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Cover Photo: Jeffrey G. Davis
Fernald Preserve

2017 Site Environmental Report

May 2018

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### Abbreviations

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<th>Description</th>
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<tbody>
<tr>
<td>AIBI</td>
<td>Amphibian Index of Biotic Integrity</td>
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<tr>
<td>AR</td>
<td>Administrative Record</td>
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<tr>
<td>ARARs</td>
<td>applicable or relevant and appropriate requirements</td>
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<tr>
<td>CAWWT</td>
<td>Converted Advanced Wastewater Treatment (facility)</td>
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<tr>
<td>CC</td>
<td>coefficient of conservatism</td>
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<tr>
<td>CERCLA</td>
<td>Comprehensive Environmental Response, Compensation, and Liability Act</td>
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<tr>
<td>DOE</td>
<td>U.S. Department of Energy</td>
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<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
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<td>FFCA</td>
<td>Federal Facility Compliance Agreement</td>
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<td>FQAI</td>
<td>Floristic Quality Assessment Index</td>
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<tr>
<td>FRL</td>
<td>final remediation level</td>
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<td>IEMP</td>
<td>Integrated Environmental Monitoring Plan</td>
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<tr>
<td>LCS</td>
<td>leachate collection system</td>
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<tr>
<td>LDS</td>
<td>leak detection system</td>
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<td>LM</td>
<td>Office of Legacy Management</td>
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<td>LMICP</td>
<td>Comprehensive Legacy Management and Institutional Controls Plan</td>
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<td>NPDES</td>
<td>National Pollutant Discharge Elimination System</td>
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<td>NPL</td>
<td>National Priorities List</td>
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<tr>
<td>NRRP</td>
<td>Natural Resource Restoration Plan</td>
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<tr>
<td>Ohio EPA</td>
<td>Ohio Environmental Protection Agency</td>
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<tr>
<td>OSDF</td>
<td>On-Site Disposal Facility</td>
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<tr>
<td>OU5 ROD</td>
<td>Operable Unit 5 Record of Decision</td>
</tr>
<tr>
<td>PCB</td>
<td>polychlorinated biphenyl</td>
</tr>
<tr>
<td>PF</td>
<td>Parshall Flume</td>
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<tr>
<td>PPDD</td>
<td>Pilot Plant Drainage Ditch</td>
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<tr>
<td>RAMP</td>
<td>Restored Area Maintenance Plan</td>
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<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
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<tr>
<td>ROD</td>
<td>Record of Decision</td>
</tr>
<tr>
<td>SARA</td>
<td>Superfund Amendments and Reauthorization Act of 1986</td>
</tr>
<tr>
<td>SSOD</td>
<td>storm sewer outfall ditch</td>
</tr>
<tr>
<td>USC</td>
<td>United States Code</td>
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Measurement Abbreviations

ft    feet
gpm   gallons per minute
lb    pounds
µg/L  micrograms per liter
Mgal  million gallons
mg/L  milligrams per liter
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Executive Summary

The Fernald Preserve 2017 Site Environmental Report provides stakeholders with the results from the Fernald Preserve, Ohio, Site’s environmental monitoring programs for 2017, a summary of the U.S. Department of Energy’s (DOE’s) activities conducted onsite, and a summary of the site’s compliance with the various environmental regulations, compliance agreements, and DOE policies that govern site activities. This report has been prepared in accordance with the “Integrated Environmental Monitoring Plan,” which is Attachment D of the Comprehensive Legacy Management and Institutional Controls Plan (LMICP).

Remediation of the Fernald Preserve has been successfully completed with the exception of the groundwater. During 2017, activities at the Fernald Preserve included:

- Environmental monitoring activities related to groundwater and surface water.
- Monitoring as specified in the site’s National Pollutant Discharge Elimination System (NPDES) permit.
- Extraction, monitoring, and treatment of contaminated groundwater from the Great Miami Aquifer (Operable Unit 5).
- On-Site Disposal Facility (OSDF) leak detection monitoring and collection, monitoring, and treatment of leachate from the OSDF.
- Ecological restoration monitoring and maintenance as well as inspections, care, and monitoring of the site and the OSDF to ensure that provisions of the LMICP are fully implemented.
- Ongoing operation of the Fernald Preserve Visitors Center, associated outreach, and educational activities.

