Paddys Run and the Great Miami River to refine the ability to distinguish site impacts from background.
- Continue to fulfill monitoring and reporting requirements associated with the site NPDES permit.
- Continue to fulfill monitoring and reporting requirements associated with the FFCA and OU5 ROD.
- Continue to fulfill DOE Order 450.1A requirements to maintain an environmental monitoring plan for surface water.
- Continue to address the concerns of the community regarding the magnitude of the Fernald Preserve's discharges to surface water (i.e., to Paddys Run and the Great Miami River).

The expectations for the sediment monitoring program are to:

- Continue monitoring sediment in the Great Miami River to confirm that the river is not being impacted by Fernald Preserve effluent discharges.
- Confirm that remediation of sediment in the Great Miami River is unnecessary and fulfill the OU5 Feasibility Study conclusion/recommendation.

The following section provides the design considerations required to fulfill these expectations.

4.3.2 Design Considerations

This section provides the IEMP surface water, treated effluent, and sediment monitoring program design considerations. The nonradiological discharge monitoring and reporting related to the NPDES permit has been incorporated into the IEMP. The radiological discharge monitoring related to the FFCA and OU5 ROD has been incorporated into the IEMP.

4.3.2.1 Constituents of Concern

A comprehensive list of surface water COCs is presented in Table 4–2. The following is a description of information provided in Table 4–2.

- Column 1, Constituent: This column represents the constituents for which an FRL was established in the OU5 ROD.
- Column 2, Final Remediation Levels: This column represents the human/health protective remediation levels for surface water that were established in the OU5 ROD.
- Column 3, FRL Basis: This column is the basis for establishment of the FRL as defined in the OU5 Feasibility Study.
- Column 4, Background Values in Surface Water: This column represents updated 95th percentile background values for Paddys Run and the Great Miami River based on data collected for the IEMP through 2011 (Revised). In addition, the original 95th percentile background values are provided from the *Remedial Investigation Report for Operable Unit 5* (DOE 1995c). The IEMP provides this information for purposes of comparison.

Table 4–2. Surface Water Selection Criteria Summary

			95th Percentile Background Level in Surface Water[b,c]			
			Paddys Run		Great Miami River	
Constituent	**FRL[a]**	**FRL Basis[a]**	**Original**	**Revised**	**Original**	**Revised**
General Chemistry (mg/L)						
Fluoride	2.0	A	0.22	0.091	0.9	0.504
Nitrate/Nitrite	2400	R	1.7	4.90	6.6	7.87
Inorganics (mg/L)						
Antimony	0.19	A	ND	0.0012	ND	0.00175
Arsenic	0.049	R	ND	0.00616	0.0036	0.0139
Barium	100	R	0.053	0.0545	0.1	0.100
Beryllium	0.0012	A	ND	0.0003	ND	0.0009
Cadmium	0.0098	B	ND	0.00074	0.01	0.000221
Chromium (VI)[d]	0.010	D	ND	0.00890	ND	0.00842
Copper	0.012	A	ND	0.00575	0.012	0.00910
Cyanide	0.012	A	ND	0.00367	0.005	0.00412
Lead	0.010	B	ND	0.00568	0.010	0.00840
Manganese	1.5	R	0.035	0.238	0.08	0.117
Mercury	0.00020	D	ND	0.000104	ND	0.000075
Molybdenum	1.5	R	ND	0.00328	0.02	0.00902
Nickel	0.17	A	ND	0.00792	0.023	0.0105
Selenium	0.0050	A	ND	0.00254	ND	0.00293
Silver	0.0050	D	ND	0.000656	ND	0.000348
Vanadium	3.1	R	ND	0.0188	ND	0.00671
Zinc	0.11	A	ND	0.0292	0.045	0.0428

Table 4–2 (continued). Surface Water Selection Criteria Summary

			95th Percentile Background Level in Surface Water[b,c]			
			Paddys Run		Great Miami River	
Constituent	**FRL[a]**	**FRL Basis[a]**	**Original**	**Revised**	**Original**	**Revised**
Radionuclides (pCi/L) and Uranium						
Cesium-137	10	R	3.1	4.74	ND	3.16
Neptunium-237	210	R	–	0.054	ND	0.083
Lead-210	11	R	–	2.97	–	2.45
Plutonium-238	210	R	ND	ND	ND	0.038
Plutonium-239/240	200	R	0.09	0.093	ND	0.01
Radium-226	38	R	0.35	0.808	0.41	0.791
Radium-228	47	R	2.1	1.73	2.2	3.79
Strontium-90	41	R	0.96	0.712	ND	1.14
Technetium-99	150	R	ND	4.64	ND	7.64
Thorium-228	830	R	ND	0.238	0.62	0.185
Thorium-230	3500	R	ND	0.539	0.36	0.605
Thorium-232	270	R	ND	0.213	ND	0.144
Uranium, Total **(µg/L)**	530	R	1.0	1.31	1.0	2.03
Pesticide/PCBs (µg/L)						
Alpha-Chlordane	0.31	R	–	ND	–	0.003
Aroclor-1254	0.20	D	–	ND	–	ND
Aroclor-1260	0.20	D	–	ND	–	ND
Dieldrin	0.020	D	–	ND	–	0.0095
Semivolatiles (µg/L)						
Benzo(a)anthracene	1.0	D	–	ND	–	ND
Benzo(a)pyrene	1.0	D	–	ND	–	ND
Bis(2-chloroisopropyl)ether	280	R	–	ND	–	ND
Bis(2-ethylhexyl)phthalate	8.4	A	–	2	–	2.5
Dibenzo(a,h)anthracene	1.0	D	–	ND	–	1.9
3,3'-Dichlorobenzidine	7.7	R	–	ND	–	ND

Table 4–2 (continued). Surface Water Selection Criteria Summary

Constituent	FRL[a]	FRL Basis[a]	95th Percentile Background Level in Surface Water[b,c]			
			Paddys Run		Great Miami River	
			Original	Revised	Original	Revised
Semivolatiles (µg/L) (Cont.)						
Di-n-butylphthalate	6000	R	–	5.09	–	5.5
Di-n-octylphthalate	5.0	D	–	1.75	–	ND
p-Methylphenol	2200	R	–	ND	–	0.6
4-Nitrophenol	7,400,000	R	–	ND	–	ND
Volatiles (µg/L)						
Benzene	280	R	–	ND	–	0.35
Bromodichloromethane	240	R	–	ND	–	ND
Bromomethane	1300	R	–	ND	–	ND
Chloroform	79	A	–	0.782	–	0.3
1,1-Dichloroethene	15	R	–	ND	–	ND
Methylene chloride	430	A	–	1	–	ND
Tetrachloroethene	45	R	–	0.367	–	ND
1,1,1-Tricholoroethane	1.0	D	–	ND	–	ND
1,1,2-Tricholoroethane	230	R	–	ND	–	ND
Other Constituents						
Ammonia	–	–	–	0.14	–	0.496
Carbon disulfide	–	–	–	ND	–	0.35
Cobalt	–	–	–	-	–	0.00287
Trichloroethene	–	–	–	0.2	–	ND

[a]Derived from OU5 ROD, Table 9–5.
A = ARAR values
B = background concentrations
D = analytical detection limit
R = human health risk
[b]ND = not detected
– = not applicable/not available
[c]For small data sets (less than or equal to seven samples), the maximum detected concentration is used as the 95th percentile.
[d]FRL based on chromium (VI); however, the analytical results are for total chromium.

Sediment samples will be collected from the two locations on the Great Miami River: one downstream from the outfall line and one background location, and analyzed for uranium as identified in Table 4–2. Samples will be collected in 2009 and then every 5 years thereafter. The sediment FRL for uranium is 210 milligram per kilogram (mg/kg).

4.3.2.2 Surface Water Cross-Medium Impact

To assess the cross-medium impact that contaminated surface water has on the underlying Great Miami Aquifer, the following design considerations are necessary:

- Samples should be collected at points near where the glacial overburden has been breached by site drainages (Figure 4–1). At these locations (i.e., STRM 4005, SWP-02, SWD-02, SWD-03, SWD-04, SWD-05, SWD-07, and SWD-08) a direct pathway exists for surface water and associated contaminants to reach the underlying sand and gravel Great Miami Aquifer.
- During remediation and restoration efforts, new wetlands and ponds were created within the site perimeter. Some of these water bodies have little or no underlying glacial overburden. Therefore, five additional surface water locations (SWD-04, SWD-05, SWD-06, SWD-07, and SWD-08) were selected to assess the possible impacts of surface water infiltrating into the aquifer. Sampling at these locations will occur semiannually for uranium to evaluate potential impacts. Data will be evaluated annually to determine the need for further sampling. Location SWD-05 was selected specifically to monitor any impact on the underlying groundwater from surface water where elevated uranium concentrations have been discovered. This area is a small watershed draining south to this location where surface water then dissipates via infiltration or evaporation. It appears from a study conducted in March 2007 that the soil leachability characteristics in this area differ from those of the surrounding area. A maintenance activity was implemented in the summer of 2007 to remove a limited amount of soil from the area. To monitor how the area has responded to this maintenance activity, another location (SWD-09) upgradient of SWD-05 is also being monitored.
- Constituents analyzed should represent those area-specific COCs identified in the OU5 Feasibility Study and subsequent fate and transport modeling as having the potential for cross-medium impact to groundwater via the surface water pathway.

4.3.2.3 Sporadic Exceedances of FRLs

Sample locations should be (1) on-property locations downstream of historical FRL exceedances, (2) at the point where Paddys Run flows off the Fernald Preserve property, and (3) at the Parshall Flume (PF 4001), where treated effluent is discharged from the Fernald Preserve to the Great Miami River. (Refer to Figure 4–2 for IEMP surface water and treated effluent sample locations).

To determine the concentration of the treated effluent constituents outside the mixing zone in the Great Miami River, a conservative calculation using the 10-year, low-flow conditions is necessary and requires that flow conditions at the Hamilton Dam gauge be periodically reviewed.

