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# Department of Energy
# Office of Legacy Management

May 27, 2010

Dear Fernald Preserve Stakeholder:

2009 SITE ENVIRONMENTAL REPORT

Enclosed for your information and reference is the Fernald Preserve Site Environmental Report for calendar year 2009. This report presents results from the environmental monitoring conducted during calendar year 2009, as well as a summary of regulatory compliance activities at the Fernald Preserve during the year.

Both the U.S. Department of Energy and its contractor, S.M. Stoller, Inc. have reviewed the report to ensure that valid and accurate environmental monitoring data are reported. This report is distributed to local, state, and federal agencies and politicians; and the public. It includes a summary report and a single volume of supporting appendices.

This summary report is intended to serve the same wide audience as past annual reports. Detailed appendices are also available, and are intended to serve a more technical audience such as the regulatory agencies, and will receive limited distribution. The summary report and appendices are available to interested stakeholders through the Visitors Center, which is located at 7400 Willey Rd., Hamilton, OH 45013; (513) 648-7500 (open Wednesday through Saturday, 9:00 a.m. to 5:00 p.m., or by appointment). The summary report will also be made available on the Department of Energy Office of Legacy Management's internet site (http://www.lm.doe.gov) under the Legacy Management Sites icon.

If you have any questions regarding this report, please email me at fernald@lm.doe.gov or call me at (513) 648-3148.

Sincerely,

Jane Powell

Jane Powell
Fernald Preserve Manager
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Enclosure: As Stated


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FERNALD PRESERVE

# 2009 Site Environmental Report

U.S. Department of Energy

Office of Legacy Management

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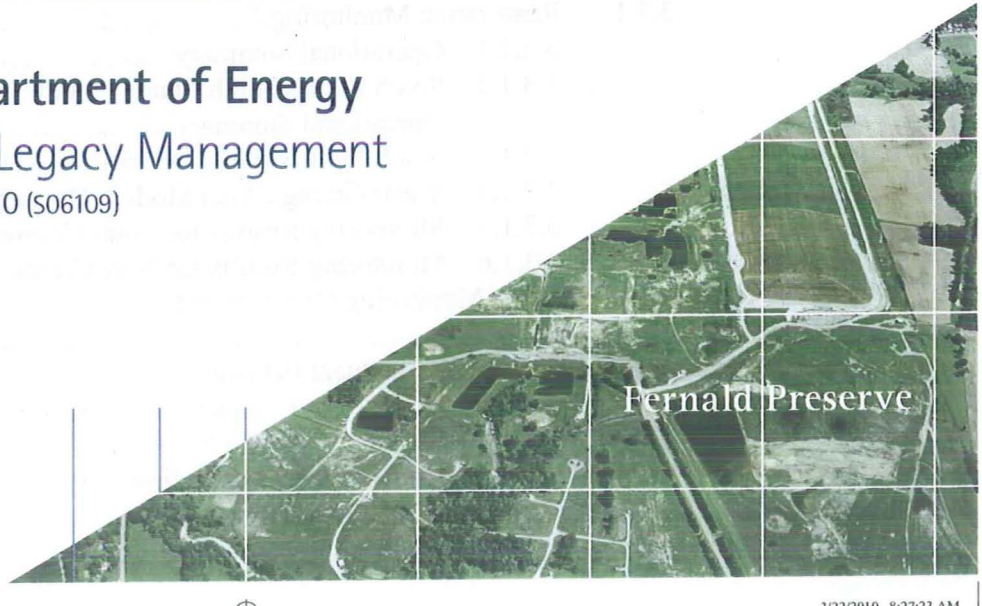


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# Contents


Abbreviations ..... v
Measurement Abbreviations ..... vii
Units (Abbreviations) and Conversion Table ..... ix
Executive Summary ..... xi
1.0 Site Background ..... 1–1
1.1 The Path to Site Closure ..... 1–3
1.2 Environmental Monitoring Program ..... 1–5
1.3 Characteristics of the Site and Surrounding Area ..... 1–6
1.3.1 Land Use and Demography ..... 1–6
1.3.2 Geography ..... 1–6
1.3.3 Geology ..... 1–11
1.3.4 Surface Hydrology ..... 1–11
1.3.5 Meteorology ..... 1–12
1.3.6 Natural Resources ..... 1–15
2.0 Remediation Status and Compliance Summary ..... 2–1
2.1 CERCLA Remediation Status ..... 2–1
2.2 Summary of Compliance with Other Requirements ..... 2–6
2.2.1 RCRA ..... 2–6
2.2.1.1 RCRA Property Boundary Groundwater Monitoring ..... 2–6
2.2.1.2 Waste Management ..... 2–6
2.2.2 Clean Water Act ..... 2–7
2.2.3 Clean Air Act ..... 2–7
2.2.4 Superfund Amendments and Reauthorization Act of 1986 ..... 2–7
2.2.5 Other Environmental Regulations ..... 2–8
2.2.6 Other Permits ..... 2–8
2.2.7 Pollution Prevention and Source Reduction ..... 2–8
2.2.8 Federal Facilities Compliance Agreement ..... 2–12
2.2.9 Environmental Management Systems Requirement ..... 2–12
2.3 Split Sampling Program ..... 2–13
3.0 Groundwater Pathway ..... 3–1
3.1 Summary of the Nature and Extent of Groundwater Contamination ..... 3–1
3.2 Selection and Design of the Groundwater Remedy ..... 3–2
3.3 Groundwater Monitoring Highlights for 2009 ..... 3–6
3.3.1 Restoration Monitoring ..... 3–12
3.3.1.1 Operational Summary ..... 3–12
3.3.1.2 South Plume/South Plume Optimization Module Operational Summary ..... 3–14
3.3.1.3 South Field Module Operational Summary ..... 3–14
3.3.1.4 Waste Storage Area Module Operational Summary ..... 3–16
3.3.1.5 Monitoring Results for Total Uranium ..... 3–17
3.3.1.6 Monitoring Results for Non-Uranium Constituents ..... 3–18
3.3.2 Other Monitoring Commitments ..... 3–20
3.4 OSDF Monitoring ..... 3–21
4.0 Surface Water and Treated Effluent Pathway ..... 4–1
4.1 Summary of Surface Water and Treated Effluent Pathway ..... 4–1
4.2 Remediation Activities Affecting the Surface Water Pathway ..... 4–3
4.3 Surface Water, Treated Effluent, and Sediment Monitoring Program for 2009 ..... 4–3

4.3.1 Surveillance Monitoring ..... 4–4
4.3.2 Compliance Monitoring ..... 4–8
4.3.2.1 FFCA and OU5 ROD Compliance ..... 4–8
4.3.2.2 NPDES Permit Compliance ..... 4–12
4.3.3 Uranium Discharges in Surface Water and Treated Effluent ..... 4–12
4.4 Sediment Monitoring ..... 4–12
5.0 Air Pathway ..... 5–1
5.1 Activities Affecting the Air Pathway ..... 5–1
5.2 Air Monitoring Program Summary for 2009 ..... 5–3
5.3 Radiological Air Particulate Sampling Results ..... 5–3
5.4 Monitoring for Direct Radiation ..... 5–6
6.0 Radiation Dose ..... 6–1
6.1 Estimated Dose from Airborne Emissions ..... 6–1
6.2 Direct Radiation Dose ..... 6–2
6.3 Total of Doses to the Maximally Exposed Individual ..... 6–4
6.4 Significance of Estimated Radiation Doses for 2009 ..... 6–4
6.5 Estimated Dose to Biota ..... 6–6
7.0 Natural Resources ..... 7–1
7.1 Ecological Restoration Activities ..... 7–1
7.1.1 Trails and Overlook Construction ..... 7–3
7.1.2 Restored Area Maintenance Activities ..... 7–3
7.1.3 Ecological Restoration Monitoring ..... 7–5
7.2 Fernald Preserve Site and OSDF Inspections ..... 7–9
7.3 Affected Habitat and Inspection Findings ..... 7–10
7.4 Threatened and Endangered Species and Species Inventories ..... 7–10
7.5 Cultural Resources ..... 7–11
8.0 References ..... 8–1
9.0 Glossary ..... 9–1

# Figures

Figure 1–1. Fernald Preserve and Vicinity ..... 1–7
Figure 1–2. Major Communities in Southwestern Ohio ..... 1–8
Figure 1–3. Fernald Preserve Perspective ..... 1–9
Figure 1–4. Cross Section of the New Haven Trough, Looking North ..... 1–12
Figure 1–5. Regional Groundwater Flow in the Great Miami Aquifer ..... 1–13
Figure 1–6. Great Miami River Drainage Basin ..... 1–14
Figure 1–7. 2002–2006 Wind Rose, 33-ft (10-m) Height ..... 1–16
Figure 1–8. 2002–2006 Wind Rose, 197-ft (60-m) Height ..... 1–16
Figure 1–9. Annual Precipitation, 1994–2009 ..... 1–17
Figure 1–10. Monthly Precipitation for 2009 Compared to Average Monthly Precipitation for 1951–2009 ..... 1–18
Figure 2–1. Uncertified Areas and Subgrade Utility Corridors ..... 2–3
Figure 2–2. 2009 DOE and OEPA Groundwater Split Sample Locations ..... 2–14
Figure 3–1. Extraction Wells Active in 2009 ..... 3–3
Figure 3–2. Diagram of a Typical Groundwater Monitoring Well ..... 3–7
Figure 3–3. Monitoring Well Relative Depths and Screen Locations ..... 3–8
Figure 3–4. Locations for Semiannual Total Uranium Monitoring ..... 3–9

Figure 3–5. Locations for Semiannual Non-Uranium Monitoring ..... 3–10
Figure 3–6. IEMP Groundwater Elevation Monitoring Wells ..... 3–11
Figure 3–7. Net Mass of Uranium Removed from the Great Miami Aquifer, 1993–2009 ..... 3–13
Figure 3–8. Total Uranium Plume in the Aquifer with Concentrations Greater Than 30 µg/L at the End of 2009 ..... 3–15
Figure 3–9. Non-Uranium Constituents with 2009 Results Above FRLs ..... 3–19
Figure 3–10. OSDF Footprint and Monitoring Well Locations ..... 3–22
Figure 4–1. Controlled Surface Water Areas and Uncontrolled Runoff Flow Directions ..... 4–2
Figure 4–2. IEMP/NPDES Surface Water and Treated Effluent Sample Locations ..... 4–5
Figure 4–3. IEMP Background Surface Water Sample Locations ..... 4–7
Figure 4–4. Annual Average Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03) Sample Location, 1985–2009 ..... 4–9
Figure 4–5. Pounds of Uranium Discharged to the Great Miami River through the Parshall Flume (PF 4001) in 2009 ..... 4–10
Figure 4–6. 2009 Monthly Average Total Uranium Concentration in Water Discharged Through the Parshall Flume (PF 4001) to the Great Miami River ..... 4–11
Figure 4–7. Uranium Discharged via the Surface Water Pathway, 1993–2009 ..... 4–13
Figure 4–8. 2009 Sediment Sample Locations ..... 4–14
Figure 5–1. Radiological AMS Locations ..... 5–2
Figure 5–2. Monthly Results and Measurement Error for Uranium in Collected Air Particulate ..... 5–5
Figure 5–3. Annual Activity and Uncertainty for Isotopes Used in NESHAP Analysis ..... 5–7
Figure 5–4. Direct Radiation (OSL) Monitoring Locations ..... 5–8
Figure 5–5. Quarterly Results for OSL Monitoring Locations ..... 5–10
Figure 6–1. Comparison of 2009 Air-Pathway Doses and Allowable Limits ..... 6–3
Figure 6–2. Comparison of 2009 All-Pathway Doses and Allowable Limits ..... 6–5
Figure 7–1. Restoration Project Areas ..... 7–2
Figure 7–2. Wetland Mitigation Areas Evaluated ..... 7–7
Figure 7–3. Threatened and Endangered Species Habitat Areas ..... 7–12
Figure 7–4. Cultural Resource Survey Areas ..... 7–14

## Tables

Table 1–1. Operable Unit Remedies ..... 1–4
Table 2–1. Compliance with Other Environmental Regulations ..... 2–9
Table 2–2. 2009 DOE/OEPA Groundwater Split Sampling Comparison ..... 2–13
Table 3–1. Groundwater Restoration Module Status for 2009 ..... 3–12
Table 3–2. Non-Uranium Constituents with Results Above FRLs During 2009 ..... 3–18
Table 3–3. OSDF Groundwater, Leachate, and LDS Monitoring Summary ..... 3–23
Table 4–1. 2009 Summary Statistics for the Sediment Monitoring Program ..... 4–15
Table 5–1. Summary of Total Uranium Activity and Particulate Concentrations in Air ..... 5–4
Table 5–2. Direct Radiation (OSL/TLD) Measurement Summary ..... 5–9
Table 6–1. Dose to MEI ..... 6–4
Table 7–1. Wetland Vegetation Monitoring Summary ..... 7–6
Table 7–2. Wetland Functional Monitoring Data Summary ..... 7–9

# Appendixes


| | |
|---|---|
| Appendix A | Supplemental Groundwater Information |
| Appendix B | Supplemental Surface Water, Treated Effluent, and Sediment Information |
| Appendix C | Supplemental Air Information |
| Appendix D | 2009 National Emissions Standards for Hazardous Air Pollutants (NESHAP) Annual Report |
| Appendix E | Ecological Restoration Monitoring |

# Abbreviations

| | |
|---|---|
| AMS | air monitoring station |
| ARARs | applicable or relevant and appropriate requirements |
| BCG | Biota Concentration Guide |
| CC | Coefficient of Conservatism |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | *Code of Federal Regulations* |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| FFCA | Federal Facility Compliance Agreement |
| FQAI | Floristic Quality Assessment Index |
| FRL | final remediation level |
| HWMUs | hazardous waste management units |
| ICRP | International Commission on Radiological Protection |
| IEMP | Integrated Environmental Monitoring Plan |
| LCS | leachate collection system |
| LDS | leak detection system |
| LM | DOE Office of Legacy Management |
| LMICP | *Comprehensive Legacy Management and Institutional Controls Plan* |
| MEI | maximally exposed individual |
| NAS | National Academy of Science |
| NCRP | National Council on Radiation Protection |
| ND | not detected |
| NESHAP | National Emissions Standards for Hazardous Air Pollutants |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| NRRP | *Natural Resource Restoration Plan* |
| OEPA | Ohio Environmental Protection Agency |
| OSDF | on-site disposal facility |
| OSL | optically stimulated luminescence |
| OU5 ROD | Operable Unit 5 Record of Decision |
| PCB | polychlorinated biphenyl |
| PF | Parshall Flume |
| RCRA | Resource Conservation and Recovery Act |
| SARA | Superfund Amendments and Reauthorization Act of 1986 |
| SSOD | storm sewer outfall ditch |
| TLD | thermoluminescent dosimeter |
| USGS | United States Geologic Survey |
| VIBI | Vegetation Index of Biotic Integrity |
| WCS | Waste Control Specialists |

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# Measurement Abbreviations

| | |
|---|---|
| cm | centimeter |
| ft | feet |
| gpm | gallons per minute |
| kg | kilogram |
| km | kilometer |
| lb | pound |
| Lpm | liters per minute |
| m | meter |
| M gal | million gallons |
| M liters | million liters |
| mg/kg | milligrams per kilogram |
| mg/L | milligrams per liter |
| mGy/day | milligray per day |
| mrem/yr | millirem per year |
| mSv/yr | millisievert per year |
| $pCi/m^3$ | picocuries per cubic meter |
| pCi/L | picocuries per liter |
| person-Sv | person-sievert |
| rem | roentgen equivalent man |
| $\mu g/m^3$ | micrograms per cubic meter |
| µg/L | micrograms per liter |

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# Units (Abbreviations) and Conversion Table

| Multiply | By | To Obtain | Multiply | By | To Obtain |
|---|---|---|---|---|---|
| inches | 2.54 | centimeters (cm) | cm | 0.3937 | inches |
| feet (ft) | 0.3048 | meters (m) | m | 3.281 | ft |
| miles (mi) | 1.609 | kilometers (km) | km | 0.6214 | mi |
| pounds (lb) | 0.454 | kilograms (kg) | kg | 2.205 | lb |
| gallons | 3.785 | liters (L) | L | 0.2642 | gallons |
| square feet ($ft^2$) | 0.0929 | square meters ($m^2$) | $m^2$ | 10.76 | $ft^2$ |
| acres | 0.4047 | hectares | hectares | 2.471 | acre |
| cubic yards ($yd^3$) | 0.7646 | cubic meters ($m^3$) | $m^3$ | 1.308 | $yd^3$ |
| cubic feet ($ft^3$) | 0.02832 | cubic meters ($m^3$) | $m^3$ | 35.31 | $ft^3$ |
| picocuries (pCi) | $10^{-12}$ | curies (Ci) | Ci | 1012 | pCi |
| pCi/L | $10^{-6}$ | microcuries per liter (μCi/L) | μCi/L | 106 | pCi/L |
| millirem (mrem) | 0.001 | rem | rem | 1000 | mrem |
| mrem | 0.01 | millisievert (mSv) | mSv | 100 | mrem |
| rem | 0.01 | sievert (Sv) | Sv | 100 | rem |
| mSv | 0.001 | Sv | Sv | 1000 | mSv |
| person-rem | 0.01 | person-Sv | person-Sv | 100 | person-rem |
| rad | 0.01 | gray (Gy) | Gy | 100 | rad |
| milligray (mGy) | 0.001 | Gy | Gy | 1000 | mGy |
| milligrams per liter (mg/L) | 1000 | micrograms per liter (μg/L) | μg/L | 0.001 | mg/L |
| Fahrenheit (˚F) | (˚F–32) x 5/9 | Celsius (˚C) | ˚C | (˚C x 9/5) + 32 | ˚F |
| **For Natural Uranium in Water** | | | | | |
| pCi/L | 0.0015 | mg/L | mg/L | 675.7 | pCi/L |
| pCi/L | 1.48 | μg/L | μg/L | 0.6757 | pCi/L |
| μg/L | 0.6757 | pCi/L | pCi/L | 1.48 | μg/L |
| **For Natural Uranium in Soil** | | | | | |
| pCi/g | 1.48 | μg/g | μg/g | 0.6757 | pCi/g |
| mg/kg | 1 | μg/g | μg/g | 1 | mg/kg |

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# Executive Summary

The *2009 Fernald Preserve Site Environmental Report* provides stakeholders with the results from the Fernald, Ohio, site's environmental monitoring programs for 2009; a summary of the U.S. Department of Energy's (DOE's) activities conducted on site; and a summary of the Fernald Preserve's compliance with the various environmental regulations, compliance agreements, and DOE policies that govern site activities. This report has been prepared in accordance with DOE Order 450.1A, *Environmental Protection Program*, and the "Integrated Environmental Monitoring Plan," which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan* (LMICP) (DOE 2009a).

The Fernald Preserve has been successfully remediated, and only the continued operation of the groundwater remedy and the care and maintenance of the on-site disposal facility (OSDF) are ongoing components of remediation.

During 2009, activities at the Fernald Preserve included:

- Prescribed burns, which were conducted for the first time.
- Ecological restoration activities as well as inspections, care, and monitoring of the site and the OSDF to ensure that provisions of the LMICP are fully implemented.
- Environmental monitoring activities related to air, surface water, and groundwater.
- Collection and treatment of leachate from the OSDF.
- Extraction and treatment of contaminated groundwater from the Great Miami Aquifer (Operable Unit 5).
- Operation of the Fernald Preserve Visitors Center, and associated outreach and educational activities.
- Construction of two new public hiking trails and a site overlook.

The following sections highlight the results of environmental monitoring activities conducted during 2009.

## Liquid Pathway Highlights

### Groundwater Pathway

The groundwater pathway at the Fernald Preserve is routinely monitored to:

- Determine hydraulic capture is maintained, track the restoration of the total uranium plume including non-uranium constituents, and evaluate water quality conditions in the aquifer that may indicate a need to modify the design or the operation of restoration modules.
- Meet compliance-based groundwater monitoring obligations.

During 2009, active restoration of the Great Miami Aquifer continued. Approximately 140 monitoring wells were sampled semiannually to determine water quality. Aquifer water elevations were measured quarterly in approximately 170 monitoring wells. The following highlights describe the key findings from the 2009 groundwater data:

- 2,447 million gallons (9,262 million liters) of groundwater were extracted from the Great Miami Aquifer, and 585 pounds (lb) (265 kilograms [kg]) of uranium were removed from the aquifer in 2009.
- The results of the 2009 groundwater capture analysis and monitoring for total uranium and non-uranium constituents indicate that the design of the groundwater remedy for the aquifer restoration system is appropriate for capture of the plume.
- Pumping of the South Plume/South Plume Optimization Module continued to meet the objective of preventing further southward migration of the southern total uranium plume beyond the extraction wells.
- Leak detection monitoring at Cells 1 through 8 of the OSDF indicates that all of the individual cell liner systems are performing as expected and within the specifications outlined in the approved OSDF design.

**Surface Water and Treated Effluent Pathway**

Surface water and treated effluent are monitored to determine the effects of Fernald Preserve activities on Paddys Run (an intermittent stream), the Great Miami River, and the underlying Great Miami Aquifer and to meet compliance-based surface water and treated effluent monitoring obligations. In addition, the results from sediment sampling are discussed as a component of this primary exposure pathway.

In 2009, 21 surface water and treated effluent locations and two sediment locations were sampled at various frequencies. The following highlights describe the key findings from the 2009 surface water, treated effluent, and sediment monitoring programs:

- In 2009, 586 lb (266 kg) of uranium were discharged in treated effluent to the Great Miami River, which was below the limit of 600 lb (272 kg) per year. Approximately 78 lb (35 kg) of uranium were released to the environment through uncontrolled storm water runoff. Therefore, the total amount of uranium released through the treated effluent and uncontrolled surface water pathways during 2009 was estimated to be 664 lb (301 kg).
- Analytical results of 32 surface water samples collected in 2009 exceeded the final remediation level (FRL) for total uranium, the site's primary contaminant. Three of the 32 exceedances were from SWD-05, and 29 are related to SWD-09 established to monitor the maintenance action completed west of the former Waste Pit Area. The surface water found at locations SWD-05 and SWD-09 does not flow off property. There were no FRL exceedances for any other constituent.
- Compliance sampling, consisting of sampling for nonradiological pollutants from uncontrolled runoff and treated effluent discharges from the Fernald Preserve, is regulated under the state-administrated National Pollutant Discharge Elimination System (NPDES) program. A new permit covering site discharges was issued by the Ohio Environmental Protection Agency and became effective in April 2009. Discharges were in compliance with effluent limits identified in the NPDES permit 100 percent of the time during 2009.
- There were no FRL exceedances for any sediment result in 2009.

## Air Pathway Highlights

The air pathway is routinely monitored to assess the impact of Fernald Preserve emissions of radiological air particulates and direct radiation on the surrounding public and environment. In addition, the data are used to demonstrate compliance with various regulations and DOE orders. Six air particulate monitoring locations (one background and five boundary monitors) and eleven dosimeters (four trail locations, five boundary locations, one location at the Visitors Center and one background location) were used in 2009 to determine compliance with the applicable limits.

The five remaining boundary monitors have been used to demonstrate that wind erosion of the remediated soil and air emissions from controlled burns (conducted in 2009) pose no significant threat to the public or the environment. An evaluation of the data collected from the air monitoring stations during the past three years demonstrates that radiological concentrations in air remain low (i.e. at or near background). Based on the data indicating emissions are at or near background and the determination by U.S. Environmental Protection Agency Office of Air and Radiation that three years of air monitoring following closure was appropriate, DOE ended the boundary air monitoring program January 4, 2010.

### Radiological Air Particulate Monitoring

Data collected from the air monitoring stations (AMSs) around the boundary of the Fernald Preserve show that the annual average radionuclide concentrations are less than 1 percent of DOE derived concentration guidelines in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.

The maximum effective dose equivalent for 2009 airborne emissions (excluding radon) at the boundary is estimated to be 0.034 millirem per year (mrem/yr) (0.00034 millisievert per year [mSv/yr]) above background, and occurred at AMS-6 along the western boundary of the site. This represents 0.34 percent of the limit established in Title 40 *Code of Federal Regulations* Part 61, "National Emissions Standards for Hazardous Air Pollutants," Subpart H, which is 10 mrem/yr (0.1 mSv/yr) above background.

### Direct Radiation Monitoring

Direct radiation measurements were collected at eleven locations. The direct radiation levels measured in 2009 indicate that the individual measurements obtained in the northeast quadrant of the site are slightly higher than background, but annual averages for on-site and background locations are not significantly different. The highest value for an on-site dosimeter produces a dose of 9 mrem/yr (0.09 mSv/yr) above background to an individual who spends the entire year (24 hours a day) at the location.

## Estimated Dose for 2009

In 2009, the maximally exposed individual, standing at the northeastern boundary monitor with the highest above-background reading, could receive a dose of 9 mrem (0.09 mSv). This estimate represents the maximum incremental dose above background attributed to inhalation of particulate and direct radiation and is exclusive of the dose received from radon. The contributions to the estimated dose are 0.034 mrem (0.00034 mSv) from air inhalation and 9 mrem (0.09 mSv) from direct radiation. This dose is 9 percent of the adopted DOE limit, which

is 100 mrem/yr (1 mSv/yr) above background (exclusive of radon), as established by the International Commission on Radiological Protection.

## Natural Resources

Natural resources include the diversity of plant and animal life and their supporting habitats found in and around the Fernald Preserve. Ecological activities were conducted sitewide during 2009. Maintenance in ecologically restored areas included construction of several new public hiking trails and an overlook, as well as planting to enhance the biowetland surface flow basin, seeding and erosion repair in several areas, and prescribed burning of prairie areas. Monitoring involved several efforts resulting from agreement among the Fernald Natural Resource Trustees. An enhanced wetland mitigation program was initiated. Activities in 2009 focused on wetland vegetation. Functional monitoring of site wetlands was also conducted. In addition to the expanded monitoring efforts, the Fernald Natural Resource Trustees conducted field walkdowns of ecologically restored areas and developed a path forward for additional maintenance and repair work in several locations.

No major issues were discovered during quarterly site and OSDF inspections, and there were no unexpected discoveries of cultural resources during 2009 construction activities.

# 1.0 Site Background

**Abbreviated Timeline**

| | |
|---|---|
| 1951 | Construction of the Feed Materials Production Center began. |
| 1952 | Uranium production started. |
| 1986 | EPA and DOE signed the Federal Facilities Compliance Agreement, thus initiating the remedial investigation/feasibility study process. |
| 1989 | Uranium production was suspended. The Fernald site was placed on the National Priorities List, which is the list of CERCLA sites most in need of cleanup. |
| 1990 | As part of the Amended Consent Agreement, the site was divided into operable units for characterization and remedy determination. |
| 1991 | Uranium production formally ended. The site mission changed from uranium production to environmental remediation and site restoration. |
| 1994 | Decontamination and dismantling of the first building was completed under the Operable Unit 3 Interim Record of Decision. |
| 1996 | The last operable unit's Record of Decision was signed, signifying the end of the 10-year remedial investigation/feasibility study process. (The Operable Unit 4 Record of Decision was later re-opened.) Construction began in support of the Operable Unit 1 selected remedy. Soil remedial excavation began as part of the Operable Unit 5 selected remedy. |
| 1997 | Construction of Cell 1 of the on-site disposal facility took place, and the first waste placement began in December. Environmental monitoring and reporting were consolidated under the IEMP to align with remediation efforts. |
| 1998 | Operable Unit 2 remedial excavations began. |
| 1999 | Excavation of the waste pits was initiated under the Operable Unit 1 Record of Decision, and the first rail shipment of waste material was transported to Envirocare of Utah, Inc. |
| 2000 | The Record of Decision Amendment for Operable Unit 4 Silos 1 and 2 Remedial Actions was signed by EPA, thus establishing a new selected remedy for Operable Unit 4. |
| 2001 | Cell 1 of the on-site disposal facility was capped. Remediation of the Southern Waste Units was completed. |
| 2002 | The Silos 1 and 2 Radon Control System began operation and successfully reduced radon levels within the silos. The off-site transfer of nuclear product material was completed. Wastes were placed into Cells 2 through 5 of the on-site disposal facility. |
| 2003 | All major Operable Unit 2 remedial actions were completed. In addition, approximately 412,000 cubic yards (315,015 cubic meters) of waste were placed in Cells 3 through 6 of the on-site disposal facility. |
| 2004 | Removal of Silos 1 and 2 wastes from the silos to the holding tank facility was initiated. Plans to reduce the size of the site's wastewater treatment infrastructure were approved and implemented. The last of Fernald's 10 uranium production complexes, plus an additional 35 structures and 73 trailers, were demolished. Also, all eight cells of the on-site disposal facility were capped or received waste, and approximately 513,000 cubic yards (392,240 cubic meters) were placed in Cells 4 through 8. |
| 2005 | Removal of Silo 3 waste was initiated, and the first shipment of waste arrived at Envirocare of Utah. Remedial actions for Operable Unit 1 were completed in June. The first shipment of Silos 1 and 2 wastes arrived at Waste Control Specialists in Texas. |
| 2006 | Remediation of the Fernald site was completed on October 29, 2006, and the site was officially transferred into DOE's Office of Legacy Management on November 17, 2006. |
| 2008 | The old Silos Warehouse was remodeled into the new Fernald Preserve Visitors Center and opened to the public in August 2008. In addition, the community was allowed unescorted access at the Fernald Preserve. |

In 1951, the U.S. Atomic Energy Commission, a predecessor agency of the U.S. Department of Energy (DOE), began building the Feed Materials Production Center on a 1,050-acre (425-hectare) tract of land outside the small farming community of Fernald, Ohio. The facility's mission was to produce "feed materials" in the form of purified uranium compounds and metal for use by other government facilities involved in the production of nuclear weapons for the nation's defense.

Uranium metal was produced at the Feed Materials Production Center from 1952 through 1989. During that time, more than 500 million pounds (lb) (227 million kilograms [kg]) of uranium metal products were delivered to other sites. These production operations caused releases to the surrounding environment, which resulted in contamination of soil, surface water, sediment, and groundwater on and around the site.

In 1991, the mission of the site officially changed from uranium production to environmental cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as Superfund), as amended. The site was renamed the Fernald Environmental Management Project in 1991. In 2003, the site name changed to the Fernald Closure Project to reflect the mission of the site as on a path to closure. In 2007, the site name changed to the Fernald Preserve to reflect the completion of the cleanup (with the exception of groundwater), the successful transition

to the DOE Office of Legacy Management (LM) in late 2006, and the new mission to be an asset to the community as an undeveloped park with an emphasis on wildlife.

S.M. Stoller Corporation, the LM Support contractor, continues to be responsible for site activities, including the ongoing groundwater remedy. The U.S. Environmental Protection Agency (EPA) Region 5 and the Southwest District Office of the Ohio Environmental Protection Agency (OEPA) provide regulatory oversight.

In the 1980s, the goals of environmental monitoring activities were to assess the impact of production operations and monitor the environmental pathways through which residents of the local community might be exposed to contaminants from the site (exposure pathways). The environmental monitoring program provided comprehensive on- and off-property surveillance of contaminant levels in surface water, groundwater, air, and biota (produce). The goal was to measure the levels of contaminants associated with uranium production operations and report this information to the regulatory agencies and stakeholders.

**Exposure Pathways**

**An exposure pathway** is a route that materials can travel between the point of release (a source) and the point of delivering a radiation or chemical dose (a receptor). At the Fernald Preserve, two primary exposure pathways (water and air) have been identified. A primary pathway is one that may allow pollutants to directly reach the public or the environment. Therefore, the water and air pathways provide a basis for environmental sampling and information useful for evaluating potential dose to the public or the environment.

**Secondary exposure pathways** have been thoroughly evaluated under previous environmental monitoring programs. Secondary exposure pathways represent indirect routes by which pollutants may reach receptors. An example of a secondary pathway is produce. Through the food chain, one organism may accumulate a contaminant and then be consumed by humans or other animals. The contaminant travels through the air to the soil, where it is absorbed into produce through the roots and is consumed by humans or animals. An evaluation of past monitoring data has shown that secondary exposure pathways at the Fernald Preserve are insignificant routes of exposure to off-site receptors. Therefore, the main focus of the site monitoring program (described in the IEMP) is on the primary exposure pathways.

Refer to Chapter 6 of this report for information pertaining to 2009 dose calculations from all pathways.

After the conclusion of the site's uranium production and the completion of the CERCLA remedy selection process, the focus was on the safe and efficient implementation of environmental remediation activities and facility decontamination and dismantling operations. In recognition of this shift in emphasis toward remedy implementation, the environmental monitoring program was revised in 1997 to align with the remediation activities planned for the Fernald site. The site's environmental monitoring program for 2009 is described in the "Integrated Environmental Monitoring Plan" (IEMP), which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan* (LMICP) (DOE 2009a). Now that remediation is complete, the emphasis has shifted again to ensure the continued protectiveness of the completed remedial actions as well as implementation of the ongoing groundwater remedy and performance of the on-site disposal facility (OSDF).

This *Fernald Preserve 2009 Site Environmental Report* summarizes the findings from the IEMP monitoring program and provides a status on the progress toward final site restoration. This report consists of the following:

**Summary Report.** The summary report (Chapters 1 through 7) documents the results of environmental monitoring activities at the Fernald Preserve in 2009. It includes a discussion of ongoing groundwater remediation activities and summaries of environmental data from groundwater, surface water and treated effluent, sediment, air, and natural resources monitoring programs. It also summarizes the information contained in the appendixes.

**Appendixes.** The detailed appendixes provide the 2009 environmental monitoring data for the various media, primarily in the form of graphs and tables. The National Emissions Standards for Hazardous Air Pollutants (NESHAP) (Title 40 *Code of Federal Regulations* [CFR] Part 61, Subpart H) compliance report is also included. The appendixes are generally distributed only to the regulatory agencies. However, a complete copy of the appendixes is available on the LM website at http://www.lm.doe.gov/land/sites/oh/fernald/fernald.htm and by contacting LM at (513) 648-7500 or S.M. Stoller Public Affairs at (513) 648-4026.

**CERCLA Remedial Process**

The process of cleaning up sites under CERCLA consists of the following general phases:

**Site Characterization**—During this phase, contaminants are identified and quantified, and the potential impacts of those contaminants on human health are determined. This phase includes the remedial investigation and the baseline risk assessment.

**Remedy Selection**—During this phase, cleanup alternatives are developed and evaluated. Activities include the feasibility study and proposed remedial action plan. After public comments are received, a remedy is selected and documented in a Record of Decision.

**Remedial Design and Remedial Action**—This phase of the CERCLA process includes the detailed design and implementation of the remedy. The CERCLA process ends with certification and site closure.

A 5-year review process is triggered by the onset of construction for the first operable unit remedial action that will result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. Of all the operable units, the site preparation construction to support the Waste Pits Project under the *Operable Unit 1 Record of Decision* (DOE 1995a) was the first such action. This construction began on April 1, 1996. Two 5-year reviews have been conducted and approved by the regulatory agencies to date (April 2001 and April 2006). These reviews ensure that the remedy remains effective and continues to be protective of human health and the environment. The next scheduled 5-year review is in early 2011.

Site closure, relative to the completion of remediation, was defined in the contract between Fluor Fernald, Inc. and DOE as the physical completion of the scope of work required by the five Records of Decision with the exception of the groundwater remedy and final disposal of the Silos 1 and 2 stabilized material.

LM assumed the long-term surveillance monitoring and maintenance of the Fernald site on November 17, 2006, to ensure continued protection of human health and the environment and continued operation of the groundwater remedy. The *Comprehensive Legacy Management and Institutional Controls Plan* (DOE 2009a) defines the activities to be conducted with respect to long-term stewardship at the Fernald Preserve. The CERCLA 5-year review process will continue to provide stakeholders with information on the remedy performance and with long-term stewardship information.

The rest of this introductory chapter provides:

- An overview of the environmental remediation completed as well as ongoing remedy implementation.
- A description of environmental monitoring activities at the Fernald Preserve.
- A description of the physical, ecological, and human characteristics of the area.

## 1.1 The Path to Site Closure

In 1986, the Fernald site began working through the CERCLA process to characterize the nature and extent of contamination at the site, establish risk-based cleanup standards, and select the appropriate remediation technologies to achieve those standards. To facilitate this process, the site was organized into five operable units in 1991. The purpose of the operable unit concept under CERCLA was to organize site components by their location or by the potential for similar technologies to be used for environmental remediation. The remedy selection process culminated in 1996 with the approval of the final Records of Decision for each of the five operable units. However, several of the Records of Decision (including those for Operable Units 1, 4, and 5) have subsequently been modified through issuance of Explanation of Significant Differences or Record of Decision Amendment documents. These documents were prepared, submitted for EPA and public review, and issued in accordance with CERCLA regulations. Following approval of the initial Records of Decision, work began on the design and implementation of the operable unit remedies. Table 1–1 describes each operable unit and an overview of its associated remedy.