Environmental monitoring programs were developed to ensure that the remedy remains protective of the environment. The requirements of these programs are described in detail in the LMICP and reported in this Site Environmental Report as outlined below.

Liquid Pathway Highlights

Groundwater Pathway

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

- Verify that hydraulic capture of the total uranium plume is maintained; track the aquifer restoration in the area of the 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 the wellfield.
- Meet compliance-based groundwater monitoring obligations.
During 2017, active restoration of the Great Miami Aquifer continued. A total of 94 monitoring wells were sampled to determine water quality. Aquifer water elevations were measured in 178 monitoring wells. The following highlights describe the key findings from the 2017 groundwater data:

- A total of 2,462 million gallons of groundwater were extracted from the Great Miami Aquifer and 503 pounds (lb) of uranium were removed from the aquifer in 2017.
- Since 1993, 46,128 million gallons of water have been pumped from the Great Miami Aquifer and 13,733 net pounds of uranium have been removed from the Great Miami Aquifer. Net pounds of uranium removed include a small amount of uranium that was reinjected into the aquifer between 1998 and 2004.
- Data collected in 2017 indicate that uranium concentrations within the footprint of the 30 micrograms per liter (µg/L) maximum uranium plume continue to decrease in response to pumping. The footprint of the maximum uranium plume in 2017 was approximately 94.4 acres, a decrease of 10.6 acres or approximately 10% from what was mapped in 2016.
- The results of the 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 remains 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.
- In 2015, an assessment of the scope of the groundwater quality monitoring program concluded that the scope of the groundwater monitoring program could be reduced. In 2016, the U.S. Environmental Protection Agency (EPA), Ohio Environmental Protection Agency (Ohio EPA), and local stakeholders approved the reduction in scope. The changes were implemented in 2017.

**Groundwater Remedy**

On July 1, 2014, a new operational design for the groundwater remedy was implemented. Three extraction wells that were no longer providing benefit to the remediation were shut down, and the pumping capacity from these wells was reallocated to extraction wells in the South Plume and southern portion of the South Field to accelerate cleanup of those areas. The system pumping rate was increased 300 gallons per minute (gpm), from 4,775 gpm to 5,075 gpm.

The new operational design is more aggressive than the previous design because, for the first 9 years, the target system pumping rate is 300 gpm higher. The new design is also more efficient because pumping rates are initially higher in the more concentrated areas of the plume, resulting in lower overall pumping rates as the remedy progresses. The lower overall pumping rates are expected to result in cost savings of approximately $6 million over the life of the pump-and-treat operation. No operational changes to the groundwater remediation occurred in 2017.

The current aquifer remedy is able to achieve uranium discharge limits (i.e., average monthly concentration of less than 30 μg/L and 600 lb annually) established in the Operable Unit 5 Record of Decision without routine groundwater treatment. Routine groundwater treatment has not been needed since 2010. Occasionally, groundwater is sent to treatment for very short periods of time. The reasons for the short periods of treatment vary, but most are related to times
when wells pumping low uranium concentrations are turned off for maintenance and wells pumping higher uranium concentrations continue pumping. In 2017, 2,462 million gallons of groundwater were pumped from the Great Miami Aquifer and 1.08 million gallons (0.04 %) of groundwater were treated.

**On-Site Disposal Facility Monitoring**

Engineered features within the OSDF continue to perform as designed, indicating that a leak from the facility is not occurring. Leachate flow continues to diminish as expected and leak detection system flow volumes indicate that the cell liners are performing well within design specifications.