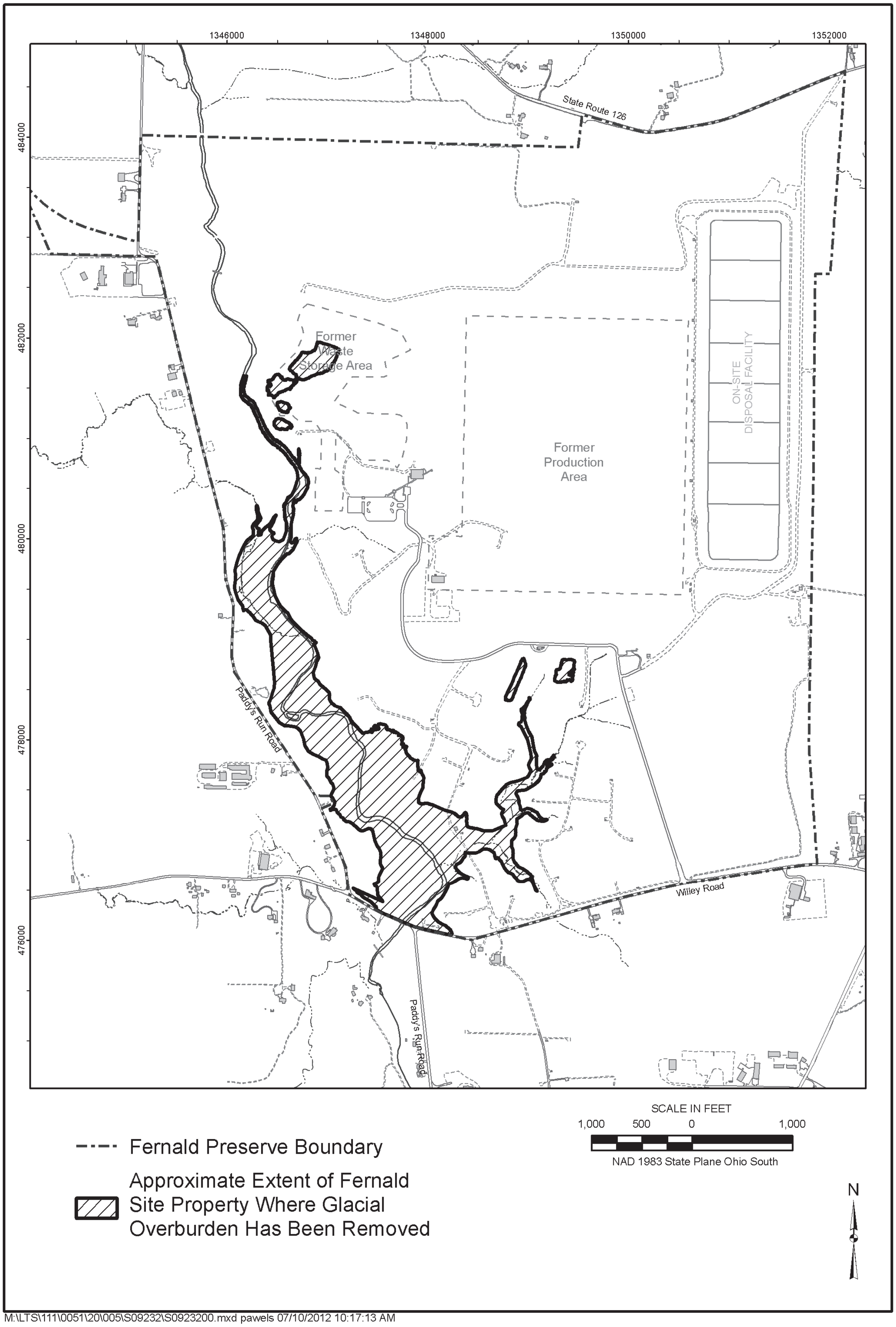

Figure 4–1. Area where Glacial Overburden Has Been Removed

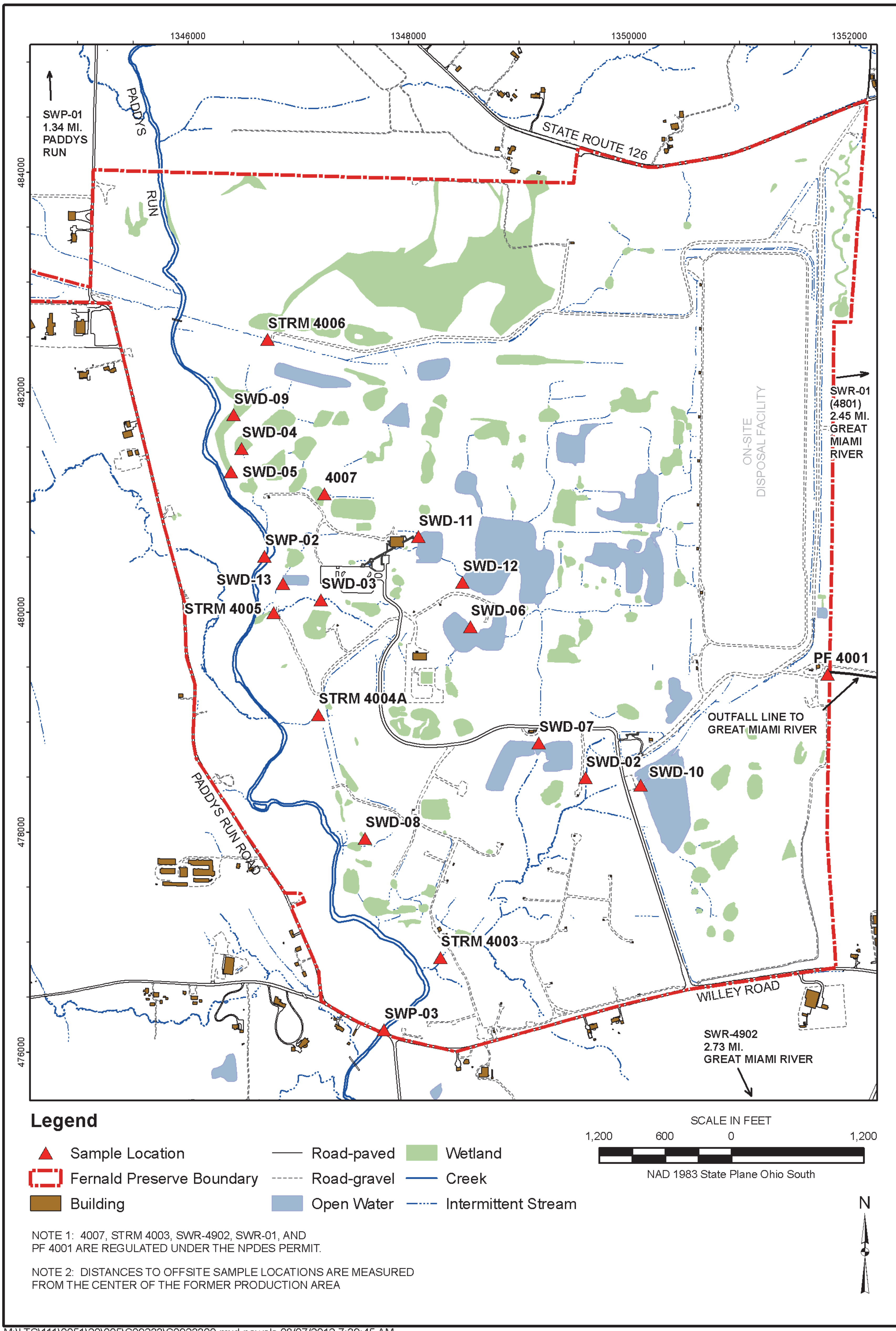

Figure 4–2. IEMP Surface Water, NPDES, and Treated Effluent Sample Locations

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To assist in the development of the scope and focus of the IEMP surface water, treated effluent, and sediment program, a review of the IEMP monitoring data is conducted periodically. The recommended parameters and locations for monitoring are indicated in Table 4–3 (i.e., IEMP Characterization). To provide surveillance monitoring for FRL exceedances, samples will be collected and analyzed for those constituents and associated monitoring frequencies identified in Table 4–3.

Table 4–3. Summary of Surface Water, Treated Effluent, and Sediment Sampling Requirements by Location

Location	Constituent[a]	IEMP Characterization Requirements (reason for selection)[b,c]	NPDES Requirements[c]
SWR-01 (SWR-4801 for NPDES only) (Great Miami River Background)	**General Chemistry:**		
	Total hardness	–	Quarterly
	Inorganics:		
	Beryllium	Semiannually (B)	–
	Cadmium	Semiannually (B)	–
	Chromium, Total	Semiannually (B)	–
	Copper	Semiannually (B)	–
	Cyanide, Total	Semiannually (B)	–
	Manganese	Semiannually (B)	Quarterly
	Mercury	Semiannually (B)	Quarterly
	Silver	Semiannually (B)	–
	Zinc	Semiannually (B)	–
	Radionuclides and Uranium:		
	Uranium, Total	Semiannually(B)	–
SWP-01 (Paddys Run Background)	**Inorganics:**		
	Beryllium	Semiannually (B)	–
	Cadmium	Semiannually (B)	–
	Chromium, Total	Semiannually (B)	–
	Copper	Semiannually (B)	–
	Cyanide, Total	Semiannually (B)	–
	Manganese	Semiannually (B)	–
	Mercury	Semiannually (B)	–
	Silver	Semiannually (B)	–
	Zinc	Semiannually (B)	–
	Radionuclides and Uranium:		
	Uranium, Total	Semiannually (B)	–
SWP-02 (Paddys Run)	**Radionuclides and Uranium:**		
	Radium-226	Annually	–
	Radium-228	Annually	–
	Technetium-99	Annually	–
	Thorium-228	Annually	–
	Thorium-230	Annually	–
	Thorium-232	Annually	–
	Uranium, Total	Semiannually (PC)	–
SWP-03 (Paddys Run at Downstream Property Boundary) (continued on next page)	**Inorganics:**		
	Beryllium	Semiannually (S)	–
	Cadmium	Semiannually (S)	–
	Chromium, Total	Semiannually (S)	–
	Copper	Semiannually (S)	–
	Cyanide, Total	Semiannually (M)	–
	Manganese	Semiannually (S)	–
	Mercury	Semiannually (M)	–

Table 4–3 (continued). Summary of Surface Water, Treated Effluent, and Sediment Sampling Requirements by Location

Location	Constituent[a]	IEMP Characterization Requirements (reason for selection)[b,c]	NPDES Requirements[c]
SWP-03 (Paddys Run at Downstream Property Boundary) (continued)	Silver	Semiannually (M)	–
	Zinc	Semiannually (M)	–
	Radionuclides and Uranium:		
	Radium-226	Annually	–
	Radium-228	Annually	–
	Technetium-99	Annually	–
	Thorium-228	Annually	–
	Thorium-230	Annually	–
	Thorium-232	Annually	–
	Uranium, Total	Semiannually (PC)	–
SWD-02 (Storm Sewer Outfall Ditch)	**Radionuclides and Uranium:**		
	Uranium, Total	Semiannually (PC)	–
SWD-03 (Waste Storage Area)	**Radionuclides and Uranium:**		
	Radium-226	Annually	–
	Radium-228	Annually	–
	Technetium-99	Annually	–
	Thorium-228	Annually	–
	Thorium-230	Annually	–
	Thorium-232	Annually	–
	Uranium, Total	Semiannually (PC)	–
PF 4001 (Parshall Flume—Treated Effluent)	**General Chemistry:**		
	Carbonaceous biochemical oxygen demand	–	2/Week
	Fluoride	–	Monthly
	Nitrate/nitrite	–	Monthly
	Oil and grease	–	2/Week
	Total dissolved solids	–	Monthly
	Total phosphorus as P	–	Weekly
	Total suspended solids	–	Daily
	Inorganics:		
	Cyanide, free	–	Monthly
	Manganese	–	2/Week
	Mercury (low level)	–	Monthly
	Radionuclides and Uranium:		
	Radium-226	Semiannually (M)	–
	Radium-228	Semiannually	–
	Technetium-99	Semiannually (M)	–
	Uranium, Total	Semiannually (PC)	Daily[d]
	Semivolatiles:		
	Bis (2-ethylhexyl) phthalate	–	Quarterly
	Other:		
	Flow rate	–	Daily
STRM 4003 (Drainage to Paddys Run)	**General Chemistry:**		
	Total suspended solids	–	Semiannually
	Inorganics:		
	Mercury (low level)	–	Semiannually
	Radionuclides and Uranium:		
	Uranium, Total	Semiannually (PC)	–
	Other:		
	Flow rate	–	Semiannually
STRM 4004A[e] (Drainage to Paddys Run)	**Radionuclides and Uranium:**		
	Uranium, Total	Semiannually (PC)	–
STRM 4005 (Drainage to Paddys Run)	**Radionuclides and Uranium:**		
	Uranium, Total	Semiannually (PC)	–

Table 4–3 (continued). Summary of Surface Water, Treated Effluent, and Sediment Sampling Requirements by Location

Location	Constituent[a]	IEMP Characterization Requirements (reason for selection)[b,c]	NPDES Requirements[c]
STRM 4006 (Drainage to Paddys Run)	**Radionuclides and Uranium:**		
	Uranium, Total	Semiannually (PC)	–
4007 (Biowetland Emergency Overflow to Paddys Run)	Flow rate	–	Daily during overflow
SWD-04[f], SWD-05[f], SWD-06[f], SWD-07[f], SWD-08[f]	**Radionuclides and Uranium:**		
	Radium-226	Annually	–
	Radium-228	Annually	–
	Technetium-99	Annually	–
	Thorium-228	Annually	–
	Thorium-230	Annually	–
	Thorium-232	Annually	–
	Uranium, Total	Semiannually	–
SWD-09	**Radionuclides and Uranium:**		
	Uranium, Total	Semiannually	–
SWD-10, SWD-11, SWD-12, SWD-13	**Radionuclides and Uranium:**		
	Uranium, Total	Annually	–
SWR-4902 (Downstream of Fernald Preserve Effluent)	**General Chemistry:**		
	Total Hardness	–	Quarterly
	Inorganics		
	Manganese	–	Quarterly
	Mercury	–	Quarterly
G10[g] (Great Miami River—downstream sediment)	Uranium, Total	Every five years	–
G2[g] (Great Miami River—sediment background)	Uranium, Total	Every five years	–

[a] Field parameter readings, taken at each location, include temperature, specific conductance, pH, and dissolved oxygen.
[b] B = background evaluation; M = based on modeling; PC = primary COC; S = sporadic exceedances of FRLs; WP = Waste Pits Excavation Monitoring
[c] "–" indicates the constituent is not included in the sample program.
[d] This constituent is sampled under the OU5 ROD.
[e] New location STRM 4004A has been identified as an alternative sample location for STRM 4004.
[f] Sampling will be conducted for 2 years to determine if sampling should continue. Locations are based on sampling from Residual Risk Assessment Analysis and lack of glacial overburden.
[g] Sampling will be conducted every 5 years per DOE/EH-0173T, Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance (DOE 1991).

Constituents are monitored at SWP-03 because it is the last location that surface water is monitored on Paddys Run prior to leaving the site, and all area-specific constituents are monitored at this location in order to be conservative. Appendix B in previous years' IEMPs provided maps detailing surface water locations with historical FRL exceedances, including those exceedances at background locations.

4.3.2.4 Impacts to Surface Water due to Storm Water Runoff

With remediation completed, there are no areas where storm water runoff is controlled, with the exception of the footprint of the CAWWT tanks located on a controlled pad. However, IEMP surface water monitoring will continue at points of storm water runoff entry into receiving waters or within main site drainage ditches (in addition to ambient monitoring for background quantification purposes). Figure 4–3 shows a comparison of average total uranium concentrations at Paddys Run at sample location SWP-03. Important distinctions regarding uranium in storm water runoff from the site to Paddys Run, based on the data in Figure 4–3, include:

- Average concentrations have been far below the human health protective surface water FRL of 530 µg/L each year since 1981, including 9 years that the site was in production.
- Annual average monthly concentrations have been consistently below the human health protective groundwater FRL of 30 µg/L each year since 1986.

4.3.2.5 Ongoing Background Evaluation

Because the remedial investigation/feasibility study background data set for Paddys Run and the Great Miami River surface water was limited by the number of samples and temporal variability represented by the samples, monitoring for surface water background has been performed from the initiation of the IEMP through 2004 for all 55 surface water FRL constituents identified in Table 4–2. Although there are only 17 area-specific surface water constituents (i.e., constituents identified as being FRL concerns and monitored under the IEMP characterization program), the extensive list of 55 constituents was monitored at background to establish a robust data set. The more extensive list was monitored at background so that if soil sampling indicated the need to expand the list of 17 area-specific surface water constituents, there would be corresponding background data.

Because soil sampling did not indicate a need to add constituents to the list of 17 area-specific surface water constituents, and an abundance of background data are available, the list of surface water constituents monitored at the background locations was reduced to coincide with the 17 area-specific constituents monitored for surface water FRLs beginning in 2005. In 2008, the list was reduced from 17 to 10 based on monitoring data results and agencies' approvals.

In 2007, the background values were recalculated using data from August 1997 through 2006. The revised values are provided in Table 4–2. Refer to Table 4–3 for background monitoring requirements; refer to Figure 4–2 for background surface water sample locations.

4.3.2.6 Fulfill NPDES Requirements

As noted in Section 4.2.2, treated effluent and storm water discharges from the Fernald Preserve are regulated under the State-administered NPDES program. Ohio EPA Permit 1IO00004*HD took effect on April 1, 2009, and will remain in effect until March 31, 2014. Figure 4–2 identifies the NPDES permit sample locations.

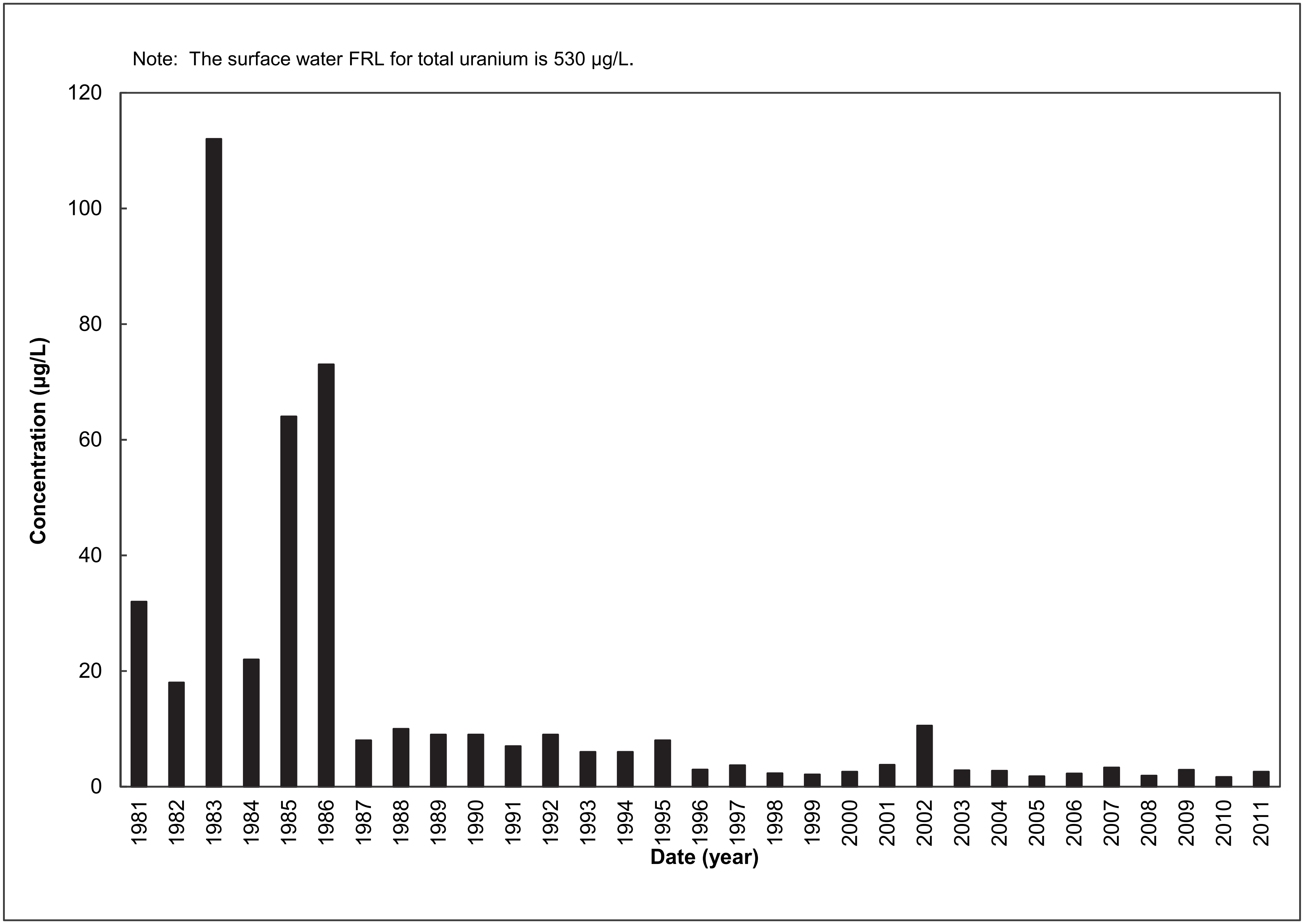

Figure 4–3. Comparison of Average Total Uranium Concentrations in Paddys Run at Willey Road Sample Location SWP-03

4.3.2.7 Fulfill Federal Facilities Compliance Agreement and OU5 ROD Requirements

The design considerations provided in Section 4.3.2 are sufficient to meet or exceed the current FFCA sampling and reporting requirements as summarized in Section 4.2.2. The sampling requirements include sampling at the Parshall Flume (PF 4001) and the South Plume extraction wells. In addition to these sampling requirements, an estimate of the amount of uranium reaching Paddys Run via uncontrolled storm water runoff is calculated. Section 3.2.2 discusses sampling of the South Plume extraction wells. As discussed in Section 6.0, monitoring data required by the FFCA have been incorporated into the comprehensive IEMP reporting structure.