*Table 1–1. Operable Unit Remedies*

| Operable Unit | Description | Remedy Overview |
|---|---|---|
| 1 | • Waste Pits 1-6<br>• Clearwell<br>• Burn pit<br>• Berms, liners, caps, and soil within the boundary | Record of Decision approved: March 1995<br>Explanation of Significant Differences approved: September 2002<br>Record of Decision Amendment approved: November 2003<br>Excavation of materials with constituents of concern above final remediation levels (FRLs), waste processing and treatment by thermal drying (as necessary), off-site disposal at a permitted facility, and soil remediation/certification.<br>**Remedial actions completed: June 2005**<br>**Final Remedial Action Report approved: August 2006** |
| 2 | • Solid waste landfill<br>• Inactive fly ash pile<br>• Active fly ash pile (now inactive)<br>• North and South Lime Sludge Ponds<br>• Other South Field areas<br>• Berms, liners, and soil within the operable unit boundary | Record of Decision approved: May 1995<br>Post-Record of Decision Fact Sheet approved: April 1999<br>Excavation of all materials with constituents of concern above FRLs, treatment for size reduction and moisture control as required, on-site disposal in the OSDF, and off-site disposal of excavated material that exceeded the waste acceptance criteria for the OSDF.<br>**Remedial actions completed: June 2006**<br>**Final Remedial Action Report approved: September 2006** |
| 3 | Former production area, associated facilities, and equipment (includes all above- and below-grade improvements), including but not limited to:<br>• All structures, equipment, utilities, effluent lines, and K-65 transfer line<br>• Wastewater treatment facilities<br>• Fire training facilities<br>• Coal pile<br>• Scrap metals piles<br>• Drums, tanks, solid waste, waste product, feedstocks, and thorium | Record of Decision for Interim Remedial Action approved: June 1994<br>Record of decision for Final remedial Action approved: August 1996<br>Adoption of Operable Unit 3 Interim Record of Decision; alternatives to disposal through the unrestricted or restricted release of materials as economically feasible for recycling, reuse, or disposal; treatment of material for on- or off-site disposal; required off-site disposal for process residues, product materials, process-related metals, acid brick, concrete from specific locations, and any other material exceeding the OSDF waste acceptance criteria; and on-site disposal for material that meets the OSDF waste acceptance criteria.<br>**Remedial actions completed: October 2006**<br>**Final Remedial Action Report approved: February 2007** |
| 4 | • Silos 1 and 2 (containing K-65 residues; demolished in 2005)<br>• Silo 3 (containing cold metal oxides; demolished in 2006)<br>• Silo 4 (empty and never used; demolished in 2003)<br>• Decant tank system<br>• Berms and soil within the operable unit boundary | Record of Decision approved: December 1994<br>Explanation of Significant Differences for Silo 3 approved: March 1998<br>Record of Decision Amendment for Silos 1 and 2 approved: July 2000<br>Record of Decision Amendment for Silo 3 approved: September 2003<br>Explanation of Significant Differences for Silos 1 and 2 approved: November 2003<br>Explanation of Significant Differences for Operable Unit 4 approved: January 2005.<br>Removal of Silo 3 materials for treatment and Silos 1 and 2 residues and decant sump tank sludges with on-site stabilization of materials, residues, and sludges followed by off-site disposal. Excavation of silos area soils contaminated above the FRLs with on-site disposal for contaminated soils and debris that meet the OSDF waste acceptance criteria; and site restoration. Concrete from Silos 1 and 2, and contaminated soil and debris that exceeded the OSDF waste acceptance criteria were disposed of off site. |

*Table 1–1 (continued). Operable Unit Remedies*

| Operable Unit | Description | Remedy Overview |
|---|---|---|
| | | **Remedial actions for Silo 3 completed: April 2006**<br>**Remedial actions involving the completion of the shipment of stabilized Silos 1 and 2 material to a temporary storage facility in Texas was completed in May 2006.**<br>**Final Remedial Action Report Approved: September 2006**<br>**Permanent disposal of the 3,776 containers of Silo 1 and 2 material began on October 7, 2009 and the last container was placed November 2, 2009** |
| 5 | • Groundwater<br>• Surface water and sediments<br>• Soil not included in the definitions of Operable Units 1 through 4<br>• Flora and fauna | Record of Decision approved: January 1996<br>Explanation of Significant Differences was approved in November 2001, formally adopting EPA's Safe Drinking Water Act maximum contaminant level for uranium of 30 micrograms per liter (µg/L) as both the FRL for groundwater remediation and the monthly average uranium effluent discharge limit to the Great Miami River.<br>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. 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. On-site disposal of contaminated soil and sediment that meet the OSDF waste acceptance criteria. Soil and sediment that exceeded the waste acceptance criteria for the OSDF was treated, when possible, to meet the OSDF waste acceptance criteria or was disposed of at an off-site facility. Also includes site restoration, institutional controls, and post-remediation maintenance.<br>**Interim Remedial Action Report approved: August 2008** |

## 1.2 Environmental Monitoring Program

In the 1980s, an environmental monitoring program was initiated to assess the impact of past operations on the environment and monitor potential exposure pathways to the local community. Additionally, characterization activities were conducted at the Fernald site for nearly 10 years through the remedial investigation phase of the CERCLA process. The initial environmental evaluations performed during the remedial investigation/feasibility study process were used to select the final remedy for Operable Unit 5, which addressed contamination in soil, groundwater, surface water, sediment, air, and biota—in short, all environmental media and contaminant exposure pathways affected by past uranium production operations at the site. The selected remedy for Operable Unit 5 defined the site's final contaminant cleanup levels and established the extent of on- and off-property remedial actions necessary to provide permanent solutions to environmental concerns posed by the site.

The Operable Unit 5 remedy included plans for removing the contamination that might be released through these exposure pathways and for monitoring these pathways to measure the site's continuing impact on the environment as remediation progresses. The characterization data used to develop the final remedy were also used to focus on and develop the environmental monitoring program documented in the IEMP.

The following describes the IEMP's key elements:

- The IEMP defines monitoring activities for environmental media, such as groundwater, surface water and treated effluent, sediment, air (including air particulate and direct radiation), and natural resources. In general, the primary exposure pathways (water and air) are monitored, and the program focuses on assessing the collective effect of sitewide emissions on the surrounding environment.
- The IEMP establishes a data evaluation and decision-making process for each environmental medium. Through this process, environmental conditions at the site are continually evaluated. These evaluations sometimes affect decisions made about the implementation of remediation activities. For example, environmental data are routinely evaluated to identify any significant trends that may indicate the potential for an unacceptable future impact to the environment if action is not taken.
- Because the type and pace of activities will change over the life of the cleanup effort, the IEMP allows for program adjustments as the mission changes. At this time, the IEMP is reviewed annually and revised as necessary to ensure that the monitoring program adequately addresses changing activities.
- The IEMP consolidates routine reporting of environmental data into this comprehensive annual report.

## 1.3 Characteristics of the Site and Surrounding Area

The natural settings of the Fernald Preserve and nearby communities were important factors in selecting the final remedy and remain important in the continual evaluation of the environmental monitoring program. Land use and demography, local geography, geology, surface hydrology, meteorology, and natural resources all impact monitoring activities and the implementation of the site remedy.

### 1.3.1 Land Use and Demography

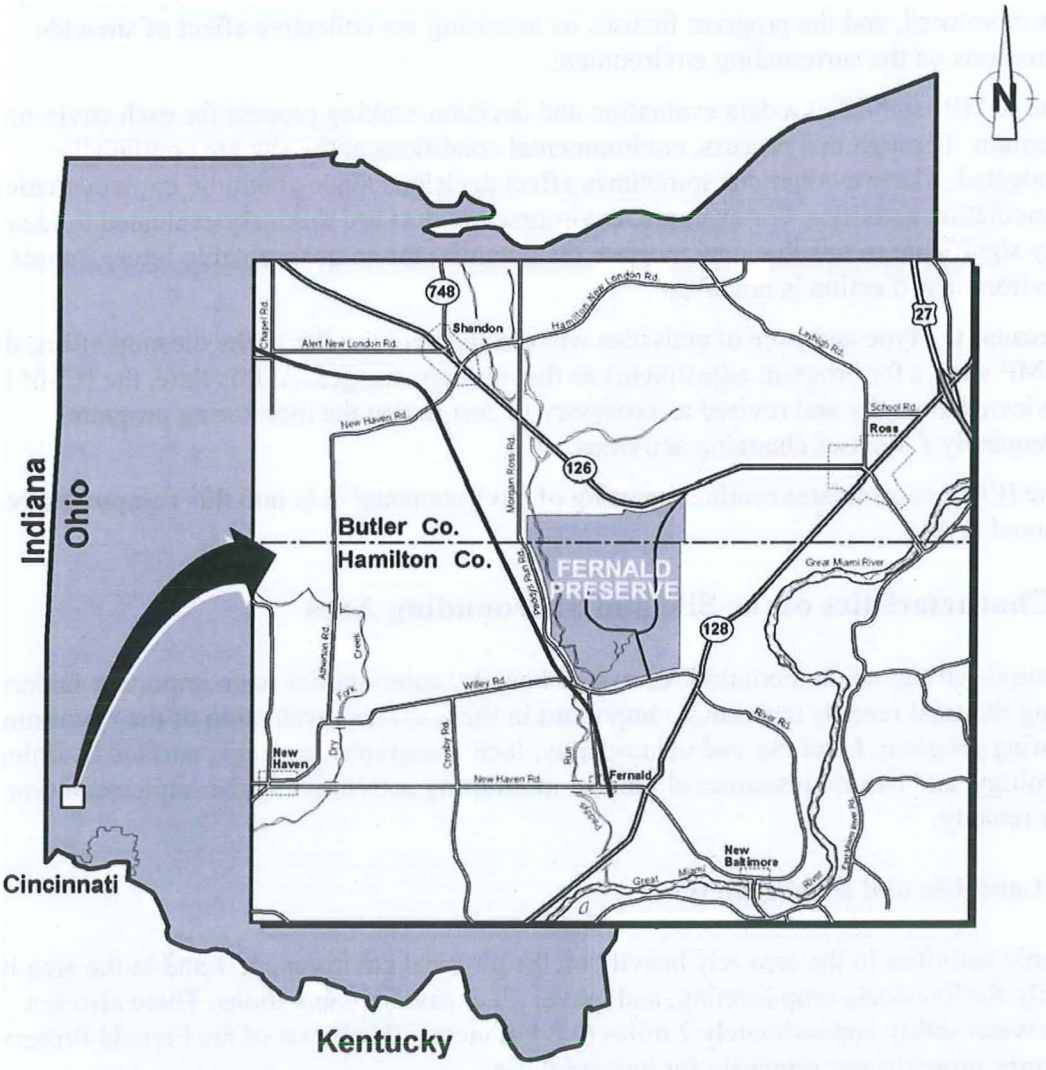
Economic activities in the area rely heavily on the physical environment. Land in the area is used primarily for livestock, crop farming, and gravel pit excavation operations. There also is a private water utility approximately 2 miles (3.2 kilometers [km]) east of the Fernald Preserve that pumps groundwater primarily for industrial use.

Downtown Cincinnati is approximately 18 miles (29 km) southeast of the Fernald Preserve (Figure 1–1). The cities of Fairfield and Hamilton are 6 and 8 miles (10 and 13 km) to the east and northeast, respectively (Figure 1–2). Scattered residences and several villages, including Fernald, New Baltimore, New Haven, Ross, and Shandon, are located near the site. According to the 2000 U.S. Census Bureau figures, there is an estimated population of 20,000 within 5 miles (8 km) of the Fernald Preserve, and an estimated 2.7 million people live within 50 miles (80 km).

### 1.3.2 Geography

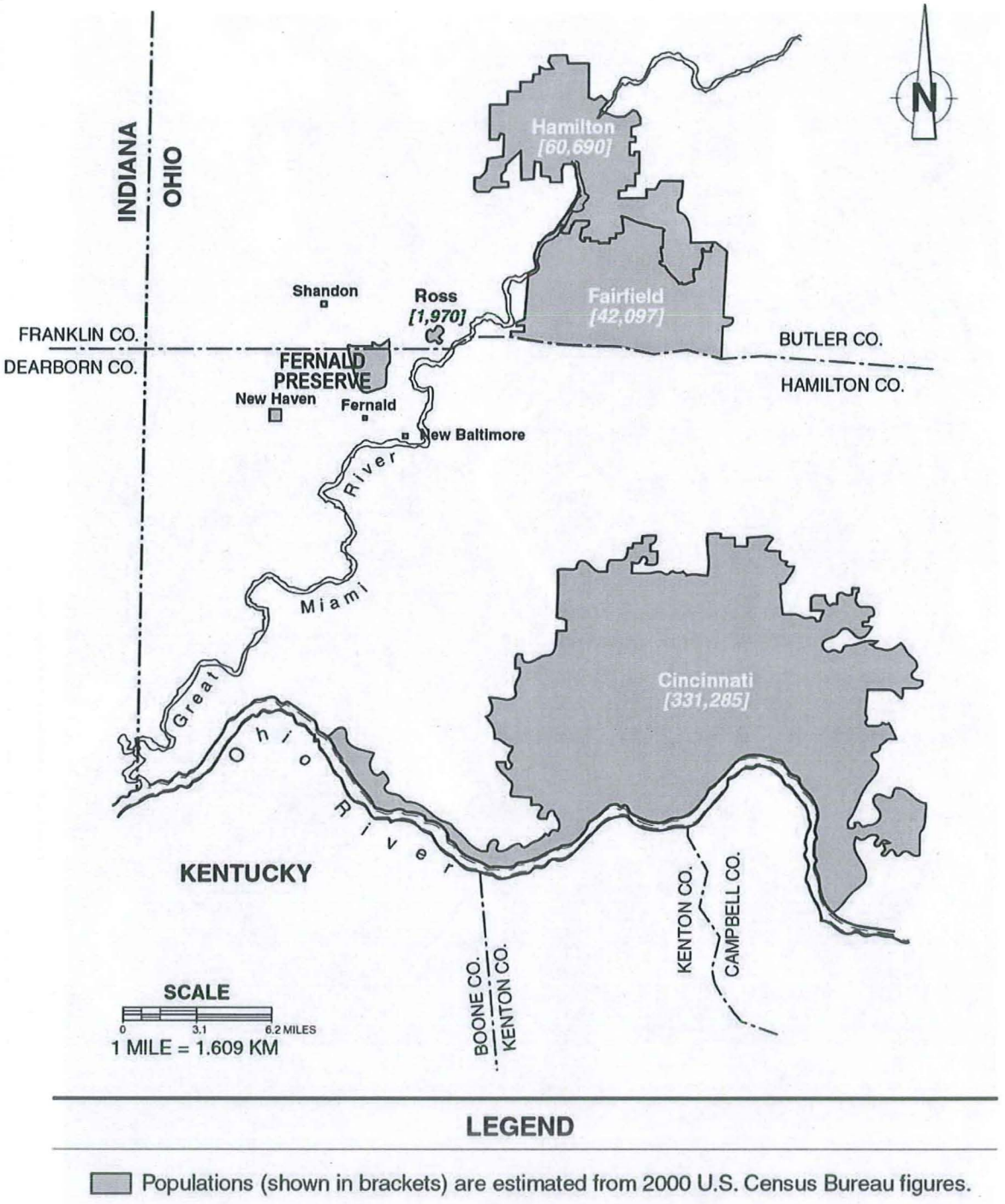
Figure 1–3 depicts the location of the major physical features of the site, such as the buildings and supporting infrastructure. The former production area and the OSDF dominate this view. The former production area occupies approximately 136 acres (55 hectares) in the center of the site, and

the OSDF occupies approximately 120 acres (48.6 hectares). The Great Miami River cuts a terraced valley to the east of the site, and Paddys Run (an intermittent stream) flows from north to south along the site's western boundary. In general, the site lies on a terrace that slopes gently among vegetated bedrock outcrops to the north, southeast, and southwest.




**The Fernald Preserve covers about 1,050 acres (425 hectares).**

*Figure 1–1. Fernald Preserve and Vicinity*

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Populations (shown in brackets) are estimated from 2000 U.S. Census Bureau figures.

*Figure 1–2. Major Communities in Southwestern Ohio*

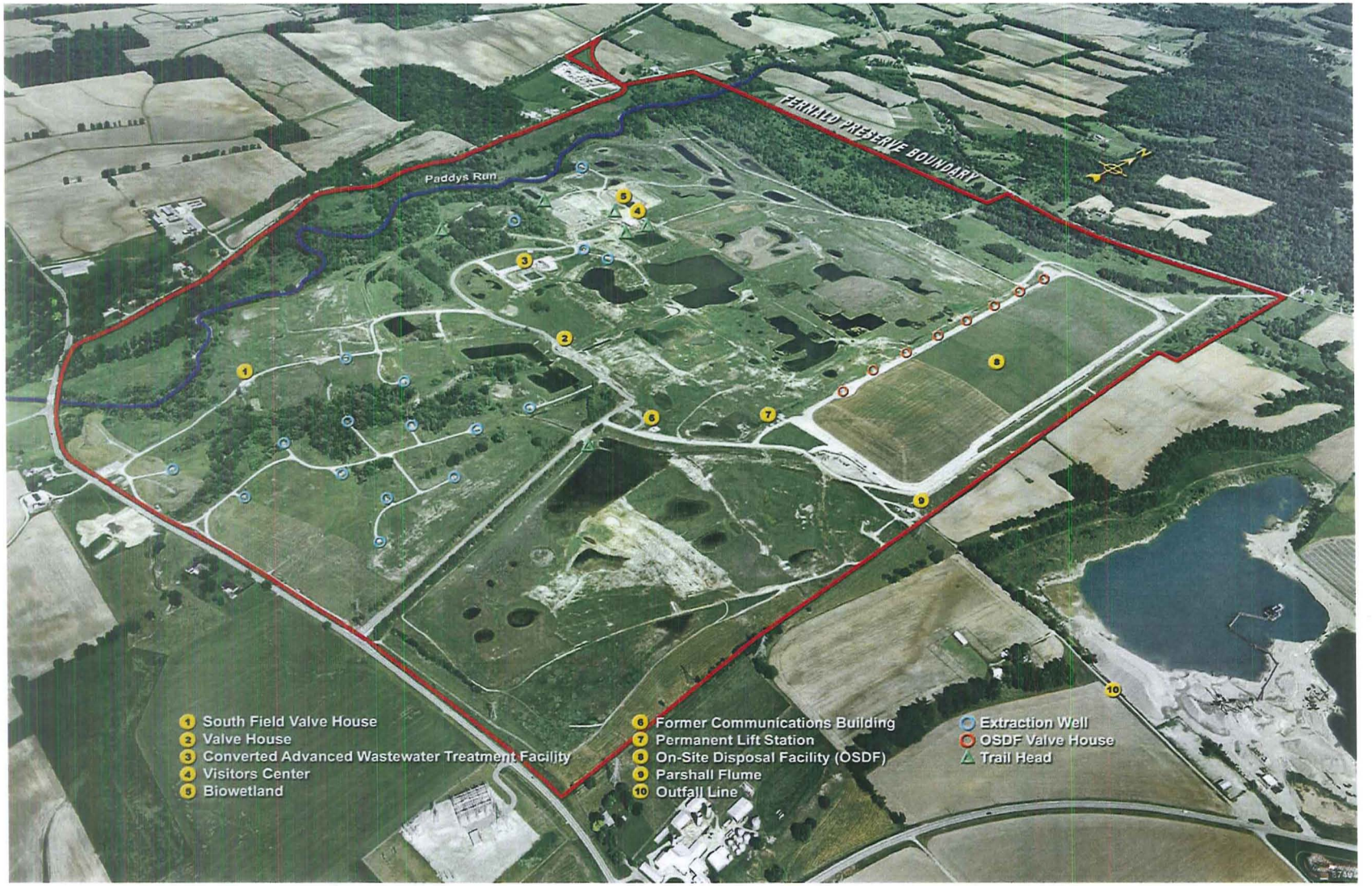


*Figure 1–3. Fernald Preserve Perspective*

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### 1.3.3 Geology

Bedrock in the area indicates that approximately 450 million years ago a shallow sea covered the Cincinnati area. Sediments that later became flat-lying shale with interbedded limestone were deposited in the shallow sea, as evidenced by the abundance of marine fossils in the bedrock. In the more recent geologic past, the advance and retreat of three separate glaciers shaped the southwestern Ohio landscape. A large river drainage system south of the glaciers created river valleys up to 200 feet (ft) (61 meters [m]) deep, which were then filled with sand and gravel when the glaciers melted. These filled river valleys are called buried valleys.

The last glacier to reach the area left a glacial overburden—a low-permeability mixture of clay and silt with minor amounts of sand and gravel—deposited across the land surface. The site is situated on a layer of glacial overburden that overlies portions of a 2- to 3-mile-wide (3- to 5-km-wide) buried valley. This valley, known as the New Haven Trough, makes up part of the Great Miami Aquifer. The impermeable shale and limestone bedrock that defines the edges and bottom of the New Haven Trough restricts the groundwater to the sand and gravel within the buried valley. Where present, the glacial overburden limits the downward movement of precipitation and surface water runoff into the underlying sand and gravel of the Great Miami Aquifer.

The Great Miami River and its tributaries have eroded considerable portions of the glacial overburden and exposed the underlying sand and gravel of the Great Miami Aquifer. Thus, in some areas, precipitation and surface water runoff can easily migrate into the underlying Great Miami Aquifer, permitting contaminants to be transported to the aquifer as well. Natural and man-made breaches of the glacial overburden were key pathways where contaminated water entered the aquifer, causing the groundwater plumes that are being addressed by aquifer restoration activities. Figure 1–4 provides a glimpse into the structure of subsurface deposits in the region along an east-west cross section through the site, and Figure 1–5 presents the regional groundwater flow patterns in the Great Miami Aquifer.

### 1.3.4 Surface Hydrology

The Fernald Preserve is located in the Great Miami River drainage basin (Figure 1–6). Natural drainage from the site to the Great Miami River occurs primarily via Paddys Run. This intermittent stream begins losing flow to the underlying sand and gravel aquifer south of the former Waste Pit Area. Paddys Run empties into the Great Miami River 1.5 miles (2.4 km) south of the site. The Great Miami River, 0.6 mile (1 km) east of the Fernald Preserve, runs in a southerly direction and flows into the Ohio River about 24 miles (39 km) downstream of the site. The segment of the river between the Fernald Preserve and the Ohio River is not used as a source of public drinking water.

The average flow volume for the Great Miami River in 2009 was 2,942 cubic feet per second (83.3 cubic meters per second). This average is based on daily measurements collected at the U.S. Geologic Survey (USGS) Hamilton stream gauge (USGS 3274000) approximately 10 river miles (16 river km) upstream of the site's effluent discharge.

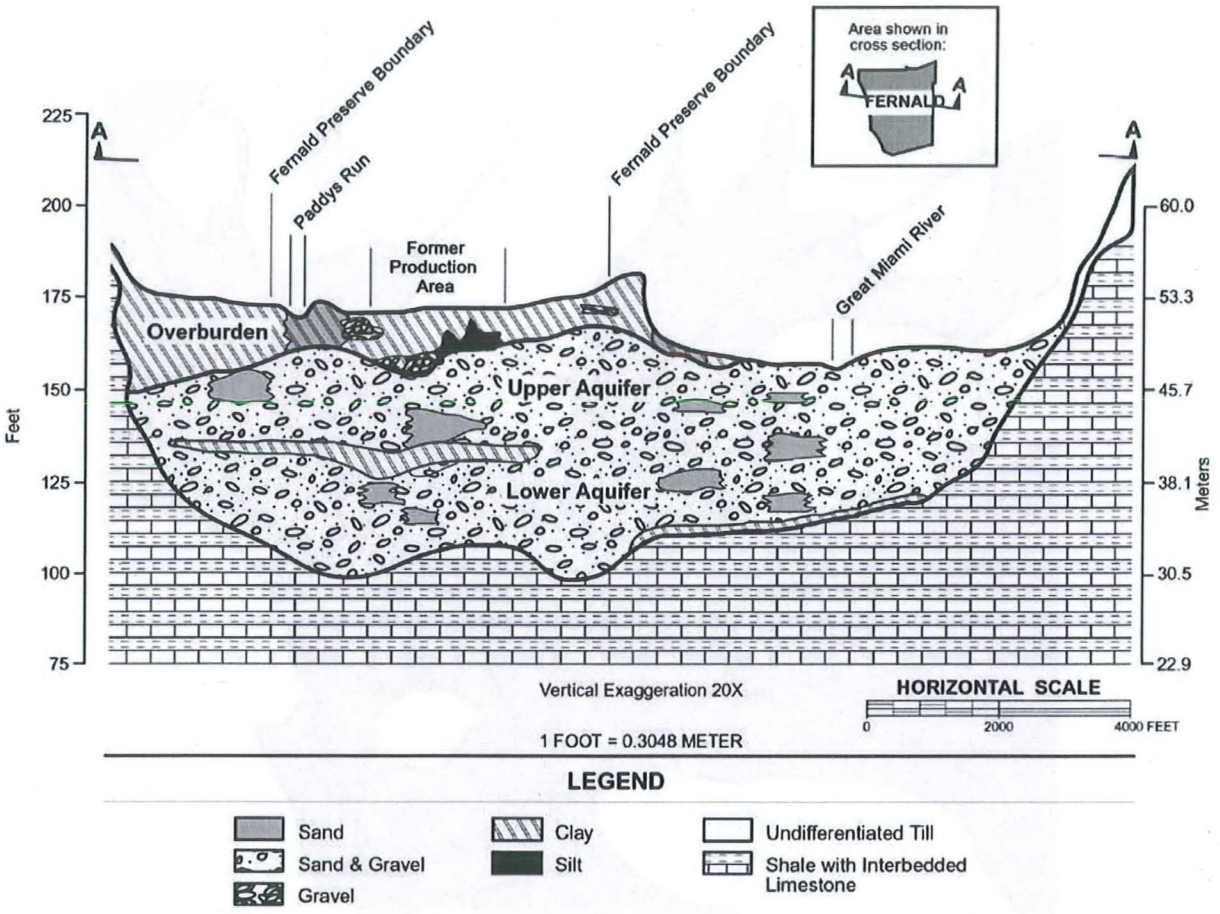
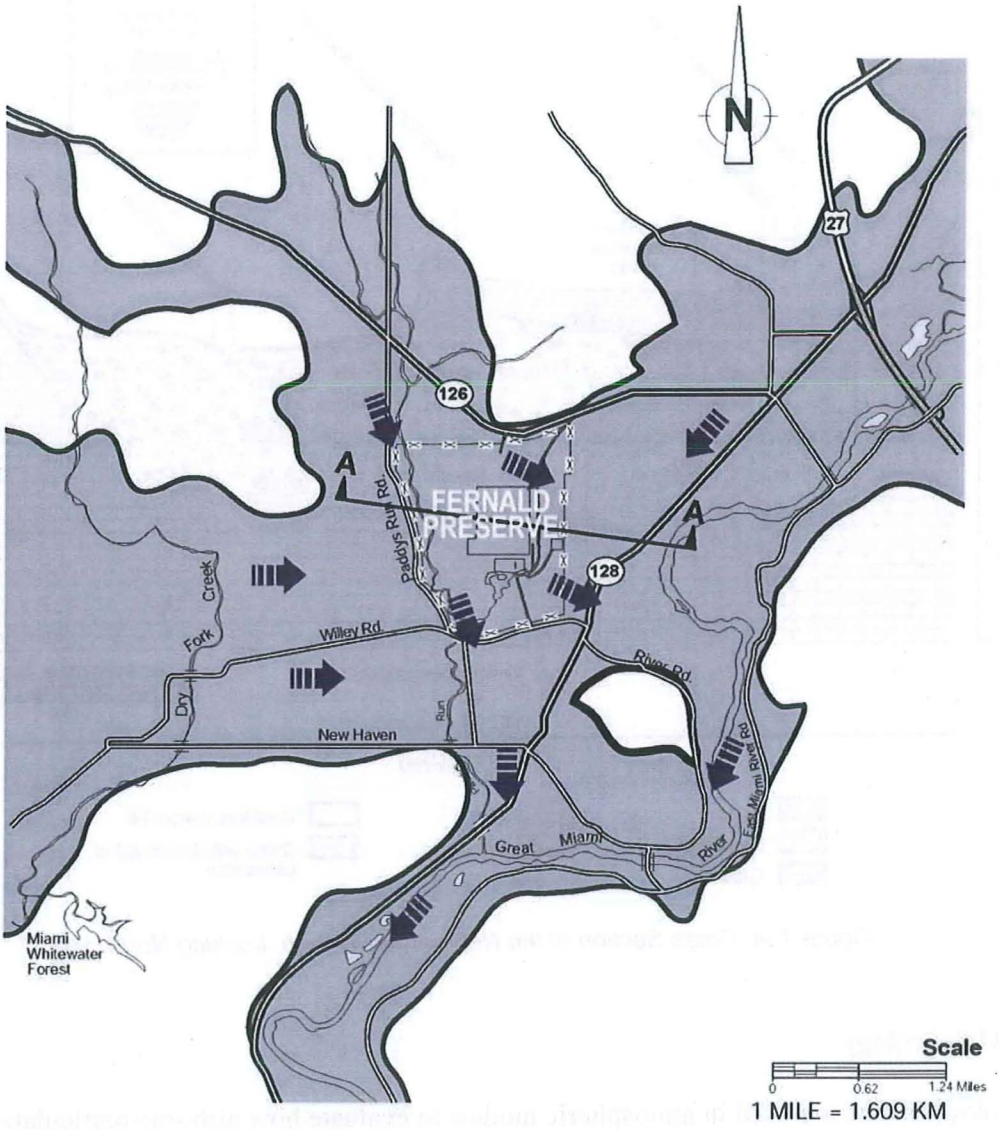



*Figure 1–4. Cross Section of the New Haven Trough, Looking North*

### 1.3.5 Meteorology

Meteorological data are used in atmospheric models to evaluate how airborne particulate is mixed and dispersed. The amount of particulate predicted to be present in the atmosphere is used to assess the impact of operations on the surrounding environment, in accordance with DOE requirements. The Fernald Preserve no longer maintains a meteorological station, and 2009 data for temperature, precipitation, and wind velocity were obtained from two available sources. Temperature and precipitation data were obtained from the Butler County Regional Airport. Wind velocity and direction were calculated from the 2002 through 2006 data collected on the site, as these parameters are sensitive to vegetation cover and topography and play a key role in predicting how pollutants are distributed in the surrounding environment at the Fernald Preserve.

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- Buried Valley Aquifer
- General Direction of Groundwater Flow
- Fernald Preserve Boundary
- Location of Cross Section Shown in Figure 1-4

*Figure 1–5. Regional Groundwater Flow in the Great Miami Aquifer*

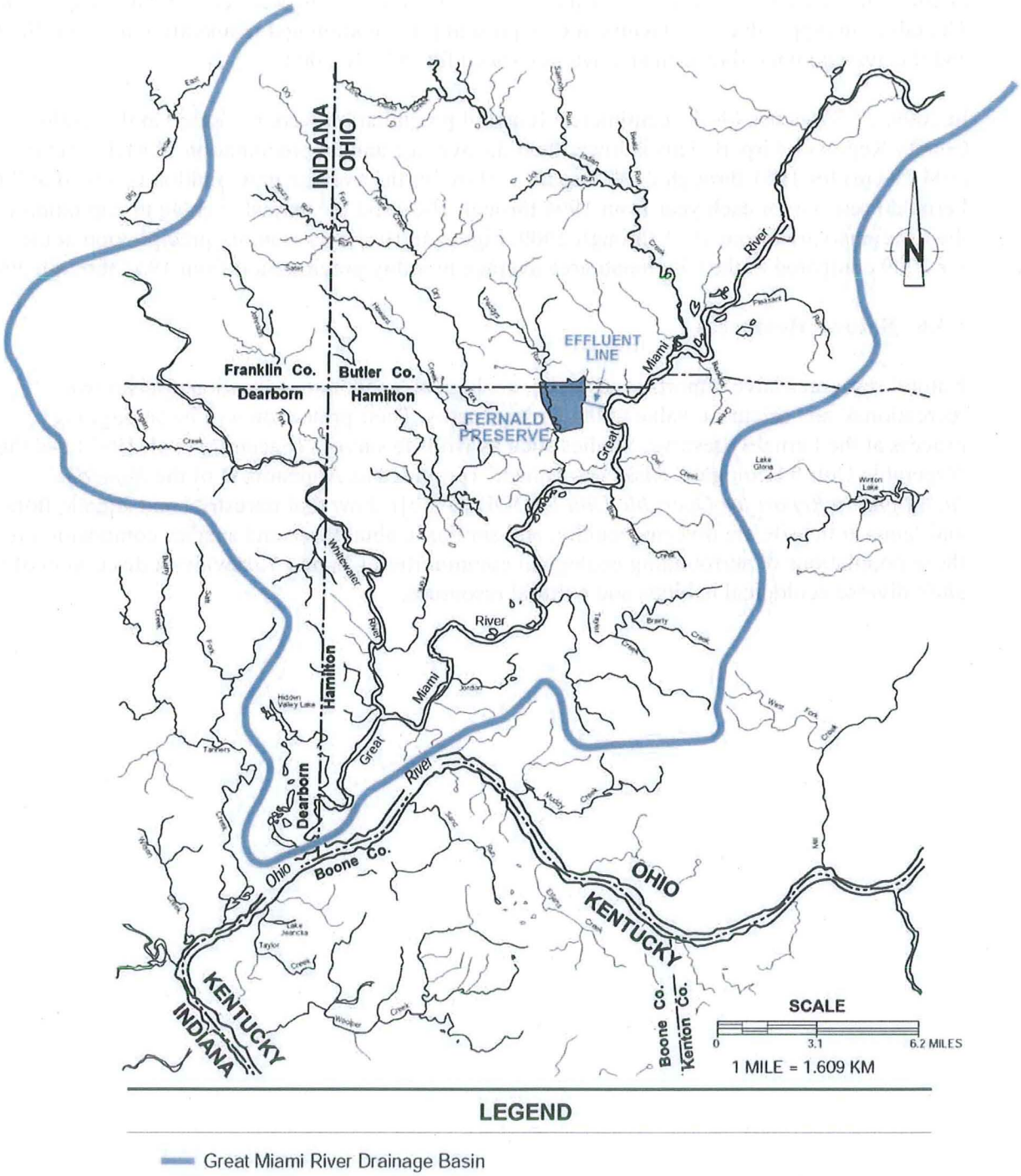


*Figure 1–6. Great Miami River Drainage Basin*

Figure 1–7 and Figure 1–8 illustrate the average wind speed and general wind direction for 2002 to 2006 measured at the 33-ft (10-m) and 197-ft (60-m) levels, respectively, in wind rose format. The tables in Appendix C, Attachment C.3, present precipitation and temperature data for 2009 and the average wind direction and average speed for 2002 to 2006.

In 2009, 37.35 inches (94.83 centimeters [cm]) of precipitation were measured at the Butler County Regional Airport. This is lower than the average annual precipitation of 41.10 inches (104.39 cm) for 1951 through 2009. Figure 1–9 shows the average precipitation recorded at the Fernald Preserve for each year from 1994 through 2009 and the annual average precipitation for the Cincinnati area from 1951 through 2009. Figure 1–10 shows monthly precipitation at the site for 2009 compared to the Cincinnati area average monthly precipitation from 1951 through 2009.

### 1.3.6 Natural Resources

Natural resources have important aesthetic, ecological, economic, educational, historical, recreational, and scientific value to the United States. Their protection will be an ongoing process at the Fernald Preserve. Studies such as wildlife surveys (Facemire et al. 1990) and the "Operable Unit 5 Ecological Risk Assessment" (provided as Appendix B of the *Remedial Investigation Report for Operable Unit 5* [DOE 1995b]) show that terrestrial and aquatic flora and fauna at the site are diverse, healthy, and similar in abundance and species composition to those populations of surrounding ecological communities. Chapter 7 provides a discussion of the site's diverse ecological habitats and cultural resources.