An assessment of the scope of the water quality monitoring program for OSDF was finalized in 2015. The assessment concluded that the scope of the leachate monitoring program could be reduced. EPA, Ohio EPA, and local stakeholders approved the reduced scope in 2016, and the changes were implemented in 2017.

**Surface Water and Effluent Pathway**

Surface water and 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 as well as to meet compliance-based surface water and effluent monitoring obligations.

In 2017, 18 surface water locations and one effluent location were sampled at various frequencies. The following highlights describe the key findings from the 2017 surface water and effluent monitoring programs.

- Since 1995, the annual uranium mass discharged in Fernald effluent to the Great Miami River has been less than Operable Unit 5 Record of Decision limit of 600 lb per year. A total of 500 lb of uranium were discharged in effluent to the Great Miami River in 2017, which was below the limit of 600 lb per year.

- Approximately 99 lb of uranium were released to the environment through uncontrolled storm water runoff from the site. Therefore, the total amount of uranium released through the effluent and uncontrolled surface water pathways during 2017 is estimated to be 599 lb.

- Analytical results of 19 surface water samples collected from SWD-09 exceeded the surface water final remediation level (FRL) for total uranium, the site’s primary contaminant. SWD-09 is one of the two locations established to monitor the 2007 maintenance action completed west of the Former Waste Pits Area. No sample result exceeded the total uranium FRL at the second location in this area (SWD-05). Analytical results of surface water samples collected at this location are trending downward. The surface water from this area does not drain directly to Paddys Run. Any infiltration down to the aquifer in this area is within the capture zone of nearby extraction wells operating as part of the groundwater remediation.

- Compliance sampling, consisting of sampling for nonradiological pollutants from uncontrolled runoff and effluent discharges from the Fernald Preserve, is regulated under the State-administrated NPDES program. Discharges in 2017 were in compliance with limits identified in the NPDES permit.
• Maintenance activities at the Converted Advanced Wastewater Treatment (CAWWT) backwash basin resulted in an unplanned release of wastewater until repairs could be made. Surface water samples were collected to assess the impact of the temporary leak, and analytical results indicated the release did not adversely impact the surface water quality beyond the CAWWT area.

**Natural Resources**

The focus of restored area maintenance activities in 2017 involved the use of prescribed burns and continued eradication of invasive species, including Amur honeysuckle (*Lonicera maackii*), using herbicide. In 2017, 74 acres of prairie vegetation were burned, including 25 acres of prairie vegetation on the OSDF cap. Erosion repair activities in the Wetland Mitigation Phase I area also occurred, along with repairing of a crossvane used for streambank stabilization in Paddys Run.

Ecological monitoring in 2017 consisted of wetland, prairie, and forest functional monitoring in the southern and eastern portions of the site, along with continued wetland mitigation monitoring and implementation monitoring within the North Woodlot Enhancement project. Results of the functional monitoring indicated ongoing establishment of native vegetation and wetland communities, although continued control of invasive species is recommended. DOE partnered with the U.S. Geological Survey and the U.S. Army Corps of Engineers to investigate innovative alternatives for monitoring restored areas. Several techniques were used and will be compared to evaluate effectiveness and efficiency. Results are anticipated in 2018.

Quarterly site and OSDF inspections continued in 2017. Findings focused mainly on invasive plants and woody vegetation on the cap of the OSDF; no major findings were identified. Debris also continues to be found, primarily in the former production and waste storage areas. Weather, erosion, and earth-moving activities occasionally reveal small pieces of debris that were not visible during remediation and restoration efforts. Examples of construction debris include pieces of concrete, rebar, clay tile, and metal. A total of 574 pieces of debris were found in 2017. Of those, three pieces (0.5%) were found to have fixed radiological contamination above background levels and were properly disposed of. A summary table of annual debris counts is provided in Appendix C.