4.3.2.8 Fulfill DOE Order 450.1A Requirements

The design considerations provided in Section 4.3.2, are sufficient to meet or exceed the requirements of DOE Order 450.1A as summarized in Section 4.2.2.

4.3.2.9 Address Concerns of the Community

In addition to the monitoring described in Section 4.3.2.4, four surface water sampling locations (SWD-10, SWD-11, SWD-12, and SWD-13) have been indentified for annual total uranium analysis. This sampling will be sufficient to address the concerns of the community. These concerns focus on limiting the amount of Fernald Preserve–related contamination entering Paddys Run and the Great Miami River. This monitoring will provide a comprehensive monitoring program in bodies of water near public access areas, in Paddys Run at the site boundary, and in the treated effluent destined for the Great Miami River.

4.4 Medium-Specific Plan for Surface Water, Treated Effluent, and Sediment Sampling

This section serves as the medium-specific plan for implementation of the sampling, analytical, and data management activities associated with the IEMP surface water, treated effluent, and sediment sampling program. The activities described in this medium-specific plan were designed to provide data of sufficient quality to meet the program expectations as stated in Section 4.3.1. The program expectations, along with the design considerations presented in Section 4.3.2, were used as the framework for developing the monitoring approach presented in this plan. All sampling procedures and analytical protocols described or referenced in this IEMP are consistent with the requirements of the FPQAPP.

4.4.1 Sampling

To fulfill the requirements of the integrated surface water, treated effluent, and sediment monitoring program, surface water and treated effluent samples shall be collected from locations shown in Figure 4–2, and sediment samples shall be collected from locations shown in Figure 4-4.

Sample analysis will be performed either on site or at off-site contract laboratories, depending on analyses required, laboratory capacity, turnaround time, and performance of the laboratory. The laboratories used for analytical testing have been audited to ensure that DOECAP or equivalent process requirements have been met as specified in FPQAPP. These criteria include meeting the requirements for performance evaluation samples, pre-acceptance audits, performance audits, and an internal quality assurance program.

4.4.1.1 Sampling Procedures

Surface water, treated effluent, and sediment will be sampled using the requirements specified in the FPQAPP, which have been incorporated into the *Fernald Preserve Environmental Monitoring Procedures* (DOE 2011a).

Tables 4–4 and 4–5 identify the sample preservative, volume, and container requirements for each constituent.

<u>Surface Water Sampling</u>
Surface water samples will be collected from locations identified in Figure 4–2. Sampling personnel will ensure that access to the sample locations will not result in the inadvertent introduction of foreign materials into the water sample. Additional precautions will be taken to avoid the introduction of floating organic material such as leaves or twigs during sample collection. Samples will be collected without disturbing bottom sediment. Sample technicians shall approach sample locations from downstream of the location; if sample locations are accessed by way of a bridge, samples shall be collected on the upstream side of the bridge.

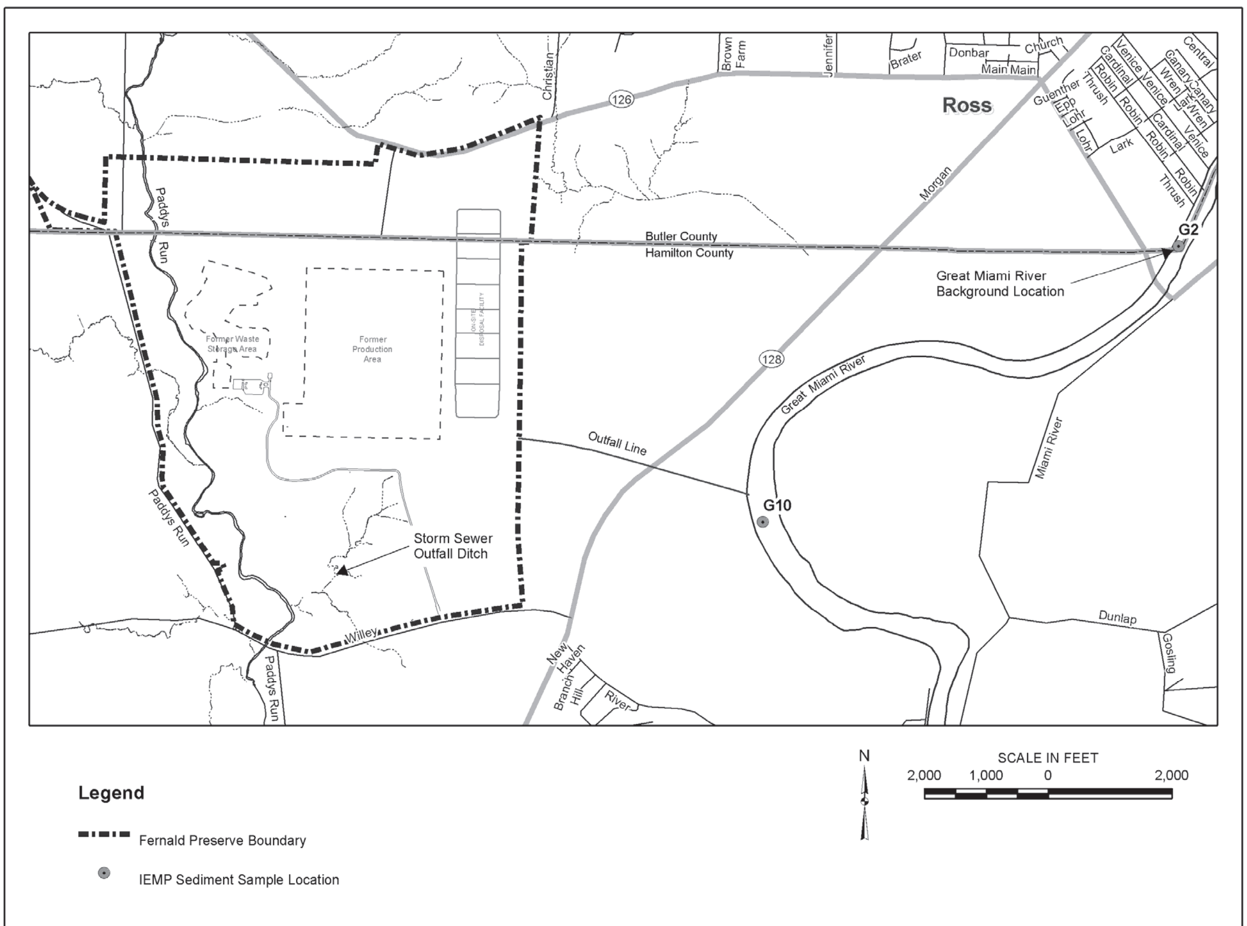

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Figure 4–4. Sediment Sample Locations

Table 4–4. Surface Water Analytical Requirements for Constituents at Sample Locations SWD-02, SWD-03, SWD-04, SWD-05, SWD-06, SWD-07, SWD-08, SWD-09, SWD-10, SWD-11, SWD-12, SWD-13, SWP-01, SWP-02, SWP-03, and SWR-01

Constituent[a]	Analytical Method	ASL	Holding Time	Preservative	Container
Inorganics:					
Beryllium Cadmium Chromium, Total Copper Manganese Silver Zinc	7000A[b], 3500[c], 6020[b], 6010B[b], or 200.2,7,8[d]	D	6 months	HNO_3 to pH <2	Plastic or glass
Mercury	7470A[b] or 245.1/245.2[e]	D	28 days	HNO_3 to pH <2	Plastic or glass
Cyanide, Total	9010B[b], 9012[b], 335.2[e], 335.3[e], or 335.4[e]	D	14 days	Cool 4°C, NaOH to pH >12	Plastic or glass
Radionuclides and Uranium:					
Radium-226 Radium-228 Technetium-99 Thorium-228 Thorium-230 Thorium-232 Uranium, Total	903.1[f] 904.0[f] EML HASL 300[g] EML HASL 300[g] EML HASL 300[g] EML HASL 300[g] 6020[b] or 200.8[d]	D	6 months	HNO_3 to pH <2	Plastic or glass
Field Parameters[h]**:**	FPQAPP[i]	A	NA[j]	NA[j]	NA[j]

Note: The analytical site-specific contract identifies the specific method.

[a] Sample locations are analyzed for a subset of these constituents (summarized in Table 4–3).
[b] Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (EPA 1998)
[c] Standard Methods for the Examination of Water and Wastewater (APHA 1989)
[d] Methods for the Determination of Metals in Environmental Samples
[e] Methods for Chemical Analysis of Water and Wastes (EPA 1983)
[f] Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980)
[g] Procedures Manual of the Environmental Measurements Laboratory.
[h] Field parameters are temperature, specific conductance, pH, and dissolved oxygen.
[i] The FPQAPP provides field methods.
[j] NA = not applicable

Table 4–5. Surface Water, Treated Effluent, and Sediment Analytical Requirements for Constituents at Sample Locations PF 4001, STRM 4003, STRM 4004A, STRM 4005, STRM 4006, SWR-4801, SWR-4902, G2, and G10

Constituent[a]	Analytical Method[b]	Sample Type[c]	ASL[b]	Holding Time[b]	Preservative[b]	Container[b]
General Chemistry:						
Carbonaceous biochemical oxygen demand	5210B[e]	Composite	C	48 hours	Cool 4°C	Plastic or glass
Fluoride	300.0[d], 340.2[d], 4500C[e]	Composite	C	28 days	None	Plastic or glass
Nitrate/nitrite	353.1[d], 353.2[d], 353.3[d], 4500D[e], or 4500E[e]	Composite	D	28 days	Cool 4°C, H_2SO_4 to pH <2	Plastic or glass
Oil and grease	1664A[g] or 5520B[e]	Grab	D	28 days	Cool 4°C, H_2SO_4 to pH <2	Glass
Total dissolved solids	160.1[d] or 2540C[e]	Grab	C	7 days	Cool 4°C	Plastic or glass
Total hardness	130.2[d] or 2340C[e]	Grab	C	28 days	Cool 4°C, H_2SO_4 to pH <2	Plastic
Total phosphorus	365.1[d], 365.2[d], 365.3[d], or 4500B[e]	Composite	C	28 days	Cool 4°C, H_2SO_4 to pH <2	Plastic
Total suspended solids	160.2[d] or 2540D[e]	Composite	C	7 days	Cool 4°C	Plastic or glass
Inorganics:						
Manganese	6020[n], 7000A[n], 3500[e], 6010B[n], 200.2,7,8[i], 220.2[d], or 272.2[d]	Composite or Grab[f]	D	6 months	HNO_3 to pH <2	Plastic or glass
Mercury	7470A[h]	Grab	D	28 days	HNO_3 to pH <2	Plastic or glass
Mercury (low level)	1631[d]	Grab	D	14 days	None	Amber glass
Cyanide, Free	335.1/335.3[d] or 4500-G[e]	Grab	D	14 days	Cool 4°C, NaOH to pH >12	Plastic or glass

Table 4–5 (continued). Surface Water, Treated Effluent, and Sediment Analytical Requirements for Constituents at Sample Locations PF 4001, STRM 4003, STRM 4004A, STRM 4005, STRM 4006, SWR-4801, SWR-4902, G2, and G10

Constituent[a]	Analytical Method[b]	Sample Type[c]	ASL[b]	Holding Time[b]	Preservative[b]	Container[b]
Radionuclides and Uranium:						
Radium-226	903.1[j]	Grab	D	6 months	HNO_3 to pH <2	Plastic or glass
Radium-228	904.0[j]					
Technetium-99	EML HASL 300[k]					
Uranium, Total	200.8[i], 6020[h], or D5174-91[l]	Composite[m]	D		HNO_3 to pH <2	Plastic or glass
Uranium, Total[n]	6020[h]	Grab[o]	D	6 months	None	500 mL plastic or glass
Semivolatiles:						
Bis(2-ethylhexyl) phthalate	625[p]	Grab	D	7 days to extraction 40 days from extraction to analysis	Cool 4°C	Glass (amber with teflon-lined cap)
Other:						
Flow rate	NA	24 hour total	NA	NA	NA	NA
Field Parameters[q]	FPQAPP[r]	Grab	A	NA	NA	NA

Note: The analytical site-specific contract identifies the specific method.
[a] This represents a comprehensive list of constituents taken from the indicated list of surface water and treated effluent monitoring locations. Each location will be analyzed for a subset of these constituents (summarized in Table 4–3).
[b] NA = not applicable.
[c] For composite samples at PF 4001, a flow-weighted composite sample collected over a 24-hour period; for STRM 4003, STRM 4004, STRM 4005, and STRM 4006, composite samples shall consist of four samples collected at intervals of at least 30 minutes but not more than 2 hours.
[d] Methods for Chemical Analysis of Water and Wastes.
[e] Standard Methods for the Examination of Water and Wastewater.
[f] Grab samples are collected at locations SWR-4801 and SWR-4902 for this constituent.
[g] Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM; Non-Polar material) by Extraction and Gravimetry.
[h] Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.
[i] Methods for the Determination of Metals in Environmental Samples.
[j] Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980).
[k] Procedures Manual of the Environmental Measurements Laboratory.
[l] American Society for Testing and Materials (ASTM).
[m] Total uranium is a grab sample at STRM 4003, STRM 4004A, STRM 4005, and STRM 4006 and a composite sample at all other locations.
[n] Covers sediment only.
[o] Grab sample for sediment is collected at locations G2 and G10 for this constituent.
[p] 40 CFR 136, Appendix A.
[q] Field parameters include dissolved oxygen, pH, specific conductance, and temperature.
[r] The FPQAPP provide field analytical methods.