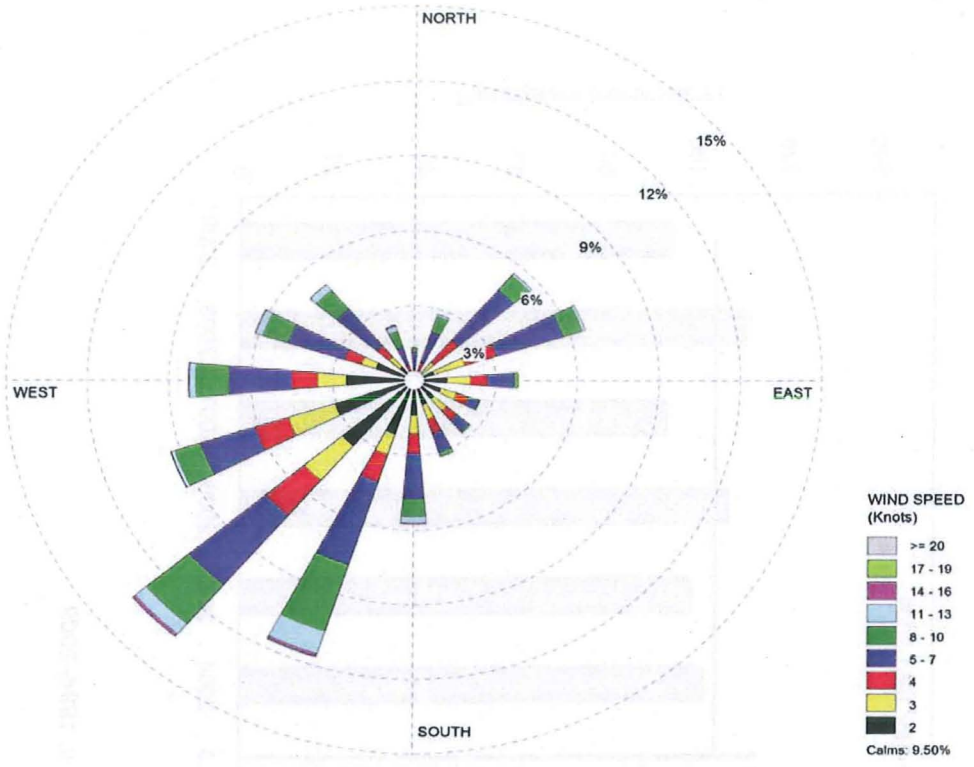


*Figure 1–7. 2002–2006 Wind Rose, 33-ft (10-m) Height*

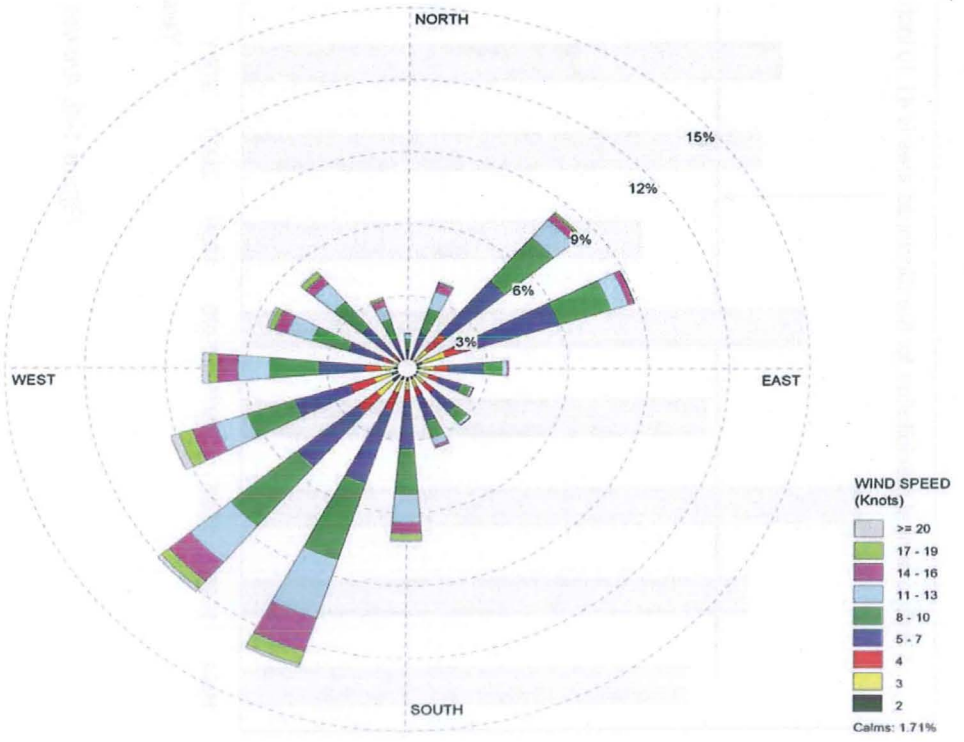


*Figure 1–8. 2002–2006 Wind Rose, 197-ft (60-m) Height*

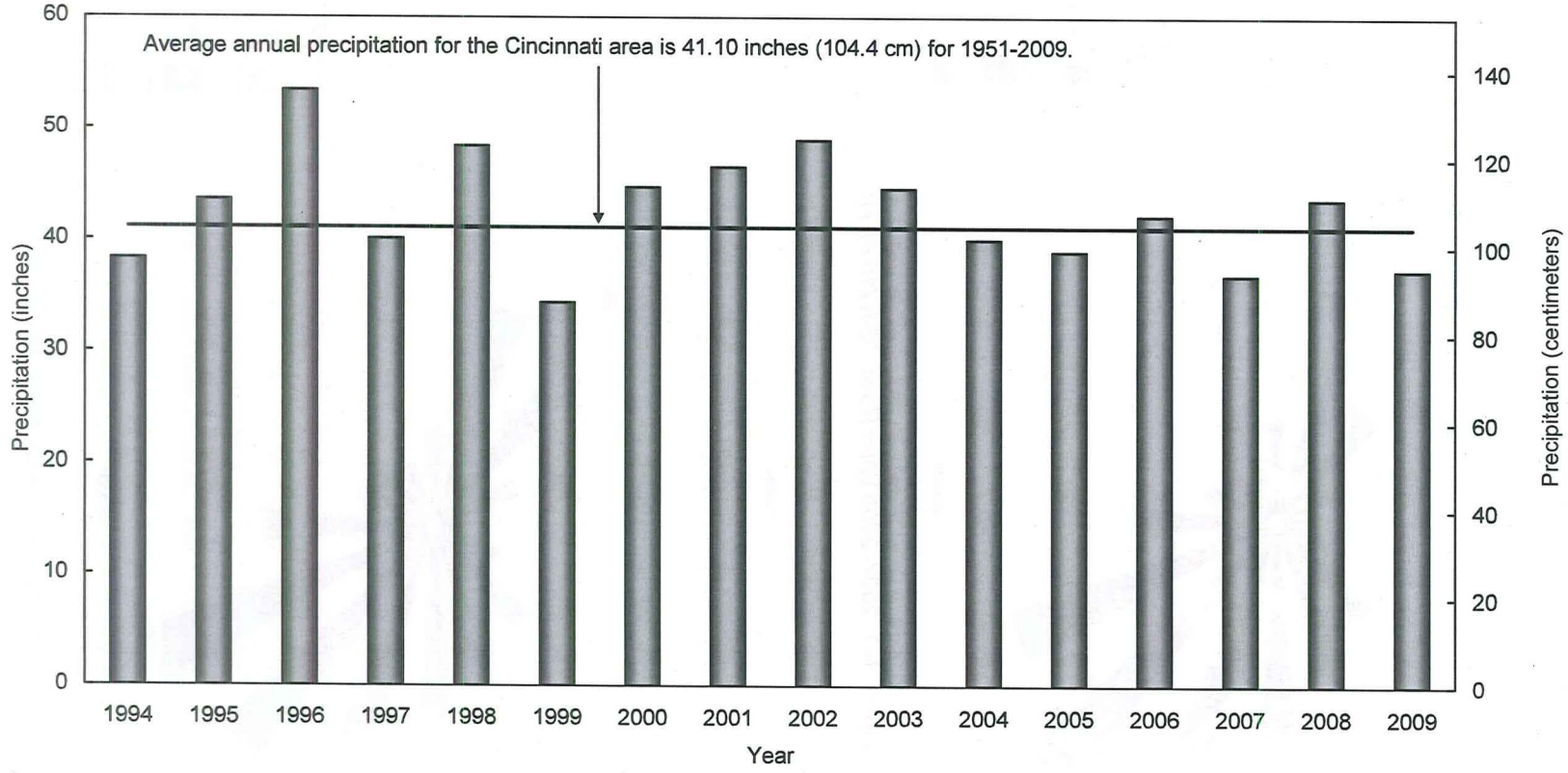


*Figure 1–9. Annual Precipitation, 1994–2009*

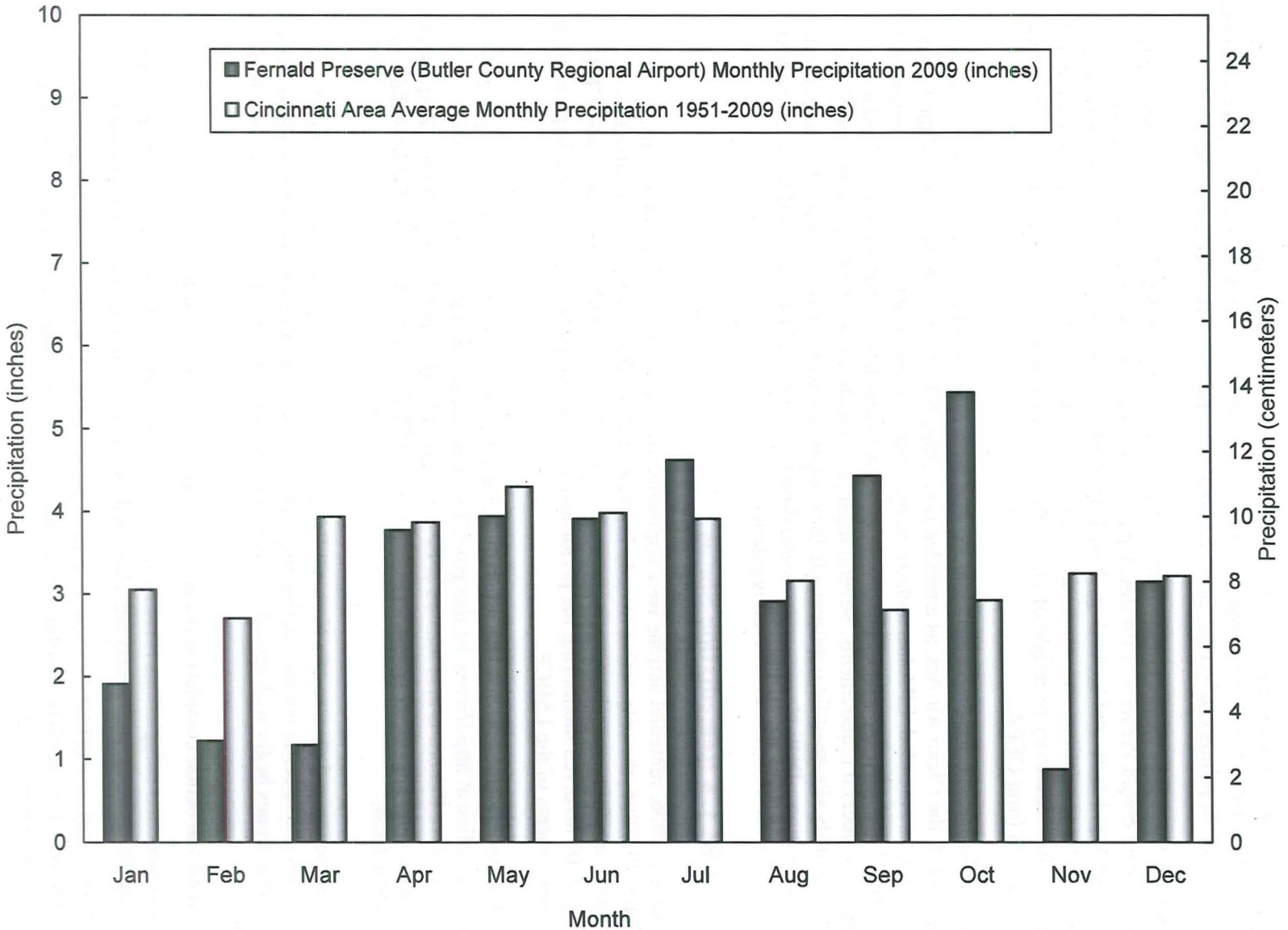


*Figure 1–10. Monthly Precipitation for 2009 Compared to Average Monthly Precipitation for 1951–2009*

# 2.0 Remediation Status and Compliance Summary

This chapter provides a summary of CERCLA remediation activities in 2009 and summarizes compliance activities with other applicable environmental laws, regulations, and legal agreements. CERCLA is the primary driver for environmental remediation of the Fernald Preserve.

EPA and OEPA enforce the environmental laws, regulations, and legal agreements governing work at the Fernald Preserve. EPA develops, promulgates, and enforces environmental protection regulations and technology-based standards. EPA regional offices and state agencies enforce these regulations and standards by review of data collected at the Fernald Preserve. EPA Region 5 has regulatory oversight of the CERCLA process at the Fernald Preserve, with active participation from OEPA.

For some programs, such as those under the Resource Conservation and Recovery Act (RCRA), as amended, the Clean Air Act, as amended (excluding NESHAP compliance), and the Clean Water Act, as amended, EPA has authorized the State of Ohio to act as the primary enforcement authority. For these programs, Ohio promulgates state regulations that must be at least as stringent as federal requirements. Several legal agreements among DOE, EPA Region 5, and OEPA identify site-specific requirements for compliance with the regulations. To comply with these regulations, DOE Headquarters issues directives to its field and area offices and conducts audits to ensure compliance with all regulations.

## 2.1 CERCLA Remediation Status

In October 2006, remedial actions were completed for four of the five operable units. As of October 29, 2006, the only active remedy implementation efforts remaining involved the continuation of the groundwater remedy under Operable Unit 5. Other activities under CERCLA during 2009 involved monitoring the performance of the completed remedies and implementing the requirements of the LMICP.

All cleanup-related CERCLA documentation, including a copy of the Administrative Record, is available online at http://www.lm.doe.gov/CERCLA/SiteSelector.aspx. A copy of the Administrative Record is also located at EPA's Region 5 office in Chicago, Illinois. Requests for documents can be made by contacting LM at (513) 648-7500 or S.M. Stoller Public Affairs at (513) 648-4026.

The completion and closure of a National Priorities List (NPL) site encompasses several milestones and specific documentation requirements for each milestone completed (EPA 2000). These milestones begin with remedial action completion and end with deletion from the NPL and include:

- Remedial action completion (Final or Interim Remedial Action Reports).
- Construction completions (Preliminary Closeout Report)—all construction activities are complete, immediate threats are addressed, and long-term threats are under control.
- Site completion (Final Closeout Report)—all site cleanup goals are met, all Records of Decision are complete, institutional controls are in place, and site conditions are protective of human health and the environment.
- Site deletion from the NPL (Notice of Intent to Delete).

Final Remedial Action Reports have been prepared and approved by both EPA and OEPA for Operable Units 1, 2, 3 and 4. The *Interim Remedial Action Report for Operable Unit 5* was approved by EPA in August 2008. That report details the ongoing aquifer restoration activities and provides information indicating that all required groundwater infrastructure has been installed and is functioning as designed. Further, the report provides information that all soils have been remediated (except those associated with the groundwater infrastructure) and that the OSDF is functioning as designed. Operable Unit 5 will remain open until a future final Remedial Action Report for Operable Unit 5 has been prepared. This report will be developed once groundwater actions are complete, and all soils and infrastructure associated with the groundwater remedy have been adequately addressed (estimated completion date in 2026, based on modeling projections). EPA issued the *Preliminary Closeout Report U. S. DOE Feed Materials Production Center, Fernald, Ohio* (EPA 2006) in December 2006.

CERCLA also requires a 5-year review process of remedial actions implemented under the signed Record of Decision for each operable unit. The purpose of a 5-year review is to determine, through evaluation of performance of the selected remedy, whether the remedy at a site remains protective of human health and the environment. The first 5-year review report for the Fernald Preserve (DOE 2001a) was approved by EPA in September 2001. The second 5-year report was submitted in April 2006 (DOE 2006a) and approved by EPA in July 2006.

CERCLA remediation highlights during 2009 included the following:

- No remediation activities were conducted for Operable Units 1, 2 and 3. Final Remedial Action Reports have been approved for each of these operable units.
- The performance of the OSDF was satisfactory during 2009. The cap underwent four formal inspections. Leachate generation has continued to decline, and liner performance is meeting design requirements. Cap performance is discussed further in Chapter 7, and leachate/leak detection performance is discussed in Chapter 3.
- Under Operable Unit 4, the final permanent disposal of Silos 1 and 2 treated waste material began on October 7, 2009, at the Waste Control Specialists (WCS) facility in Andrews, Texas. The last container was placed on November 2, 2009.
- Figure 2–1 indicates those soil areas that remain uncertified pending the end of the groundwater remedy and the decontamination and decommissioning of the related facilities and the associated utilities. Elevated uranium concentrations persist in surface water in an area adjacent to former Waste Pit 3. No specific actions other than continued monitoring were conducted in 2009. This issue is further explained in Chapter 4.
- Ecological restoration of the entire property continued during 2009, and required site inspections were performed. There were no instances of breaches in or violations of the institutional controls established in the LMICP. Further discussion of the site inspection process is included in Chapter 7.

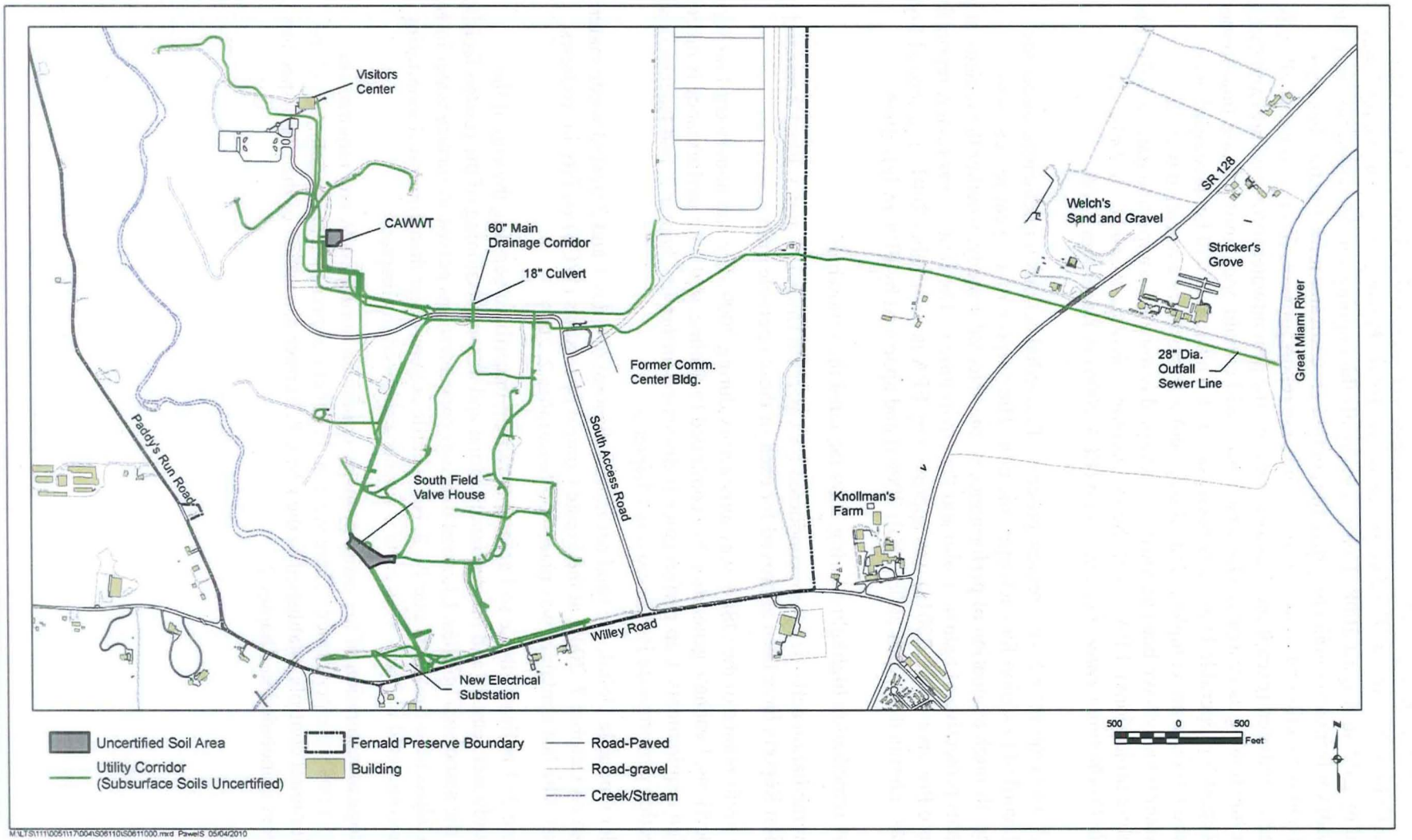


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*Figure 2–1. Uncertified Areas and Subgrade Utility Corridors*

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*OSDF After Completion of all Caps*

*The Converted Advanced Wastewater Treatment Facility*

For 2009, the ongoing groundwater remedy resulted in a total of 2,447 million gallons (M gal) (9,262 million liters [M liters]) of groundwater being extracted from the Great Miami Aquifer, and 585 lb (265 kg) of uranium were removed from the aquifer. Chapter 3 discusses groundwater monitoring and remediation performance.

## 2.2 Summary of Compliance with Other Requirements

CERCLA requires compliance with other laws and regulations as part of remediation of the Fernald Preserve. These requirements are referred to as applicable or relevant and appropriate requirements (ARARs). ARARs that are pertinent to remediation of the Fernald Preserve are specified in the Record of Decision for each operable unit. This section of the report highlights some of the major requirements related to environmental monitoring and waste management and describes how the Fernald Preserve complied with these requirements in 2009.

The regulations discussed in this section have been identified as ARARs within the Records of Decision. The Fernald Preserve must comply with these regulations while site remediation under CERCLA is under way; compliance is enforced by EPA and OEPA. Some of these requirements include permits for controlled releases, which are also discussed in this section.

### 2.2.1 RCRA

RCRA regulates the treatment, storage, and disposal of hazardous waste and mixed waste that contains radioactive and hazardous waste components. These wastes are regulated under RCRA and Ohio hazardous waste management regulations; therefore, the Fernald Preserve must comply with legal requirements for managing hazardous and mixed wastes. OEPA has been authorized by EPA to enforce its hazardous waste management regulations in lieu of the federal RCRA program. In addition, hazardous waste management is subject to the 1988 Consent Decree, the 1993 Stipulated Amendment between the State of Ohio and DOE, and a series of Director's Final Findings and Orders issued by OEPA.

Although the RCRA regulations remain applicable, the Fernald Preserve had no hazardous waste treatment, storage, or disposal activities during 2009.

#### 2.2.1.1 RCRA Property Boundary Groundwater Monitoring

The Director's Findings and Orders for Groundwater, which were signed September 10, 1993, described an alternate monitoring system for RCRA groundwater monitoring. A revision of this document was approved on September 7, 2000, to align with the groundwater monitoring strategy identified in the IEMP. The Property Boundary Groundwater Monitoring program is discussed in Chapter 3.

#### 2.2.1.2 Waste Management

Wastes managed during 2009 were limited to small quantities of low-level radioactive wastes, small volume of universal waste, and uncontaminated solid wastes.

### 2.2.2 Clean Water Act

Under the Clean Water Act, as amended, the Fernald Preserve is governed by the National Pollutant Discharge Elimination System (NPDES) regulations that require the control of discharges of nonradiological pollutants to waters of the State of Ohio. The NPDES permit, issued by the State of Ohio, specifies discharge and sample locations, sampling and reporting schedules, and discharge limitations. The Fernald Preserve submits monthly reports on NPDES activities to OEPA demonstrating compliance with stipulated discharge limits. There were no instances of noncompliance during 2009. Chapter 4 discusses the surface water and treated effluent information in detail.

### 2.2.3 Clean Air Act

NESHAP Subpart H imposes a limit of 10 millirem per year (mrem/yr) (0.1 millisievert per year [mSv/yr]) on the effective dose equivalent to the maximally exposed individual (MEI) as a result of all radioactive air emissions (excluding radon) from the facility in a single year. For 2009, the Fernald Preserve was in compliance with the NESHAP dose limit as determined by ambient air monitoring at the Fernald Preserve's boundary. Appendix D contains the NESHAP Annual Report for 2009.

OEPA is authorized to enforce the State of Ohio's air standards for particulate matter at the Fernald Preserve. Compliance is accomplished by implementing the Fugitive Dust Control Policy negotiated between DOE and OEPA in 1997. The policy allows for visual observation of fugitive dust and implementation of dust control measures.

### 2.2.4 Superfund Amendments and Reauthorization Act of 1986

The Superfund Amendments and Reauthorization Act of 1986 (SARA) amended CERCLA and was enacted, in part, to clarify and expand CERCLA requirements. SARA Title III is also known as the Emergency Planning and Community Right to Know Act.

A letter was submitted to OEPA, to the local emergency planning committees of Hamilton and Butler Counties, and to the Crosby Township Fire Department on February 24, 2008, stating that the Fernald Preserve was not required to submit the SARA Title III, Section 312, Emergency and Hazardous Chemical Inventory Report for 2009. During 2009 there were no chemicals stored on the Fernald Preserve above threshold planning quantities.

Another SARA Title III report, the Section 313 Toxic Chemical Release Inventory Report (Form R), is required if quantities of chemicals released at the Fernald Preserve exceed an applicable threshold for any SARA 313 chemical. If required, the Toxic Chemical Release Inventory Report lists routine and accidental releases and information about the activities, uses, and waste for each reported toxic chemical. No chemical releases have exceeded the threshold for several years. On June 30, 2009, a negative survey report was submitted to OEPA documenting that no such chemicals above thresholds were on site at any time during 2008. No chemical exceeded a reporting threshold during 2008.

Also under SARA Title III, any off-site release meeting or exceeding a reportable quantity as defined by SARA Title III, Section 304, requires that immediate notifications be made to local

emergency planning committees and the state emergency response commission. Notifications are also made to the National Response Center and other appropriate federal, state, and local regulatory entities. All releases that might occur at the Fernald Preserve are evaluated and documented to ensure that proper notifications are made in accordance with SARA, and under CERCLA Section 103, RCRA, the Toxic Substances Control Act, the Clean Air Act, the Clean Water Act, and Ohio environmental laws and regulations. There were no releases at the Fernald Preserve that met the reporting criteria under CERCLA during 2009.

### 2.2.5 Other Environmental Regulations

The Fernald Preserve is also required to comply with other environmental laws and regulations in addition to those described above. Table 2–1 summarizes compliance with each of these requirements for 2009.

### 2.2.6 Other Permits

Certain environmental laws are implemented through permits. However, there are no other permits currently in effect other than the Fernald Preserve's permit for discharging water under NPDES regulations discussed in Section 2.2.2.

### 2.2.7 Pollution Prevention and Source Reduction

The Fernald Preserve is actively involved in an effort to reduce solid, hazardous, radioactive, and mixed waste generation and to eliminate or minimize pollutants released to all environmental media. Various waste streams were recycled during 2009, including:

- 5,466 lb (12,479 kg) of paper
- 62 lb (28.1 kg) of aluminum
- 559 lb (254 kg) of electronic equipment (universal waste)
- 61 toner cartridges
- 2,010 lb (911 kg) of commingled materials
- 1,200 lb (553 kg) of metal

*Table 2–1. Compliance with Other Environmental Regulations*

| Regulation and Purpose | Background Compliance Issues | 2009 Compliance Activities |
|---|---|---|
| **Toxic Substances Control Act** | | |
| Regulates the manufacturing, use, storage, and disposal of toxic materials, including polychlorinated biphenyl (PCB) and PCB items. | The last routine Toxic Substances Control Act inspection of the Fernald Preserve's program was conducted by EPA Region 5 on September 21, 1994. No violations of PCB regulations were identified during the inspection. | No PCB liquids were shipped in 2009. |
| **Ohio Solid Waste Act** | | |
| Regulates infectious waste. | The Fernald Preserve was registered with OEPA as a generator of infectious waste (generating more than 50 pounds [23 kg] per month) until December 6, 1999, when OEPA concurred with the Fernald Preserve's qualification as a small quantity generator. | No infectious waste activities were required in 2009. |
| **Federal Insecticide, Fungicide, and Rodenticide Act** | | |
| Regulates the registration, storage, labeling, and use of pesticides (such as insecticides, herbicides, and rodenticides). | The last inspection of the Federal Insecticide, Fungicide, and Rodenticide Act program conducted by EPA Region 5 on September 21, 1994, found the Fernald Preserve to be in full compliance with the requirements mandated by the Federal Insecticide, Fungicide, and Rodenticide Act. | Pesticide applications at the Fernald Preserve were conducted according to federal and state regulatory requirements. |
| **National Environmental Policy Act** | | |
| Requires the evaluation of environmental, socioeconomic, and cultural impacts before any action, such as a construction or cleanup project, is initiated by a federal agency. | An Environmental Assessment for proposed final land use was issued for public review in 1998. It was prepared under DOE's guidelines for implementation of National Environmental Policy Act, 10 CFR 1021. The assessment requires consulting the public before any decisions on land use are made; it includes previous DOE commitments. | No National Environmental Policy Act activities were required in 2009. |
| **Endangered Species Act** | | |
| Requires the protection of any threatened or endangered species found at the site as well as any critical habitat that is essential for the species' existence. | Ecological surveys conducted by Miami University and DOE, in consultation with the Ohio Department of Natural Resources and the U.S. Fish and Wildlife Service, have established the following list of threatened and endangered species and their habitats existing on site:<br><br>Cave salamander, state-listed endangered—marginal habitat, none found; Sloan's crayfish, state-listed threatened—found on northern sections of Paddys Run; Indiana brown bat, federally listed endangered—found in riparian areas along Paddys Run. | No surveys were conducted specifically for endangered species in 2009. A bat survey did take place in May, as part of the Fernald Preserve BioBlitz (discussed in Section 7), but no Indiana bats were observed. |

*Table 2–1 (continued). Compliance with Other Environmental Regulations*

| Regulation and Purpose | Background Compliance Issues | 2009 Compliance Activities |
|---|---|---|
| **Floodplains/Wetlands Review Requirements** | | |
| DOE regulations require a floodplain/wetlands assessment for DOE construction and improvement projects. | A wetlands delineation of the Fernald Preserve, completed in 1992 and approved by the U.S. Army Corps of Engineers in August 1993, identified 36 acres (15 hectares) of freshwater wetlands on the Fernald Preserve property. | No assessments were performed in 2009. |
| **National Historic Preservation Act** | | |
| Establishes a program for the protection, maintenance, and stewardship of federal prehistoric and historic properties. | The Fernald Preserve is located in an area of sensitive historic and prehistoric cultural resources that are eligible for or on the National Register of Historic Places. These cultural resources include historic structures, buildings, and bridges, plus Native American villages and campsites. | No cultural resource surveys were necessary in 2009. Monitoring for unexpected discoveries was conducted during sitewide field activities. |
| **Native American Graves Protection and Repatriation Act** | | |
| Establishes a means for Native Americans to request the return or "repatriation" of human remains and other cultural items. Federal agencies must return human remains, associated funerary objects, sacred objects, and objects of cultural patrimony to the Native American nations or tribes with cultural affiliation to the remains or material. | Native American remains have been discovered during remediation activities at the Fernald Preserve. Native American remains and artifacts have been removed or left in place, with consultation from Native American nations, tribes, and groups. | No Native American remains were discovered or repatriated to Native American nations, tribes, or groups in 2009. As stated above, monitoring for unexpected discoveries was conducted during sitewide field activities. |

*Table 2–1 (continued). Compliance with Other Environmental Regulations*

| Regulation and Purpose | Background Compliance Issues | 2009 Compliance Activities |
|---|---|---|
| **Natural Resource Requirements Under CERCLA and Executive Order 12580** | | |
| Requires DOE to act as a trustee (i.e., guardian) for natural resources at its federal facilities. | DOE and the other trustees, which include OEPA and the U.S. Department of the Interior (administered by the U.S. Fish and Wildlife Service), meet regularly to discuss potential impact to natural resources and to coordinate trustee activities. The trustees also interact with the Fernald Citizens Advisory Board and Community Reuse Organization. | In November 2008, the State of Ohio and DOE reached a settlement of the 1986 Natural Resource injury claim at Fernald. While the components of restoration had been established through a 2001 Memorandum of Understanding (DOE 2001b) and restoration of the site continues, the State of Ohio and DOE settled outstanding issues such as the payment of monetary penalties, establishment of environmental covenants, and a mutually agreed Natural Resource Restoration Plan (NRRP), which is Appendix B of the *Partial Consent Decree Resolving Ohio's Natural Resource Damage Claim against DOE* (State of Ohio 2008). In 2009, activities commenced as required in the final NRRP. This work included issue of the Wetland Mitigation Monitoring Plan and subsequent initiation of enhanced monitoring, as well as a resumption of functional phase monitoring. The Fernald Trustees also completed walkdowns of all restored areas to develop a path forward for future maintenance and repair activities. Chapter 7 provides a summary of trustee activities and monitoring data. |

The Fernald Preserve's affirmative procurement program involves source reduction and the use of EPA-designated materials to increase the market for recovered materials. In accordance with Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance,* and Executive Order 13423, *Strengthening Federal Environmental, Energy and Transportation Management*, the Fernald Preserve uses 30 percent post-recycled-content copier paper. The Fernald Preserve generated and submitted an annual report demonstrating compliance with these orders in December 2009.

As part of the Annual Waste Reduction Report under DOE Order 450.1A, the Fernald Preserve generated and submitted a summary report of waste generated and pollution prevention progress in December 2009.

### 2.2.8 Federal Facilities Compliance Agreement

In July 1986, DOE entered into a Federal Facility Compliance Agreement (FFCA) with EPA, which requires the Fernald Preserve to:

- Maintain a sampling program for the South Plume extraction wells and report the results to the EPA, OEPA, and Ohio Department of Health. The sampling program conducted to address this requirement has also been modified over the years and is currently governed by an agreement reached with EPA and OEPA on May 1, 1996. These data are reported through IEMP reports (refer to Appendix A).
- Maintain a continuous sample collection program for radiological constituents at the treated effluent discharge points and report the results to EPA, OEPA, and the Ohio Department of Health. The sampling program to address this requirement has been modified over the years and is currently governed by an agreement reached with EPA and OEPA that became effective May 1, 1996. These data are reported through IEMP reports (refer to Appendix B).

### 2.2.9 Environmental Management Systems Requirement

DOE requires that sites develop and implement an Environmental Management System as a means of systematically planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals. This requirement is specified in DOE Order 450.1A, *Environmental Protection Program.*

The implementation of an Environmental Management System ensures that sound stewardship practices protective of the air, water, land, and other natural and cultural resources potentially affected by operations are employed throughout the project. An Environmental Management System is a systematic process for reducing the environmental impacts resulting from DOE and contractor work activities, products, and services and directs work to occur in a manner that protects workers, the public, and the environment. The process adheres to "Plan-Do-Check-Act" principles, mandates environmental compliance, and integrates green initiatives into all phases of work, including scoping, planning, construction, subcontracts, and operations. Proposed site maintenance activities will be assessed for opportunities to improve environmental performance and sustainable environmental practices. Some areas for consideration include reusing and recycling products or wastes, using environmentally preferable products (i.e., products with recycled content, such as office furniture; products with reduced toxicity; and energy efficient products), using alternative fuels and renewable energy, and making environmental habitat improvements.

## 2.3 Split Sampling Program

Since 1987, DOE has participated in the split sampling program with the State. Split samples are obtained when technicians alternately add portions of a sample to two individual sample containers. This collection method helps ensure that both samples are as identical as possible. The split samples are then submitted to two analytical laboratories; this allows for an independent comparison of data to ascertain laboratory analysis and field quality assurance. In addition to split sampling, OEPA performs independent sampling.

In 2009, DOE and OEPA cooperated in the split sampling program. Samples of groundwater were split, and the results are provided in Table 2–2. (Split sample locations are provided in Figure 2–2.)