Several surveys for endangered species, including running buffalo clover and spring coral root, were conducted in 2017 prior to field activities. No endangered plants were found during these surveys. Other activities associated with endangered species in 2017 included release of 115 pairs of the federally endangered American burying beetle (*Nicrophorus americanus*). DOE renewed the agreement with the U.S. Fish and Wildlife Service and Cincinnati Zoo in 2017 to release the beetles onsite through 2022. The agreement is part of an effort to reestablish populations of the beetle in the state of Ohio.

In 2017, there were no unexpected discoveries of cultural resources. Because all ground-disturbing field activities in 2017 occurred in previously surveyed areas, no archaeological surveys were necessary.
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 Facility Compliance Agreement, thus initiating the remedial investigation/feasibility study process under the National Contingency Plan.
1989 Uranium production suspended. The Fernald site was placed on the National Priorities List, 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 (ROD).
1996 The last operable unit's ROD was signed, signifying the end of the 10-year remedial investigation/feasibility study process. (The Operable Unit 4 ROD was later reopened.) 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 the On-Site Disposal Facility (OSDF) began. First waste placement began in December. Environmental monitoring and reporting were consolidated under the Integrated Environmental Monitoring Plan (IEMP).
1998 Operable Unit 2 remedial excavations began.
1999 Excavation of the waste pits began (Operable Unit 1 ROD), and the first rail shipment of waste 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 OSDF was capped. Remediation of the Operable Unit 2 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 offsite transfer of nuclear product material was completed. Wastes were placed in OSDF Cells 2 through 5.
2003 All major Operable Unit 2 remedial actions were completed. In addition, approximately 412,000 cubic yards of waste were placed in OSDF Cells 3 through 6.
2004 Removal of Silos 1 and 2 wastes from the silos to the holding tank facility began. 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. All eight cells of the OSDF were capped or received waste. Approximately 513,000 cubic yards were placed in Cells 4 through 6.
2005 Removal of Operable Unit 4, Silo 3 waste began and the first shipment of this 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 With the exception of groundwater remediation, site remediation was completed October 29, 2006. The site was officially transferred to 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. The community was allowed unescorted access to the Fernald Preserve.
2012 The throughput capacity of the Converted Advanced Wastewater Treatment Facility (CAWWT) was reduced from 1,600 gallons per minute (gpm) to 500–600 gpm.
2014 On July 1, 2014, a new groundwater remediation operational design was implemented (DOE 2014). The target system pumping rate was 300 gpm higher than the previous design and accelerated cleanup.
2015 The decision to reduce wastewater treatment capacity to 50 gpm was made.
2017 Completed removal of treatment media, demolition of existing piping and tanks to allow room for the new wastewater treatment capacity within CAWWT, and design of the new system which began in 2016. Low-level radioactive waste from the demolition project was disposed of at Waste Control Specialists in Texas. Construction of the new treatment system began.

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 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) 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 (Title 42 United States Code Section 9601 [42 USC 9601] et seq.). 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) ushered in by the successful transition to the DOE Office of Legacy Management (LM) in late 2006, with the new mission to be an asset to the community as an undeveloped park, with an emphasis on wildlife.

DOE’s Legacy Management 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 (Ohio EPA) provide regulatory oversight.

In the 1980s, the goals of environmental monitoring 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.

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, in 1997 the environmental monitoring program was revised to align with the remediation activities planned for the Fernald site. The site’s environmental monitoring program is described in the “Integrated Environmental Monitoring Plan” (IEMP), which is Attachment D of the Comprehensive Legacy Management and Institutional Controls Plan (LMICP) (DOE 2018). The environmental monitoring program is designed 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 2017 Site Environmental Report summarizes the findings from the monitoring program and provides a status on the progress toward final site restoration. This report consists of the following:

**Summary Report:** The summary report (Sections 1.0 through 5.0) documents the results of environmental monitoring activities at the Fernald Preserve in 2017. It includes a discussion of ongoing groundwater remediation activities and summaries of environmental data from groundwater, surface water and effluent, and natural resources monitoring programs. It also summarizes the information contained in the appendixes. A glossary is included at the end of the summary report.