Treated Effluent Sampling

Treated effluent samples will be collected by means of flow-proportional samplers at the Parshall Flume. After every 24 hours of operation, the collected liquid is removed from the automatic sampler to provide a daily flow-weighted sample of the treated effluent. A portion of each daily sample is analyzed to determine the estimate of total uranium discharged to the Great Miami River for the day. The Parshall Flume (PF 4001) will be analyzed for the constituents listed in Table 4–3.

Sediment Sampling

Sampling is typically performed in summer or fall in order to take advantage of the abundance of fresh sediment deposited during flood conditions that commonly occur after winter and spring seasons. Only recently deposited surface sediment shall be collected, typically from deposition locations such as areas with a slow flow rate (e.g., obstructions in the stream bed that allow sediment to be deposited).

The locations of the sediment sample points are approximate and may change based on where stream flow has deposited sufficient material for sampling. Samples shall be collected from the top 2 inches and consist of fine-grained material. Any free water shall be drained from the sample and any non-sediment materials shall be discarded, then the sediment material shall be placed in the sample container.

4.4.1.2 Quality Control Sampling Requirements

Quality control samples will be taken according to the frequency recommended in the FPQAPP. These samples will be collected and analyzed to evaluate the possibility that some controllable practice, such as sampling technique, may be responsible for introducing bias into the project's analytical results. Quality control samples will be collected as follows:

- One field duplicate sample shall be collected each quarter at a randomly selected surface water sample location.
- One field duplicate will be collected from the G10 sediment location in the Great Miami River.
- Trip blanks will be prepared for each sampling team on each day of sampling when organic compounds are included in the respective analytical program. They will be prepared before the sampling containers enter the field and will be taken into the field and handled along with the collected samples. Trip blanks will not be opened in the field.

For low-level mercury, all field sampling equipment will be sent to the off-site laboratory for decontamination. The off-site laboratory shall document certification of cleanliness via equipment rinsate blank analysis. In addition, trip blanks and field blanks will be supplied by the off-site laboratory and shall accompany the samples from collection to receipt at the laboratory.

4.4.1.3 Decontamination

In general, decontamination of equipment is minimized because reusable equipment is not used during sample collection. However, if decontamination is required, then it will be performed between sample locations to prevent the introduction of contaminants or cross contamination into the sampling process. The decontamination requirements are identified in the FPQAPP.

Sampling bailers used in sampling for mercury at NPDES permit locations will be decontaminated at a contract laboratory.

4.4.1.4 Waste Disposition

Contact waste that is generated by the field technicians during field sampling activities is collected, maintained, and disposed of as necessary.

4.5 IEMP Surface Water, Treated Effluent, and Sediment Monitoring Data Evaluation and Reporting

This section describes the methods for analyzing data generated by the IEMP surface water, treated effluent, and sediment monitoring program and summarizes the data evaluation process and actions associated with various monitoring results. The planned reporting structure for IEMP-generated surface water, treated effluent, and sediment data, including specific information to be reported in the annual SER, is also provided.

4.5.1 Data Evaluation

Data resulting from the IEMP surface water, treated effluent, and sediment program will be evaluated to meet the program expectations identified in Section 4.3.1. Based on these expectations, the following questions will be answered through the surface water, treated effluent, and sediment data evaluation process, as indicated:

- Are surface water contaminant concentrations such that cross-medium impacts to the underlying aquifer could be expected?

  Data from sample locations near areas where the glacial overburden is breached by site drainages will be compared to surface water and groundwater FRLs to assess potential impacts to the Great Miami Aquifer. Basic statistics, such as the minimum, maximum, and mean, will be generated annually. The data generated from individual sampling events will be trended by sample location over time via graphical and, if necessary, statistical methods when sufficient data become available. If trends above the historical ranges or above FRLs are observed, actions shown in Figure 4–5 will be implemented.

  The personnel responsible for the restoration of the Great Miami Aquifer will be informed so that any potential adverse cross-medium impacts can be factored into the site groundwater remedy. Decision-making process described in Figure 4–5 can be implemented as necessary.

- Do the sporadic exceedances of FRLs continue to occur? Are concentrations decreasing or increasing?

  Data evaluation will consist of direct comparison of data to FRLs. It is likely that the list of constituents monitored with respect to FRLs can be reduced (i.e., IEMP Characterization Monitoring).

- Has storm water runoff caused an undue adverse impact to the surface water or treated effluent?

  Trend analyses of data will be used to identify trends that may require further investigation of activities occurring within the drainage basin (or basins).

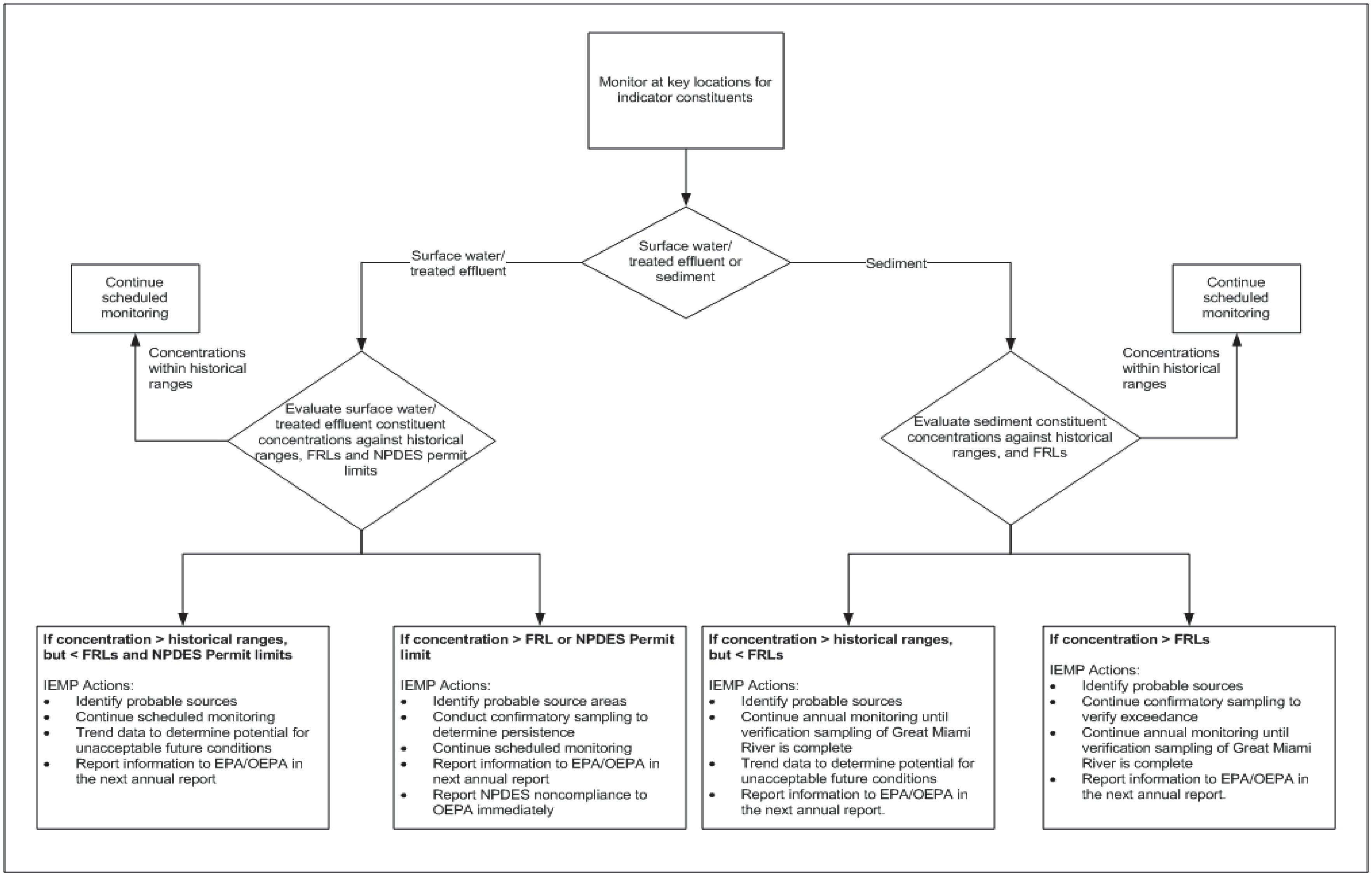

Figure 4–5. IEMP Surface Water and Sediment Data Evaluation and Associated Actions

- Are the requirements of the NPDES permit being fulfilled?

  Data collected to fulfill the site NPDES permit requirements will be evaluated for compliance with the NPDES permit provisions. This evaluation will serve to identify whether immediate reporting of noncompliance to Ohio EPA is necessary and to determine the appropriate corrective actions to address the noncompliance.

- Are the FFCA and OU5 ROD reporting requirements being fulfilled?

  Radiological discharges to the Great Miami River and Paddys Run are regulated by the FFCA and OU5 ROD. Reporting requirements have been incorporated into the IEMP reporting structure and include a cumulative summary of pounds of total uranium discharged and the monthly average total uranium concentration discharged to the Great Miami River.

- Have the residual contaminant concentrations detected in sediment samples from the Great Miami River changed as a result of runoff and treated effluent from the site?

  Data evaluation will consist of comparison to historical data, background levels, and FRLs. This evaluation will identify long-term trends of targeted radiological constituents in sediment to determine if the potential exists for an FRL exceedance in the future.

- Should the sediment program be refined in scope?

  Data evaluation to determine if the IEMP sediment program should be revised will be based on the comparison to historical ranges and the sediment FRLs. Data evaluation to address any remaining expectations identified in Section 4.3.1 is encompassed in the data evaluation techniques described above.

- Are the program and reporting requirements of DOE Order 450.1A being met?

  DOE Order 450.1A requires that DOE implement and report on an environmental protection program for the Fernald Preserve. The surface water and treated effluent monitoring program is one component of the sitewide IEMP monitoring program. This IEMP and the annual SER fulfill the requirements of this DOE order.

- Are community concerns being met through the surface water, treated effluent, and sediment IEMP program?

  The IEMP fulfills the needs of the Fernald Preserve community by presenting surface water and treated effluent environmental results in the annual SER. The specific community concern of the magnitude of Fernald Preserve discharges to Paddys Run and the Great Miami River is addressed in the annual SER in the surface water and treated effluent section.

4.5.2 Reporting

The IEMP surface water, treated effluent, sediment, and semiannual FFCA data will be reported in the annual SER and on the LM website at http://www.lm.doe.gov/fernald/Sites.aspx.

Data on the LM website will be in the format of searchable data sets and downloadable data files. Additional information on IEMP data reporting is provided in Section 6.0.

The annual SER will be issued each June. This comprehensive report will discuss a year of IEMP data previously reported on the LM website. The annual SER will include the following:

- An annual summary of data from the IEMP surface water, treated effluent, and sediment monitoring program.
- Constituent concentrations for each sample location.
- Statistical analysis summary for constituents, as warranted by data evaluation.
- Status of FFCA and OU5 ROD Great Miami River effluent limits, to be presented graphically showing status of compliance with the 30-µg/L and 600-pound total uranium limits.
- Status of regulatory compliance with provisions of the NPDES permit.
- Actions taken to mitigate unacceptable surface water conditions revealed by the IEMP surface water sampling program.
- Observed trends and results of the data comparison to FRLs.

Because the IEMP is a living document, a structured schedule of annual reviews and 5-year revisions has been instituted. The annual review cycle provides the mechanism for identifying and initiating any surface water, treated effluent, and sediment program modifications (i.e., changes in constituents, locations, or frequencies) that are necessary. Any program modifications that may be warranted prior to the annual review will be communicated to EPA and Ohio EPA.

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5.0 Dose Assessment Program

Section 5.0 discusses the reasons for eliminating the air particulate monitoring, the monitoring strategy for direct radiation, and the technical approach for conducting and reporting the annual sitewide radiological dose assessment to meet the intentions of DOE Order 5400.5 and monitoring requirements of DOE Order 450.1A. The sources associated with air monitoring requirements were removed in 2006; however, limited monitoring occurred through 2009, as identified in previous IEMP revisions, to ensure that all air monitoring requirements were met and levels were acceptable from a closure standpoint. Air particulate monitoring ceased at the beginning of 2010.

5.1 Integration Objectives for the Dose Assessment Program

The IEMP dose assessment-program objectives are consistent with program objectives in previous IEMP revisions. The objectives include assessing the annual effective radiation dose to a human receptor to demonstrate compliance with the requirements of DOE orders. A reporting plan is provided in Section 6.0 to define the integration and reporting strategy for all media.

5.2 Background, Regulatory Drivers, and Requirements

Past assessments were prepared to confirm that radiological doses to the public from routine operations and emissions comply with the dose limits set by EPA and DOE regulations and orders. With the completion of remedial activities in October 2006, operational sources for the emission of particulates to the air pathway no longer exist. Two years of post-remediation (soil remediation was completed in 2006) air monitoring have shown that the air inhalation dose at the Fernald Preserve boundary is orders of magnitude lower than the NESHAP limit of 10 mrem/yr (the value was 0.034 mrem/yr in 2009; see Appendix D of 2009 SER). Additionally, the measured post-remediation values are well below 1 mrem/yr, which is the NESHAP threshold for the monitoring requirement. That is, NESHAP monitoring is no longer required because the dose is less than 1 mrem/yr. NESHAP monitoring was discontinued at the end of 2009. As DOE Order 5400.5 follows NESHAP requirements for air inhalation, there is no significant dose to the public from the air inhalation pathway when the values are less than 1 mrem/yr; therefore, air monitoring data are no longer a component of the annual dose assessments. Dose assessments for DOE Order 5400.5 use the annual direct radiation measurements and annual surface water results for radionuclides to calculate the total dose to the public.

5.3 Analysis of Regulatory Drivers, DOE Policies, and Other Fernald Preserve Site-Specific Agreements

This section identifies the pertinent regulatory requirements, including ARARs and to-be-considered requirements, for the scope and design of the dose assessment program. These requirements were used to confirm that the program satisfied the regulatory obligations for monitoring (activated by the RODs) and achieved the intentions of other pertinent criteria (such as DOE orders and the Fernald Preserve existing agreements) that had a bearing on the scope of dose assessment.

5.3.1 Approach

The analysis of additional regulatory drivers and policies for dose assessments was conducted by identifying the suite of ARARs and to-be-considered requirements in the approved CERCLA RODs and legal agreements that contain specific dose assessment requirements. This subset was further divided to identify requirements with sitewide implications (i.e., those within the scope of the IEMP [DOE 1997d]). Sections 5.11 and 6.0 outline the plan for complying with the reporting requirements invoked by the IEMP regulatory drivers.