*Table 2–2. 2009 DOE/OEPA Groundwater Split Sampling Comparison*

| Sample Location[a] | 2009 Sample Date | Constituent | DOE Result (µg/L) | OEPA Result (µg/L) | FRL (µg/L) |
|---|---|---|---|---|---|
| 2060 | April | Total Uranium | 56.8 | 45.5 | 30 |
| 2060 | October | Total Uranium | 50.9 | 47.9 | 30 |
| 13 | April | Total Uranium | 21.9 | 20.2 | 30 |
| 13 | October | Total Uranium | 15.3 | 10.1 | 30 |
| 14 | April | Total Uranium | 4.82 | 2.20 | 30 |
| 14 | October | Total Uranium | 4.92 | 3.46 | 30 |

[a]Refer to Figure 2–2 for groundwater split sample locations.

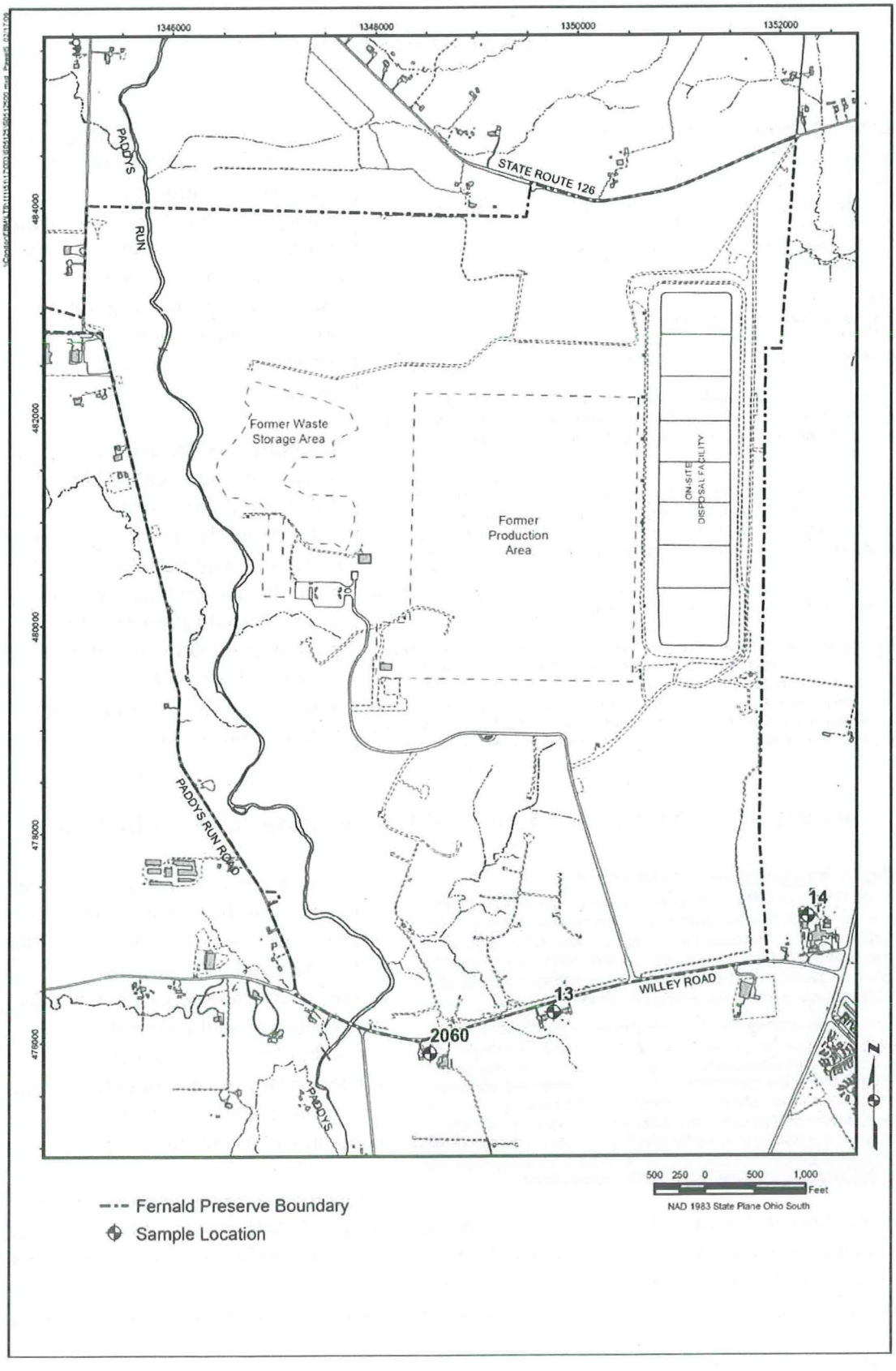


*Figure 2–2. 2009 DOE and OEPA Groundwater Split Sample Locations*

# 3.0 Groundwater Pathway

**Results in Brief: 2009 Groundwater Pathway**

**Groundwater Remedy**

Since 1993

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

During 2009

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

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

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

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

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

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

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

## 3.1 Summary of the Nature and Extent of Groundwater Contamination

**Groundwater Modeling at the Fernald Preserve**

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

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

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

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

## 3.2 Selection and Design of the Groundwater Remedy

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

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

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

**Re-Injection at the Fernald Site**

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

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

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

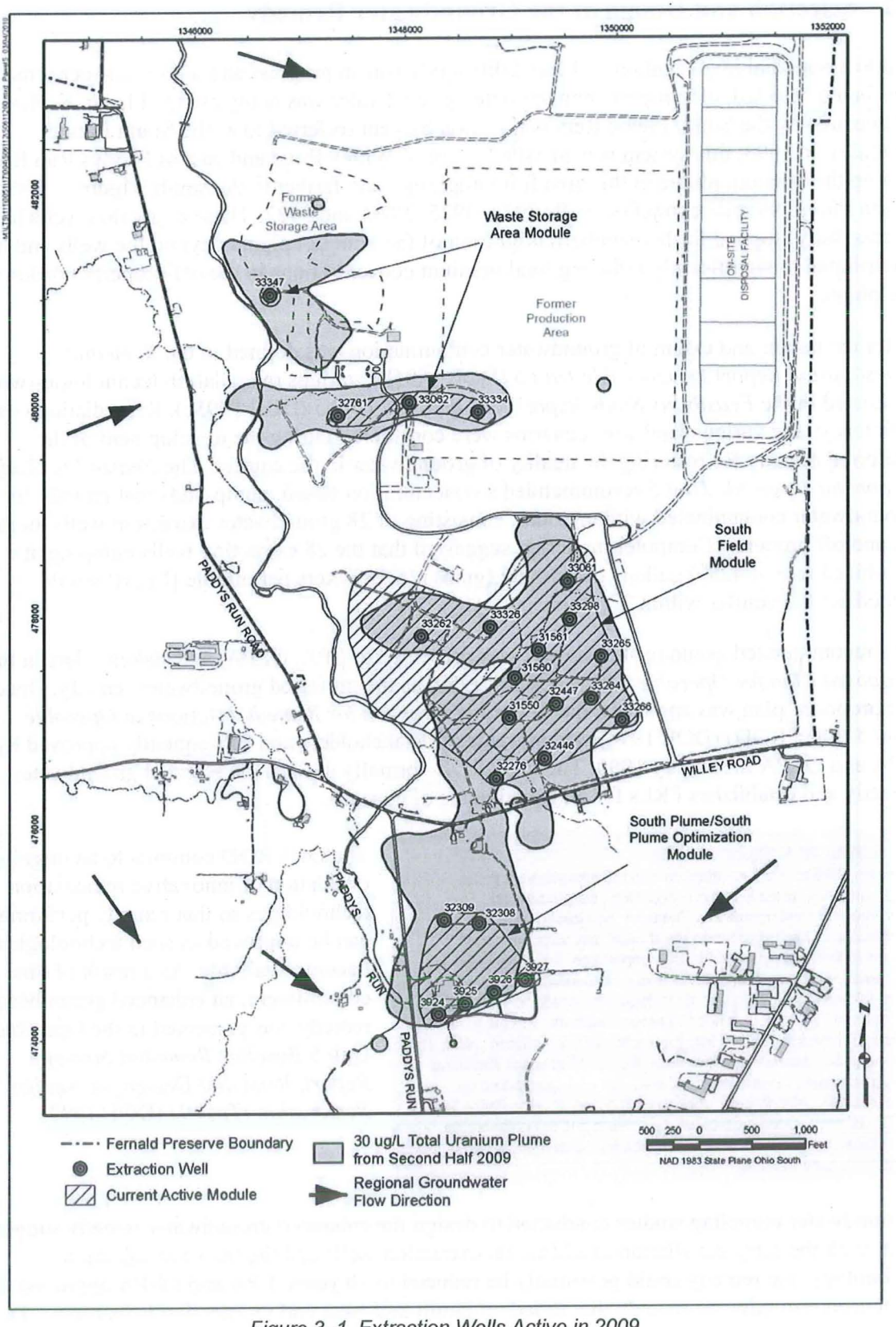


*Figure 3–1. Extraction Wells Active in 2009*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## 3.3 Groundwater Monitoring Highlights for 2009

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

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

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

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

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

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

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

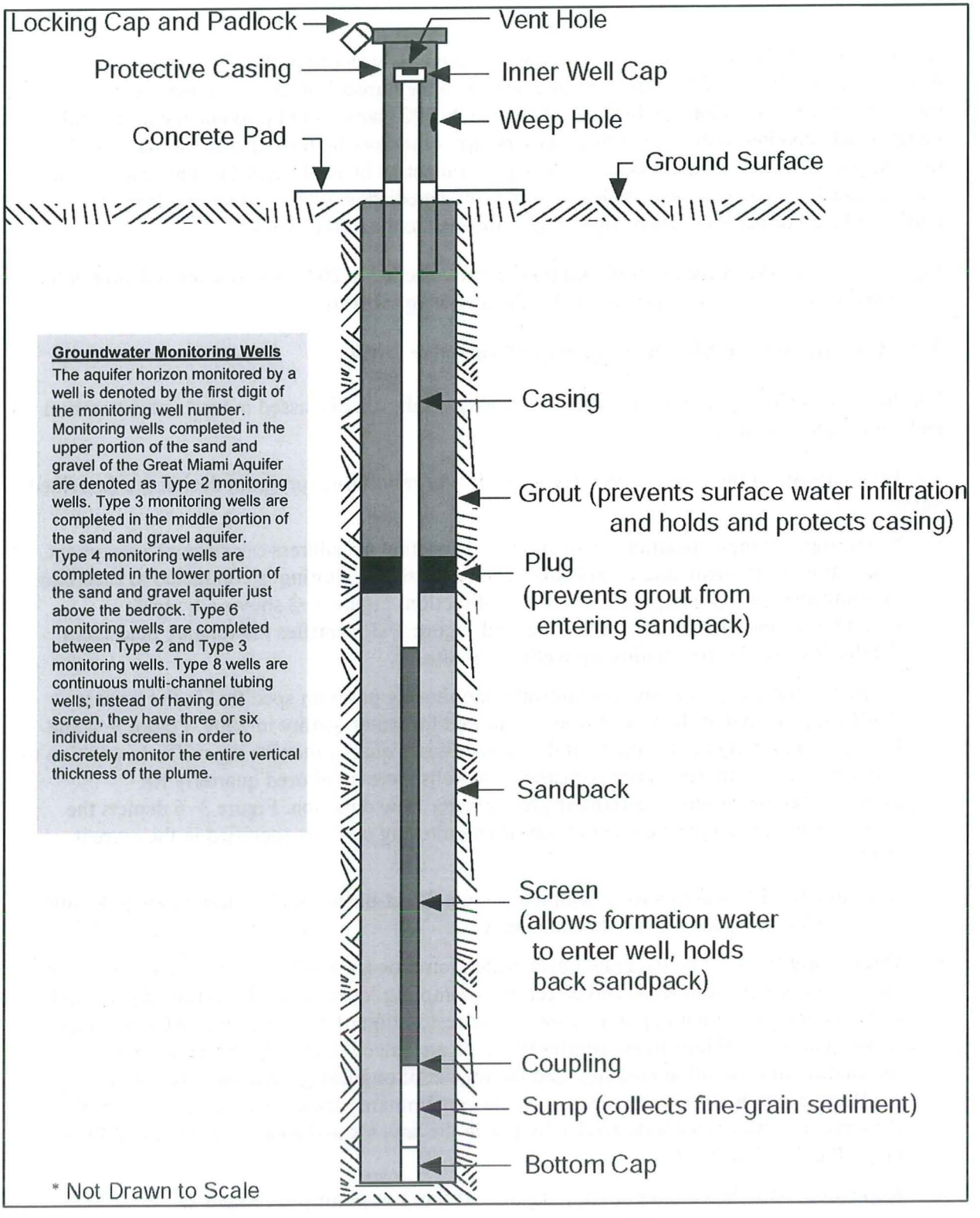


*Figure 3–2. Diagram of a Typical Groundwater Monitoring Well*

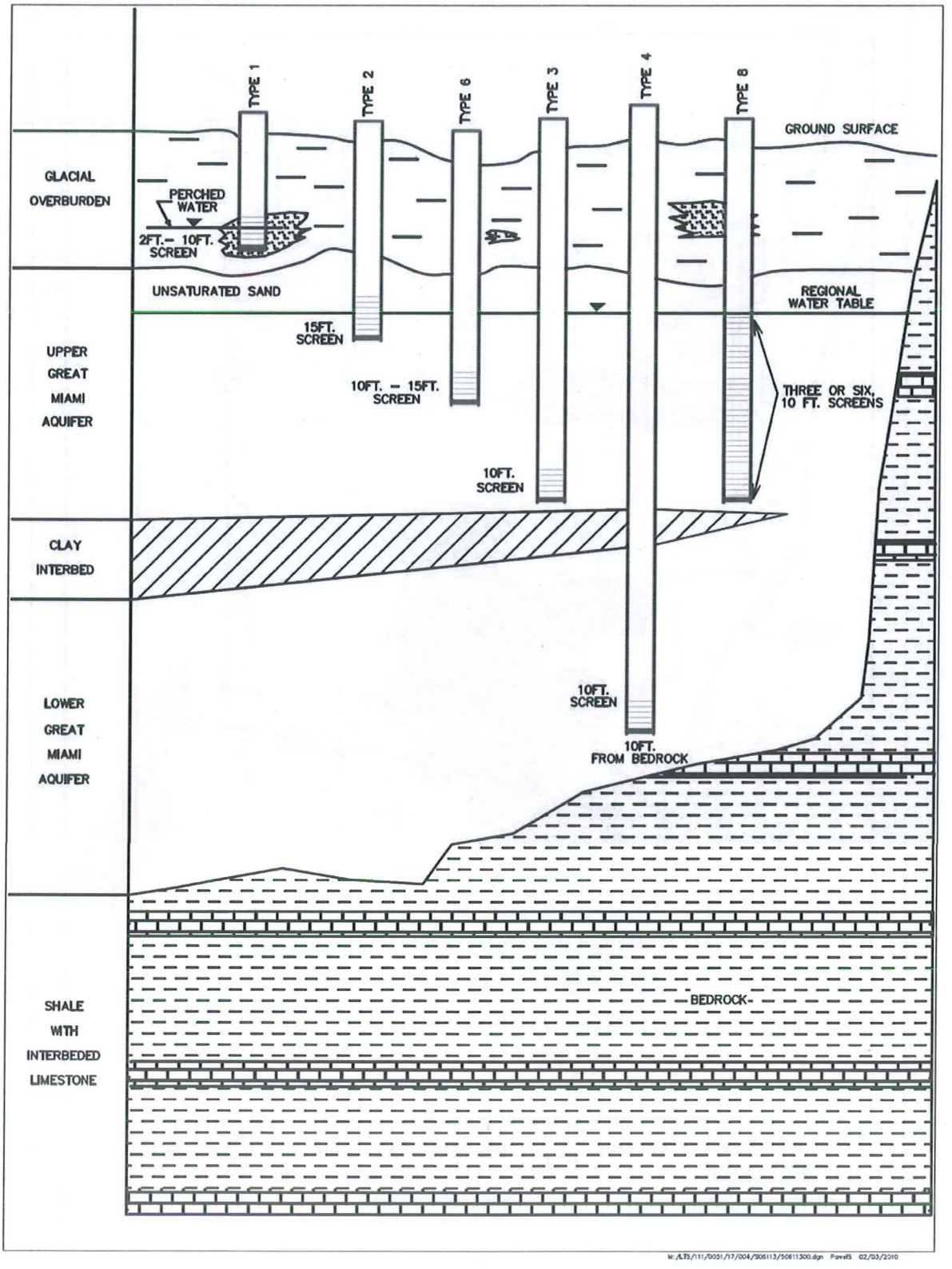


*Figure 3–3. Monitoring Well Relative Depths and Screen Locations*

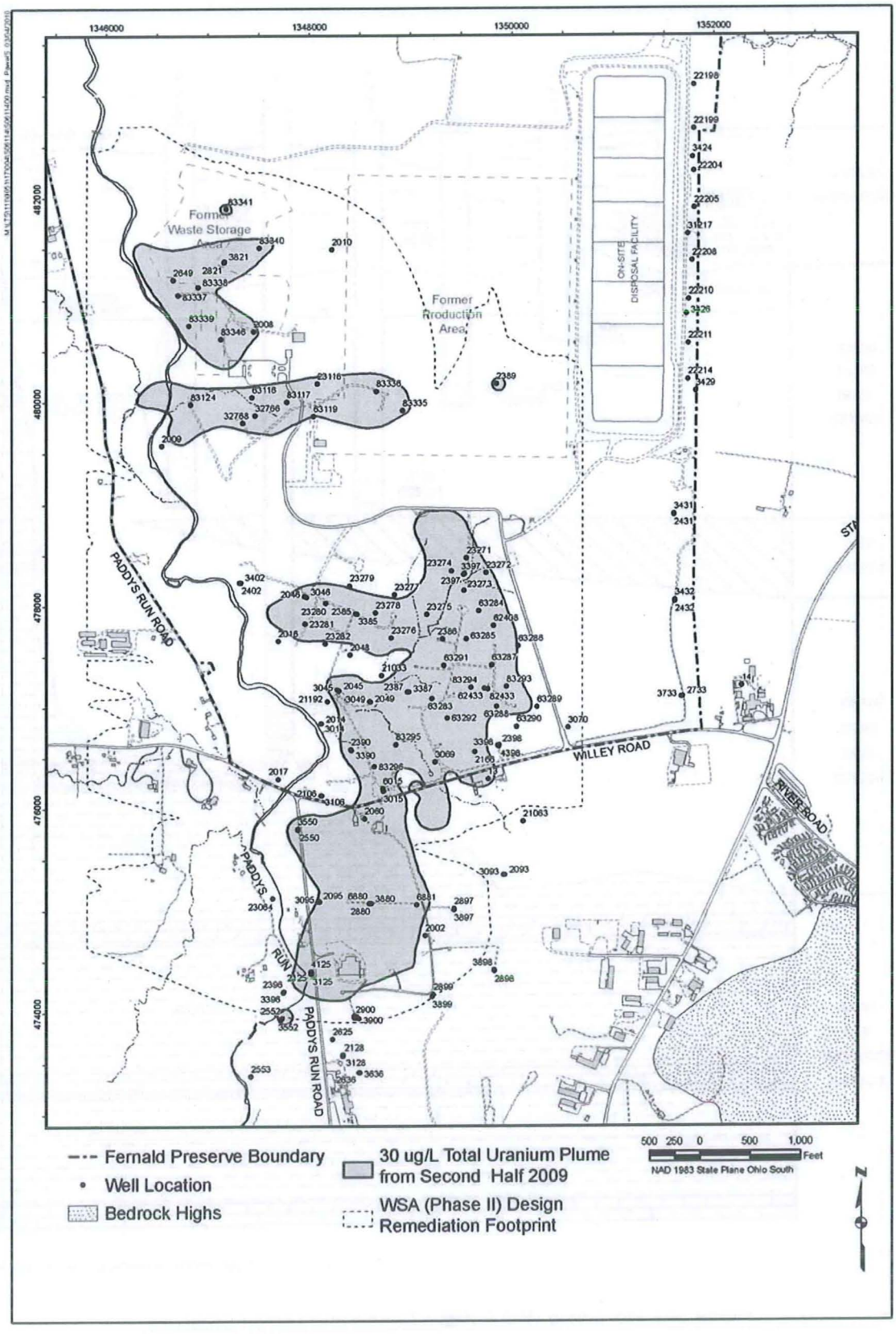


*Figure 3–4. Locations for Semiannual Total Uranium Monitoring*

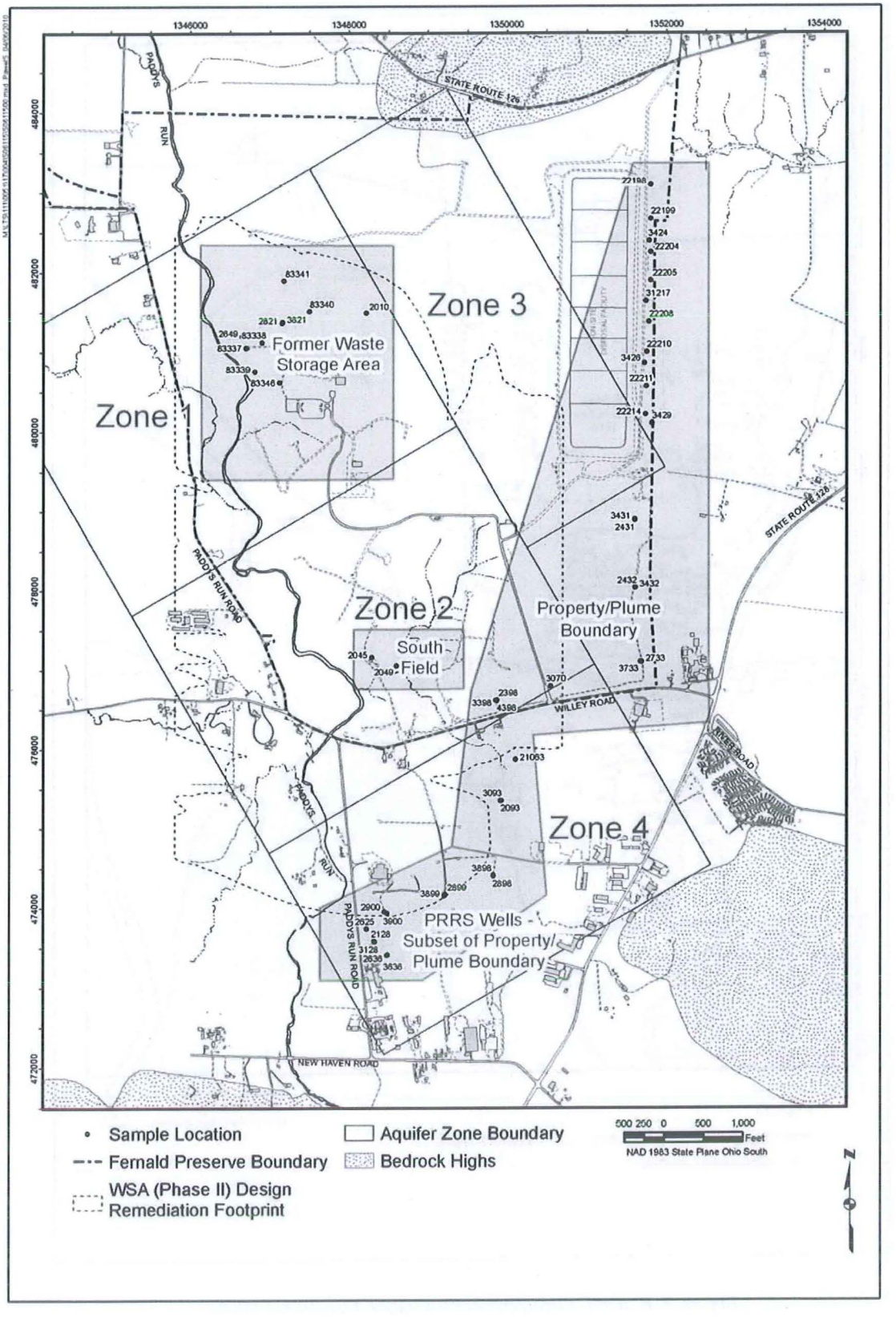


*Figure 3–5. Locations for Semiannual Non-Uranium Monitoring*

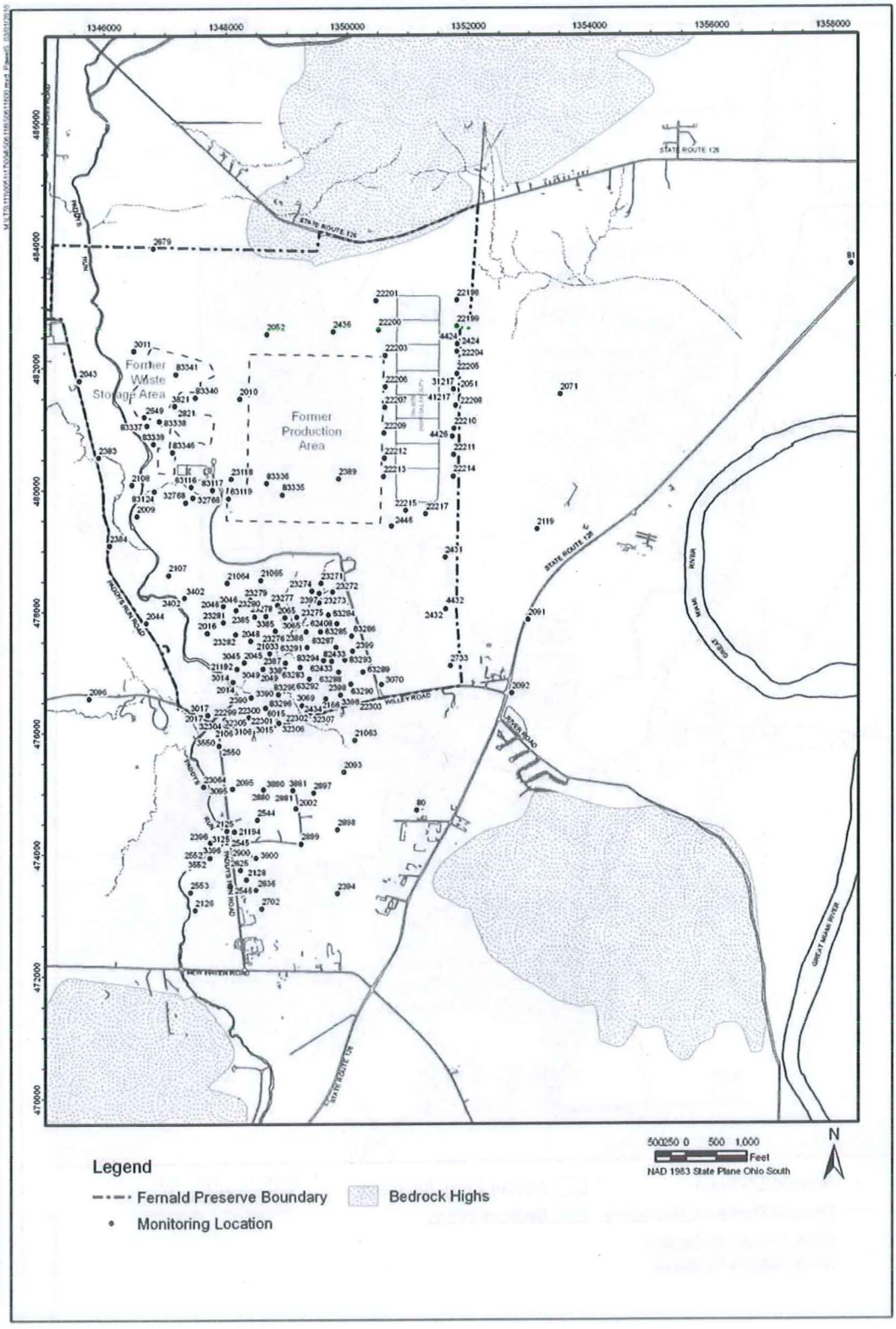


*Figure 3–6. IEMP Groundwater Elevation Monitoring Wells*

### 3.3.1 Restoration Monitoring

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

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

#### 3.3.1.1 Operational Summary

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

*Table 3–1. Groundwater Restoration Module Status for 2009*

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

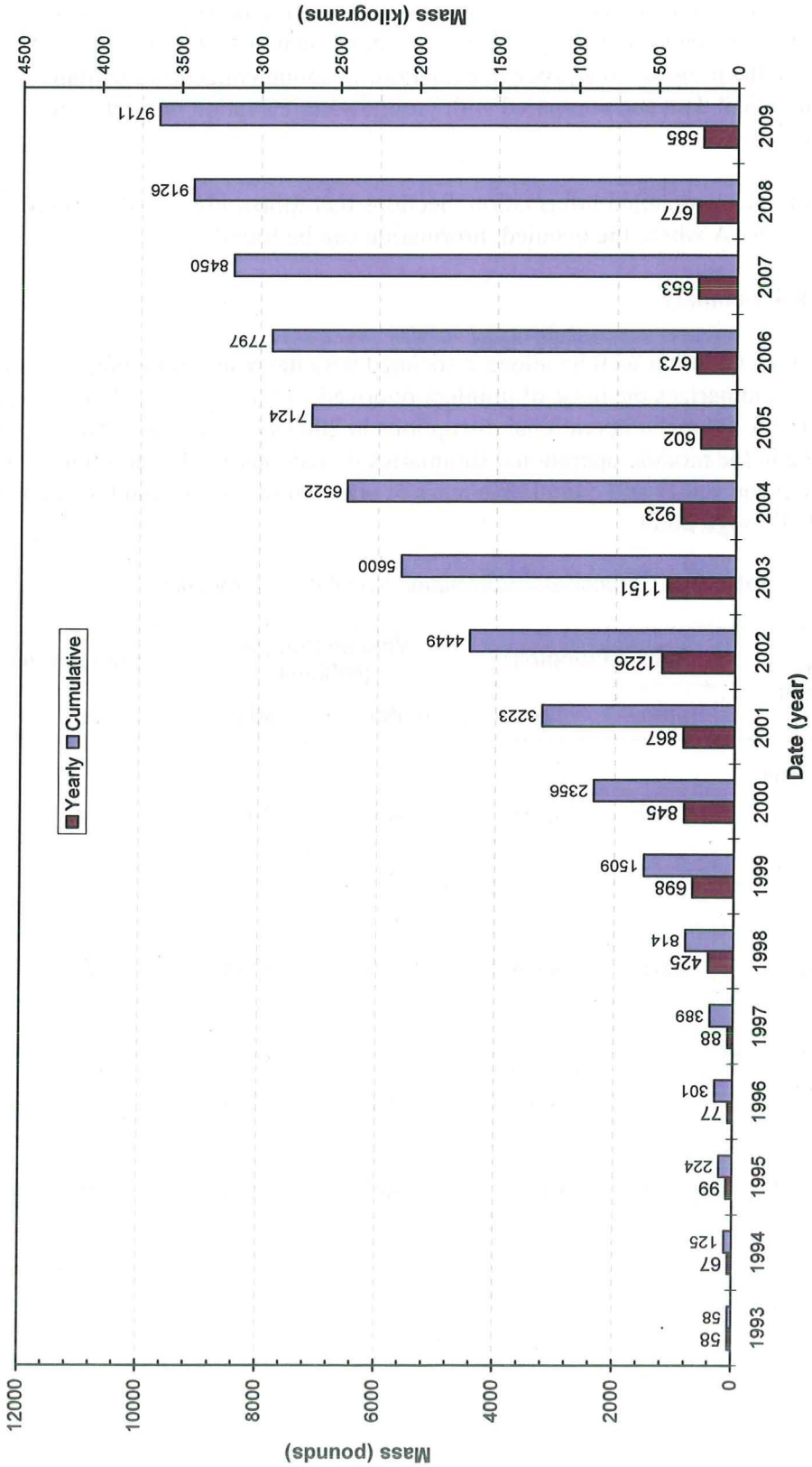


*Figure 3–7. Net Mass of Uranium Removed from the Great Miami Aquifer, 1993–2009*

Since 1993:

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

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

#### 3.3.1.2 South Plume/South Plume Optimization Module Operational Summary

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

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

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

#### 3.3.1.3 South Field Module Operational Summary

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

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

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

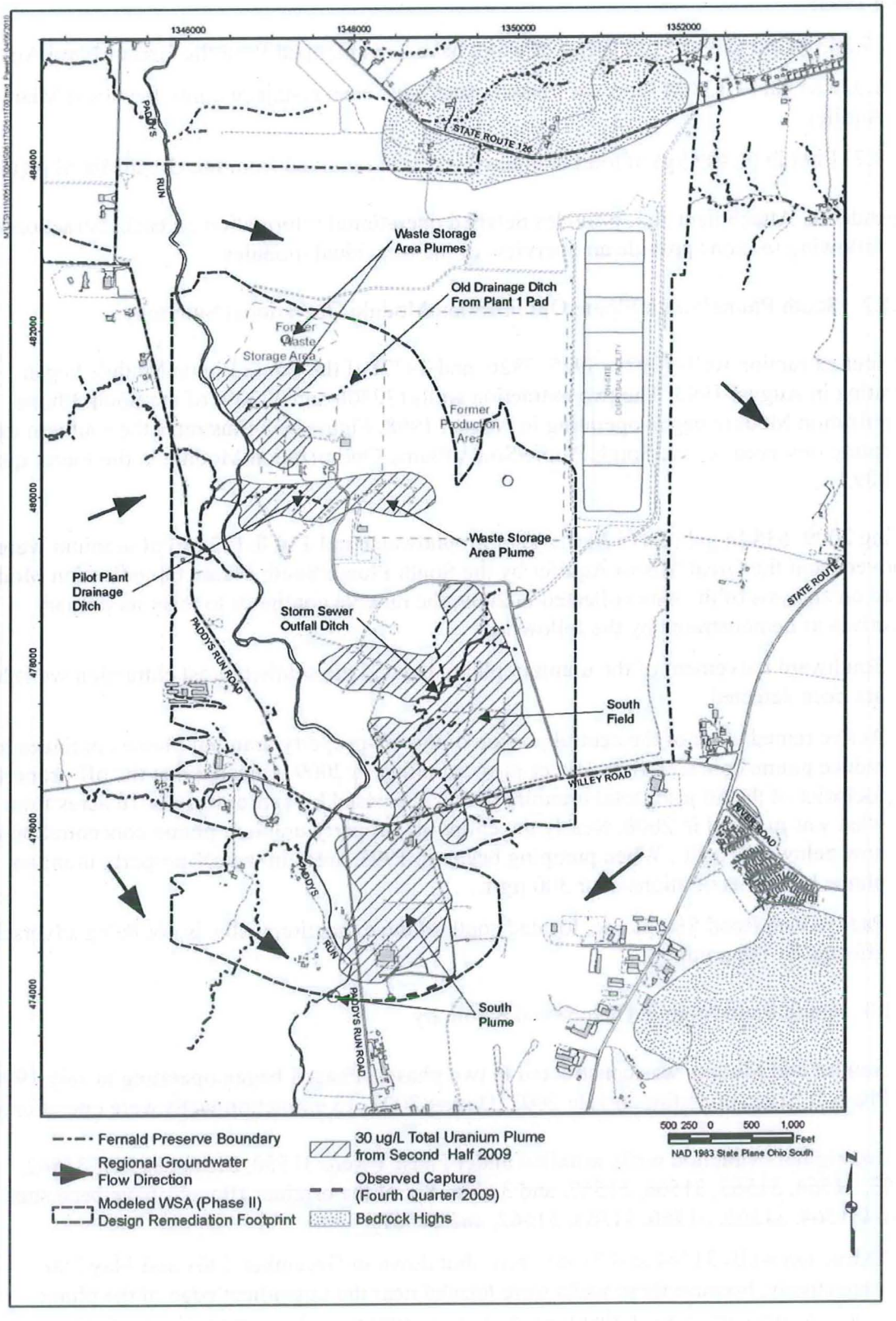


*Figure 3–8. Total Uranium Plume in the Aquifer with Concentrations Greater Than 30 µg/L at the End of 2009*

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

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

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

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

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

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

#### 3.3.1.4 Waste Storage Area Module Operational Summary

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

well 33334) and became operational June 29, 2006. Phase II consisted of one additional extraction well (extraction well 33347), which became operational on October 5, 2006.