**Appendixes:** The detailed appendixes provide the 2017 environmental monitoring data for the various media, primarily in the form of graphs, figures, and tables. The appendixes are generally distributed only to the regulatory agencies. However, a complete copy of the appendixes is available on the LM website at https://www.lm.doe.gov/fernald/Sites.aspx or by contacting LM at (513) 648-3333; Navarro Research and Engineering, Inc. Public Affairs at (513) 648-6000; or sending an email to fernald@lm.doe.gov.
The remainder of this introductory section 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 and ecological characteristics of the area.

1.1 The Path to Site Closure

In 1986, the Fernald site initiated 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, in 1991 the site was organized into five operable units. The purpose of the operable unit concept under CERCLA was to organize site components by geographical location and 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 (RODs) for all five operable units. However, several of the RODs (including those for Operable Units 1, 4, and 5) have subsequently been modified through issuance of Explanation of Significant Difference documents or ROD Amendment documents. These documents were prepared, submitted for EPA and public review, and issued in accordance with CERCLA regulations. Following approval of the initial RODs, work began on the design and implementation of the operable unit remedies. Table 1 describes each operable unit and gives an overview of its associated remedy.
### Table 1. Operable Unit Remedies

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<th>Description</th>
<th>Remedy Overview</th>
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| 1             | Waste Pits 1–6  
• Clear well  
• Burn pit  
• Berms, liners, caps, and soil within the boundary  
ROD approved: March 1995  
Explanation of Significant Differences approved: September 2002  
ROD Amendment approved: November 2003  
Excavation of materials with constituents of concern above final remediation levels (FRLs), waste processing and treatment by thermal drying (as necessary), offsite disposal at a permitted facility, and soil remediation/certification.  
**Remedial actions completed: June 2005**  
**Final Remedial Action Report approved: August 2006** |
| 2             | Solid waste landfill  
• Inactive fly ash pile  
• Active fly ash pile (now inactive)  
• North and South Lime Sludge Ponds  
• Other South Field areas  
• Berms, liners, and soil within the operable unit boundary  
ROD approved: May 1995  
Post-ROD fact sheet approved: April 1999  
Excavation of all materials with constituents of concern above FRLs, treatment for size reduction and moisture control as required, onsite disposal in the OSDF, and offsite disposal of excavated material that exceeded the waste acceptance criteria for the OSDF.  
**Remedial actions completed: June 2006**  
**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:  
• All structures, equipment, utilities, effluent lines, and K-65 transfer line  
• Wastewater treatment facilities  
• Fire training facilities  
• Coal pile  
• Scrap metals piles  
• Drums, tanks, solid waste, waste product, feedstocks, and thorium  
ROD for Interim Remedial Action approved: June 1994  
ROD for Final Remedial Action approved: August 1996  
Adoption of Operable Unit 3 Interim ROD; alternatives to disposal through the unrestricted or restricted release of materials as economically feasible for recycling, reuse, or disposal; treatment of material for onsite or offsite disposal; required offsite 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 onsite disposal for material that meets the OSDF waste acceptance criteria.  
Post-ROD fact sheet that identifies clean buildings, structures, and materials for beneficial reuse under LM approved: December 2006.  
**Remedial actions completed: October 2006**  
**Final Remedial Action Report approved: February 2007** |
Table 1 (continued). Operable Unit Remedies