5.3.2 Air Requirements

The air monitoring program described in previous IEMPs was developed with full consideration of the regulatory drivers and policies. Table 5–1 lists the air-monitoring drivers, the previous monitoring conducted to comply with them, and results for the path forward. The results indicate that 3 years of post-remediation monitoring for air particulates have provided sufficient data to discontinue future monitoring of particulate levels.

5.3.3 Dose Requirements

A sitewide radiological dose assessment is required to demonstrate compliance with DOE Order 5400.5. Table 5–2 lists the sitewide dose tracking and annual assessment tasks. The dose assessment described here and in Appendix C of previous IEMPs was developed with full consideration of the regulatory drivers and policies, as discussed in previous IEMPs.

The exposure to all radiation sources, as a consequence of routine activities at a DOE site, shall not cause an effective dose equivalent of greater than 100 mrem/yr to any member of the public. The annual effective dose equivalent is a weighted summation of doses to various organs of the body, which is incorporated in the derived concentration guidelines (DCGs) used to assess dose from the air and surface water pathways. For the Fernald Preserve, it is defined as the sum of external-radiation exposure plus the dose derived from the surface water pathway. These pathways are the only potential exposures to the public that could exceed 1 percent (1 mrem) of the 100-mrem/yr limit.

Exposure to direct radiation (gamma, X-ray and beta) is assessed quarterly using optically stimulated luminescence (OSL) dosimeters placed along the site trails and boundary (Section 5.8.1). Previous monitoring for direct radiation was performed using thermoluminescent dosimeters (TLDs), which had a nominal energy response of 0.03 to 1.25 million electron volts (MeV). OSL dosimeters have a wider energy-response range (0.005 to 20 MeV). DOE Order 5400.5 is not prescriptive on the monitoring devices that must be used to assess the direct radiation dose, but analytical integrity must be maintained, and the yearly dose to members of the public, from all pathways, must be less than 100 mrem above background.

Table 5–1. Air Monitoring Regulatory Drivers, Required Actions, and Results

IEMP		
DRIVER	**REQUIRED ACTION**	**RESULTS**
DOE Order 450.1A, Environmental Protection Program Environmental Monitoring Plan for all media	• Requires DOE facilities that use, generate, release, or manage significant pollutants or hazardous materials to develop and implement an environmental monitoring plan. • The previous IEMPs described effluent and surveillance monitoring as required by DOE Order 450.1A.	The final year of soil remediation at the Fernald Preserve was 2006. By the end of October 2006, all major sources of airborne contamination were removed from the site or placed in the OSDF. In recognition of the removal of emissions sources from the site, the number of air monitoring stations was decreased from 17 to 11 in April 2006 (DOE 2006c and from 11 to 6 in November of 2006 (DOE2006d). Monitoring data collected from 2006 through 2009 indicated that no additional air particulate monitoring is required for airborne contamination.
DOE Order 5400.5, Proposed 10 CFR 834 Radiation Protection of the Public and Environment	• Establishes radiological dose limits and guidelines for the protection of the public and environment. Under this requirement, the exposure to members of the public associated with activities from DOE facilities from all pathways must not exceed, in 1 year, an effective dose equivalent of 100 mrem. • For radiological dose due to airborne emissions only, the DOE order requires compliance with the 40 CFR 61 Subpart H limit of an effective dose equivalent of 10 mrem/year to a member of the public. Demonstration of compliance with this standard is to be based on an air monitoring approach. • The DOE order also provides guidelines for radionuclide concentrations in air (known as Derived Concentration Guides).	• In 2008, the maximally exposed individual, standing at the eastern boundary monitor with the highest above-background reading, could receive a dose of 9 mrem. The contributions to the estimated dose are 0.034 mrem from air inhalation and 9 mrem from direct radiation. This dose is 9 percent of the adopted DOE limit, which is 100 mrem/yr above background (exclusive of radon), as established by the International Commission on Radiological Protection. • Monitoring data collected from 2006 through 2009 have demonstrated that the Fernald Preserve no longer has the potential to expose members of the public to an effective dose equivalent of 100 mrem/yr. • The final year of soil remediation at the Fernald Preserve was 2006. By the end of October 2006, all major sources of airborne contamination were removed from the site or placed in the OSDF. Three years of post-monitoring data have demonstrated that the Fernald Preserve no longer has the potential to expose members of the public to an effective dose equivalent of 10 mrem/yr.

Table 5–1 (continued). Air Monitoring Regulatory Drivers, Required Actions, and Results

IEMP		
DRIVER	**REQUIRED ACTION**	**RESULTS**
Federal Facility Agreement Control and Abatement of Radon-222 Emissions	• Ensures that DOE takes all necessary actions to control and abate radon-222 emissions at the Fernald Preserve. • Previous IEMPs included radon monitoring.	Waste material generated from uranium extraction processes performed decades ago contained radium-226, which produces radon. This waste material is no longer a source for radon at the site because the last of this material was shipped off site in 2006. Present radon sources at the Fernald Preserve are limited to residual radium-226 concentrations in the soil (near-background levels) and waste material disposed of in the OSDF. Waste materials in the OSDF are covered with a polyethylene liner and several feet of stone and soil, which provides an effective radon barrier. Two years of continued monitoring demonstrated that no additional monitoring is required for radon. Radon monitoring was discontinued in 2009.
DOE Order 435.1, Radioactive Waste Management	• RODs are filed with HQs. • Be in compliance with DOE 5400.5 Radiation Protection of the Public and Environment. • Requires low-level radioactive waste disposal facilities to perform environmental monitoring. • Previous IEMPs boundary monitoring included air monitoring at locations adjacent to the OSDF.	Waste materials in the OSDF are covered with a polyethylene liner and several feet of stone and soil, which provides an effective radon barrier. Three years of continued monitoring have shown that no additional air monitoring is required.
CERCLA Remedial Design Work Plan (DOE 1996c)	Monitoring will be conducted as required following the completion of cleanup to assess the continued protectiveness of the remedial actions.	Three years of continued monitoring have shown the protectiveness of the remedial actions, and thus no additional monitoring is required.

Table 5–2. Sitewide Dose Tracking and Annual Assessment Tasks

IEMP	Tasks
Evaluate planned activities and conditions at beginning of the year	Annual Sitewide Planning
Conduct routine OSL monitoring at background, Trail, and site boundary locations; collect surface-water samples	Routine Site Monitoring
Directly compare routine monitoring results to annual dose benchmarks; report and evaluate any exceedances	Preventive Tracking/Feedback
Based on monitoring data, calculate annual doses at monitoring locations	DOE Order 5400.5 Compliance Demonstration
Prepare summaries and the annual dose assessment report	Reporting

Public exposure due to the ingestion of a DOE drinking water source shall not result in an effective dose equivalent greater than 4 mrem/yr. Although there is no DOE drinking water source at the Fernald Preserve, an on-site visitor may illegally wade in the ponds and incidentally ingest the surface water. This scenario will be treated as a member of the public drinking from a DOE drinking water supply.

DOE Order 5400.5 states that the absorbed dose to native aquatic organisms shall not exceed 1 rad per day from exposure to the radioactive material in liquid wastes discharged to natural waterways. DOE has issued a technical standard entitled *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002b), and supporting software (RAD-BCG) for use in the evaluation and reporting of biota dose limits. A biota dose assessment divides the radionulcide concentration in surface water by a biota concentration guide (BCG) and sums the BCGs for all radionuclides. If the resulting sum is less than 1.0, compliance with the biota dose limit is achieved. Since 1999, the sum has been below 0.06, and in 2007 (the first year after closure) the sum dropped to 0.009 (DOE 2008b). There is no reasonable basis to assume that post-closure discharges in future years will exceed the 0.06 sum observed during active remediation. Therefore, dose calculations for aquatic organisms were discontinued.

5.4 Program Expectations and Design Considerations

5.4.1 Program Expectations

The IEMP dose assessment program is required by DOE Order 5400.5 and will meet the following expectations:

- As discussed above, the air monitoring program was discontinued after 2009. Air monitoring results are less than 1 mrem/yr and are no longer a component of the dose calculation.
- Direct radiation exposure will be measured using OSL dosimeters to support the annual dose calculation.
- Incidental ingestion of surface water will be assessed as part of the annual dose calculation.
- Provide a program that promotes the continued confidence of the public and is responsive to concerns raised by stakeholders.

5.4.2 Design Considerations

The assessment of air dose in previous years relied on a monitoring design that included collection of particulate samples, readings from continuous radon monitors, and TLD measurements. Particulate samples were discontinued in 2010 because post-remediation data from 2007 through 2009 indicate that radionuclide levels are similar to background. Radon monitoring was discontinued in 2009. The direct-radiation component of the monitoring program will continue.

The direct-radiation component of the monitoring program is designed to assess the external environmental dose from gamma ray, X-ray, and beta radiation. This is accomplished using 12 OSL dosimeters: six are collocated with the former air-particulate monitors and six are placed along the hiking trails (Figure 5–1). At each location, three OSL devices are placed approximately one meter above the ground to assess the precision of the data. The OSL devices are processed quarterly at a DOE–approved laboratory.

The OSL devices deployed in 2009 replace the TLDs used in previous years. OSL dosimeters have a superior energy-response range (0.005 to 20 MeV), relative to TLDs (0.03 to 1.25 MeV), and the stored energy can be measured many times (without losing the exposure record) because the radiation dose is measured using a light-emitting diode, rather than the thermal annealing process used to read TLDs. Thermal annealing erases the exposure record held in the TLD.

The monitoring plan meets the following criteria:

- Provide quarterly analysis to evaluate direct radiation levels.
- Account for the annual dose from direct radiation to support the annual dose assessment required by DOE Order 5400.5.

Table 5–3 summarizes the sampling and analysis plan for the direct radiation monitoring program.

Table 5–3. Analytical Summary for Direct Radiation

Analyte	Sample Matrix	Sample Frequency	ASL
Gamma and Beta Radiation	OSL	Quarterly	B

5.5 Plan for External-Radiation Monitoring

This plan is for implementation of the sampling, analytical, and data-management activities associated with external-radiation monitoring. The program expectations and design presented in Section 5.4 were used as the framework for developing the monitoring approach presented in this section. The activities described here were designed to provide environmental data of sufficient quality to meet the intended data use. All sampling procedures and analytical protocols described or referenced in this plan are consistent with the requirements of the FPQAPP.

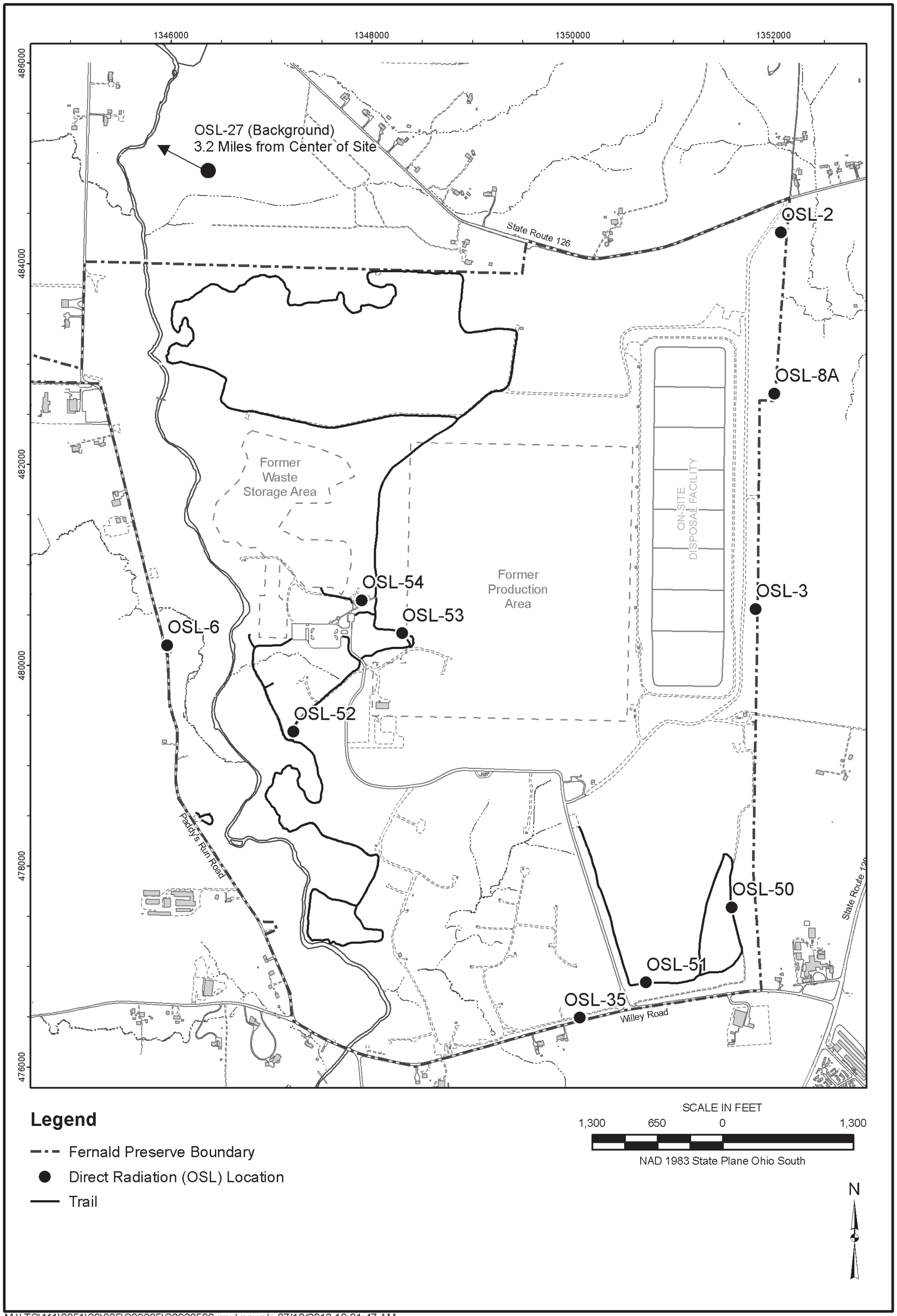

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Figure 5–1. OSL Dosimeter Locations

5.5.1 Sampling Program

Sample analysis will be performed at off-site contract laboratories. Laboratories will be selected based on analyses required, laboratory capacity, turnaround time, and performance of the laboratory. The laboratories used for analytical testing will be DOE-accredited, as specified in FPQAPP. These criteria include performance evaluation samples, pre-acceptance audits, performance audits, and an internal quality assurance program.

5.5.1.1 Sampling Procedures

External-radiation monitoring will be performed following the requirements specified in the FPQAPP, which have been incorporated into the *Fernald Preserve Environmental Monitoring Procedures* (DOE 2011a).

Table 5–3 provides a sample and analytical summary for the external-radiation monitoring program. Environmental dosimeters must meet the following criteria, according to DOE guidance:

- Environmental dosimeters shall be mounted at 1 meter above ground.
- The frequency of exchange should be based on predicted exposure rates from site operations.
- The exposure rate should be long enough (typically one calendar quarter) to produce a readily detectable dose.
- Calibration, readout, storage, and exposure periods used should be consistent with the American National Standard Institute standard recommendations.

All OSL dosimeters placed in the field are tracked via a field-tracking log documenting when and where dosimeters were deployed as well as scheduled collection dates.