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

### 3.3.1.5 Monitoring Results for Total Uranium

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

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

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

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

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

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

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

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

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

#### 3.3.1.6 Monitoring Results for Non-Uranium Constituents

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

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

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

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

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

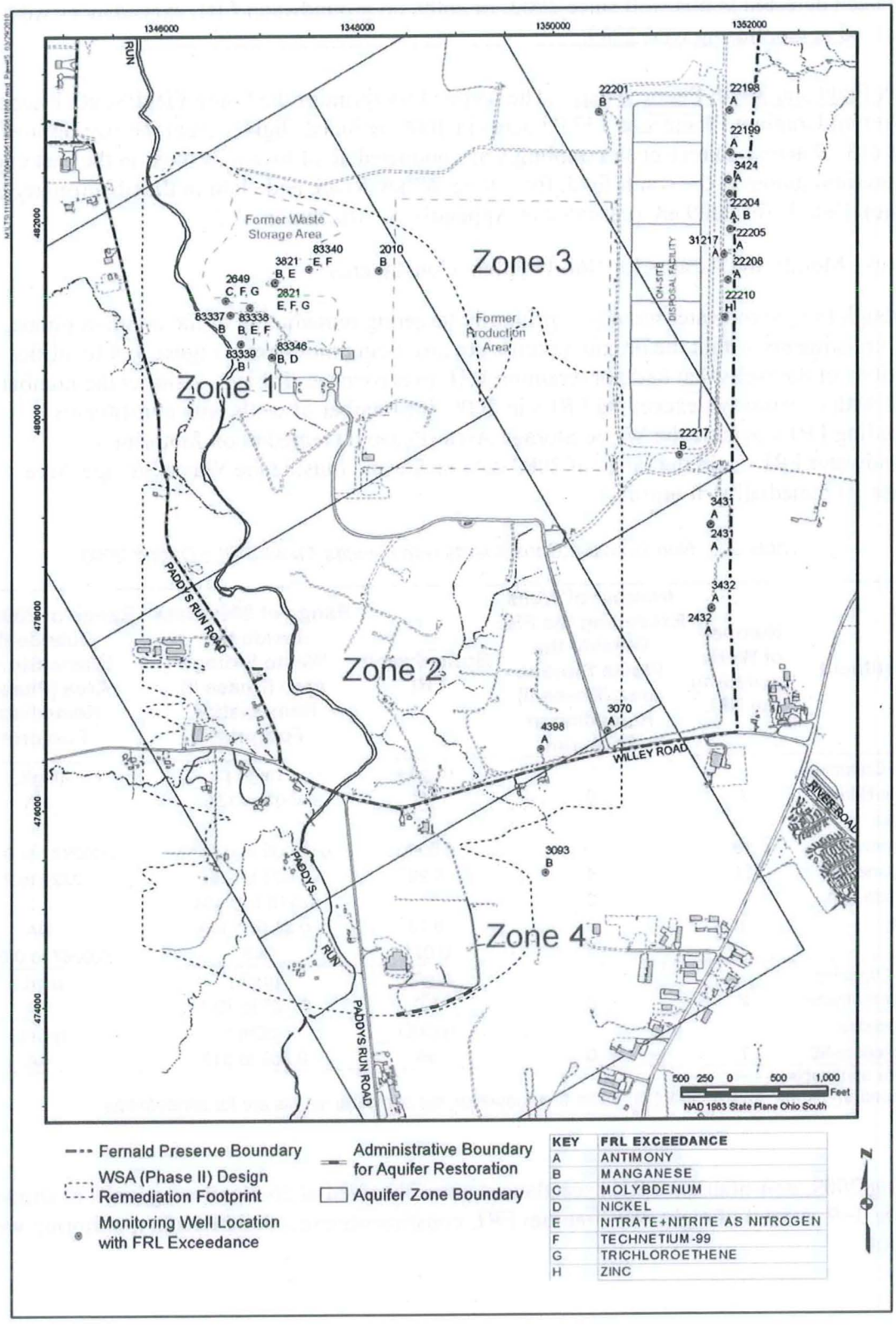


*Figure 3–9. Non-Uranium Constituents with 2009 Results Above FRLs*

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

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

### 3.3.2 Other Monitoring Commitments

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

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

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

As indicated in Chapter 2, OEPA issued the Director's Findings and Orders on September 7, 2000. These orders specify that the site's groundwater monitoring activities will be

implemented in accordance with the IEMP. The revised language allows modification of the groundwater monitoring program as necessary, via the IEMP revision process (subject to OEPA approval), without issuance of a new Director's Order. As determined by OEPA, the IEMP will remain in effect following remediation.

## 3.4 OSDF Monitoring

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

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

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

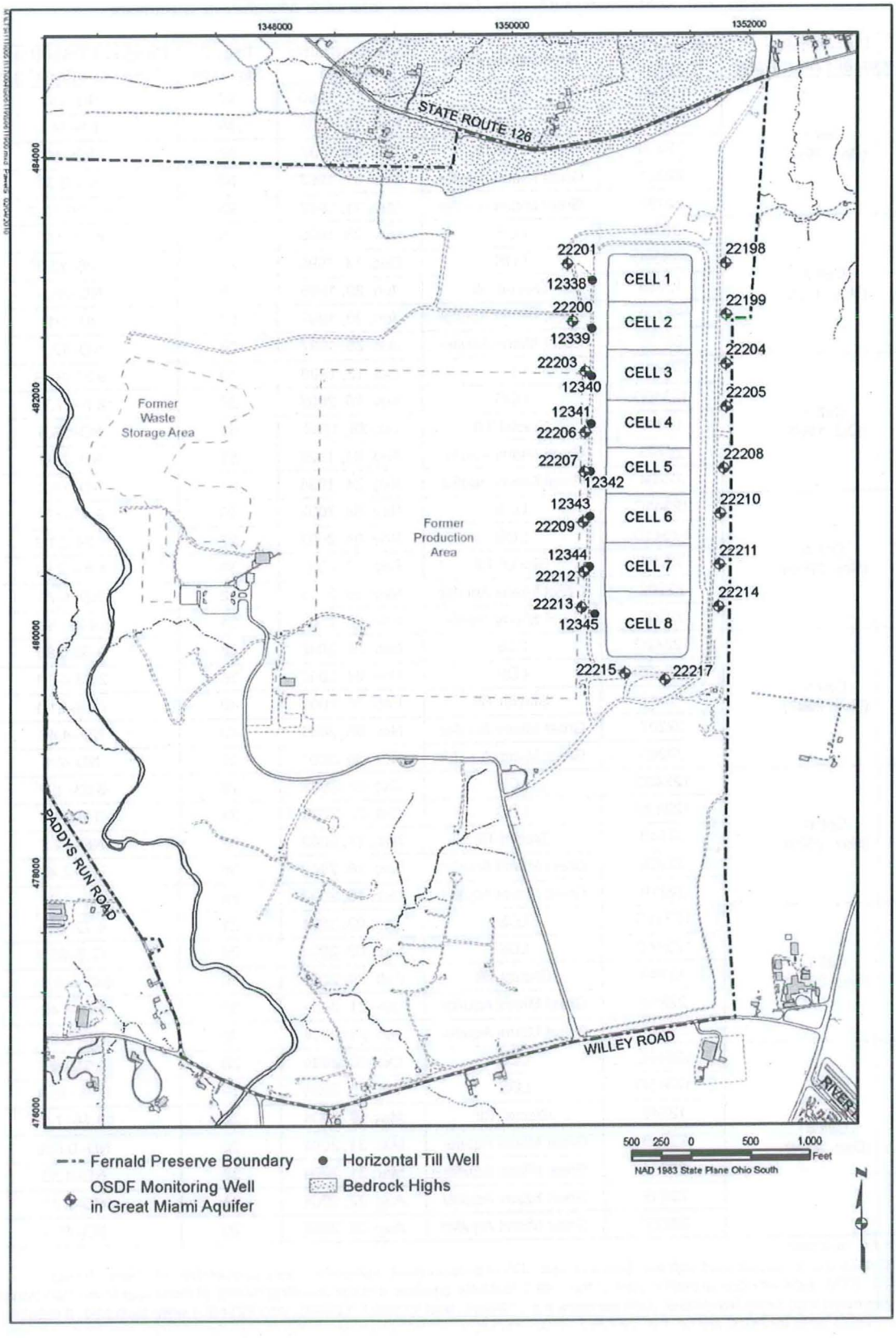


*Figure 3–10. OSDF Footprint and Monitoring Well Locations*

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

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

[a]ND = not detected

[b]Some data are not considered representative of true LDS uranium concentrations in Cell 2 (December 14, 1998, through May 23, 2000, data set) due to malfunction in the Cell 2 leachate pipeline and the resulting mixing of individual flows. Additionally, it is suspected that some November 2004 samples (i.e., 12339C and 12339D, 12340C, and 12340D) were switched. If data from these events were included above, the maximum total uranium concentrations would be 71 µg/L for 12339D and 72.4 µg/L for 12340D.

[c]Monitoring location 22216 was plugged and abandoned in April 2006. Monitoring location 22217 is its replacement. The results listed for location 22217 also include the results for location 22216.

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# 4.0 Surface Water and Treated Effluent Pathway

**Results in Brief: 2009 Surface Water and Treated Effluent Pathway**

**Surveillance Monitoring**—No treated effluent analytical results from samples collected in 2009 exceeded the surface water FRL for total uranium, the primary site contaminant. Thirty-two surface water analytical results exceeded the surface water FRL for total uranium. Sample results from four surface water cross-media locations exceeded the groundwater FRL for total uranium.

**Uranium Discharges**—In 2009, 586 lb (266 kg) of uranium were discharged in treated effluent to the Great Miami River. Approximately 78.4 lb (35.6 kg) of uranium were released to the environment through uncontrolled storm water runoff. The estimated total pounds of uranium released through the surface water and treated effluent pathway (approximately 664 lb [302 kg]) increased 2 percent from the 2008 estimate.

**Sediment**—In 2009, there were no FRL exceedances for any sediment result.

This chapter presents the 2009 monitoring activities and results for surface water, treated effluent, and sediment to determine the effects of site activities on the surface water pathway.

In general, low levels of contaminants enter the surface water pathway at the Fernald Preserve by two primary mechanisms: treated effluent that is monitored as it is discharged to the Great Miami River, and uncontrolled runoff entering the site's drainages from remediated areas that are now certified and restored. Because these discharges have continued through remediation and legacy management, the surface water and sediment pathways will continue to be monitored. Effective use of the site's wastewater treatment capabilities and implementation of runoff and sediment controls minimize the site's impact on the surface water pathway.

## 4.1 Summary of Surface Water and Treated Effluent Pathway

**To assist in the understanding of this chapter, the following key definitions are provided:**

- **Controlled runoff** is contaminated storm water that is collected and, under normal circumstances, treated and discharged to the Great Miami River as treated effluent. However, the only storm water controlled is currently that associated with the footprint of the outdoor processing activities at the wastewater treatment facility.
- **Uncontrolled runoff** is storm water that is not collected for treatment, but enters the site's natural drainages.
- **Treated effluent** is water that is treated through the site's wastewater treatment facility and then discharged to the Great Miami River.
- **Surface water** is water that flows within natural drainage features.

The treated effluent pathway consists of flows discharged to the Great Miami River via the Parshall Flume (PF 4001). Discharges through this point are considered under the control of wastewater operations. Treated effluent is currently composed of treated and untreated groundwater, leachate from the OSDF, and storm water associated with the footprint of the outdoor processing activities at the wastewater treatment facility.

The volume and flow rate of uncontrolled runoff depends on the amount of precipitation within any given period of time. Figure 1–10 in Chapter 1 shows monthly precipitation totals for 2009. Figure 4–1 shows the site's natural drainage features. The site's natural surface water drainages include several tributaries to Paddys Run (e.g., SSOD) as well as the northeast drainage that flows to the Great Miami River. The arrows on Figure 4–1 indicate the general flow direction of uncontrolled runoff that is determined from the topography. Uncontrolled runoff from the Fernald Preserve leaves the property via two drainage pathways: Paddys Run and the northeast drainage ditch.

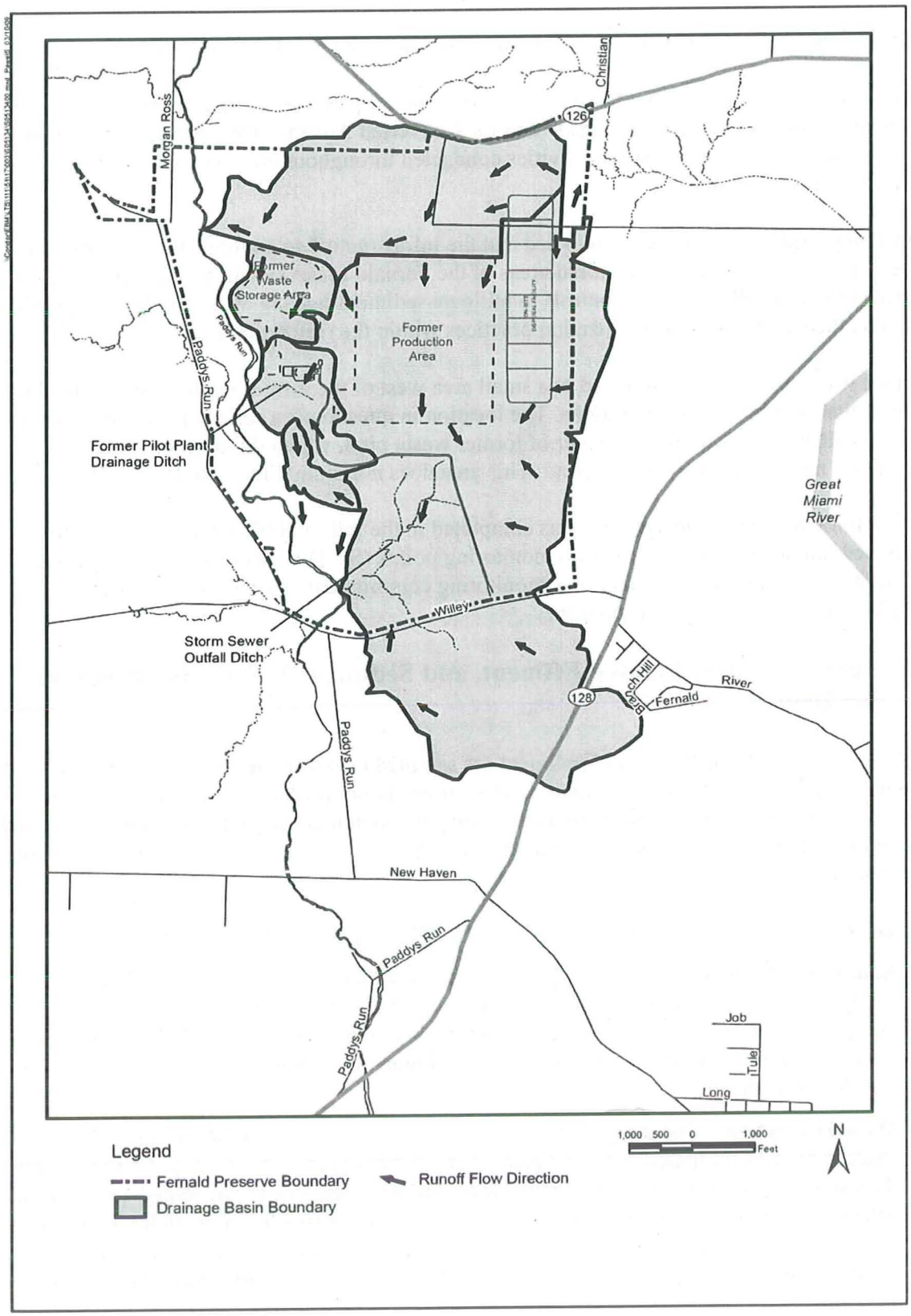


*Figure 4–1. Controlled Surface Water Areas and Uncontrolled Runoff Flow Directions*

## 4.2 Remediation Activities Affecting the Surface Water Pathway

Activities that had the potential to affect the surface water pathway included routine operation and maintenance activities of the OSDF and the Converted Advanced Wastewater Treatment facility, and ecological restoration activities conducted throughout the property, including repairing areas of erosion.

Now that remediation has been completed and the infrastructure to continue the groundwater remedy has been installed, the restored areas of the Fernald Preserve will be the primary focus relative to uncontrolled runoff. Controls to mitigate sediment leaving the site will be primarily based on the vegetation and stabilization practices within the restored areas.

Surface water monitoring conducted in a small area west of the former waste pits continued to show elevated uranium concentrations. The location in question is a series of small puddles and drainage ditches due west of the center of former waste pit 3, which drain generally south to a depression near the former cement pond. This area does not drain directly to Paddys Run.

After a limited maintenance activity was completed in the fall of 2007, DOE committed to continued monitoring of the area. Two monitoring points (SWD-05 and SWD-09) were added to the surface water program to fulfill this monitoring commitment. These two locations are sampled weekly, when water is present.

## 4.3 Surface Water, Treated Effluent, and Sediment Monitoring Program for 2009

Surface water, treated effluent, and sediment are sampled to determine the effect of the Fernald Preserve's activities on the environment. Surface water is sampled at several locations in the site's drainages and analyzed for various radiological and nonradiological constituents. Treated effluent is sampled prior to discharge into the Great Miami River. Sediment is sampled for total uranium in the Great Miami River.

The key elements of the surface water and treated effluent program design are:

- **Sampling**—Sample locations, frequency, and constituents were selected to address requirements of the NPDES Permit, the FFCA, and the OU5 ROD and to provide a comprehensive assessment of surface water quality at key locations, including two background locations (refer to Figure 4–2 and Figure 4–3). Surface water is monitored for 16 FRL constituents.
- **Data Evaluation**—The integrated data evaluation process focuses on tracking and evaluating data compared with background and historical ranges, FRLs, and NPDES limits. This information is used to assess impacts on surface water due to site remediation activities affecting uncontrolled runoff or treated effluent. The assessment also includes identifying the potential for impacts from surface water to the groundwater in the underlying Great Miami Aquifer. The ongoing data evaluation is designed to support remedial action decision making.

- **Reporting**—Surface water and treated effluent data are reported through the annual Site Environmental Report. Monthly discharge monitoring reports required by the NPDES permit are submitted to OEPA.

In 2009, the IEMP sediment monitoring sampling frequency was changed from annual to once every five years at the suggestion of OEPA per DOE/EH-0173T, Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance (January 1991). The data are reported through the annual Site Environmental Report.

Data from samples collected under the IEMP are used to fulfill surveillance and compliance monitoring functions. Surveillance monitoring results of the IEMP surface water and treated effluent program are used to assess the collective effectiveness of site storm water controls and wastewater treatment processes in preventing unacceptable impacts to the surface water and groundwater pathways. Compliance monitoring includes sampling at storm water and treated effluent discharge points and is conducted to comply with provisions in the NPDES permit, the FFCA, and the OU5 ROD. The data are routinely evaluated to identify any unacceptable trends and to trigger corrective actions when needed to ensure protection of these critical environmental pathways. Figure 4–2 depicts IEMP/NPDES surface water and treated effluent sample locations; Figure 4–3 shows IEMP background sample locations. In 2009, four new surface water sampling locations (SWD-10, SWD-11, SWD-12, and SWD-13) were added to the surface water monitoring program. These locations were added to monitor bodies of water near public access areas.

### 4.3.1 Surveillance Monitoring

**Treated effluent is discharged to the Great Miami River through the effluent line identified on Figure 4–2. Samples of the treated effluent are collected at the Parshall Flume (PF 4001). The resulting data are used to calculate the concentration of each FRL constituent after the effluent water mixes with the water in the Great Miami River.**

Data resulting from 2009 semiannual sampling events were evaluated to provide surveillance monitoring of site activities. This evaluation indicated that during 2009, 32 surface water analytical results from established sampling locations exceeded the surface water FRL for total uranium. Three results from SWD-05 and 29 results from SWD-09 exceeded the surface water FRL for total uranium. SWD-05 and SWD-09 are surface water monitoring points established to monitor the area west of the former waste pits where elevated surface water uranium concentrations have been detected in the past. There were no exceedances of total uranium in any of the treated effluent samples, and there were no non-uranium FRL exceedances.

The following two key sample locations represent points where surface water or treated effluent leaves the site:

- Paddys Run at the Willey Road property boundary (surface water sample location SWP-03).
- PF 4001 is located at the entry point of the treated effluent line leading to the Great Miami River.

There were no exceedances of the surface water FRLs during 2009 at these two locations.

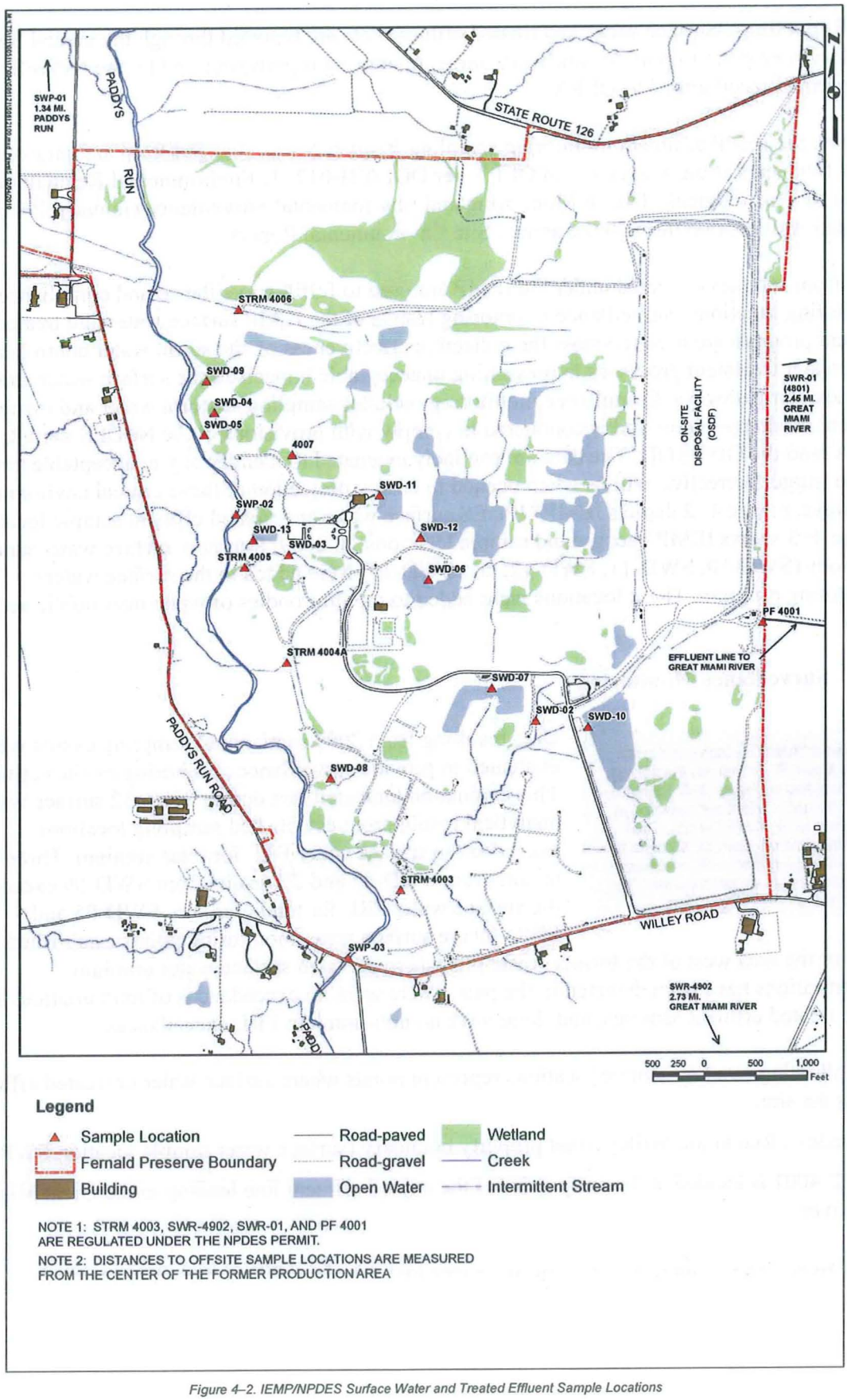


*Figure 4–2. IEMP/NPDES Surface Water and Treated Effluent Sample Locations*

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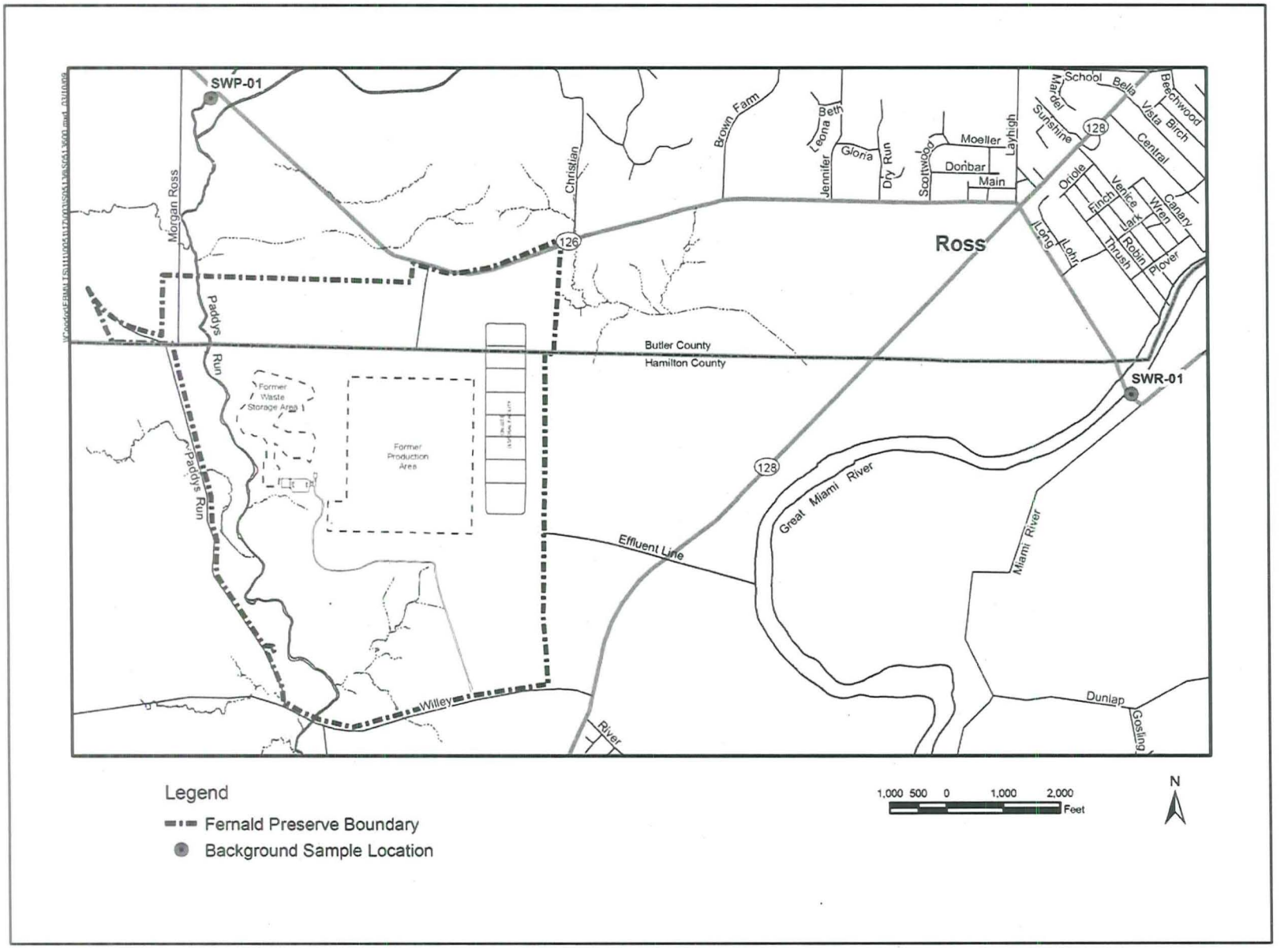


*Figure 4–3. IEMP Background Surface Water Sample Locations*

The maximum total uranium concentration at SWP-03 during 2009 was 2.97 µg/L, well below the surface water total uranium FRL of 530 µg/L. Figure 4–4 shows the annual average total uranium concentration in Paddys Run at Willey Road for the period 1985 through 2009. This figure illustrates the decrease of the total uranium concentration in Paddys Run from 1986.

Samples collected at PF 4001 are used in the surveillance evaluation because this is the last point where treated effluent is sampled prior to discharge to the Great Miami River. The maximum daily total uranium concentration at PF 4001 in 2009 was 34.3 µg/L, well below the surface water total uranium FRL of 530 µg/L. Data collected from this location cannot directly be compared to the surface water FRL without considering the effect of the effluent waters mixing with the Great Miami River. This comparison is done through the use of a mixing equation when constituents exceed the FRL. After the actual flow rate in the Great Miami River and the discharge flow rate in which this maximum uranium concentration was observed were accounted for, the resulting concentration in the river was estimated to be 2.71 µg/L.

Evaluation of surface water data is also performed to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer. In areas where there is no glacial overburden, a direct pathway exists for contaminants to reach the aquifer. This contaminant pathway to the aquifer was considered in the design of the groundwater remedy. The groundwater remedy includes placing groundwater extraction wells downgradient of these areas where direct infiltration occurs in order to mitigate any potential cross-media impacts during surface remediation. To provide this assessment, sample locations were selected to evaluate contaminant concentrations in surface water just upstream of, or within, those areas where site drainages have eroded through the protective glacial overburden. The locations are SWP-02, SWD-02, SWD-03, SWD-04, SWD-05, SWD-07, SWD-08, and STRM 4005.

In 2009 surface water cross-media impact locations STRM 4005, SWD-04, SWD-05, SWD-08 had sample results that exceeded the total uranium groundwater FRL of 30 µg/L. Additional details of the FRL exceedances are presented in Appendix B, Attachment B.1.

### 4.3.2 Compliance Monitoring

#### 4.3.2.1 FFCA and OU5 ROD Compliance

The Fernald Preserve is required to monitor treated effluent discharges at PF 4001 for total uranium mass discharges and total uranium concentrations. This requirement is identified in the July 1986 FFCA and the OU5 ROD. The OU5 ROD requires treatment of effluent so that the mass of total uranium discharged to the Great Miami River through PF 4001 does not exceed 600 lb (272 kg) per year. The OU5 ROD (DOE 1996) and the subsequent *Explanation of Significant Differences for Operable Unit 5* (DOE 2001d) also require that the monthly average total uranium concentration in the effluent must be at or below 30 µg/L.

Figure 4–5 shows that the cumulative mass of total uranium discharged to the Great Miami River during 2009 was 586 lb (266 kg), which is below the annual discharge limit of 600 lb (272 kg). Figure 4–6 shows that the monthly average total uranium concentration was below the 30 µg/L limit every month during 2009.

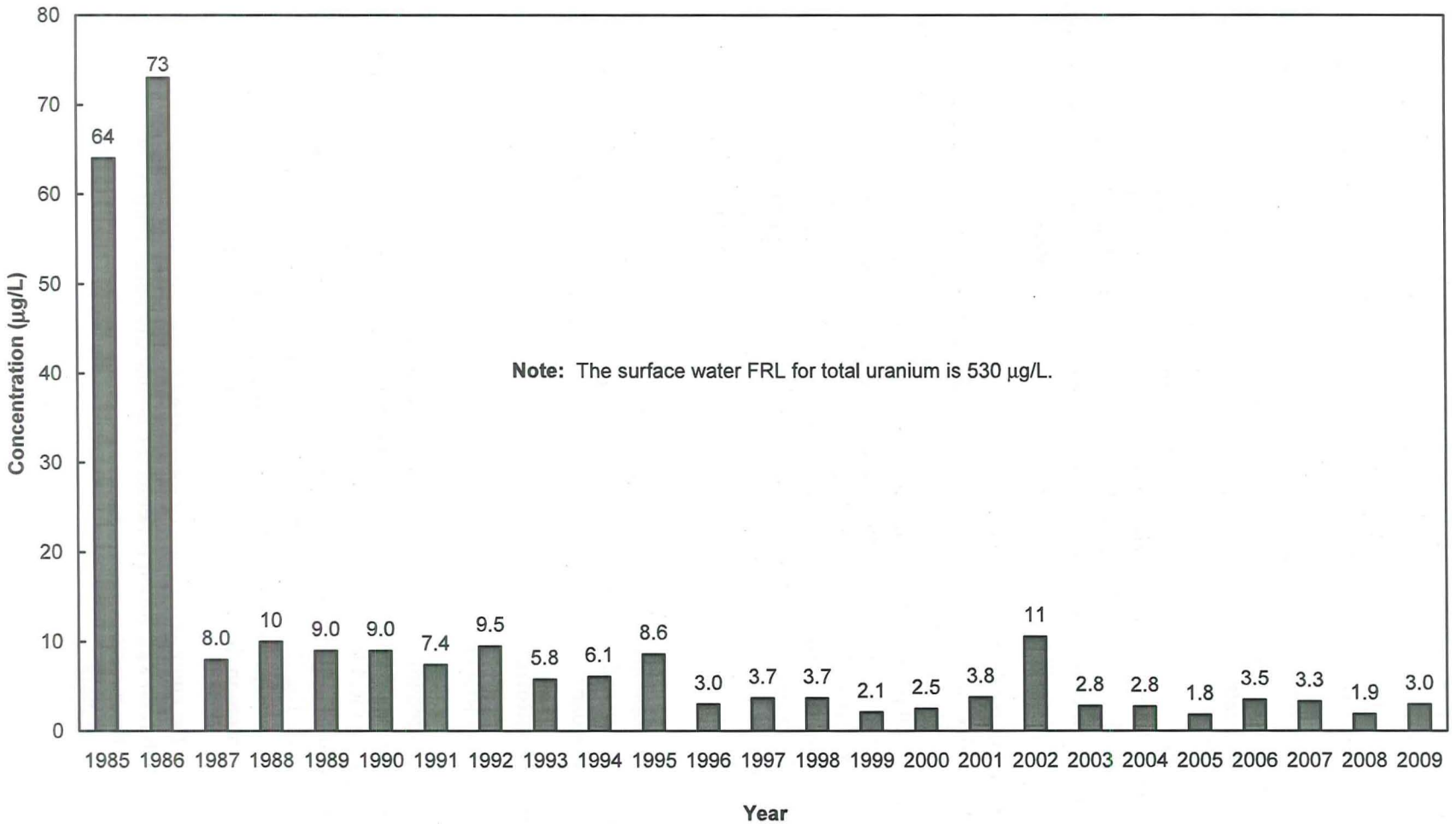


*Figure 4–4. Annual Average Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03) Sample Location, 1985–2009*

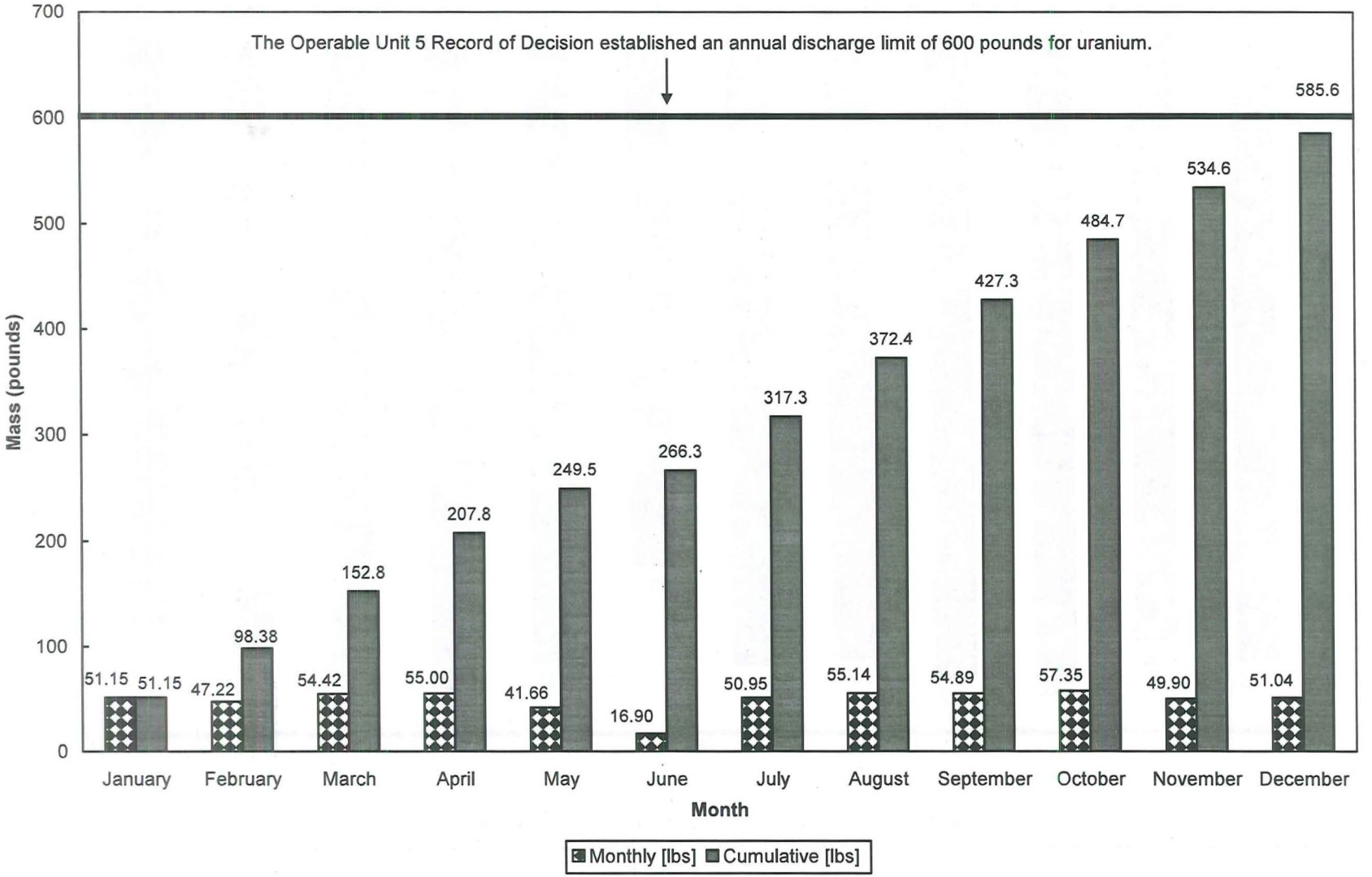


*Figure 4–5. Pounds of Uranium Discharged to the Great Miami River through the Parshall Flume (PF 4001) in 2009*