<table>
<thead>
<tr>
<th>Operable Unit</th>
<th>Description</th>
<th>Remedy Overview</th>
</tr>
</thead>
</table>
| 4             | • Silos 1 and 2 (containing K-65 residues; demolished in 2005)  
• Silo 3 (containing cold metal oxides; demolished in 2006)  
• Silo 4 (empty and never used; demolished in 2003)  
• Decant tank system  
• Berms and soil within the operable unit boundary | ROD approved: December 1994  
Explanation of Significant Differences for Silo 3 approved: March 1998  
ROD Amendment for Silos 1 and 2 approved: July 2000  
ROD Amendment for Silo 3 approved: September 2003  
Explanation of Significant Differences for Silos 1 and 2 approved: November 2003  
Explanation of Significant Differences for Operable Unit 4 approved: January 2005  
Removal of Silo 3 materials for treatment and Silos 1 and 2 residues and decant sump tank sludges with onsite stabilization of materials, residues, and sludges followed by offsite disposal. Excavation of silos area soils contaminated above the FRLs with onsite 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 offsite.  
Remedial actions for Silo 3 completed: April 2006  
Remedial actions involving the completion of the shipment of stabilized Silos 1 and 2 material to a temporary storage facility in Texas were completed in May 2006.  
Permanent disposal of the 3,776 containers of Silos 1 and 2 material began on October 7, 2009, and the last container was placed on November 2, 2009. |
| 5             | • Groundwater  
• Surface water and sediments  
• Soil not included in the definitions of Operable Units 1 through 4  
• Flora and fauna | ROD approved: January 1996  
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 as both the FRL for groundwater remediation and the monthly average uranium effluent discharge limit to the Great Miami River.  
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 presented an unacceptable threat through contaminant migration to the underlying aquifer. Onsite disposal of contaminated soil and sediment that met the OSDF waste acceptance criteria. Soil and sediment with contaminant concentrations 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 offsite facility. Also includes site restoration, institutional controls, and post-remediation maintenance.  
Interim Remedial Action Report approved: August 2008 |

1.2 Environmental Monitoring Program

In the 1980s, DOE initiated an environmental monitoring program to assess the impact of past operations on the environment and to monitor potential exposure pathways to the local community. Additionally, for nearly 10 years DOE conducted characterization activities at the
Fernald site 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 progressed. 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 effluent, and natural resources. In general, the primary exposure pathway is monitored, and the program focuses on assessing the effect 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. 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.
- The IEMP is reviewed annually and revised as necessary to ensure that the monitoring program adequately addresses monitoring requirements.
- 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 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 crop farming and gravel pit excavation operations. There also is a private water utility approximately 2 miles east of the Fernald Preserve that pumps groundwater primarily for industrial use.

Downtown Cincinnati is approximately 18 miles southeast of the Fernald Preserve (Figure 1). The cities of Fairfield and Hamilton are 6 and 8 miles to the east and northeast, respectively (Figure 2). Scattered residences and several villages, including Fernald, New Baltimore, New Haven, Ross, and Shandon, are also located near the site.
1.3.2 Geography

Figure 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 occupied approximately 136 acres in the center of the site and the OSDF occupies approximately 120 acres. 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.
Figure 2. Major Communities in Southwestern Ohio
Figure 3. Fernald Preserve Perspective
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) 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 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 and transport contaminants 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 4 provides a view of the structure of subsurface deposits in the region along an east-west cross section beneath the site and through the New Haven Trough and Figure 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 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 Pits Area. Paddys Run empties into the Great Miami River 1.5 miles south of the site. The Great Miami River, 0.6 mile east of the Fernald Preserve, runs in a southerly direction and flows into the Ohio River about 24 miles 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 2017 was 5,062 cubic feet per second. This average is based on daily measurements collected at the U.S. Geological Survey Hamilton stream gauge (USGS 3274000) approximately 10 river miles upstream of the site’s effluent discharge.
Figure 4. Schematic Cross Section of the New Haven Trough, Looking North
Figure 5. Regional Groundwater Flow in the Great Miami Aquifer
Figure 6. Southern Portion of the Great Miami River Drainage Basin
In 2017, 46.93 inches of precipitation were measured at the Butler County Regional Airport. This measurement, which represents precipitation at the site, is higher than the average annual Cincinnati area precipitation of 41.30 inches for 1951 through 2017. Figure 7 shows the total annual precipitation recorded at the Fernald Preserve for each year from 1991 through 2017 and the annual precipitation for the Cincinnati area from 1951 through 2017. Figure 8 shows monthly precipitation at the site for 2017, compared to the Cincinnati area average monthly precipitation from 1951 through 2017.