5.5.1.2 Quality Control Sampling Requirements

Triplicate OSL dosimeters will be placed at each location and collected and analyzed to evaluate precision in the external-radiation measurement. Quarterly data from the three dosimeters at each location must agree within 15 percent, or the results will be considered suspect and invalid. If field dosimeters have results below the level detected on the control dosimeter (i.e., non-detected result), the results for the individual dosimeter will be reported as ½ the control dosimeter result for that quarter.

5.6 Data Evaluation

This section provides the methods to be used in analyzing the data generated by the external-radiation monitoring. It summarizes the data evaluation process and actions associated with various monitoring results. The planned reporting structure for data provided in the annual SER is also discussed.

Data produced from the external-radiation monitoring will be evaluated to meet the program expectations identified in Section 5.4.1. Based on these expectations, the following questions will be answered:

- Are the program and reporting requirements of DOE Order 450.1A being met?

  DOE Order 450.1A requires that DOE implement and report on an environmental protection program for the Fernald Preserve. External-radiation monitoring is one component of the sitewide IEMP monitoring program. The IEMP and the annual SER fulfill the requirements of this DOE order.

- Are the program goals in line with ALARA?

  The external-radiation monitoring provides a quarterly assessment of exposure for the site and background locations, and this is used to evaluate ALARA.

- Are community concerns being met through the external-radiation monitoring?

  The IEMP fulfills the needs of the Fernald Preserve community by presenting monitoring results in the annual SER.

Data generated from individual OSL dosimeter locations will be trended over time. Historical TLD and OSL dosimeter monitoring data will be used to assess whether current trends are similar, increasing, or decreasing, relative to previous years.

Measurements from the external-radiation monitoring and surface water ingestion dose will be evaluated with respect to the program expectations (Section 5.4.1) and design (Section 5.4.2). Data evaluation consists of answering the following question:

- Do external radiation levels and water dose indicate an exceedance of the 100-mrem/year limit (DOE Order 5400.5).

5.7 General Technical Approach

This section presents the general technical approach for dose tracking and the annual dose assessment, including an explanation of exposure pathways, surveillance and characterization of these pathways, and the dose calculation procedure.

5.7.1 Exposure Pathways

Human receptors may be exposed through the external radiation pathway. The radioactive source for this exposure pathway is the remediated soil. A surface-water pathway is also possible because the site is open to the public, and unescorted hiking is permitted on designated trails. Although wading and swimming are prohibited in the site ponds, incidental ingestion of surface water is a viable exposure pathway for visitors that do not follow the rules.

5.7.2 Potential Receptors

Hypothetical receptors represent conservative, but reasonable, exposure scenarios and locations. An off-property resident is assumed to live at the fence line, receive external radiation from the adjacent site soil. The on-site visitor is exposed via external radiation and ingestion of surface water. Compliance with DOE Order 5400.5 will be based on the higher dose calculated for the two receptors.

5.7.3 Routine Surveillance of Pathways

Remediated soil is the source for external radiation, while surface water serves as an additional source of radionuclide ingestion for the on-site visitor. External radiation is monitored quarterly with OSL dosimeters placed at the fence line, the Visitors Center, and along hiking trails. Radionuclide concentrations in the surface water are obtained annually (semiannually for uranium) from ponds and wetland locations (Table 4–3).

5.8 Dose Assessment Approach

5.8.1 External Radiation

OSL dosimeters will be used to monitor external radiation along the fence line (five locations), at the visitor center (one location) and along the hiking trails (five locations). The five fence-line locations (Figure 5–1) used for the 2007, 2008 and 2009 SERs will continue to be used in outyears. Two of the five hiking locations will be on the Lodge Pond Trail, one on the Biowetland Trail, and one on the Weapons to Wetlands Trail. Trail locations were determined based on the highest residual radionuclide concentrations in the certified soil.

5.8.2 Surface-Water Pathway

Samples collected from ponds and wetlands (Figure 4–2) will be used to assess the internal dose to a visitor that illegally wades in the pond and incidentally ingests surface water. The sample with the highest radionuclide concentrations will be selected to evaluate DOE Order 5400.5, which requires that the dose due to ingestion of water be kept below 4 mrem/yr.

5.9 Frequency of Analysis and Analytical Results

The frequency of analysis and laboratory quality assurance/quality control must be sufficient to maintain program integrity and confidence in the assessment of the 100 mrem/yr dose. Quarterly results for external radiation and semiannual samples for surface water are reasonable frequencies for an LM site. All environmental sample collection and analysis conducted at the Fernald Preserve are subject to the quality assurance requirements of the FPQAPP.

5.9.1 OSL Dosimeters and Surface-Water Samples

OSL dosimeters will be collected, measured, and replaced on a quarterly basis to assess gamma radiation from residual radionuclide concentrations. Quarterly dose measurements for each location will be summed to obtain the annual external dose due to gamma radiation. The highest gamma dose will be used to assess the 100 mrem/yr limit for all pathways. Locations for the OSL dosimeters are shown on Figure 5–1.

Ponds and wetlands sampled semiannually for total uranium and annually for isotopes of thorium, radium, and technetium will provide the data to assess the site dose for a visitor that illegally wades and incidentally ingests surface water. Figure 4–2 provides the surface water sample locations.

5.9.2 Managing Analytical Results

The analysis of environmental samples may result in reported contaminant concentrations that are at or below the minimum detectable concentration (MDC). Contaminant concentrations that are at or below the MDC are statistically indistinguishable from concentrations found in a blank sample. Therefore, results that are reported at or below the MDC will be set to zero for the dose assessment.

All MDCs must meet the limits established in the FPQAPP. Detectable contaminant concentrations will be converted to net concentrations by subtracting the background concentration from the measured result.

5.10 All-Pathway Dose Calculations

This section describes the calculations for demonstrating compliance with the 100-mrem/yr, all-pathway dose limit in DOE Order 5400.5. Estimates of annual dose are based on the background-corrected concentration of a contaminant in each environmental medium.

The general form of the dose assessment equation is:

$$D = C_{i,m} \times I_m \times DCF_i$$

where:

D = Dose (mrem/year)

$C_{i,m}$ = Background-corrected concentration of radionuclide "i" in medium "m" (pCi/kg or pCi/L)

I_m = Intake (ingestion) rate for medium (kg/year or L/year)

DCF_i = Dose conversion factor for radionuclide "i" (mrem/pCi)

In general, external radiation and surface water doses will be calculated separately and then combined into the DOE all-pathway annual dose.

Quarterly OSL dosimeters results are reported as mrem per quarter, and the 4 quarters will be added together to obtain the yearly dose for external radiation.

DOE Order 5400.5 states that DOE sources of drinking water must maintain EPA drinking water standards, and radionuclide concentrations must be low enough to ensure that an internal dose is less than 4 mrem/yr. Although the 4 mrem/yr standard applies to drinking water, it will be used to assess the dose to an on-site visitor that illegally enters the ponds and incidentally ingests the surface water. Surface water samples will be screened to obtain the sample with the highest uranium value, and the volume of surface water ingested will be set to the value used for the Fernald Preserve visitor in the *Interim Residual Risk Assessment for the Fernald Closure Project* (DOE 2007), which is 0.6 liter per year. Water DCGs in Chapter III of DOE Order 5400.5 are based on an internal exposure of 100 mrem/yr and a person consuming drinking water at a rate of 730 liters per year. Therefore, the DCGs must be adjusted to account for the 4 mrem/yr limit and much lower intake attributed to incidental ingestion of surface water (DCG × 4/100 × 730/0.6). The dose from each isotope will be summed to obtain the total surface water dose, and this sum will be compared to the 4 mrem/yr criterion to evaluate compliance with DOE Order 5400.5.

5.11 Reporting

OSL dosimeter data, surface water monitoring data, and the annual dose assessment will be reported according to the schedule in Section 6.0. The annual dose assessment will summarize monitoring results and calculated doses from the external radiation and surface water pathways. Calculated doses will be compared to the regulatory limits to evaluate compliance with DOE Order 5400.5.

6.0 Program Reporting

6.1 Introduction

This section summarizes how the reporting discussions in Sections 3.0 through 5.0 are integrated and provides an overview of the entire environmental data reporting strategy.

6.2 IEMP Monitoring Summary

The IEMP monitoring scope for groundwater, surface water, sediment, and dose has been described in detail in Sections 3.0 through 5.0. The summary that follows is intended to provide the basis for each medium's monitoring program. Evaluation of each program will form the basis for any IEMP program modifications in the future.

Groundwater: The groundwater monitoring program for the Great Miami Aquifer provides for monitoring water quality and water levels in monitoring wells distributed over the aquifer restoration area, along the Fernald Preserve's downgradient property boundary, and at a few private well locations. These wells provide a monitoring network to track the progress of the aquifer restoration and to monitor groundwater quality in the area of the OSDF. The analytical requirements for this monitoring program are based on the FRLs documented in the ROD for Remedial Actions at OU5.

Surface Water: The surface water and treated effluent monitoring program is designed to assess the impacts on surface water. The nonradiological discharge monitoring and reporting related to the NPDES permit have been incorporated into the IEMP.

Sediment: The IEMP sediment sampling program determines whether substantial changes to current residual contaminant conditions occur in the sediment along the Great Miami River. Sediment sampling will continue every 5 years at the Great Miami River sample points for uranium to verify that no adverse impacts have occurred to sediment.

Dose: The dose assessment program is designed to assess the annual effective radiation dose to a human receptor to demonstrate compliance with the requirements of DOE orders. There are 12 OSL dosimeters located at the Fernald Preserve: six are collocated with the former air particulate monitors and six are placed along the hiking trails. The surface water data from the current year is used to assess the annual sitewide radiological dose from this pathway.

The IEMP will be reviewed and revised each September. Revisions will identify any program modifications and any changes to existing regulatory agreements or requirements applicable to sitewide monitoring.

In addition to the IEMP-sponsored review and revision obligations, an independent review and assessment mechanism exists through the Cost Recovery Grant reached between Ohio EPA and DOE. The Cost Recovery Grant provides a way for Ohio EPA to conduct an independent review of DOE environmental monitoring programs. Ohio EPA's role, as defined in the Cost Recovery

Grant, is to independently verify the adequacy and effectiveness of DOE's environmental monitoring programs through program review and independent data collection. Any environmental data collected independently by Ohio EPA are provided to DOE. Modifications to the scope or focus of the IEMP as a result of Ohio EPA's activities will be incorporated as necessary via the annual LMICP review process.

6.3 Reporting

As stated in Section 1.0, a primary objective of the IEMP is to successfully integrate the numerous routine environmental reporting requirements under a single comprehensive framework. The IEMP centralizes, streamlines, and focuses sitewide environmental monitoring and associated reporting under a single controlling document.

The IEMP reporting frequency will be annual with a continued emphasis on timely data reporting in the form of electronic files (i.e., the LM website). The annual SER will continue to be submitted by June 1 to provide a comprehensive evaluation of IEMP data for both the regulatory agencies and the public, and electronic data will be made available to the regulatory agencies as soon as data have been reviewed.

LM Website

The LM website (http://www.lm.doe.gov/Fernald/Sites.aspx) allows the regulatory agencies and members of the public to access Fernald Preserve data in a timely manner. The data are available after analysis and entry into the SEEPro environmental database. The OSL dosimeter data, OSDF Leachate Collection System and Leak Detection System volumes, and groundwater operational data are provided as downloadable files on the LM website. Groundwater, surface water, and sediment data are available through user-defined queries that use the Geospatial Environmental Mapping System (GEMS). GEMS is a internet-based application that provides the ability to query LM environmental data. Once the user is on the GEMS website, the environmental data can be queried by selecting Environmental Reports from the menu. A tutorial is available under Help, which is also on the menu. The use of the LM website for reporting IEMP data provides the agencies with access to IEMP data sooner than through the annual reports. In addition to the environmental media addressed in the IEMP, water quality and water accumulation rate data from the OSDF are included on the LM website.

Based on the objective of the dose assessment described in Section 5.0, the dose assessment results will be presented via two reporting mechanisms: regulatory interfaces and annual reporting.

Annual Site Environmental Reports

The annual SER will continue to be submitted to EPA and Ohio EPA on June 1 of each year. It will continue to document the technical monitoring approach and to summarize the data for each environmental medium. The report will also include water quality and water accumulation rate data from the OSDF monitoring program. The summary report serves the needs of both the regulatory agencies and the public. The accompanying detailed appendixes are a compilation of the information reported on the LM website and are intended for a more technical audience, including the regulatory agencies.

Table 6–1 identifies the media that are being reported under the IEMP and the associated reporting schedule.

Table 6–1. IEMP Reporting Schedule

	First Quarter			Second Quarter			Third Quarter			Fourth Quarter		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Groundwater/OSDF[a]	∗	∗	∗	∗	∗	∗ ●	∗	∗	∗	∗	∗	∗
Surface Water[b]	∗	∗	∗	∗	∗	∗ ●	∗	∗	∗	∗	∗	∗
NPDES Permit Compliance	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
Dose						●						

∗ = LM website Data Reporting
● = Annual Reporting
♦ = Monthly Reporting

[a] Encompasses aquifer restoration operational assessment, aquifer conditions, and OSDF groundwater monitoring.
[b] Encompasses NPDES and IEMP characterization monitoring.

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Appendix A

Natural Resource Monitoring Plan

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Contents

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Acronyms and Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
LM	DOE Office of Legacy Management
EPA	U.S. Environmental Protection Agency
FQAI	Floristic Quality Assessment Index
IEMP	Integrated Environmental Monitoring Plan
LMICP	Legacy Management Institutional Control Plan
NEPA	National Environmental Policy Act
NRMP	Natural Resource Monitoring Plan
NRRP	Natural Resource Restoration Plan
OAC	Ohio Administrative Code
OHPO	Ohio Historical Preservation Office
ORC	Ohio Revised Code
U.S.C.	*United States Code*
WMMP	Wetland Mitigation Monitoring Plan

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1.0 Introduction and Objectives

The purpose of the Natural Resource Monitoring Plan (NRMP) is to outline a comprehensive plan for monitoring natural resources at the Fernald Preserve. Monitoring related to natural resources include the following: (1) monitoring the status of several priority natural resource areas to maintain compliance with applicable regulations; (2) monitoring of completed restoration projects as specified in the Natural Resource Restoration Plan (NRRP), which is Appendix B of the *Consent Decree Resolving Ohio's Natural Resource Damage Claim against DOE* (State of Ohio 2008); and (3) monitoring impacts to natural resources from site activities. The results of this monitoring will be used to inform the U.S. Environmental Protection Agency (EPA), Ohio Environmental Protection Agency (Ohio EPA), and the Fernald Natural Resource Trustees of the status of natural resources at the Fernald Preserve. Monitoring results will be reported in the annual Site Environmental Reports.

2.0 Analysis of Regulatory Drivers

As shown in Table 1, regulatory drivers for the management of natural resources and associated impact monitoring include six areas: endangered species protection; wetlands/floodplain regulations; cultural resource management; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) natural resource trusteeship process; the National Environmental Policy Act (NEPA); and the NRRP.