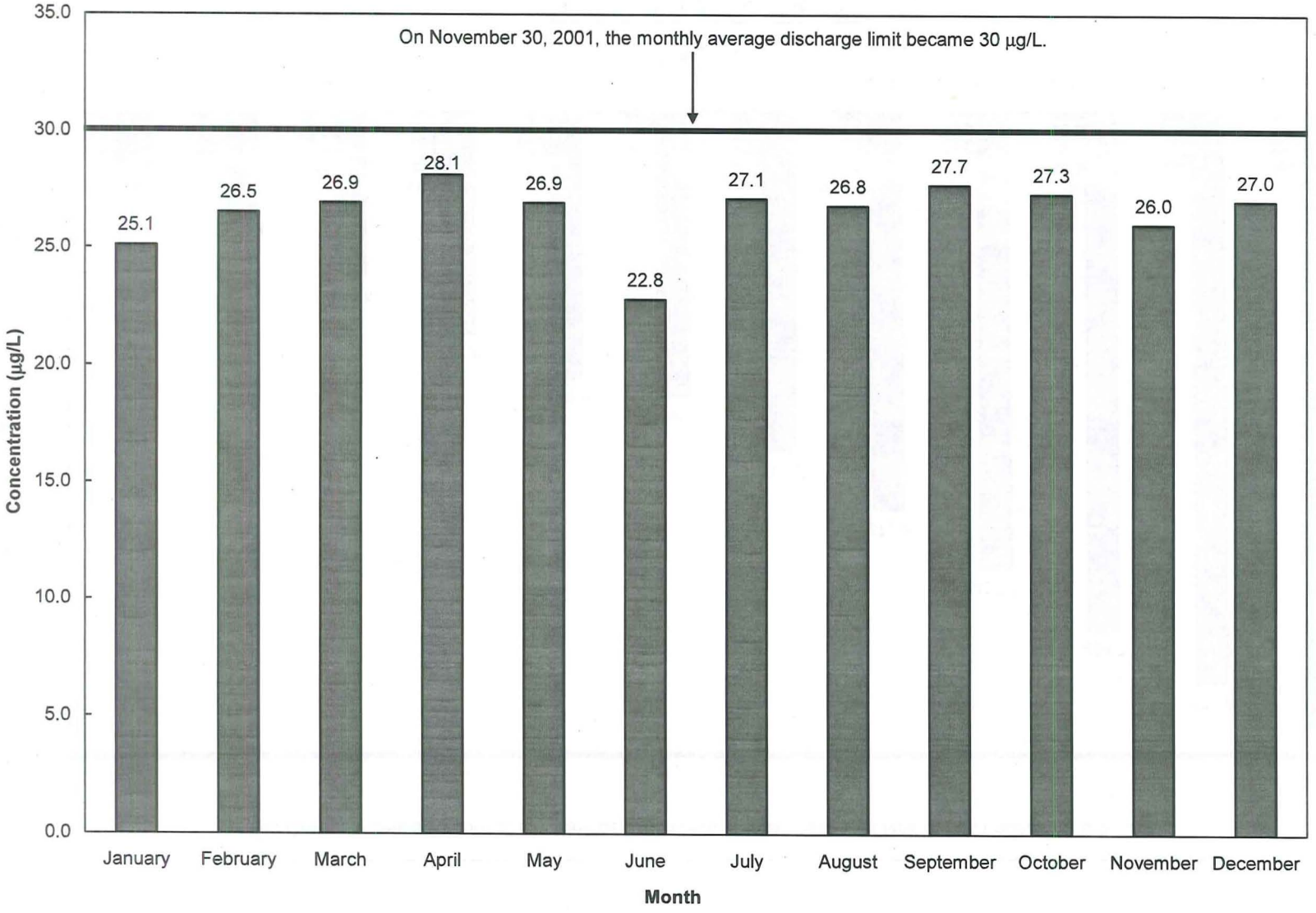


*Figure 4–6. 2009 Monthly Average Total Uranium Concentration in Water Discharged Through the Parshall Flume (PF 4001) to the Great Miami River*

#### 4.3.2.2 NPDES Permit Compliance

Compliance sampling, consisting of sampling for nonradiological pollutants from uncontrolled runoff and treated effluent discharges from the Fernald Preserve, is regulated under the state-administrated NPDES program. A new permit was received from OEPA on April 1, 2009, and is effective until March 31, 2014. There were no incidents of NPDES noncompliance in 2009.

### 4.3.3 Uranium Discharges in Surface Water and Treated Effluent

As identified in Figure 4–5, 586 lb (266 kg) of uranium in treated effluent were discharged to the Great Miami River through PF 4001 in 2009. In addition to the treated effluent, uncontrolled runoff is also contributing to the amount of uranium entering surface water. Figure 4–7 presents the pounds of uranium from the uncontrolled runoff and controlled discharges from 1993 through 2009.

A loading term is used to estimate the pounds of uranium discharged to Paddys Run via uncontrolled runoff. This loading term was revised and approved in August 2004 based on total uranium data, which reflect the decreasing total uranium concentrations measured at points discharging to Paddys Run. Total uranium concentrations measured in Paddys Run were decreasing through remediation as a result of significant improvements in the capture of contaminated storm water and should remain low now that soil remediation has been completed. The loading term is 2.1 lb of uranium per inch of rainfall.

During 2009, 37.35 inches (94.87 cm) of precipitation fell at the Fernald Preserve; therefore, an estimated 78.4 lb (35.6 kg) of uranium entered the environment through uncontrolled runoff.

The estimated total amount of uranium discharged to the surface water pathway for the year, including controlled treated effluent discharges and uncontrolled runoff, was approximately 664 lb (301 kg).

## 4.4 Sediment Monitoring

In 2009, the IEMP sediment monitoring sampling frequency was changed from annual to once every five years at the suggestion of OEPA per DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (January 1991). Sediment is a secondary exposure pathway and is monitored to assess the impact of remediation activities on sediments deposited along surface water drainages. Sediment samples are collected at strategic locations in the Great Miami River (i.e., upgradient and downgradient of the effluent line). In 2009, the downstream location was moved to the opposite side of the river and closer to the effluent line because of accessibility issues with the old downstream location. The new location is designated G10. Sediment samples analyzed for total uranium were collected in October 2009 at two locations in the Great Miami River (Figure 4–8). Table 4–1 presents the 2009 results, which show that all uranium results were below the sediment FRL of 210 milligrams per kilogram (mg/kg). Appendix B, Attachment B.2 contains additional details of the sediment monitoring results.

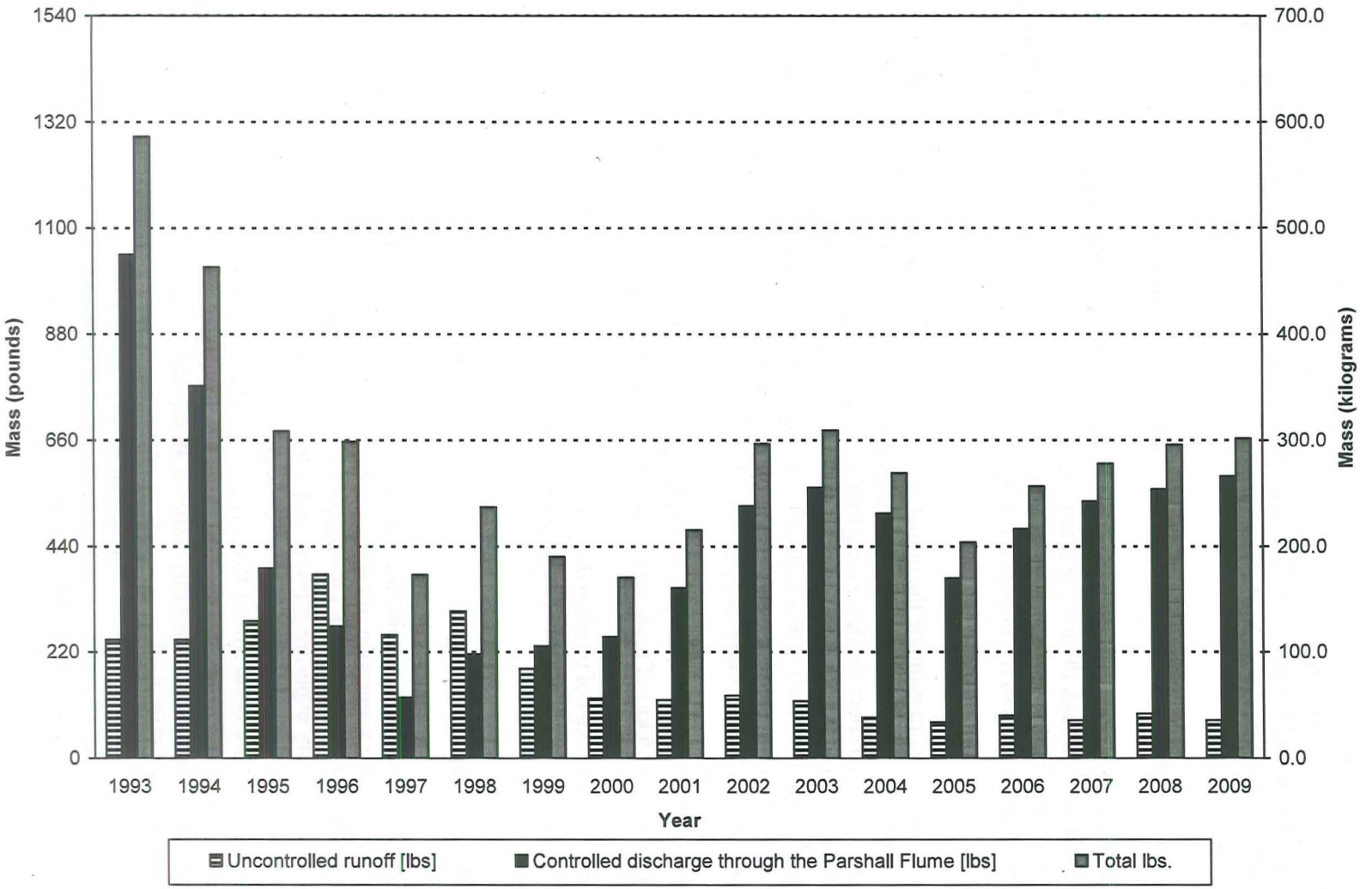


*Figure 4–7. Uranium Discharged via the Surface Water Pathway, 1993–2009*

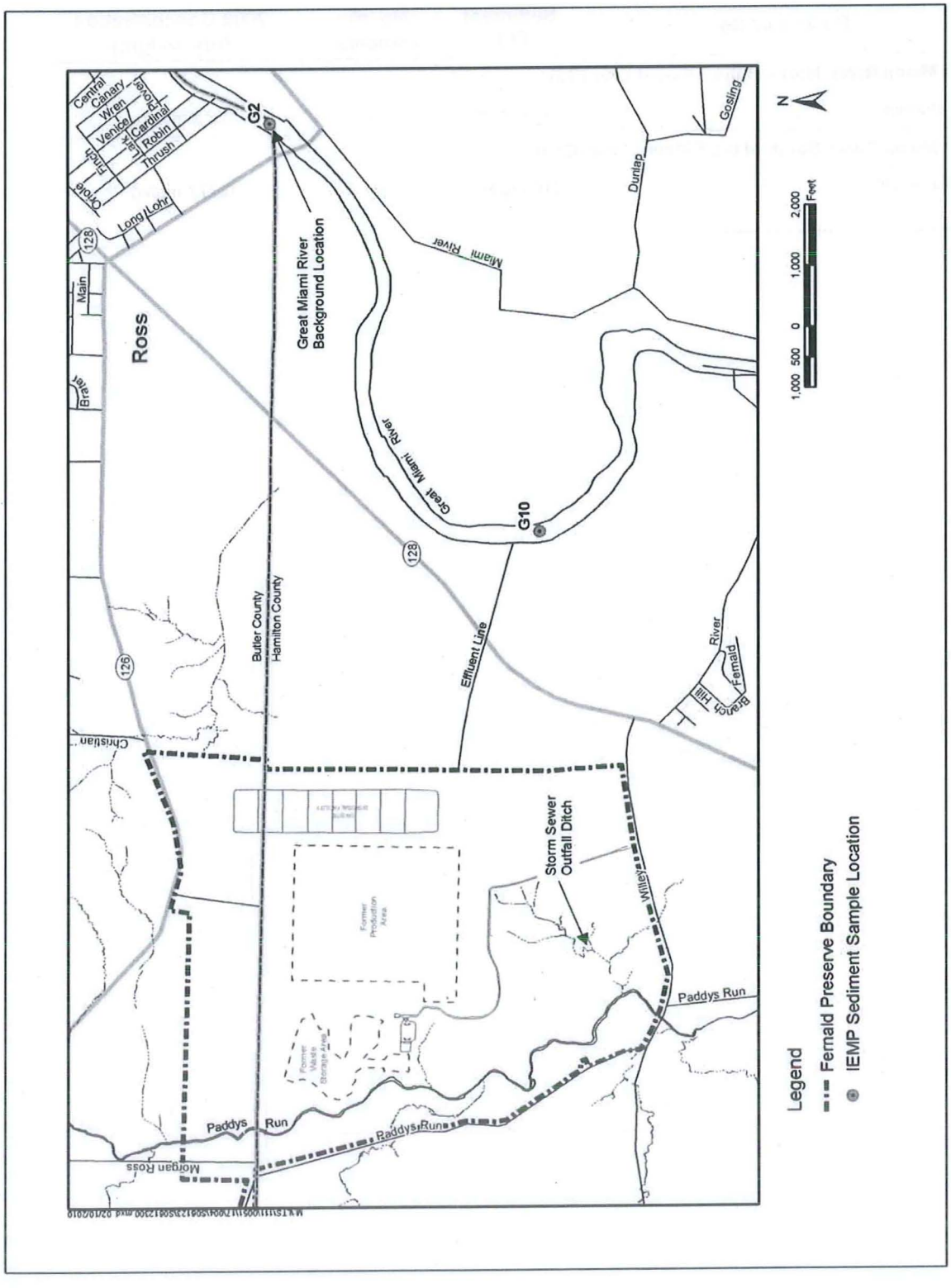


*Figure 4–8. 2009 Sediment Sample Locations*

*Table 4–1. 2009 Summary Statistics for the Sediment Monitoring Program*

| Radionuclide | Sediment FRL | No. of Samples | 2009 Concentration (dry weight) |
|---|---|---|---|
| **Great Miami River, North of the Effluent Line (G2)** | | | |
| Total Uranium | 210 mg/kg | 1 | 0.625 mg/kg |
| **Great Miami River, South of the Effluent Line (G10)** | | | |
| Total Uranium | 210 mg/kg | 1 | 0.777 mg/kg |

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# 5.0 Air Pathway

This chapter describes the air-pathway monitoring program used to track and evaluate airborne emissions from the Fernald Preserve. It includes a discussion of radiological air particulates and direct radiation.

**Results in Brief: 2009 Air Pathway**

**Radiological Air Particulates**—Data collected from the site boundary AMSs show that average concentrations for each radionuclide monitored were less than 1 percent of the corresponding DOE derived concentration guide.

**Direct Radiation**—2009 direct radiation measurements at the site boundary were similar to those measured in 2008. The maximum measured annual dose at the site boundary was 9 mrem above background.

Air-pathway monitoring focuses on airborne pollutants carried from the site as particles or gas and how these pollutants are distributed in the environment. The physical form and chemical composition of pollutants influence their dispersal in the environment and the delivered radiation dose. For example, fine particles and gases remain suspended, while larger, heavier particles tend to settle and deposit on the ground. Chemical properties determine whether the pollutant will dissolve in water, be absorbed by plants and animals, or remain in sediment and soil.

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. Therefore, the number of air monitoring stations (AMSs) was decreased from 17 to 11 in April 2006 (DOE 2006c) and from 11 to 6 in November 2006 (DOE 2006d). The six remaining monitors are located at five boundary locations and one background location (Figure 5–1). They have been used to demonstrate that wind erosion of the remediated soil and air emissions from controlled burns (conducted in 2009) pose no significant threat to the public or the environment. An evaluation of the data collected from the air monitoring stations during the past three years demonstrates that radiological concentrations in air remain low (i.e. at or near background). Based on the data indicating emissions are at or near background and the determination by EPA Office of Air and Radiation that three years of air monitoring following closure was appropriate, DOE ended the boundary air monitoring program January 4, 2010.

The site's air monitoring approach (presented in the IEMP) provides an ongoing assessment of the particulate emissions originating from wind erosion of soil, as well as direct radiation levels at the site boundary, hiking trails, and the Visitors Center. Results of the 2009 assessment indicate that particulate and direct-radiation measurements remain at the low levels observed in 2008, which reflects the absence of any significant surface contamination source on the Fernald Preserve.

## 5.1 Activities Affecting the Air Pathway

As the mission of the Fernald Preserve changed from production to remediation to wildlife preserve, work activities also changed. This change in work scope altered the characteristics of sources that emit pollutants in the environment via the air pathway. During the production years, the primary emission sources were point sources (i.e., stacks and vents) from process facilities. During remediation, the dominant emission sources were associated with construction activities in the form of fugitive emissions (i.e., excavation, hauling and processing of waste and contaminated soil, demolition of production facilities, and general activities supporting the remediation process) and the storage of radon-generating waste materials.

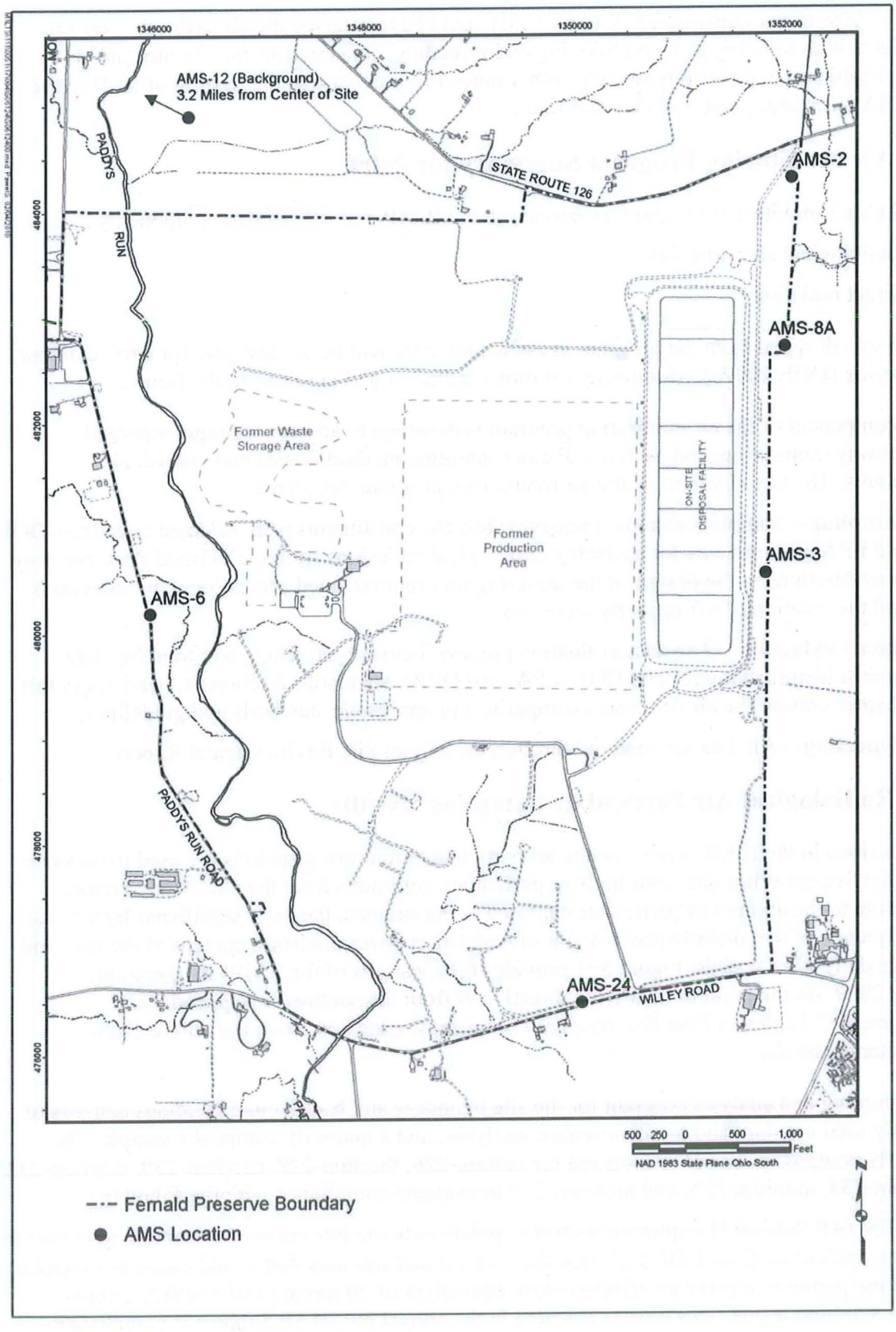


*Figure 5–1. Radiological AMS Locations*

During 2009, minor construction activities that could have affected the air pathway were those associated with mowing, soil conditioning and reseeding, construction and maintenance of hiking trails, and controlled burns. One other noteworthy event was the nesting of birds in the AMS-8A air monitor station (May and June).

## 5.2 Air Monitoring Program Summary for 2009

The site's air monitoring program, as defined in the IEMP, consists of two components:

- Radiological air particulate
- Direct radiation

Radon was dropped from the program in 2008, and 2009 will be the last year for particulate air monitoring (DOE 2009b). Monitoring for direct radiation will continue in the future.

Each component of the air monitoring program is designed to address a unique aspect of air-pathway monitoring, and each has distinct sampling methodologies and analytical procedures. The key elements of the air monitoring program design are:

- **Sampling**—Sample locations, frequency, and the constituents were selected to address DOE and EPA requirements for assessing radiological emissions from the Fernald Preserve. Key considerations in the design of the sampling program included prevailing wind directions and the location of off-property receptors.
- **Data Evaluation**—The data evaluation process focuses on tracking and trending data against historical ranges and DOE, EPA, and OEPA standards. Sections 5.3 and 5.4 in this chapter present the air data and a comparison to applicable standards and guidelines.
- **Reporting**—All data are reported through the annual Site Environmental Report.

## 5.3 Radiological Air Particulate Sampling Results

As described in the IEMP, high-volume air particulate monitoring stations are used to measure the collective contributions from fugitive particulate emissions from the site. Many factors contribute to the amount of particulate captured at the stations; the most significant factors are the frequency of soil disturbance, amount of vegetation cover, moisture content of the soil, and average daily wind speeds. Figure 5–1 provides the locations of the AMSs in operation during 2009. As the predominant wind direction is from the southwest (Appendix C, Attachment C.3), three of the five boundary monitors are located along the northeastern perimeter of the site.

The sampling and analysis program for the site boundary and background locations consists of monthly total uranium and total particulate analyses, and a quarterly composite sample. The quarterly composite sample is analyzed for radium-226, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238 to evaluate compliance with the following:

- NESHAP Subpart H requirements that stipulate radionuclide emissions (excluding radon) to the ambient air from DOE facilities shall not exceed amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem/yr (0.1 mSv/yr) above background levels. This dose is reported in the annual NESHAP Subpart H compliance report, which is attached as Appendix D.

- DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, guidelines for concentrations of radionuclides in air emissions. These guidelines, referred to as derived concentration guide values, are concentrations of radionuclides that, under conditions of continuous exposure for one year by one exposure mode (e.g., inhalation or ingestion), would result in a dose of 100 mrem (1.0 mSv) to the public. These derived concentration guide values are not limits, but serve as reference values to assist in evaluating the radiological air particulate data.

Table 5–1 presents a summary of the minimum, maximum, and average concentrations for total uranium and total particulate in 2009 and 2008, as based on monthly samples. The 2009 maximum values for uranium and particulate are slightly lower than the 2008 maximums. At the five boundary stations, uranium ranged from $4.2 \times 10^{-6}$ to $20 \times 10^{-6}$ picocuries per cubic meter (pCi/m$^3$), which is much less than 1 percent of the DOE derived concentration guide value of $100{,}000 \times 10^{-6}$ pCi/m$^3$. Total particulate concentrations at the boundary ranged from 7.6 to 47 micrograms per cubic meter (µg/m$^3$). There are no general or site-specific regulatory limits associated with total particulate measurements.

*Table 5–1. Summary of Total Uranium Activity and Particulate Concentrations in Air*

| Location | 2009 Total Uranium (pCi/m$^3$) | 2008 Total Uranium (pCi/m$^3$) | 2009 Total Particulate (µg/m$^3$) | 2008 Total Particulate (µg/m$^3$) |
|---|---|---|---|---|
| **Boundary Locations** | | | | |
| Minimum | $4.2 \times 10^{-6}$ | $5.1 \times 10^{-6}$ | 7.6 | 4.0 |
| Maximum | $20 \times 10^{-6}$ | $77 \times 10^{-6}$ | 47 | 65 |
| Average | $10 \times 10^{-6}$ | $13 \times 10^{-6}$ | 23 | 26 |
| **Background Location** | | | | |
| Minimum | $7.8 \times 10^{-6}$ | $8.1 \times 10^{-6}$ | 15 | 17 |
| Maximum | $12 \times 10^{-6}$ | $13 \times 10^{-6}$ | 42 | 44 |
| Average | $9.2 \times 10^{-6}$ | $11 \times 10^{-6}$ | 24 | 26 |

Figure 5–2 shows total uranium variation at the boundary and background locations. Monthly results for 2009 are shown with the reported analytical uncertainty plotted as error bars. June and July samples for AMS-8A have no uranium or particulate results, as the samples were fouled by nesting birds, and DOE and OEPA concluded the results were invalid. Measurement uncertainty indicates that most monthly results for the boundary monitors slightly exceed the uranium activity measured at the background location. However, the measured uranium activity at the boundary is much less than the DOE derived concentration guidance value ($100{,}000 \times 10^{-6}$ pCi/m$^3$). Additional statistical analysis and graphical displays of the 2009 data are provided in Appendix C, Attachment C.1.

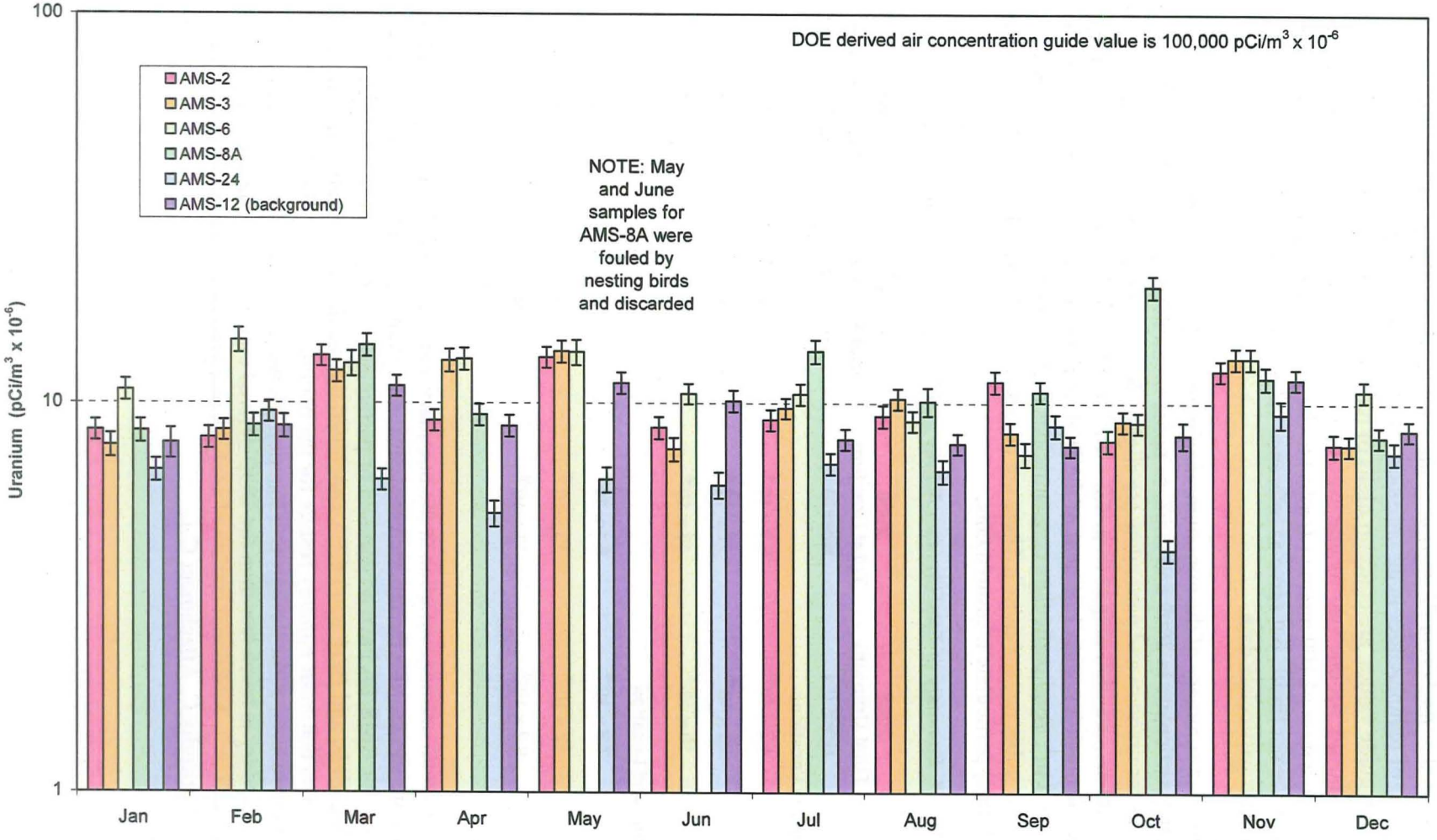


*Figure 5–2. Monthly Results and Measurement Error for Uranium in Collected Air Particulate*

In 2009, the quarterly composite samples were formed for each monitor from the monthly samples and analyzed for radium-226, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238. As noted above, June and July samples (representing the months of May and June) from AMS-8A were fouled by nesting birds and results are not reported. Therefore, the second-quarter sample for AMS-8A was a single sample from the month of April.

Figure 5–3 plots the annual activity and uncertainty for the quarterly results to show that boundary results are similar to background, with the exception of a lower thorium-228 and uranium-234 activity for AMS-24. Appendix C, Attachment C.1 presents the complete annual summary for the data, and Appendix D documents that the results are in compliance with the NESHAP 10 mrem/yr (0.1 mSv/yr) dose limit (the maximum dose for 2009 is 0.034 mrem/yr [0.00034 mSv/yr] at AMS-6).

## 5.4 Monitoring for Direct Radiation

Direct radiation originates from sources such as cosmic radiation, naturally occurring radionuclides in soil and food, and anthropogenic radioactive materials. Gamma rays and X-rays are the dominant types of radiation that create a public exposure concern because they penetrate into the deep tissues of the body. The largest historical source of direct radiation at the Fernald Preserve was waste material associated with the Silos Project. The last waste material associated with the Silos Project was removed from the site in 2006. Presently, there are no significant sources for direct radiation at the Fernald Preserve. During 2009, direct radiation levels at the Fernald Preserve were continuously measured at four trail locations, the Visitors Center, five boundary locations, and one background location with optically stimulated luminescence (OSL) dosimeters. The background location is located 3.2 miles from the center of the Fernald Preserve (Figure 5–4). The energy response of the OSL dosimeters is different from that of the thermoluminescent dosimeters (TLDs) used in previous years, which accounts for the difference in absolute values for each detector. However, the difference between the background and boundary monitors is similar for both types of detectors, and this difference (dose above background) is used to assess receptor dose.

Table 5–2 provides the annual range of direct radiation measurements for 2009 and 2008, and Figure 5–5 illustrates the quarterly results for 2009. Each quarterly result represents the average of three measurements obtained from three separate dosimeters placed at each location (except for the fourth quarterly result for OSL-52 because two of the three dosimeters were stolen). In general, the first-quarter results were slightly less than other quarters. On the basis of background results, most results are slightly higher, and the Visitors Center results are lower due to the shielding provided by the building materials. However, as noted in Appendix C, Attachment C.2, the boundary measurements are similar to background when statistical variability is evaluated, which is in agreement with removal of the last direct radiation sources in 2006. This observation should be noted when reviewing the dose assessment presented in Chapter 6 and Appendix D (i.e., there is no significant dose associated with direct radiation).