1.3.5 Natural Resources

Natural resources have important aesthetic, ecological, economic, educational, historical, recreational, and scientific value to the United States. Their establishment and protection is an ongoing process at the Fernald Preserve. Section 5.0 discusses the site’s diverse natural and cultural resources, and it summarizes 2017 ecological restoration projects, along with results of inspection, monitoring, and maintenance activities.
Average annual precipitation for the Cincinnati area is 41.3 inches for 1951-2017.

Figure 7. Cincinnati Area Annual Precipitation, 1991–2017
Figure 8. Monthly Precipitation for 2017 Compared to Average Monthly Precipitation for 1951–2017
2.0 Remediation Status and Compliance Summary

This section provides a summary of CERCLA remediation activities in 2017 and summarizes compliance activities with other applicable environmental laws, regulations, and legal agreements. Compliance under CERCLA dictates the environmental remediation of the Fernald Preserve.

EPA and Ohio EPA 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 Ohio EPA.

For some programs, such as those under the Resource Conservation and Recovery Act (RCRA), as amended (42 USC 6901 et seq.), the Clean Air Act, as amended (42 USC 7401 et seq.), excluding National Emissions Standards for Hazardous Air Pollutants compliance, and the Clean Water Act, as amended (33 USC 1251 et seq.), EPA has authorized the State of Ohio to act as the primary enforcement authority. For these programs, the State of Ohio promulgates state regulations that must be at least as stringent as federal requirements. Several legal agreements among DOE, EPA Region 5, and Ohio EPA 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 and compliance agreements.

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 remaining active remediation involves the ongoing groundwater remedy under Operable Unit 5. Activities under CERCLA during 2017 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 (AR), is available online at https://www.lm.doe.gov/CERCLA_Home.aspx. The original and a copy of the AR are located in the records warehouse at the LM Business Center in Morgantown, West Virginia. The Fernald Preserve records staff can be contacted by phone at (513) 648-3106 for assistance in searching for a document in the CERCLA AR. The CERCLA AR is updated as new documents are created.

The completion and closure of a National Priorities List (NPL) site encompasses several milestones and specific documentation requirements for each milestone completed (EPA 2011). 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 completion (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 RODs 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).

DOE has prepared, and both EPA and Ohio EPA have approved, Final Remedial Action Reports for Operable Units 1, 2, 3, and 4. EPA approved the Interim Remedial Action Report for Operable Unit 5 (DOE 2008) in August 2008. That report detailed the ongoing aquifer restoration activities and provided information indicating that all required groundwater infrastructure had been installed and was functioning as designed. Furthermore, 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. DOE will develop that report once groundwater actions are complete and all soils and infrastructure associated with the groundwater remedy have been adequately addressed (estimated completion date in 2039, based on modeling projections reported in the 2014 Operational Design report [DOE 2014]). EPA issued the Preliminary Closeout Report U.S. DOE Feed Materials Production Center, Fernald, Ohio (EPA 2006) in December 2006. The estimated duration for certifying the last area of the aquifer as being clean and the estimated duration required to remove the wellfield infrastructure can be found in the Fernald Groundwater Certification Plan (DOE 2006a).

CERCLA (Section 121(c)) also requires a 5-year review process of remedial actions implemented under the signed ROD 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. EPA approved the first 5-year review report for the Fernald Preserve (DOE 2001c) in September 2001. The second 5-year review report was submitted in April 2006 (DOE 2006b) and approved by EPA in September 2006. The third 5-year review report was submitted to EPA in March 2011 (DOE 2011) and approved by EPA in August 2011. The fourth 5-year review began in 2015 and was approved by EPA in September 2016 (DOE 2016b). The fifth 5-year review will begin in 2020.