2.1 Threatened and Endangered Species

The federal laws and regulations listed below mandate that any action authorized, funded, or carried out by the U.S. Department of Energy (DOE) cannot jeopardize the continued existence of any threatened or endangered (i.e., listed) species or result in the destruction or adverse modification of the constituent elements essential to the conservation of a listed species within a defined critical habitat. Additional requirements may apply if it is determined that a proposed activity could adversely affect these species or their habitat. These laws and regulations include the Endangered Species Act (Title 16 *United States Code* [USC] §1531 et seq.) and its associated regulations (Title 50 *Code of Federal Regulations* [CFR] Part 17 [50 CFR 17] and 50 CFR 402).

State law also protects endangered species by prohibiting the taking or destruction of any state-listed endangered species. These laws are found in *Ohio Revised Code* (ORC) §1518 and §1531, as well as in *Ohio Administrative Code* (OAC) §1501.

2.2 Wetlands/Floodplains

Executive Order 11990, *Protection of Wetlands*, and Executive Order 11988, *Protection of Floodplains*, which are implemented by 10 CFR 1022, "Compliance with Floodplain and Wetland Environmental Review Requirements," specify the requirement for a Floodplain/Wetland Assessment in cases where DOE is responsible for providing federally undertaken, financed, or assisted construction and improvements that may impact floodplains or wetlands. This regulation further requires that DOE exercise leadership to minimize the destruction, loss, or degradation of wetlands; and preserve and enhance the natural and beneficial values of wetlands.

Table 1. Fernald Site Natural Resource Monitoring

Driver	Action
Endangered Species Act Ohio Endangered Species Regulations	The IEMP describes management of existing habitat and follow-up surveys.
Clean Water Act Section 404	The IEMP describes the monitoring of mitigation wetlands.
National Historic Preservation Act Native American Graves Protection and Repatriation Act Archaeological Resources Protection Act	The IEMP describes the monitoring of cultural resources.
CERCLA Executive Order 12580 National Contingency Plan	The IEMP and Volume I of the LMICP describes the CERCLA Natural Resources Trusteeship process.
NEPA	The IEMP discusses the substantive requirements of NEPA for protecting sensitive environmental resources.
NRRP	The IEMP discusses restored area monitoring.

Pursuant to Section 404 of the Clean Water Act and 33 CFR 323.3, any activity that results in the discharge of dredged or fill material out of or into a wetland or water of the United States requires permit authorization by the Army Corps of Engineers. These permits can be in the form of either nationwide permits (33 CFR 330) or individual permits (33 CFR 323), depending on the nature of the activity.

Section 401 of the Clean Water Act and 33 CFR 325.2(b)(1)(ii) also require that a Section 401 State Water Quality Certification be obtained to authorize discharges of dredged and fill material under a Section 401 permit. In Ohio, the Section 401 State Water Quality Certification program is administered by Ohio EPA pursuant to OAC 3745-32.

2.3 Cultural Resource Management

Management of cultural resources, particularly archeological sites, is mandated by the National Historic Preservation Act (16 U.S.C. §470), the Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 et seq.), and the Archeological Resources Protection Act (16 U.S.C. §470aa-470ll). The associated regulations for the above laws are found in 36 CFR 800, 43 CFR 10, and 43 CFR 7, respectively. These laws and regulations ensure that archeological resources on federal land are appropriately managed. Section 106 of the National Historic Preservation Act ensures that DOE considers the effect of its undertakings on properties eligible for listing on the National Register of Historic Places. The Native American Graves Protection and Repatriation Act and 43 CFR 10 require that the rightful control of Native American cultural items discovered on federal land be relinquished to the appropriate culturally affiliated tribe. Federal land is defined as "land that is owned or controlled by a federal agency." Cultural items are defined as "human remains, associated funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony." The Archeological Resources

Protection Act and 43 CFR 7 ensure that competent individuals carry out archeological excavations in a scientific manner.

DOE signed a Programmatic Agreement with the Advisory Council on Historic Preservation and the Ohio Historic Preservation Office (OHPO) that streamlines the National Historic Preservation Act Section 106 consultation process. Monitoring provisions are included as part of this agreement to ensure that appropriate management is implemented for any eligible properties at the Fernald Preserve. At the request of OHPO, the *Programmatic Agreement Among the U.S. Department of Energy Office of Legacy Management and the Ohio Historical Preservation Office Regarding Archaeological Investigations at the Fernald Preserve* (OHPO 2012) was updated in 2012. The reporting frequency was changed from annual to "as needed."

2.4 The CERCLA Natural Resource Trusteeship Process

CERCLA, Executive Order 12580, and the National Contingency Plan require certain federal and state officials to act on behalf of the public as trustees for natural resources. Natural Resource Trustees for the Fernald Preserve are the Secretary of DOE; the Secretary of the U.S. Department of the Interior, as represented by the U.S. Fish and Wildlife Service; and officials of the Ohio EPA, appointed by the governor of Ohio.

The role of the Natural Resource Trustees is to act as guardians for public natural resources at or near the Fernald Preserve. The trustees are responsible for determining if natural resources have been injured as a result of a release of a hazardous substance or oil spill from the site, and if so, how to restore, replace, or acquire the equivalent natural resources to compensate for the injury. As the responsible party, DOE is potentially liable for costs related to natural resource injury.

The Fernald Natural Resource Trustees began meeting in June 1994 to evaluate and determine the feasibility of integrating the trustees' concerns with site remediation activities. The trustees identified their desire to resolve DOE's liability by integrating restoration activities with the Fernald Site's remediation.

A long-standing natural resource damage claim was settled in 2008. Volume I of the Fernald Preserve Legacy Management and Institutional Controls Plan describes the Trustee settlement agreement. As part of the settlement, the Trustees finalized the NRRP. The NRRP specifies an enhanced monitoring program for ecologically restored areas at the site. In addition, an enhanced wetlands mitigation monitoring program was developed, along with the resumption of functional-phase monitoring in restored areas. As stated in Section 1.0, this monitoring will be summarized in the annual Site Environmental Reports. Detailed results of restoration monitoring will be provided annually in the appendix to the Site Environmental Report.

2.5 National Environmental Policy Act

In addition to the regulatory drivers summarized above, aspects of natural resource management and monitoring are mandated through the incorporation of substantive NEPA requirements into remedial action planning. In June 1994, DOE issued a revised secretarial policy on NEPA compliance. This policy called for the integration of NEPA requirements into the CERCLA decision-making process. Therefore, requirements for the protection of sensitive environmental resources, including threatened and endangered species and cultural resources, are to be considered throughout legacy management activities.

3.0 Program Expectations and Design Considerations

The expectations of the monitoring and reporting as outlined in the NRMP are as follows:

- Provide a mechanism to monitor the status of the Fernald Site's natural resources to remain in compliance with applicable laws and regulations.
- Monitor restored areas to ensure that requirements of the NRRP are being met and that restored areas continue to develop and function as designed.

The results of the monitoring outlined in this NRMP will be compiled and reported to EPA and Ohio EPA. Results will be reviewed to ensure that ecologically restored areas are performing as designed. If results indicate that a restored area is not functioning as intended, DOE's Office of Legacy Management (LM), in consultation with EPA, Ohio EPA, and the Natural Resource Trustees, will decide the appropriate corrective actions.

4.0 Natural Resource Monitoring Plan

Monitoring was implemented during remediation activities to identify impacts to natural resources at the Fernald Site with particular emphasis placed on meeting regulatory requirements for NEPA, threatened or endangered species, wetlands/floodplains, and cultural resources. To accommodate natural resource monitoring, priority natural resource areas have been established across the Fernald Preserve (Figure 1).

4.1 Threatened and Endangered Species

A number of endangered species surveys have been conducted at the Fernald Preserve. The state-listed threatened Sloan's crayfish (*Orconectes sloanii*) and the federally endangered Indiana brown bat (*Myotis sodalis*) are the only threatened or endangered species to have a known population at the site. However, there is the potential for other state-listed and federally listed threatened or endangered species to have habitat ranges that encompass or occupy the Fernald Preserve. If activities at the Fernald Preserve could potentially impact Indiana bat or Sloan's crayfish habitat, active monitoring of those areas will resume. Monitoring for several other listed species that may be present at the Fernald Preserve will take place if potential habitat would be impacted by site activities.

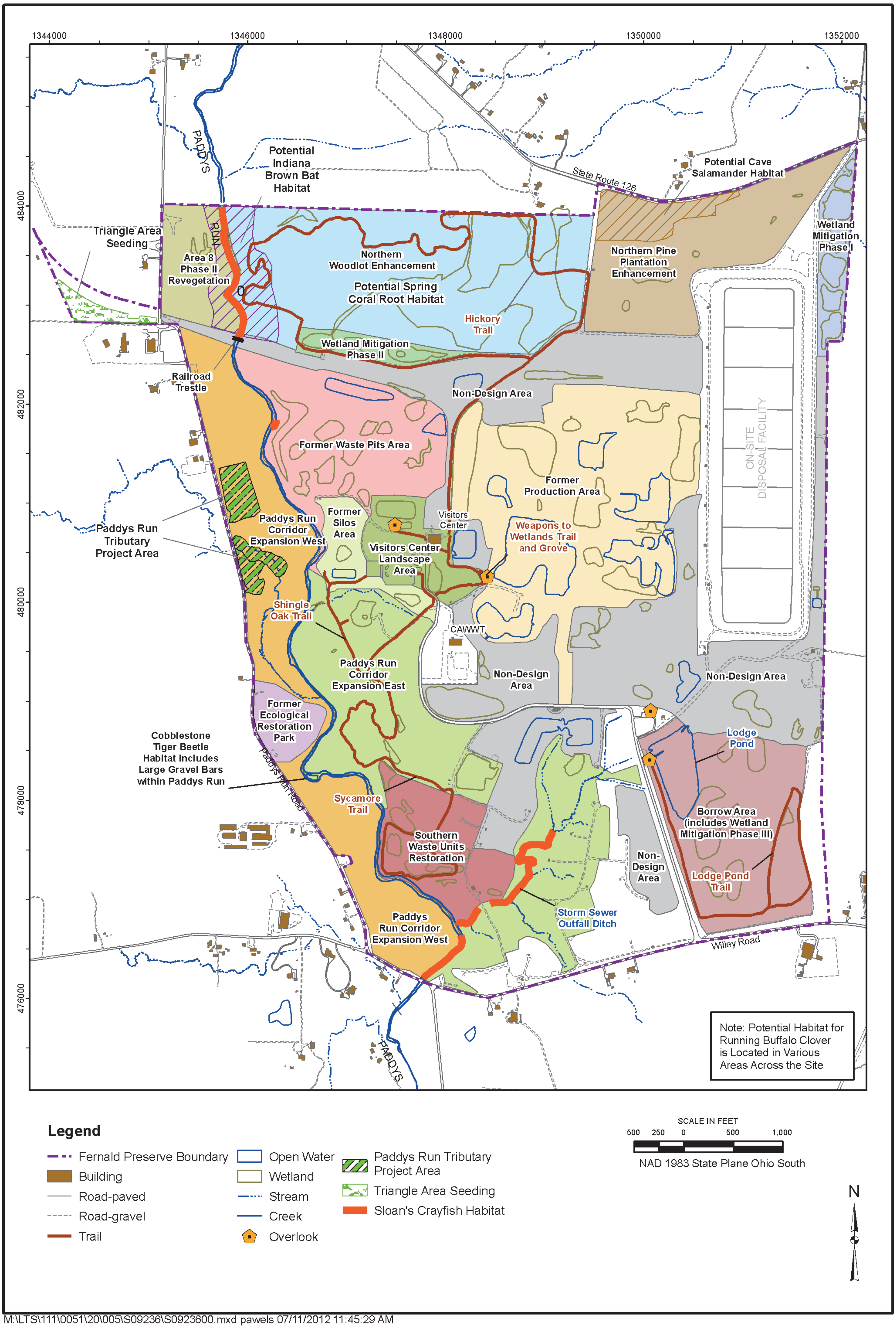

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Figure 1. Priority Natural Resource Areas

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4.1.1 Sloan's Crayfish

The state-listed threatened Sloan's crayfish is a small crayfish found in the streams of southwest Ohio and southeast Indiana. It prefers streams with constant (though not necessarily fast) current flowing over rocky bottoms. Several populations of Sloan's crayfish have been found at the Fernald Site in Paddys Run and the Storm Sewer Outfall Ditch. In dry periods, the crayfish retreat to the deeper pools that remain, primarily upstream of the former rail trestle, located approximately at the boundary between Hamilton and Butler counties. A significant population of Sloan's crayfish also resides in an off-property section of Paddys Run at New Haven Road.

This species resides with one other competing species of crayfish (*Orconectes rusticus*) that is generally considered more aggressive. In addition, the Sloan's crayfish is sensitive to siltation in streams.

Impacts on Sloan's crayfish are similar to those on other aquatic organisms in Paddys Run. Impacts of concern would include excavation and alteration of the streambed along with increased siltation and runoff into Paddys Run. With the majority of on-site soil disturbance now complete, habitat impacts are not expected. A survey of Sloan's crayfish was conducted in 2008 to assess the post-closure status of the on-site population. If the potential for impacts does return, a Sloan's crayfish management plan will be put in place. This plan would detail monitoring and contingency plans to mitigate impacts.

4.1.2 Indiana Brown Bat

Good to excellent summer habitat for the federally listed endangered Indiana brown bat (*Myotis sodalis*) has been identified north of the former rail trestle along Paddys Run. The habitat provides an extensive mature canopy from older trees and the presence of water throughout the year. In 1999, one adult female was captured along Paddys Run and released. Potential impacts to Indiana brown bat habitat would include tree removal and stream alteration in the northern on-property sections of Paddys Run. Because the bats use loose-bark trees for their maternal colonies, removal of trees would impact this species by eliminating its summer habitat.

The habitat of the Indiana brown bat was monitored during remediation activities to identify any unanticipated impacts during remediation. A follow-up survey was conducted in the summer of 2002 as a result of remediation activities north of the train trestle along Paddys Run. No Indiana brown bats were found during this survey.

DOE and the agencies agreed to keep the former rail trestle in place after a thorough review of the impacts that would result from its removal. The trestle was modified to promote use by bats.

Monitoring methods for the Indiana brown bat would consist of visual observations of that activity and mist netting in areas suitable as bat flyways and where canopy occurs. Mistnetting would occur between May 15 and August 15, because some bats begin to disperse for winter shelter in late August. Data recorded at each sampling site would include type of habitat, water depth and permanence, type of bottom, tree species and size, and presence of hollow trees or trees with loose bark in the vicinity.

In addition to mistnets, bat detectors (which indicate bat activity) would be used during all sampling to detect echolocation calls near the net. The number of calls on the detector would be recorded to indicate the effectiveness of the nets in relation to bat activity. Bat detectors can also be used to sample areas of marginal habitat to determine if netting should be attempted.

One such sampling event took place in the summer of 2007. While several species of bats were collected, no Indiana brown bats were captured. Visual monitoring for bat activity was conducted through 2008. At this time, no further monitoring is required. If disturbances to the trestle or any other portion of the Indiana brown bat habitat area are required during the summer breeding season, additional monitoring activities will be necessary.