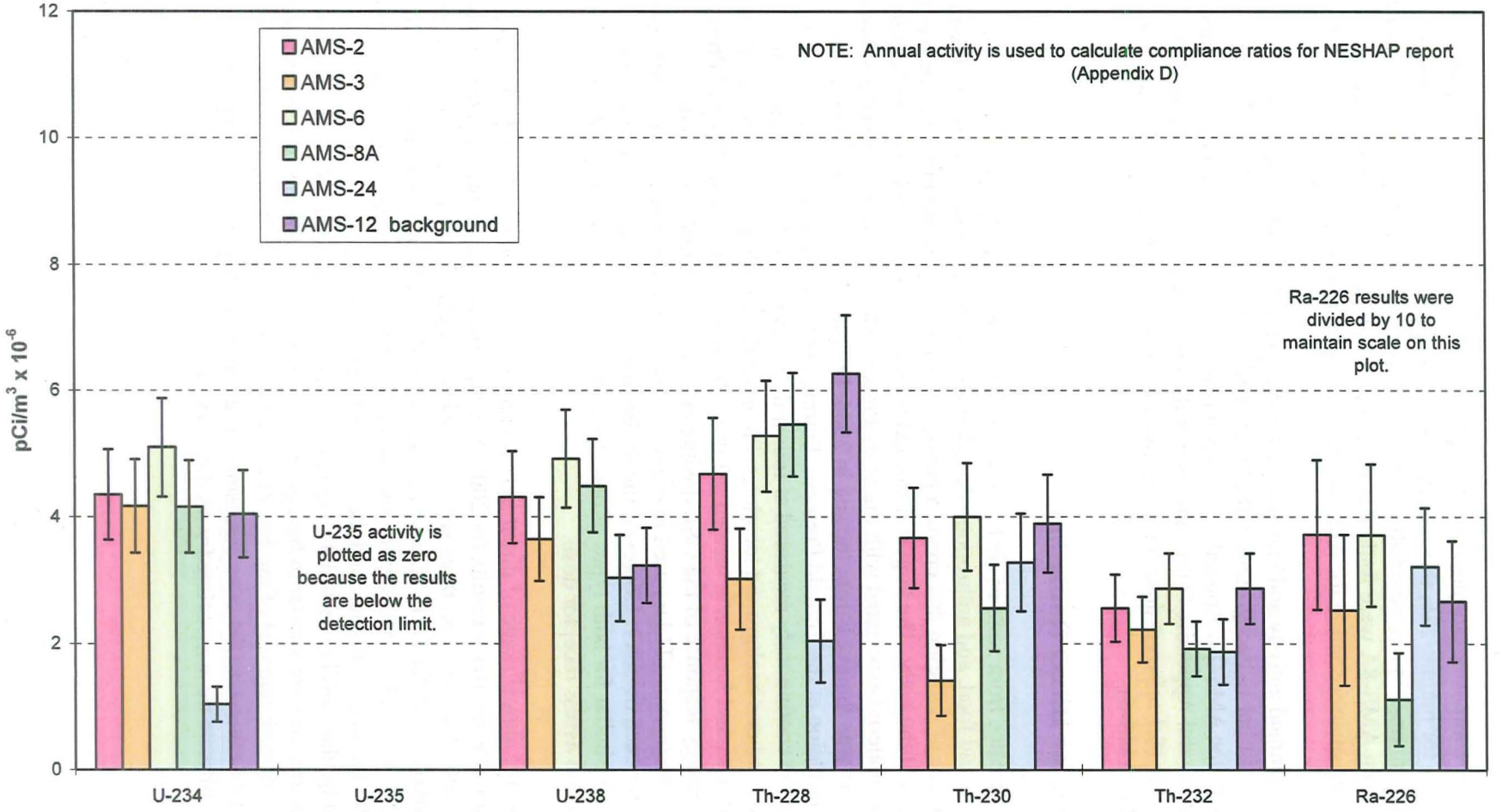


*Figure 5–3. Annual Activity and Uncertainty for Isotopes Used in NESHAP Analysis*

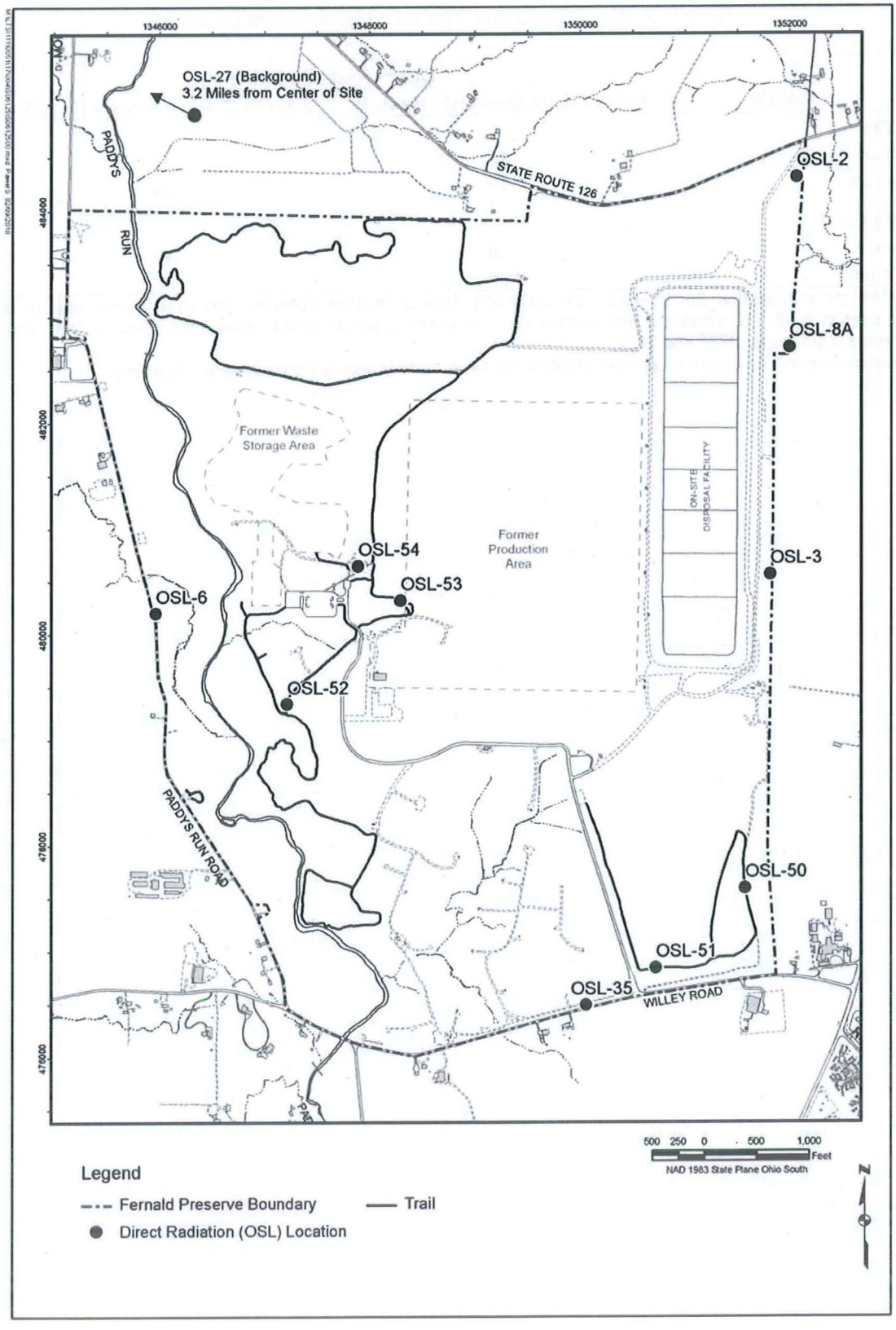


*Figure 5–4. Direct Radiation (OSL) Monitoring Locations*

*Table 5–2. Direct Radiation (OSL/TLD) Measurement Summary*

| Location | Direct Radiation (mrem) | |
|---|---|---|
| | Sum of 2009 Quarterly Results[a] | Sum of 2008 Quarterly Results |
| **On Site** | | |
| Minimum | 20 | 48 |
| Maximum | 29 | 54 |
| **Background[b]** | | |
| Minimum | 20 | 48 |
| Maximum | 20 | 48 |

[a]2009 values are less than 2008 because the 2009 OSL dosimeters have a different energy response, relative to TLDs used in 2008. The difference between background and boundary is used to assess the receptor dose, and this difference is similar for 2008 and 2009.
[b]The minimum and maximum results are identical because there is only one background dosimeter.

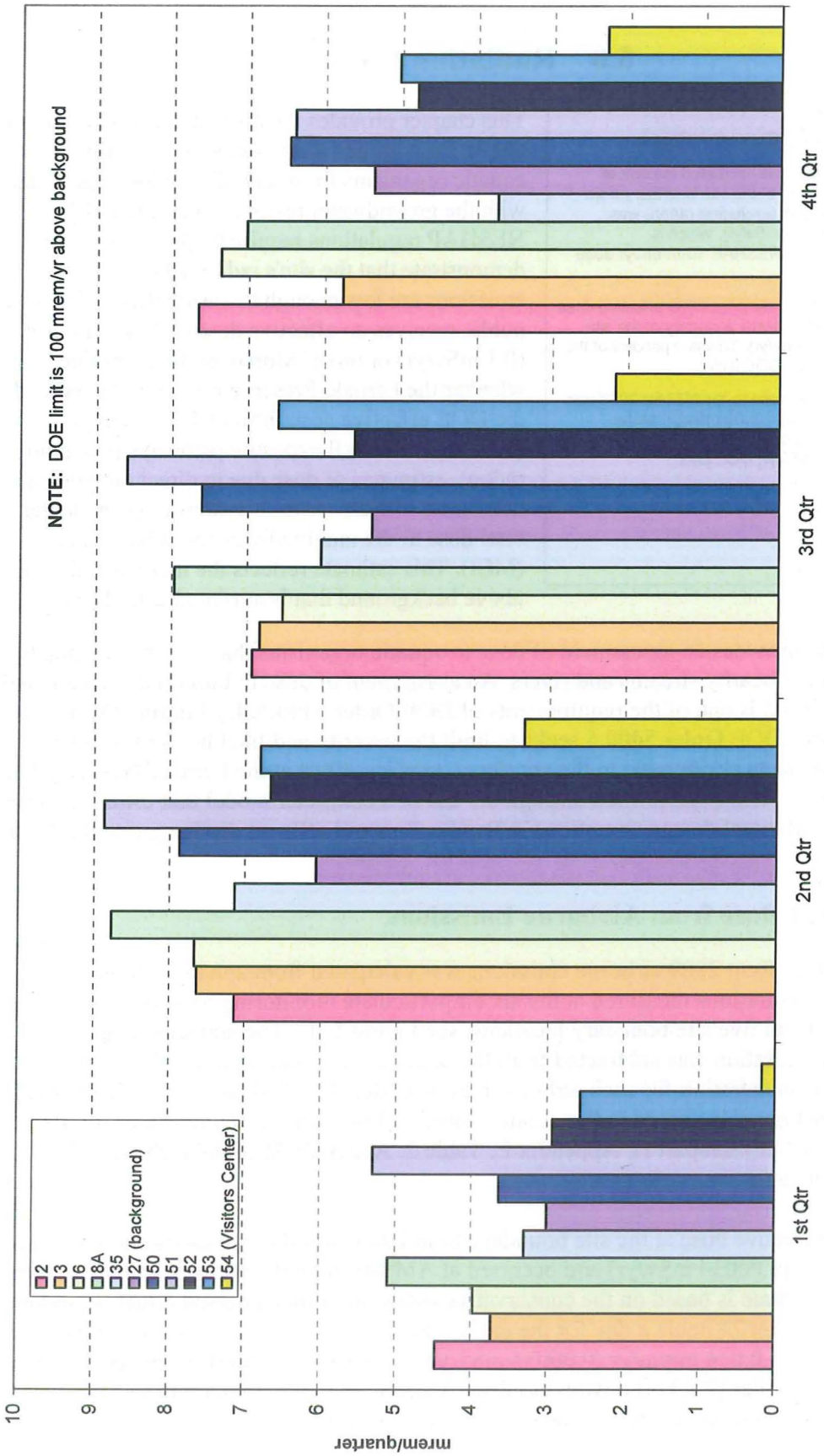


*Figure 5–5. Quarterly Results for OSL Monitoring Locations*

# 6.0 Radiation Dose

**Results in Brief: 2009 Estimated Doses**

**Airborne Emissions**—The estimated maximum effective dose equivalent at the site boundary from 2009 airborne emissions (excluding radon) was 0.034 mrem/yr (0.00034 mSv/yr), which is 0.34 percent of the EPA NESHAP 10-mrem/yr dose limit.

**Direct Radiation**—The estimated 2009 effective dose equivalent at the northeastern boundary of the site was 9 mrem/yr (0.09 mSv/yr). This is 9 percent of the 100-mrem/yr (1-mSv/yr) DOE limit.

**Dose to the MEI**—The dose to the MEI for 2009 was estimated to be 9 mrem/yr (0.09 mSv/yr) at the northeastern boundary of the site. This is 9 percent of the 100-mrem/yr (1-mSv/yr) DOE limit.

This chapter provides the estimated 2009 dose to the public from air and direct radiation pathways and to aquatic organisms from remedial actions associated with the groundwater restoration program. EPA NESHAP regulations require the Fernald Preserve to demonstrate that the site's radionuclide airborne emissions are low enough to ensure that no one in the public receives an effective dose of 10 mrem/yr (0.1 mSv/yr) or more. Moreover, to determine whether the Fernald Preserve is in compliance with the DOE effective dose limit of 100 mrem/yr (1 mSv/yr) from all exposure pathways (excluding radon), estimates of dose due to direct radiation are combined with airborne emissions to estimate the total dose to the maximally exposed individual (MEI). This estimate reflects the incremental dose above background that is attributable to the site.

This chapter also provides an assessment of dose to aquatic organisms that may be affected by the site's effluent to nearby streams and rivers. An assessment of dose to biota (i.e., aquatic and terrestrial organisms) is one of the requirements of DOE Order 5400.5. By limiting the dose to aquatic organisms, DOE Order 5400.5 seeks to limit the severity and likelihood of off-site environmental impacts attributable to the aquifer restoration effort at the Fernald Preserve. The dose assessment to biota is performed through the use of a computer model that estimates dose from measured radionuclide concentrations in Paddys Run and effluent discharged to the Great Miami River.

## 6.1 Estimated Dose from Airborne Emissions

The estimated dose from 2009 airborne emissions was calculated from annual average radionuclide concentrations measured at the six air particulate monitoring locations (one background and five site boundary locations; see Figure 5–1). The annual average background concentration was subtracted from the boundary concentrations to derive the net annual average concentration for each airborne radionuclide. Dose estimates were determined by converting the net annual average radionuclide concentrations to doses using values listed in 40 CFR 61 (NESHAP) Subpart H, Appendix E, Table 2. Appendix D contains the detailed accounting of the data.

The maximum effective dose at the site boundary from 2009 airborne emissions was estimated to be 0.034 mrem/yr (0.00034 mSv/yr) and occurred at AMS-6 along the western boundary of the site. This dose estimate is based on the conservative assumption that a person remains outdoors at the AMS-6 location 24 hours a day for the entire year; the actual dose received by this receptor would be lower than 0.034 mrem/yr (0.00034 mSv/yr), because the nearest residence is located approximately 1.5 miles (2.4 km) downwind from AMS-6. The 2009 maximum site boundary dose is slightly higher than the 2008 value (0.017 mrem/yr [0.00017 mSv/yr]).

Figure 6–1 provides a comparison between the air-pathway doses at the background and maximum boundary locations with the annual NESHAP limit of 10 mrem/yr (0.1 mSv/yr). The background and maximum boundary doses shown on Figure 6–1 are due to the airborne concentration of radium, thorium, and uranium. The maximum air-pathway dose of 0.034 mrem/yr (0.00034 mSv/yr) is in addition to the background dose of 0.17 mrem/yr (0.0017 mSv/yr) and the maximum dose represents 0.34 percent of the annual NESHAP limit. Appendix D provides the estimated dose at every boundary air monitor.

A collective effective dose provides an aggregate measure of the impact of airborne emissions from the Fernald Preserve to the population in the area. The collective effective dose from 2009 airborne emissions (excluding radon) to the population within 50 miles (80 km) of the Fernald Preserve was estimated to be 0.014 person-rem (0.00014 person-sievert [person-Sv]) for a population of 2.7 million. The collective effective population dose for all pathways (air and direct radiation) was estimated to be 0.042 person-rem (0.00042 person-Sv). For comparison, background radiation from the sun and naturally occurring radionuclides in the earth and food products delivered an estimated collective effective dose of 300,000 person-rem (3,000 person-Sv) to the population within 50 miles of the Fernald Preserve.

## 6.2 Direct Radiation Dose

Direct radiation dose to deep tissue is primarily the result of gamma and X-ray emissions from radionuclides. The largest historical source of direct radiation at the site was the waste materials stored in the silos. This and all other significant surface radiation sources were removed from the site in 2006. Remaining surface sources for radiation are soil, which contains radium, thorium, and uranium isotopes at activities that are below the FRLs established in the OU5 ROD (DOE 1996), and small pieces of debris that are exposed by soil erosion.

In past years, an estimate of direct radiation dose was calculated for the resident living nearest the boundary location with the highest measurement. This dose was estimated by using the net measurement at the location and accounting for the distance between the boundary location and the residence, which lowered the direct radiation dose because dose decreases with distance from the radiation source. The boundary fence was removed in late 2006, and direct radiation is now assessed at the monitor location, because there is no fence to prevent an individual from standing at this location. Calculation of dose at the monitor location accounts for the higher doses in 2007 through 2009, relative to dose reported in the *Fernald Preserve 2006 Site Environmental Report* (DOE 2007).

From the data in Table 5–2, the maximum measurement is 29 mrem/yr (0.29 mSv/yr) at OSL-8, and the background dose is 20 mrem/yr (0.20 mSv/yr). The difference in the OSL dose between OSL-8 dosimeter and the background dosimeter is 9 mrem/yr (0.09 mSv/yr), which is assumed to be the direct radiation dose for a hypothetical individual who stands at OSL-8 for one year. This is a very conservative estimate of the dose, as an individual would not spend an entire year at OSL-8. Additionally, Appendix C, Attachment C.2 shows that the present measurements at the boundary are indistinguishable from background results when statistical variability is considered.

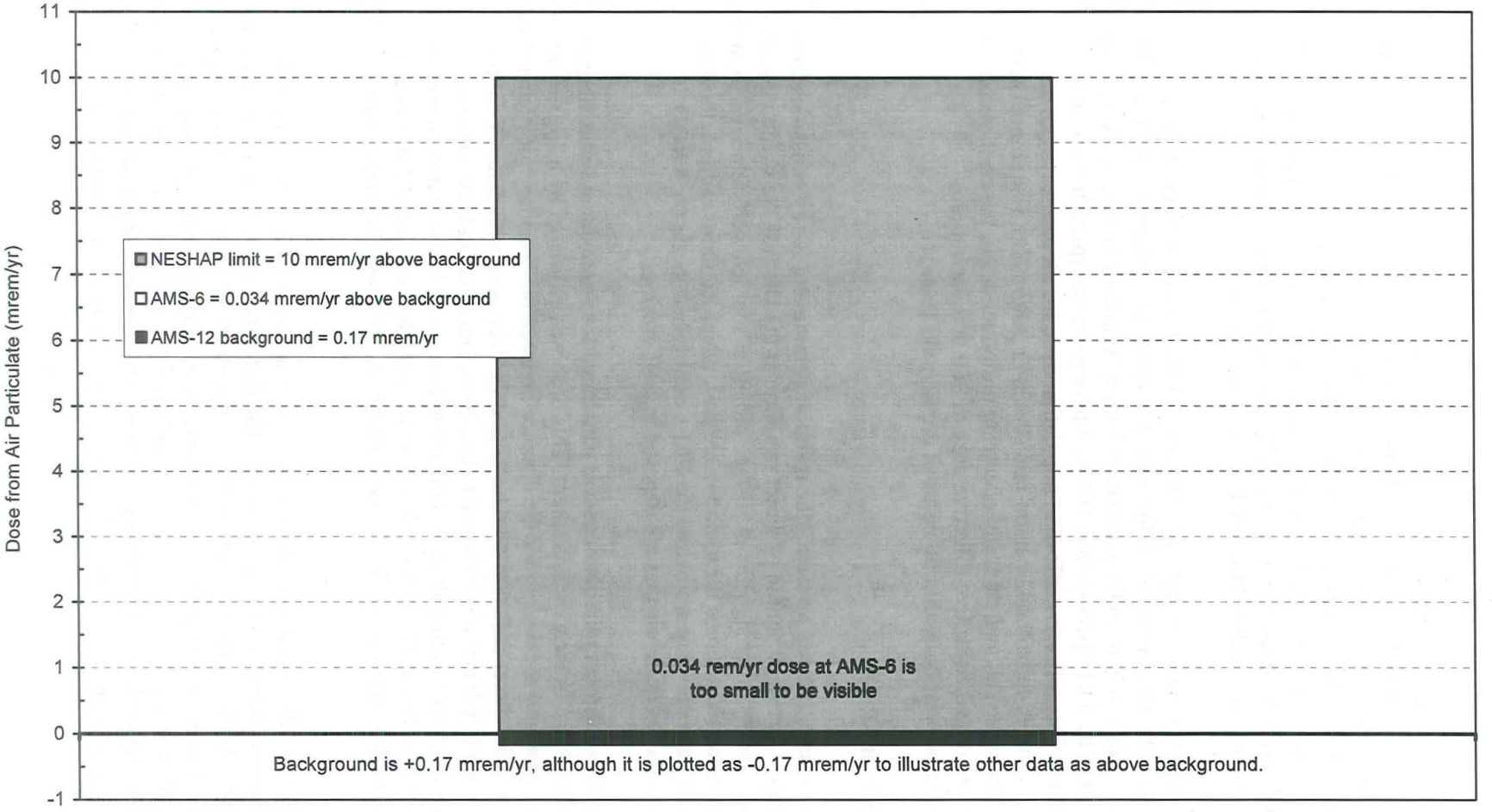


*Figure 6–1. Comparison of 2009 Air-Pathway Doses and Allowable Limits*

## 6.3 Total of Doses to the Maximally Exposed Individual

The MEI is the member of the public who receives the highest estimated effective dose based on the sum of the individual pathway doses. It is the maximum dose because the MEI is assumed to spend 24 hours a day, 365 days a year at the site boundary where maximum direct radiation and air dose are measured. As shown in Table 6–1, the 2009 dose to the MEI is 9 mrem/yr (0.09 mSv/yr) and represents the sum of the estimated doses from direct radiation and airborne emissions (excluding radon). The conservative assumptions used throughout the dose calculation process ensure that the dose to the MEI is the maximum possible dose any member of the public could receive.

*Table 6–1. Dose to MEI*

| Pathway | Dose Attributable to the Fernald Preserve | Applicable Limit |
|---|---|---|
| Direct radiation at OSL-8 | 9 mrem/yr | 100 mrem/yr (total for all pathways) |
| Airborne emissions at AMS-6 (excluding radon) | 0.034 mrem/yr | 10 mrem/yr (air pathway) |
| MEI[a] | 9 mrem/yr | 100 mrem/yr (total for all pathways) |

[a]MEI is the sum of direct radiation and particulate.

The contributions to this all-pathway dose are:

- 9 mrem/yr (0.09 mSv/yr) from direct radiation to a receptor standing at OSL-8, located near the northeastern boundary of the site.
- 0.034 mrem/yr (0.00034 mSv/yr) from air inhalation dose to a receptor standing at AMS-6, located near the western boundary of the site.

The estimate represents the incremental dose above background attributable to the Fernald Preserve, exclusive of the dose received from radon. (Radon monitoring was eliminated at the end of 2008 because it was at background levels.) Figure 6–2 provides a comparison between the average background radiation dose at the background location (20 mrem/yr [0.20 mSv/yr]) and the dose to the MEI (9 mrem/yr [0.09 mSv/yr]), relative to the annual DOE limit (100 mrem/yr [1 mSv/yr]).

## 6.4 Significance of Estimated Radiation Doses for 2009

One method of evaluating the significance of the estimated doses is to compare them with doses received from background radiation. Background radiation delivers an annual dose of approximately 100 mrem/yr (1 mSv/yr) from natural sources, excluding radon. For example, the dose received each year from cosmic and terrestrial background radiation contributes approximately 26 mrem/yr (0.26 mSv/yr) and 28 mrem/yr (0.28 mSv/yr), respectively. This sum (54 mrem/yr) is about three times greater than the direct radiation dose of 20 mrem/yr at the background location, and it is six times greater than the 9-mrem/yr-above-background dose estimated for the individual at OSL-8. The 100 mrem/yr per person background also includes dose from the ingestion of food and medical X-rays (about 46 mrem/yr), which is not

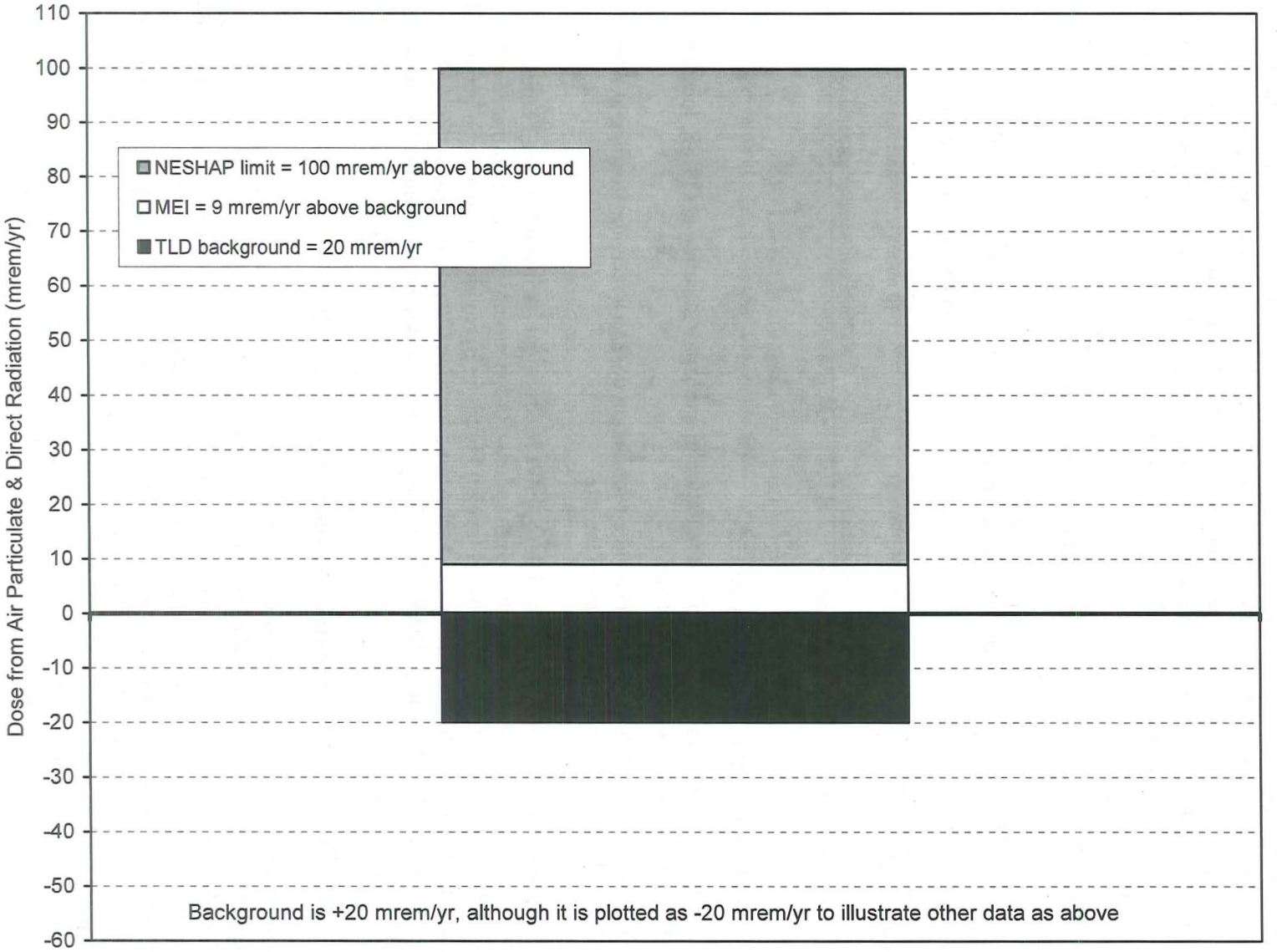


*Figure 6–2. Comparison of 2009 All-Pathway Doses and Allowable Limits*

recorded by the direct radiation OSLs at the boundary and background locations. In addition, the background radiation dose will vary in different parts of the country. Living in the Cincinnati, Ohio, area contributes an annual dose of approximately 110 mrem/yr (1.1 mSv/yr), whereas living in Denver, Colorado, increases the background to approximately 125 mrem/yr (1.25 mSv/yr) (NAS 1980, NCRP 1984).

Another method of determining the significance of the estimated dose is to compare it with dose limits developed to protect the public. The International Commission on Radiological Protection (ICRP) has recommended that members of the public receive less than 100 mrem/yr (1 mSv/yr) above background. As a result of this recommendation, DOE has incorporated 100 mrem/yr (1 mSv/yr) above background as the limit in DOE Order 5400.5. The sum of all estimated doses from 2009 site operations (9 mrem/yr [0.09 mSv/yr], excluding radon) is considerably below this limit (Figure 6–2).

## 6.5 Estimated Dose to Biota

DOE Order 5400.5 requires that populations of aquatic biota be protected at a dose limit of 1 rad/day (10 milligray per day [mGy/day]). 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.

In general, the dose and compliance assessment process involves comparing radionuclide concentrations measured in surface water or sediment samples to biota concentration guides (BCGs) established by researchers. The BCGs are set so that biota exposed at the BCG level would not be expected to exceed the biota dose limit of 1 rad/day (10 mGy/day) during a calendar year. The measured radionuclide concentration in water or sediment is divided by the appropriate BCG value, and if the resulting fraction is less than 1.0, compliance with the biota dose limit is demonstrated for that nuclide. BCGs have been established for radionuclides that are relatively common constituents in past releases to the environment from DOE facilities. At facilities such as the Fernald Preserve, where multiple contaminants (e.g., radium, thorium, and uranium) can be released, a "sum-of-the-fractions" rule applies. The sum-of-the-fractions rule means each radionuclide fraction (i.e., the measured concentration divided by the BCG for that nuclide) must be summed, and the sum of all nuclide fractions must be less than 1.0.

For 2009, compliance with the dose limit to aquatic biota was determined by using the maximum concentration of each radionuclide found in Paddys Run at Willey Road (SWP-03) and effluent discharged from PF 4001 to the Great Miami River (refer to Chapter 4). The maximum concentration in water delivered from the Parshall Flume and Paddys Run is multiplied by the annual volume of water discharged from the Parshall Flume and Paddys Run to obtain a net mass for each nuclide delivered to the Great Miami River. The net mass is divided by the sum of the discharge volumes and low-flow volume from the Great Miami River to derive input concentrations to the RAD-BCG computer model. The results of this assessment indicate that the sum of the fractions for radium, technetium, thorium, and uranium isotopes is 0.005, which is well below the compliance threshold value of 1.0. Appendix C, Attachment C.4 provides additional information on the biota dose assessment.

# 7.0 Natural Resources

This chapter provides background information on the natural resources associated with the Fernald Preserve and summarizes the activities in 2009 relating to these resources. Included in this chapter is a discussion of the following:

- Ecological restoration activities.
- Fernald Preserve site and OSDF inspections.
- Affected habitat areas.
- Threatened and endangered species.
- Cultural resources.

Much of the 1,050 acres (425 hectares) of the Fernald Preserve property is undeveloped land that provides habitat for a variety of animals and plants. Wetlands, deciduous and riparian (streamside) woodlands, old fields, grasslands, and aquatic habitats are among the site's natural resources. Over 900 acres of the site have undergone ecological restoration. Figure 7–1 shows the restoration project areas that have been completed. Some of these areas provide habitat for state and federal endangered species. Cultural resources, such as prehistoric archaeological sites, can also be found at the Fernald Preserve.

Monitoring of these natural and cultural resources is addressed in the Natural Resource Monitoring Plan, which is included in the IEMP. The Natural Resource Monitoring Plan presents an approach for monitoring and reporting the status of several priority natural resources to remain in compliance with pertinent regulations and agreements. The site and OSDF inspection process, which is defined in the LMICP, also helps to evaluate the condition of natural resources at the Fernald Preserve.

The approach for monitoring and maintenance of ecologically restored areas was revised in 2009. DOE and OEPA signed a Consent Decree in November 2008 that settles a long-standing natural resource damage claim under Section 107 of CERCLA. As a result, the Fernald Natural Resource Trustees (DOE, OEPA, and the U.S. Department of Interior) have finalized the Natural Resource Restoration Plan (NRRP), which is Appendix B of the *Partial Consent Decree Resolving Ohio's Natural Resource Damage Claim against DOE* (State of Ohio 2008). The NRRP specifies an enhanced monitoring program for ecologically restored areas at the site. These new monitoring activities were started in 2009, with extensive vegetation monitoring across site wetlands. The Natural Resource Trustees also collectively evaluated restored areas by conducting field walkdowns in the summer of 2009. This effort led to the development of a path forward for additional maintenance and repair in some areas.

## 7.1 Ecological Restoration Activities

The Fernald Preserve's mission of long-term stewardship under LM involves the establishment, management, and monitoring of ecologically restored areas across the site. In 2009, approximately five miles of new trails were added to the site trail system. In addition, a vehicle turnaround and overlook were constructed along the site access road. This overlook provides a different perspective of the former production area. Maintenance in ecologically restored areas

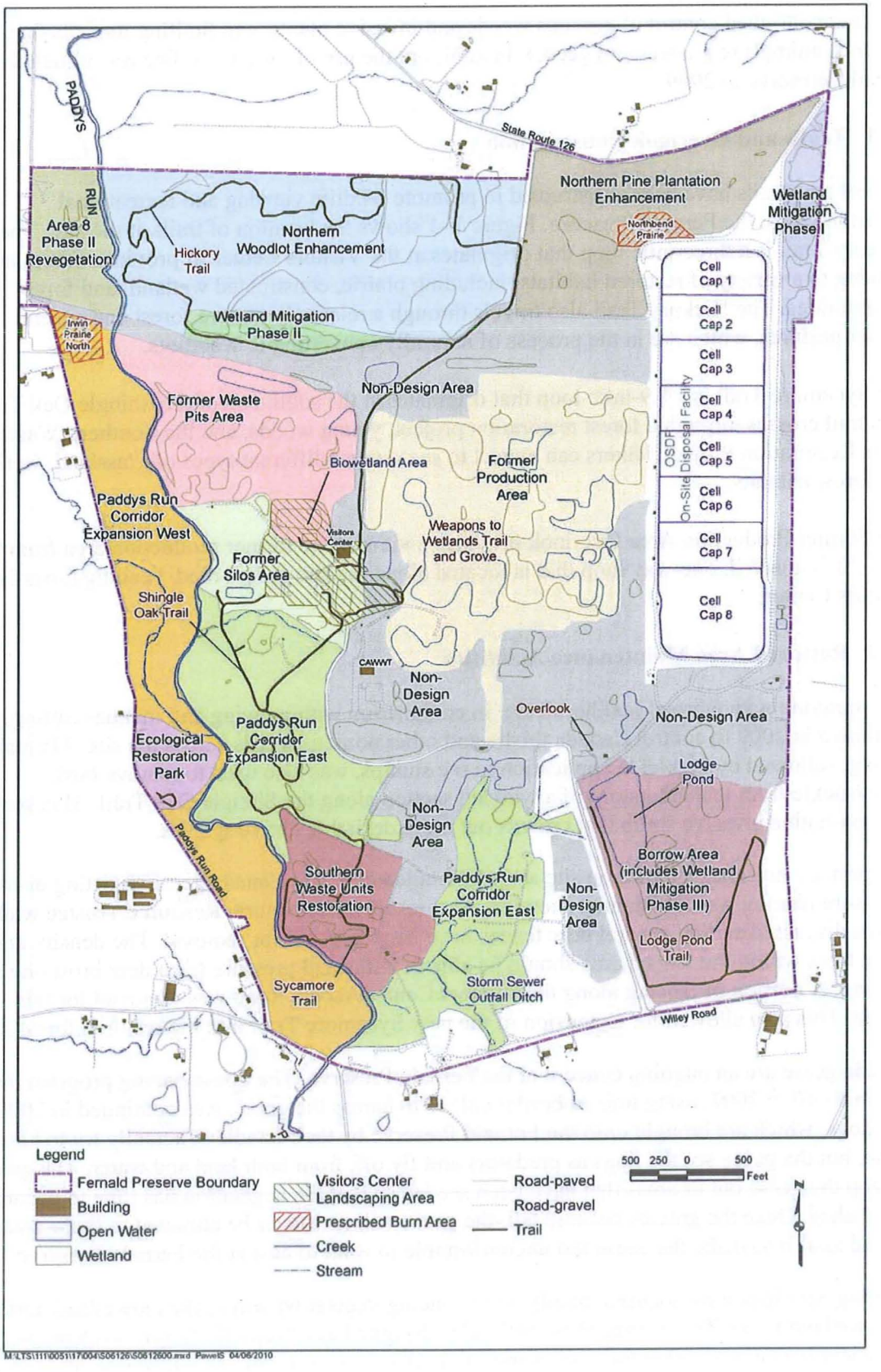


*Figure 7–1. Restoration Project Areas*

included continued control of noxious weeds and invasive plants, and limiting impacts due to nuisance animals (e.g., deer and geese). In addition, the use of prescribed fire was initiated at the Fernald Preserve in 2009.

### 7.1.1 Trails and Overlook Construction

Several new trails have been constructed to promote wildlife viewing and recreational opportunities at the Fernald Preserve. Figure 7–1 shows the location of trails at the site. The Hickory Trail is a three-mile loop that originates at the Visitors Center. It provides access and viewing to a variety of restored habitats, including prairie, constructed wetland, and forest communities. The Hickory Trail also travels through a relatively mature forest and several former pastures, which are in the process of naturally converting to woodlots.

The Sycamore Trail is a 1.9-mile loop that originates at the south end of the Shingle Oak Trail. This trail crosses through a forest restoration project, young woods, and the Southern Waste Units Restoration Project. Hikers can expect to see several different types of grassland, wetland, and forest habitats.