4.1.3 Running Buffalo Clover

Surveys conducted in 1994 of the federally listed endangered running buffalo clover (*Trifolium stoloniferum*) found no individuals of this species at the Fernald Site. However, because running buffalo clover is found nearby in the Miami Whitewater Forest, the potential exists for this species to establish at the Fernald Site. The running buffalo clover prefers habitat with well-drained soil, filtered sunlight, limited competition from other plants, and periodic disturbance. This plant is a perennial that forms long stolons, rooting at the nodes. The plant is also characterized by erect flowering stems, typically 3 to 6 inches tall, with two leaves near the summit topped by a round flower head. If surveys are necessary, they would be conducted between May and June, which is the optimal time frame for blooms. An appropriate number of transects would be walked in suspected areas to identify the running buffalo clover. If populations are discovered, then best management practices will be used to minimize any impending impacts.

4.1.4 Spring Coral Root

The state-listed threatened spring coral root (*Corallorhiza wisteriana*) is a white-and-red orchid that blooms in April and May and grows in partially shaded areas of mesic deciduous woods, such as forested wetlands and wooded ravines. Although surveys conducted in 1994 and 1995 indicated that no individuals were found, suitable habitat exists in portions of the northern woodlot.

A floristic analysis for the northern woodlot and associated northern forested wetland was conducted in 1998. No spring coral root was observed during this survey.

4.1.5 Cave Salamander

The state-listed endangered cave salamander (*Eurycea lucifuga*) is a slender, orange salamander with irregular black dots. It is found in caves, springs, small limestone streams, outcrops, and spring houses where groundwater is present. In Ohio, cave salamanders have only been documented in Hamilton, Butler, and Adams Counties. Suitable habitat within the Fernald Preserve is limited, but populations have been observed just north of the site. A survey conducted in 1993 did not reveal any individuals on site.

4.1.6 Cobblestone Tiger Beetle

The state-listed threatened cobblestone tiger beetle (*Cicindela marginipennis*) is a black and grey beetle with a red abdomen. It is found on large gravel bars on medium sized rivers. Populations have been recorded east of the Fernald Preserve along the Great Miami River. Potential habitat on site would be limited to large gravel bars in Paddys Run.

4.2 Wetlands/Floodplains

Approximately 11.87 acres of on-property wetlands adjacent to the former production area were impacted as a result of contaminated soil excavation. The 26-acre northern forested wetland area and associated drainage characteristics were avoided and protected during remediation activities. A mitigation ratio of 1.5:1 (i.e., 1.5 acres of wetlands replaced for every one acre of wetland disturbed) was negotiated between DOE and the appropriate agencies (i.e., EPA, Ohio EPA, U.S. Fish and Wildlife Service, and Ohio Department of Natural Resources). As a result of this agreement, 17.8 acres of new wetlands was established to compensate for the impacts during remediation.

To ensure mitigation acreage is achieved, an enhanced wetland mitigation monitoring program was established. On-site created wetlands are evaluated pursuant to existing Ohio EPA performance standards and monitoring protocols. The *Fernald Preserve Wetland Mitigation Monitoring Plan* (WMMP) (DOE 2009a) was developed by the Fernald Natural Resource Trustees that establishes the site wetland monitoring requirements. The WMMP details performance standards and remaining monitoring requirements for completed wetland mitigation projects. In addition, this plan identifies additional on-site wetlands that may contribute to compensatory wetland acreage. Performance standards and monitoring requirements are set forth for these areas as well.

The WMMP established a three-year monitoring program, from 2009 to 2011. Approximately 31.3 acres of jurisdictional wetlands were delineated from this effort, thereby satisfying the need for creating 17.85 acres of compensatory mitigation wetlands. Monitoring results and the wetland delineation were summarized in the *Fernald Preserve Wetland Mitigation Monitoring Report* (WMMR) (DOE 2012). The Fernald Natural Resource Trustees approved the WMMR in April 2012, with the provision that site wetlands continue to be evaluated as part of the functional monitoring program.

4.3 Cultural Resource Management

All field personnel must comply with the *Procedure for Unexpected Discovery of Cultural Resources* (DOE 2009b) if cultural resources are uncovered during ground-disturbing activities. If ground-disturbing activities must occur during legacy management, limited monitoring will occur in all areas that have been surveyed to identify any unexpected discoveries of human remains (Figure 2). More intensive field monitoring will take place only in areas known to have a high potential for archaeological sites as determined by previous investigations. In most instances, discovery of human remains in previously surveyed areas will require data recovery work. Disturbance of previously unsurveyed areas will require at least a Phase I investigation prior to soil disturbance. A summary of all cultural resource field activities is provided separately from the IEMP under the Programmatic Agreement for Archeological Activities at the Fernald Site. As stated above, the Programmatic Agreement (OHPO 2012) was revised to change the reporting frequency from annual to "as needed." Monitoring of cultural resource areas will continue during legacy management to ensure that the areas are not being disturbed, as is described in the Institutional Controls Plan.

4.4 Restored Area Monitoring

Restored area monitoring is required following the completion of natural resource restoration work. Monitoring of restored areas involved two phases: implementation-phase monitoring and functional-phase monitoring. Additional species inventory activities may be conducted as well, in order to document wildlife use and ecological communities at the Fernald Preserve. Procedures for field implementation of restored area monitoring and species inventory activities are provided in the *Fernald Preserve Ecological Monitoring Methods Plan* (DOE 2010).

Implementation-phase monitoring is conducted to ensure that restoration projects are completed pursuant to their NRRP and to determine vegetation survival and herbaceous cover. Planted vegetation must have 80 percent survival in any restored area, determined by mortality counts. Any seeded area must have 90 percent cover, with 50 percent being native species.

Functional-phase monitoring is conducted to evaluate the progress of a restored community against pre-restoration baseline conditions and an ideal reference site. Woody and herbaceous vegetation species are evaluated for species richness, density, and frequency. Size of woody vegetation is also recorded. Functional monitoring was conducted through the fall of 2005. With finalization of the NRRP in November 2008, functional-phase monitoring resumed in 2009. The WMMR subsequently established that the three-year rotation for functional monitoring would continue in 2012.

4.4.1 Implementation-Phase Monitoring

To determine vegetation survival, mortality counts are conducted at the end of the first growing season following installation. Each container-grown and balled and burlapped tree and shrub is inspected and assigned one of four categories: alive, resprout, vitality, or dead. Trees and shrubs will be considered "alive" when their main stem and/or greater than 50 percent of the lateral stems are viable. "Resprout" trees and shrubs will have a dead main stem, with one or more new shoots growing from the stem or the root mass. Plants will be categorized as "vitality" when less than 50 percent of its lateral branches are alive. "Dead" trees will have no signs of life at all.

For seeded areas within a restoration project, the Natural Resource Trustees agreed to a 90 percent cover survival rate for cover crops (necessary for slope stabilization and erosion control) and 50 percent survival rate for native species at the end of the implementation monitoring period as a goal.

All seeded areas are evaluated within each restoration project. Depending on the size of the restoration project, seeded areas may be grouped into habitat-specific subareas. For each distinct area, at least three 1-meter-square quadrats are randomly distributed and surveyed. Field personnel estimate the total cover and list all species present within each quadrat. The data collected will be used to determine total cover, percent native species composition, and relative frequency of native species, as described below.

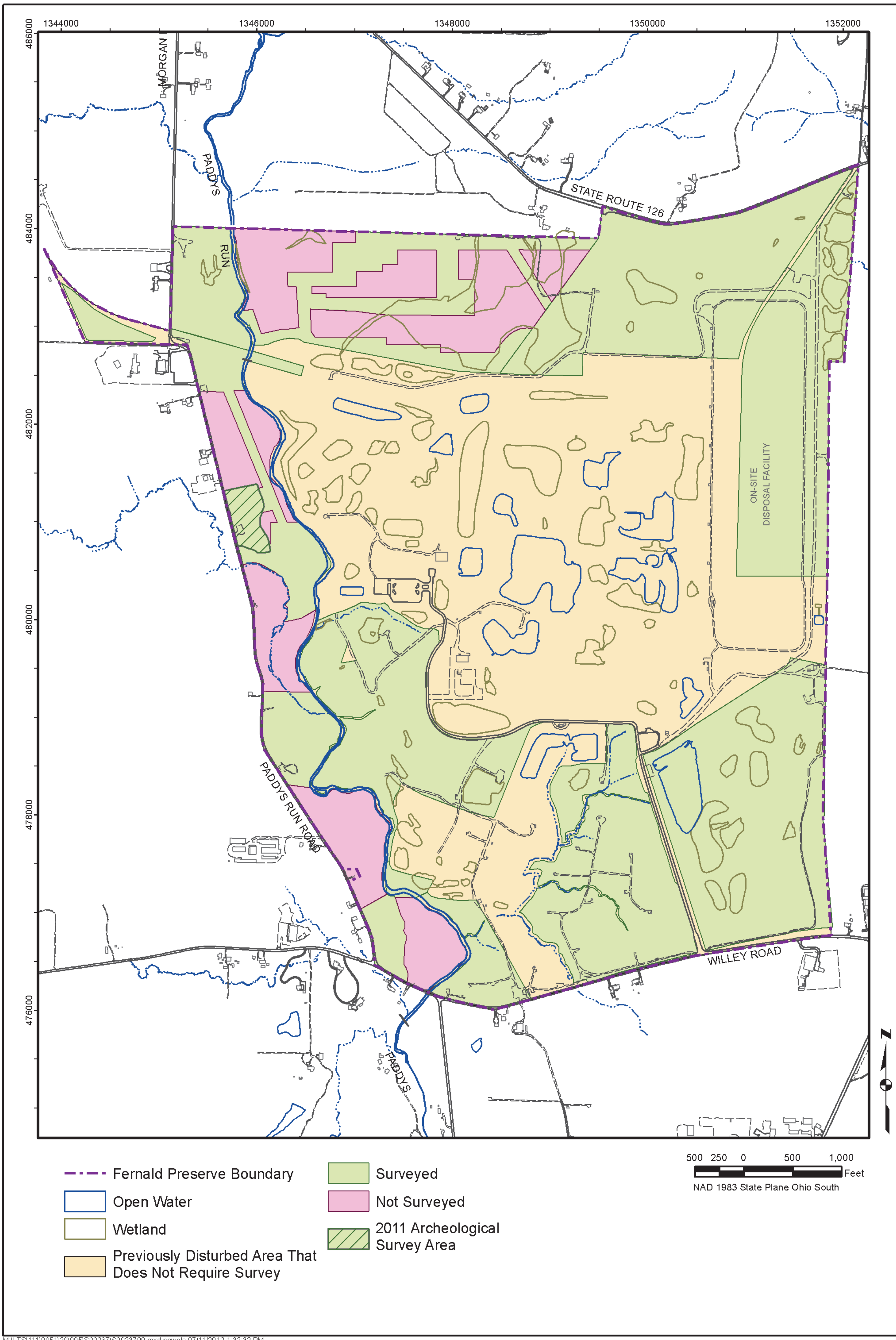

Figure 2. Cultural Resource Survey Areas

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For total cover, the quadrat-specific cover estimates are averaged. Percent native species composition is calculated by dividing the total number of species surveyed into the total number of native species present. The relative frequency of native species is determined by first recording the number of times each species appears in a quadrat. Next, the number of times a species appears in each quadrat is divided by the total number of quadrats surveyed. Finally, the frequencies of all native species is summed and divided by the total of all frequencies within a given area.

By collecting the information described above, DOE will evaluate implementation-phase success of seeded areas based on two criteria. First, 90 percent cover must be met by the end of the first growing season. Second, the goal of 50 percent native species composition or relative frequency must be obtained by the end of the implementation monitoring period. These criteria address both erosion control and native community establishment, which are the two primary goals of seeding in restored areas.

4.4.2 Functional Monitoring

Functional monitoring focuses on an entire habitat (e.g., prairie, wetland, forest) instead of an individual project. Functional monitoring helps determine if restored habitats at the Fernald Preserve are progressing when compared to baseline conditions and established reference sites. Functional monitoring has a longer duration and a lower frequency of data collection (e.g., every 3 years). Functional monitoring will quantitatively evaluate progress of restored habitat against a baseline and toward an established reference site.

Functional monitoring is not a pass/fail determination like implementation-phase monitoring. Instead, functional monitoring is a means of evaluating the progress of the restored community against pre-restoration baseline conditions and target reference sites already achieving high ecological function. Evaluation of woody and herbaceous vegetation is the main focus of functional monitoring. Vegetation indices are used for comparisons, as well as several wildlife-based evaluations. Floristic Quality Assessment Index (FQAI) is the primary monitoring parameter that has been and will continue to be used in functional monitoring.

Baseline conditions were measured at the Fernald Preserve in 2001 and 2002. To establish the needed reference site data, DOE teamed with the University of Dayton and collected the data outlined above from reference sites agreed upon by the Natural Resource Trustees in 2002. Restored habitats on the Fernald Closure Project were grouped together as wetlands, prairies/savannas, or forest/riparian. Information collected include species richness, density, and frequency. Woody vegetation size is also recorded. From these parameters, sites are evaluated through FQAI, the extent of native species present, and the extent of hydrophytic species present (for wet areas).

Several wildlife evaluations have been conducted in addition to vegetation surveys. These include amphibian and macroinvertebrate sampling and migratory waterfowl observations. Casual wildlife observations have also been recorded in each study area.

Functional monitoring data on site wetlands were collected in 2003, data on prairies/savannas were collected in 2004, and data on woodlands were collected in 2005. Functional monitoring was discontinued in 2006, then resumed in 2009 following settlement of the natural resource damage claim. Monitoring activities follow a three-year rotation of wetland communities, prairie communities, and forest communities.

4.5 Natural Resource Data Evaluation and Reporting

The results of natural resource monitoring will be integrated with annual reporting, a commitment in the IEMP. Annual Site Environmental Reports will provide appropriate updates on unexpected impacts to natural resources and the results of specific natural resource monitoring that have been implemented. The annual Site Environmental Report will include a summary of the findings. A detailed discussion and evaluation of the available data will be presented in an appendix to the Site Environmental Report. Significant findings as a result of natural resource monitoring will be communicated to EPA and Ohio EPA as needed. Results from all monitoring activities are used to direct restored area maintenance activities, through the concept of Adaptive Management.

5.0 References

DOE (U.S. Department of Energy), 2009a. *Fernald Preserve Wetland Mitigation Monitoring Plan*, Revision 0, Office of Legacy Management, Grand Junction, Colorado.

DOE (U.S. Department of Energy), 2009b. *Procedure for Unexpected Discovery of Cultural Resources*, Revision 0, Office of Legacy Management, Grand Junction, Colorado.

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DOE (U.S. Department of Energy), 2012. *Fernald Preserve Wetland Mitigation Monitoring Report*, Office of Legacy Management, Grand Junction, Colorado.

OHPO (Ohio Historical Preservation Office), 2012. *Programmatic Agreement Among the U.S. Department of Energy Office of Legacy Management and the Ohio Historical Preservation Office Regarding Archaeological Investigations at the Fernald Preserve,* April.

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