The Former Production Area Overlook provides a view of the former production area from the south. It is a paved, one-way loop that is located along the site access road, heading towards the Visitors Center.

### 7.1.2 Restored Area Maintenance Activities

Spot spraying with a broad-leaf herbicide, in conjunction with mowing and manual cutting, was continued in 2009 to control Canada thistle and other noxious weeds across the site. Manual cutting, followed by herbicide application to the stumps, was also used to remove bush honeysuckle from the understory of a wooded section along the Shingle Oak Trail. This species is a non-native invasive shrub that crowds out more desirable native species.

The primary nuisance animals on site are white-tailed deer and Canada geese. Existing deer-exclosure fencing was maintained sitewide. As a result of the Natural Resource Trustee walk downs discussed earlier, several deer fences have been targeted for removal. The density and size of the trees within the fenced area should be able to withstand pressure from deer browsing and rubbing. A portion of fencing along the Visitors Center Access Road was removed for this reason. This also allowed for expansion of the new Sycamore Trail into the restored forest area.

Canada geese are an ongoing concern at the Fernald Preserve. The goose hazing program that was initiated in 2007, using trained border collies to harass the geese, was continued in 2009. The dogs, which are brought onto the Fernald Preserve by their handlers, actually try to herd the geese, but the geese see the dogs as predators and fly off, from both land and water. The goal is to keep the geese out of areas that have been seeded so that the vegetation has time to become established. Once the grasses become tall, the geese will no longer be attracted to those areas. A second goal is to make the geese too uncomfortable to want to nest at the Fernald Preserve.

Planting activities were focused mainly on enhancing vegetation within the biowetland surface flow wetland basin. The surface flow wetland is designed as a "zero discharge" system, meaning that water is removed either through evaporation, plant transpiration, or infiltration into the soil. Because of the heavy clay content of the area, soil infiltration is very slow. Therefore, a dense

stand of vegetation is needed to maximize the amount of plant transpiration that takes place. Some erosion repair work was conducted in spring 2009 along the northern edge of the basin and the associated emergency spillway. Following these repairs, about 4,500 wetland plants were installed across the basin. These herbaceous "plugs" are the quickest way to get vegetation established in some wetland areas.

Several small prairie patches were seeded in 2009. Field personnel applied yard waste compost and seeded approximately two acres north of the biowetland area and in the northern portion of the Waste Pits. These efforts were used to evaluate different methods for ground preparation prior to seeding.

Prescribed burns were conducted at the Fernald Preserve for the first time in 2009. The use of prescribed fire is the preferred tool for prairie management. The tallgrass prairie species that have been seeded at the Fernald Preserve are well adapted to periodic fires. Most prairie species are deep-rooted. They have an extensive root system that is developed before the stem and leaf clump form above the surface. The root system allows them to be burned, eliminating the above-surface plant clump, without killing the plant. After a burn, when prairie plants grow back from the roots, they are vibrant. The burns convert the plant material to ash, reducing the accumulation of thatch. The ash breaks down quickly, since it is in contact with the soil, and the nutrients in the ash become available in the soil. Also, the blackened ash-covered ground absorbs more heat from sunlight and warms the soil. As a result, the soil reaches a temperature conducive to germination and native plant growth earlier in the spring. The growing season for the grasses and wildflowers is increased, and the sunlight on the soil surface promotes the growth of new plants and increases the productivity of existing plants.

Two areas were burned in 2009. Figure 7–1 shows the location of the Irwin Prairie North Burn and the North Bend Prairie Burn. Both burns were conducted safely with no incidents and within the parameters of the approved Prescribed Burn Plan.

### 7.1.3 Ecological Restoration Monitoring

**Vegetation Monitoring Parameters**
There are a number of ways to evaluate the type and quality of vegetation within an area. At the Fernald Preserve, vegetation monitoring is focused around determining the extent of native species composition, along the data that are collected to determine the Floristic Quality Assessment Index (FQAI), which is one of the parameters used to determine the score for VIBI. The FQAI process is described in the FQAI for vascular plants and mosses for the State of Ohio (Andreas 2004). The specific parameters used at the Fernald Preserve include the following:

**Total Species**: The total number of species sampled within a given area.

**Native Species**: The total number of species that are native to Ohio. The Ohio Vascular Plant Database is used to determine whether a species is native (Andreas 2004).

**Percent Native Species**: This is the number of native species divided into the total number of species. Relative frequency of native species has also been used in the past. This is calculated by dividing the frequency (or number of times a species is observed) into the total number of observations for a given area.

**Average Coefficient of Conservatism (CC)**: The CC is a number from 0 to 10 that has been assigned to virtually every species that may be found in Ohio. The CC value is related to how "tolerant" a species is and what its habitat requirements are. Non-native plants have a CC of 0. Common species that can grow in a wide variety of habitats are considered "tolerant," and are scored a CC between 0 and 3. Native plants with very specific habitat requirements are scored high CC values, in the 7 to 10 range. Again, The Ohio Vascular Plant Database lists the CC for each plant found in Ohio.

**Floristic Quality Assessment Index (FQAI)**: The CC values described above are used to calculate the FQAI. The FQAI is the sum of CC values divided by the square root of the total number of species for a given area.

**Percent Hydrophytic**: This parameter is specific to wetland functional monitoring. A hydrophytic plant thrives in wet conditions. The percent hydrophytic parameter is calculated by dividing the number of wetland species into the total number of species observed within a given area.

Ecological restoration monitoring has been divided into two phases: the implementation phase and the functional phase. Implementation phase monitoring is conducted to ensure that restoration projects are completed as intended in their designs. This effort involves the mortality counts and herbaceous cover estimates that are conducted after a project is completed. No implementation activities were required in 2009.

Functional-phase monitoring is more general and considers projects in terms of their contribution to the ecological community as a whole. This is accomplished by comparing projects to pre-remediation baseline conditions and to ideal reference sites. The Natural Resource Restoration Plan, which was finalized in November 2008 with settlement of the Natural Resource Damage Claim, reinstituted the use of functional-phase monitoring as a means of evaluating restored communities. The Natural Resource Restoration Plan also calls for an enhanced wetland mitigation monitoring program.

Ecological restoration monitoring in 2009 centered on the start of the expanded wetland mitigation monitoring program described earlier. DOE has the responsibility to create 17.85 acres of jurisdictional wetlands at the Fernald Preserve. While over 80 acres of wetland habitat have been created as part of ecological restoration activities, DOE needs to demonstrate that at least 17.85 acres of these meet the definition of a "jurisdictional" wetland. A wetland is considered "jurisdictional" if it meets specific criteria regarding vegetation, hydrology (water), and soils. To accomplish this, the *Fernald Preserve Wetland Mitigation Monitoring Plan* (DOE 2009c) was developed to establish performance standards and monitoring requirements for wetland mitigation projects at the Fernald Preserve. The plan adopts existing OEPA performance standards and monitoring protocols for emergent wetlands. A series of parameters will be evaluated between 2009 and 2011, including the shape and size of wetlands, water elevations, soil and water chemistry, vegetation, amphibians, and other wildlife. This new process takes the place of previous efforts that included a one-time vegetation survey and annual water quality sampling.

For 2009, monitoring activities focused on characterizing wetland vegetation. Twenty-three wetland basins were surveyed using a process called Vegetation Index of Biotic Integrity (VIBI).

VIBI is a scoring system that uses vegetation data collected from fixed plots. Figure 7–2 shows the location of the fixed plot grids within each of the wetland basins evaluated. Table 7–1 summarizes the findings. The results from this first monitoring effort were very encouraging. As stated above, VIBI is one of a number of performance criteria outlined in the Wetland Mitigation Monitoring Plan. This plan sets a goal to achieve a VIBI of at least 48 for restored wetlands at the Fernald Preserve. Fifteen of the wetland areas evaluated met this criterion in 2009.

*Table 7–1. Wetland Vegetation Monitoring Summary*

| Restoration Project Area | Wetland Area | Size (Acres) | Vegetation Index of Biotic Integrity |
|---|---|---|---|
| Borrow Area (BAP) | BAPW2 | 3.35 | 50 |
| | BAPW3 | 0.56 | 32 |
| | BAPW4 | 1.30 | 36 |
| | BAPW7 | 0.36 | 50 |
| | BAPW9 | 0.83 | 59 |
| Former Production Area (FPA) | FPAW2 | 4.25 | 25 |
| | FPAW4 | 1.20 | 50 |
| | FPAW5 | 2.91 | 51 |
| | FPAW7 | 2.47 | 34 |
| | FPAW9 | 2.51 | 50 |
| | PREW6 | 2.32 | 43 |
| Northern Pine Plantation Enhancement (NPP) | NPPW4 | 2.24 | 51 |
| | NPPW5 | 0.14 | 51 |
| Wetland Mitigation Phase I (WM1) | WM1W1 | 1.00 | 40 |
| | WM1W2 | 1.38 | 71 |
| | WM1W3 | 0.93 | 61 |
| | WM1W4 | 1.08 | 61 |
| | WM1W5 | 0.27 | 26 |
| | WM1W6 | 1.68 | 67 |
| | WM1W7 | 0.77 | 54 |
| Wetland Mitigation Phase II (WM2) | WM2W1 | 0.94 | 50 |
| | WM2W2 | 0.94 | 43 |
| | WM2W3 | 1.19 | 57 |

In addition to the enhanced wetland mitigation monitoring program, functional monitoring of restored areas resumed as well. This process compares restored communities to pre-restoration "baseline" conditions and high-quality reference sites. Baseline and reference sites were characterized in 2001 and 2002. From 2003 to 2005, restored areas were evaluated. Instead of a project-specific data set, broader community types (i.e. wetlands, prairie, and forest) were evaluated. Wetlands were evaluated in 2003, prairie communities in 2004, and forest habitats in 2005. For 2009, the wetland data collected as part of the VIBI process can be used to compare to the established baseline and reference site data, as shown in Table 7–2. Results show dramatic improvement in all categories over baseline conditions, with percent native species approaching reference site conditions.

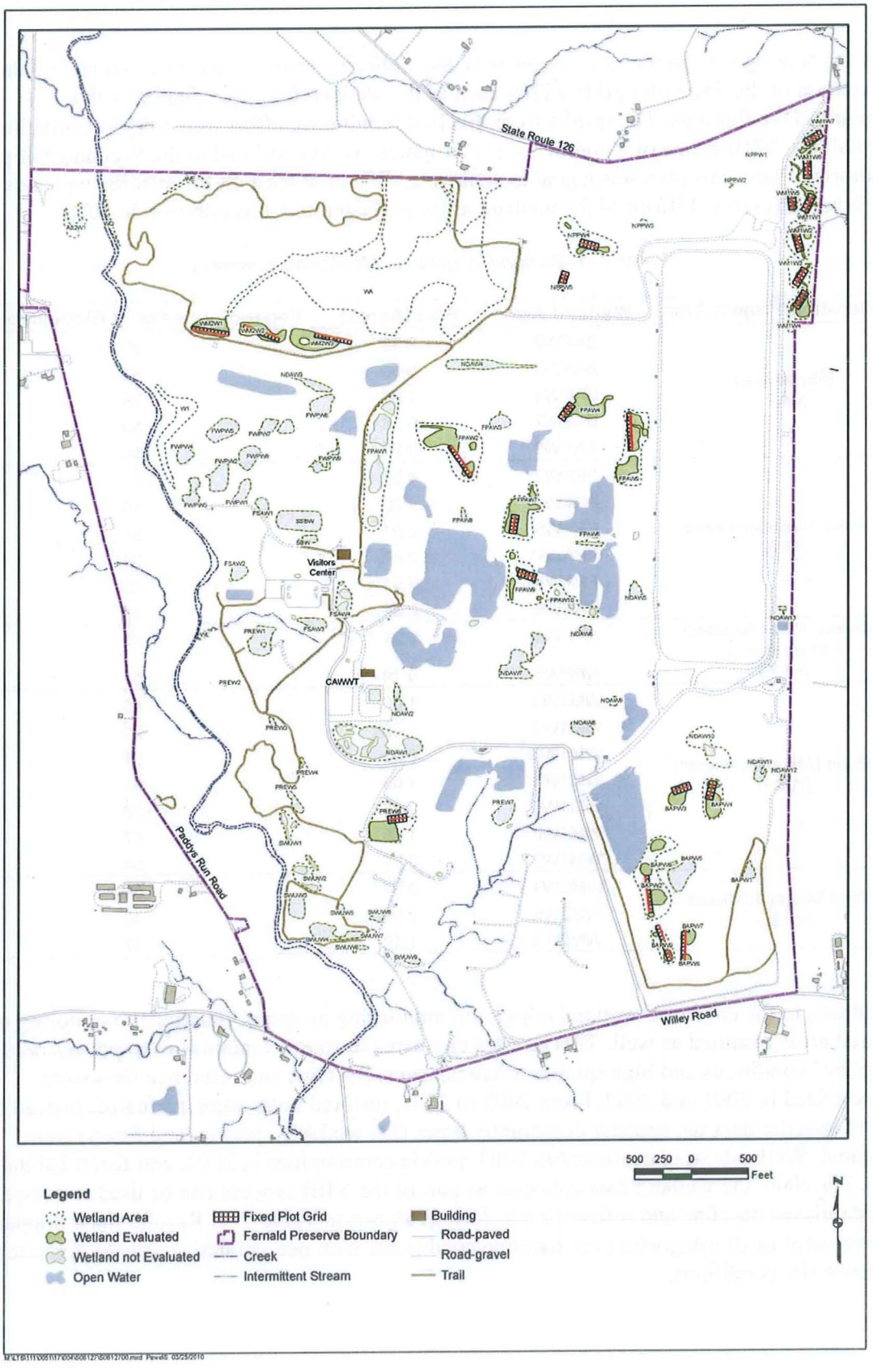


*Figure 7–2. Wetland Mitigation Areas Evaluated*

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*Table 7–2. Wetland Functional Monitoring Data Summary*

| | Restoration Project Area | | | | | Wetland | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **WM1** | **WM2** | **BAP** | **FPA** | **NPP** | **Baseline** | **Reference** | **2003 Summary** |
| Total Species | 141 | 67 | 101 | 101 | 78 | 33 | 61 | 62 |
| Native Species | 101 | 53 | 76 | 81 | 62 | 17 | 55 | 49 |
| Percent Native | 72 | 79 | 76 | 80 | 79 | 48 | 90 | 79 |
| Average CC[a] | 1.90 | 2.03 | 1.92 | 2.17 | 2.14 | 1.12 | 3.49 | 2.21 |
| FQAI[b] | 14.11 | 13.10 | 13.53 | 14.80 | 15.71 | 6.44 | 27.27 | 17.40 |
| Percent Hydrophytic | 58 | 49 | 44 | 44 | 45 | 24 | 51 | 64 |

[a]CC = Coefficient of Conservatism
[b]FQAI = Floristic Quality Assessment Index

The 2003 summary data are from the WM1 wetland area. While the percent native and average Coefficient of Conservatism (CC) values are higher than the 2009 WM1 data, this is primarily due to sampling technique. Pursuant to the *Fernald Preserve Wetland Mitigation Monitoring Plan* (DOE 2009c), fixed plot grids were used to collect vegetation data. In 2003, transects were established around the perimeter of wetland basins. This may have biased the 2003 results in terms of species identified. The fixed plot method provides a more comprehensive inventory of plants within wetland areas, as evidenced by the greater total number of species observed in 2009.

*Prescribed fire is a new prairie management tool at the Fernald Preserve. The North Bend Prairie was successfully burned in March, 2009.*

## 7.2 Fernald Preserve Site and OSDF Inspections

The LMICP sets out a routine inspection process for both the site and the OSDF. Inspections are conducted quarterly with joint participation from DOE and the regulators. Inspections document

evidence of unauthorized uses of the site, the effectiveness of institutional controls, and the need for repairs. Ecologically restored areas are evaluated for the presence of noxious weeds, erosion, the condition of vegetation, and signs of damage from nuisance animals. Findings in 2009 were very similar to those of 2008 and focused mainly on noxious weeds, debris, erosion, and areas of sparse vegetation.

For the OSDF inspections, the vegetated cap is walked down and evaluated to ensure that the integrity of the cap is maintained. Erosion rills, holes from burrowing animals, noxious weeds, settlement cracks, and other indications that there may be an issue with the proper functioning of the cap are flagged and repaired. In 2009, there were no signs that the integrity of the cap had been compromised in any way. Findings consisted mainly of rocks larger than 4 inches in diameter, presence of noxious weeds, and animal burrows.

## 7.3 Affected Habitat and Inspection Findings

With large-scale remediation complete, the potential for unanticipated habitat impacts is limited. Nevertheless, impacts may occur during construction or maintenance activities. In 2009, no large areas of restored habitat were affected. Impacts due to trail and overlook construction were minimal. Some minor erosion control work was conducted in the former Southern Waste Units area in response to inspection findings.

## 7.4 Threatened and Endangered Species and Species Inventories

**Sloan's Crayfish**—The state-listed threatened Sloan's crayfish (*Orconectes sloanii*) is found in southwest Ohio and southeast Indiana. It prefers streams with constant (though not necessarily fast) current flowing over rocky bottoms. A large, well-established population of Sloan's crayfish is found at the Fernald Preserve in the northern reaches of Paddys Run.

**Indiana Brown Bat**—The federally listed endangered Indiana brown bat (*Myotis sodalis*) forms colonies in hollow trees and under loose tree bark along riparian (streamside) areas during the summer. Excellent habitat for the Indiana brown bat has been identified at the Fernald Preserve along the wooded banks of the northern reaches of Paddys Run. The habitat provides an extensive mature canopy of older trees and water throughout the year. One Indiana brown bat was captured and released on the property in August 1999.

**Running Buffalo Clover**—The federally listed endangered running buffalo clover (*Trifolium stoloniferum*) is a member of the clover family whose flower resembles that of the common white clover. Its leaves, however, differ from those of white clover in that they are heart-shaped and a lighter shade of green. Running buffalo clover has not been identified at the Fernald Preserve; however, because running buffalo clover is found nearby in the Miami Whitewater Forest, the potential exists for this species to become established at the site. The running buffalo clover prefers habitat with well-drained soil, filtered sunlight, limited competition from other plants, and periodic disturbances. Suitable habitat areas include partially shaded former grazed areas along Paddys Run and the storm sewer outfall ditch.

**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 forested wetlands and wooded ravines. This plant has not been identified at the Fernald Preserve; however, suitable habitat exists in portions of the northern woodlot.

**Cave Salamander**—The state-listed endangered cave salamander (*Eurycea lucifuga*) is slender, red to orange with irregular black dots. It is found in caves, springs, small limestone streams, outcrops, and old springhouses where groundwater is present. It has only been documented in Ohio in Hamilton, Butler, and Adams counties. Suitable habitat within the Fernald Preserve is limited, but populations have been observed just north of the site.

**Cobblestone Tiger Beetle**—The state-listed threatened cobblestone tiger beetle (*Cicindela marginipennis*) is recognized by its olive-gray back, white sides, and red abdomen. It's found on large gravel bars on medium-sized rivers. Populations have been recorded east of the Fernald Preserve along the Great Miami River.

The Endangered Species Act requires the protection of any federally listed threatened or endangered species and any habitat critical for the species' existence. Several Ohio laws mandate the protection of state-listed endangered species as well. Since 1993 a number of surveys have been conducted to determine the presence of any threatened or endangered species at the site. As a result of these surveys, the federally listed endangered Indiana brown bat and the state-listed threatened Sloan's crayfish have been

found at the Fernald Preserve. In addition, suitable habitat exists for the federally listed endangered running buffalo clover, the state-listed threatened spring coral root, the state-listed endangered cave salamander, and the state-listed threatened cobblestone tiger beetle. None of these species have been found on the site, but their habitat ranges encompass the Fernald Preserve. Figure 7–3 shows the potential habitats for these species. According to provisions in the IEMP, threatened or endangered species habitat will be surveyed prior to any construction activities. If threatened or endangered species are present, appropriate avoidance or mitigation efforts will be taken.

No specific threatened or endangered species surveys were conducted in 2009. However, several species inventories did take place. In May, the Fernald Preserve BioBlitz was held. This 24 hour event was a blend of science, celebration, education, and community. Scientists and subject matter experts from a variety of fields led families, scouts, youth groups, and others on searches for bugs, spiders, snakes, birds, mammals, flowers, and trees. This event expanded the site's biological database, but more importantly it also engaged members of the public in the methods involved in conducting field studies. A BioBlitz is an excellent way to learn about the biodiversity at the Fernald Preserve and the surrounding area and to better understand how to protect the many different species that live here.

Reptile and small mammal surveys were conducted around a number of site wetlands using coverboards, which are 2-ft. by 4-ft. pieces of corrugated sheet metal. Animals are attracted to the cover and warmth the coverboards provide. Several snakes and five small mammals were observed, including a bog lemming, which has not been previously identified at the Fernald Preserve.

DOE is continuing its participation in several bird data-collection efforts. Information on birds breeding at the Fernald Preserve is provided to the Ohio Breeding Bird Atlas. In 2009, over 100 species of birds were recorded as probable or confirmed breeding at the site, and 85 species were confirmed nesting. The large prairie areas that surround the open water and wetlands support significant numbers of breeding grassland species, including those listed as species in decline by the National and Ohio Audubon Societies. Nesting species observed include northern bobwhite, dickcissel, Henslow's and grasshopper sparrows, horned lark, and eastern meadowlark. During the National Audubon Society's 2009 Christmas Bird Count, over 1,000 birds were observed using the Fernald Preserve, representing 47 species. The site routinely holds close to 1,000 waterfowl during the spring and fall migrations.

## 7.5 Cultural Resources

The Fernald Preserve and surrounding area are located in a region of rich soil and many sources of water, such as the Great Miami River. Because of its advantageous location, the area was settled repeatedly throughout prehistoric and historical time, resulting in richly diverse cultural resources. In summary, 148 prehistoric and 40 historic sites have been identified within 1.24 miles (2 km) of the Fernald Preserve.

Several laws have been established to protect cultural resources. The National Historic Preservation Act requires DOE to consider the effects of its actions on sites that are listed or eligible for listing on the National Register of Historic Places. The Native American Graves Protection and Repatriation Act (43 CFR 10) requires that prehistoric human remains and associated artifacts be identified and returned to the appropriate Native American tribe.

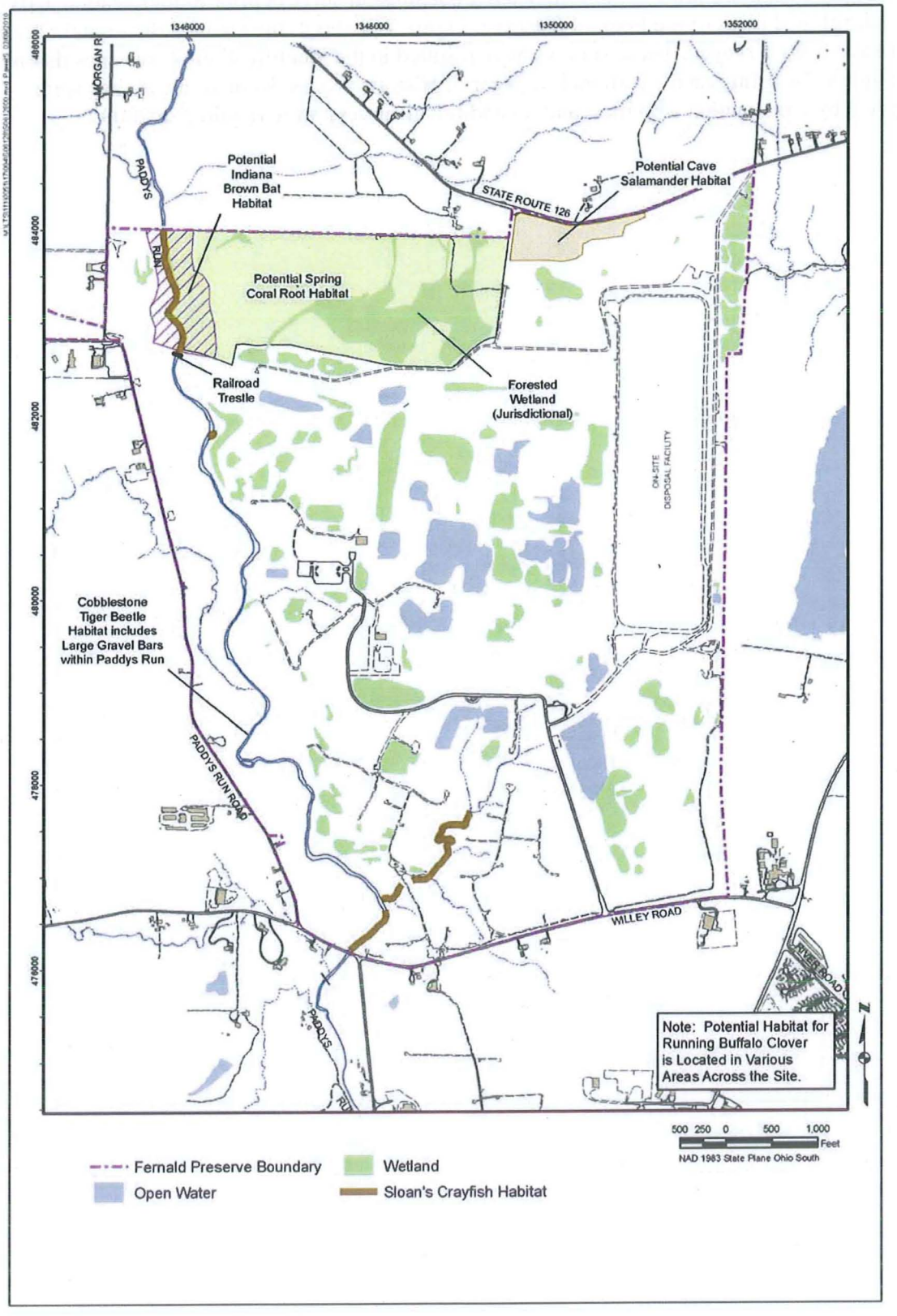


*Figure 7–3. Threatened and Endangered Species Habitat Areas*

To comply with these laws, DOE conducted archeological surveys prior to remediation activities in undeveloped areas of the Fernald Preserve. Figure 7–4 shows the areas of the Fernald Preserve that have been surveyed. These surveys have resulted in the identification of five sites that may be eligible for listing on the National Register of Historic Places. None of these sites were affected by construction activities, and no additional surveys were required in 2009.

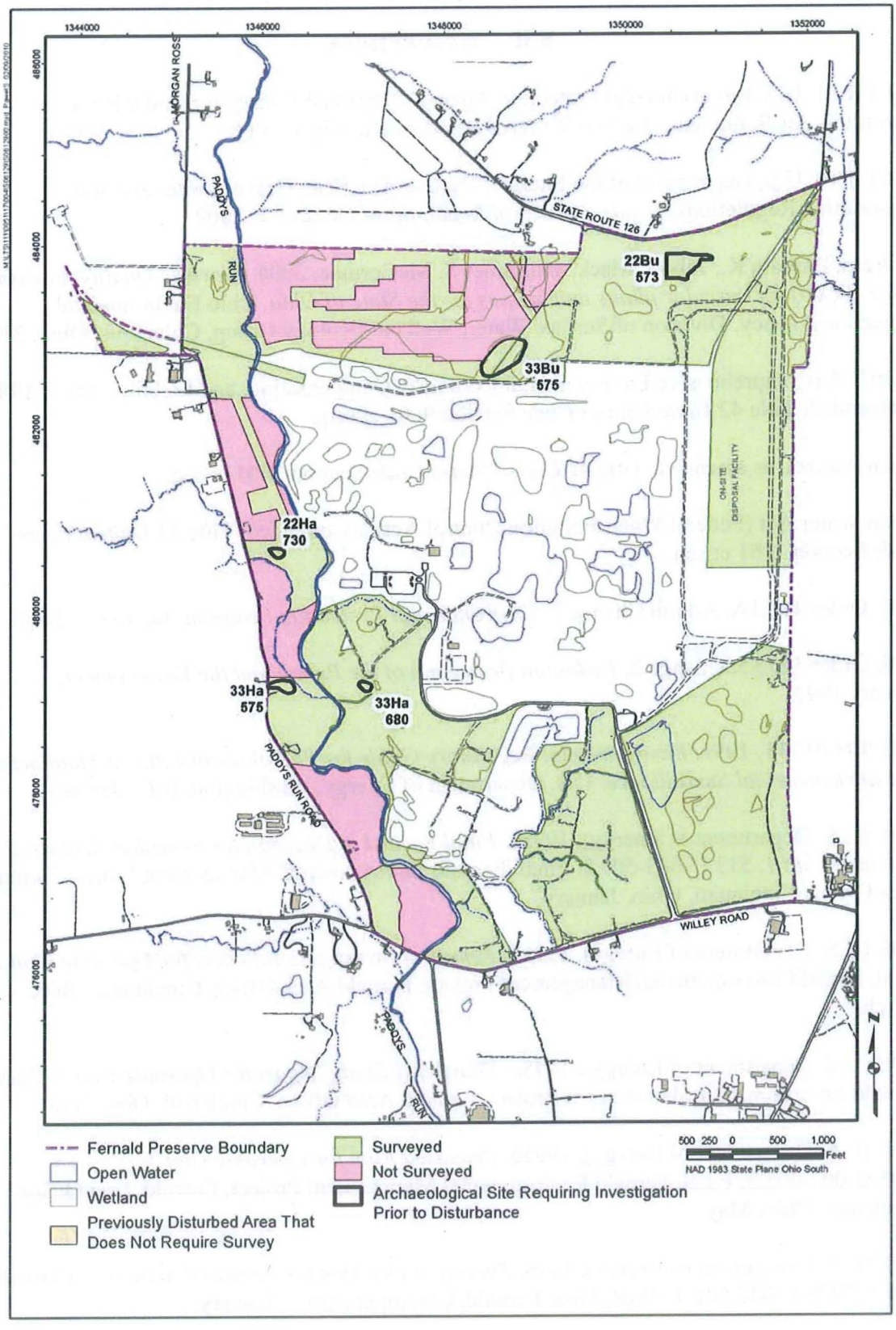


*Figure 7–4. Cultural Resource Survey Areas*

# 8.0 References


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# 9.0 Glossary

***Alpha Particle***—Type of particulate radiation emitted from the nucleus of an atom. It consists of two protons and two neutrons. It does not travel long distances and loses its energy quickly.

***Aquifer***—A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield economical quantities of water to wells and springs.

***ARARs***—An acronym for "applicable or relevant and appropriate requirements." Requirements set forth in regulations that implement environmental and public health laws and must be attained or exceeded by a selected remedy unless a waiver is invoked. ARARs are divided into three categories: chemical-specific, location-specific, and action-specific, according to whether the requirement is triggered by the presence or emission of a chemical, by a vulnerable or protected location, or by a particular action.

***Background Radiation***—Particle or wave energy spontaneously released from atomic nuclei in the natural environment, including cosmic rays and such releases from naturally radioactive elements outside and inside the bodies of humans and animals, and fallout from nuclear weapons tests.

***Beta Particle***—Type of particulate radiation emitted from the nucleus of an atom that has a mass and charge equal in magnitude to that of the electron.

***Bypass Events***—A bypass event occurs when storm water is diverted around water treatment facilities and is directly discharged to the Great Miami River via the Fernald site effluent line. Bypass events can occur during sizeable precipitation or when water treatment facilities are down for maintenance. Bypassing treatment is only implemented when the site's storm water retention capacity is in danger of being exceeded.

***Capture Zone***—Estimated area that is being "captured" by the pumping of groundwater extraction wells. The definition of the capture zone is important in ensuring that the uranium plumes targeted for cleanup are being remediated.

***Certification***—The process by which a soil remediation area is certified as clean. Samples from the area are collected and analyzed, and then the contaminant levels are compared to the final remedial levels established in the OU5 ROD. Not all soil remediation areas at the Fernald site require excavation before certification is done.

***Contaminant***—A substance that when present in air, surface water, sediment, soil, or groundwater above naturally occurring (background) levels causes degradation of the media.

***Controlled Runoff***—Contaminated storm water requiring treatment; it is collected, treated, and eventually discharged to the Great Miami River as treated effluent.

***Curie (Ci)***—Unit of radioactivity that measures the rate of spontaneous, energy-emitting transformations in the nuclei of atoms.

***Dose***—Amount of radiation absorbed in tissue.

***Ecological Receptor***—A biological organism selected by ecological risk assessors to represent a target species most likely to be affected by site-related chemicals, especially through bioaccumulation. Such organisms may include terrestrial and aquatic species.

***Effective Dose Equivalent***—The sum of the products of the dose equivalent received by specified tissues of the body and tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the risk of health effects to the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent due to penetrating radiation from sources external to the body. Effective dose equivalent is expressed in units of rem or sievert.

***Exposure Pathway***—A route materials can travel between the point of release and the point of delivery of a radiation or chemical dose to a receptor organism.

***Fly Ash***—The ash remaining after burning coal in a boiler plant.

***Gamma Ray***—Type of electromagnetic radiation of discrete energy emitted during radioactive decay of many radioactive elements.

***Glacial Overburden/Glacial Till***—Silt, sand, gravel, and clay deposited by glacial action on top of the Great Miami Aquifer and surrounding bedrock highs.

***Great Miami Aquifer***—Sand and gravel deposited by the meltwaters of Pleistocene glaciers within the entrenched ancestral Ohio and Miami rivers. This is also called a buried channel or a sand and gravel aquifer.

***Groundwater***—Water in a saturated zone or stratum beneath the surface of land.

***Implementation monitoring***—The process used to evaluate the success of vegetation establishment in ecological restoration areas. Implementation monitoring usually consists of determining percent survival of planted trees and shrubs and percent total cover and native species cover for seeded areas.

***Mixed Waste***—Hazardous waste that has been contaminated with low-level radioactive materials.

***Point Source***—The single defined point (origin) of a release such as a stack, vent, or other discernable conveyance.

***Radiation***—The energy released as particles or waves when an atom's nucleus spontaneously loses or gains neutrons or protons. The three main types are alpha particles, beta particles, and gamma rays.

***Radioactive Material***—Refers to any material or combination of materials that spontaneously emits ionizing radiation.

***Radionuclide***—Refers to a radioactive nuclide. There are several hundred known radionuclides that are artificially produced and naturally occurring. Radionuclides are characterized by the number of neutrons and protons in an atom's nucleus and their characteristic decay processes.

***Receptors***—Individuals or organisms that are or can be impacted by contamination.

***Remedial Action***—The actual construction and implementation phase of a Superfund site cleanup that follows the remedy selection process and remedial design.

***Remedial Investigation/Feasibility Study***—The first major event in the remedial action process that serves to assess site conditions and evaluate alternatives to the extent necessary to select a remedy.

***Removal Action***—A short-term cleanup or removal of released hazardous substances from the environment. This occurs in the event of a release or the imminent threat of release of hazardous substances into the environment.

***Roentgen Equivalent Man (rem)***—A special unit of dose equivalent that expresses the effective dose calculated for all radiation on a common scale; the absorbed dose in rads multiplied by certain modifying factors (e.g., quality factor); 100 rem = 1 sievert.

***Sediment***—The unconsolidated inorganic and organic material that is suspended in surface water and is either transported by the water or has settled out and become deposited in beds.

***Source***—A controlled source of radioactive material used to calibrate radiation detection equipment. Can also be used to refer to any source of contamination (e.g., a point source such as the stack on the waste pits stack, a source of radon such as the silo's headspace).

***Surface Water***—Water that is flowing within natural drainage features.

***Thermoluminescent Dosimeter (TLD)***—A device used to monitor the amount of radiation absorbed and stored within the thermoluminescent material.

***Treated Effluent***—Water from numerous sources at the site that is treated through one of the site's wastewater treatment facilities and discharged to the Great Miami River.

***Uncontrolled Runoff***—Storm water that is not collected by the site for treatment, but enters the site's natural drainages.

***Volatile Organic Compound***—A hydrocarbon compound, except methane and ethane, with a vapor pressure equal to or greater than 0.1 millimeter of mercury.

***Waste Acceptance Criteria***—Disposal facilities specify the types and sizes of materials, acceptable levels of constituents, and other criteria for all material that will be disposed in that facility. These are known as waste acceptance criteria. Off-site disposal facilities (such as the

7237

Nevada Test Site) that dispose of Fernald waste have specific waste acceptance criteria. In addition, the OSDF had waste acceptance criteria that were approved by the regulatory agencies. The Waste Acceptance Organization was responsible for ensuring that all waste placed in the OSDF met all of the applicable criteria before waste placement.