CERCLA remediation highlights during 2017 included the following:

• The performance of the OSDF was satisfactory during 2017. The OSDF underwent five formal inspections. Minor maintenance of the cap and associated drainages continues. Activities include removal of small trees and shrubs, spot herbicide application on woody stumps and other invasive plant species, and repairing animal burrows. Through 2015, cap maintenance involved mowing, raking, and baling the cells on a 3-year rotation. Raking and baling the cap generates a large number of hay bales that must remain onsite. Pursuant to the LMICP, the preferred approach to OSDF cap management is to conduct prescribed burns. After receiving approval from key stakeholders, the first burn of the vegetation on the OSDF occurred in March of 2016 when vegetation on the caps of Cells 4, 5, and 6 was successfully burned. The second prescribed burn of the vegetation on the OSDF occurred in March of 2017 when the vegetation on the caps of Cells 7 and 8 was successfully burned. Follow-up evaluations of vegetation after both burns indicate that the vegetation is responding well to the controlled burns. Leachate generation has continued to decline and liner performance is
meeting design requirements. Leachate/leak detection performance is discussed in Section 3.0. Cap performance is discussed further in Section 5.0.

- Figure 9 indicates 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. Weekly surface water monitoring continued in 2017. This issue is further discussed in Section 4.0. The Paddys Run streambank stabilization project was completed in 2016 to prevent migration of Paddys Run into this area. A repair to replace several boulders on an in-stream crossvane that were dislodged during 2016 flooding occurred in 2017.

- Monitoring and maintenance of ecologically restored areas continued during 2017 and all required site inspections were performed. Inspection findings in 2017 were similar to those of previous years and consisted mainly of the presence of invasive vegetation and deer exclosure fencing that was damaged by fallen trees and limbs. Debris also continues to be found, primarily in the Former Production Area and former Waste Pits Area. Minor violations of the institutional controls established in the LMICP included occasional instances of hikers straying off trail. Restoration activities included the erosion repair in the Wetland Mitigation, Phase I project area. Section 5.0 includes further discussion of the restored area activities and the site inspection process.

- For 2017, the ongoing groundwater remedy resulted in extraction of 2,462 million gallons (Mgal) of groundwater from the Great Miami Aquifer and removal of 503 lb of uranium from the aquifer. Section 3.0 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 ROD 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 2017.

The regulations discussed in this section have been identified as ARARs within the RODs. The Fernald Preserve must comply with these regulations while site remediation under CERCLA is underway; compliance is enforced by EPA and Ohio EPA. 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 (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. EPA has authorized Ohio 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 to the Consent Decree between the State of Ohio and DOE, and a series of Director’s Final Findings and Orders issued by Ohio EPA.

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 alternative 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. Section 3.3.2 provides a more detailed discussion of groundwater monitoring program for the property boundary.

2.2.1.2 Waste Management

Although the RCRA regulations remain applicable, the Fernald Preserve had no hazardous waste treatment, storage, or disposal activities during 2017. Wastes managed during 2017 were limited to universal waste, uncontaminated solid wastes, and low-level radioactive wastes. Wastewater from the OSDF is managed through the Clean Water Act.

Between November 2016 and January 2017, 38 containers of low-level radioactive waste were transported via 14 separate shipments to Waste Control Specialists in Texas for disposal. The low-level radioactive waste was generated as a result of the Converted Advanced Wastewater Treatment (CAWWT) facility demolition project (Section 3.3.1.1). Debris that was discovered during site inspections and construction projects (Section 5.2) was also included in the shipments to Waste Control Specialists. The total volume shipped was 10,343 cubic feet. The total weight shipped was 268 tons, and the total radioactivity was 0.381 curie, with ranges from 0.000694 to 0.0962 curie per shipment. The remaining work associated with the CAWWT project to be completed in 2018 is expected to create a lower volume of additional low-level radioactive waste. The radioactivity levels of the waste will be similar to that shipped in late 2016 and early 2017.

2.2.2 Clean Water Act

Under the Clean Water Act, as amended, the Fernald Preserve is governed by 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 for storm water and wastewater, specifies discharge and sample locations, sampling and reporting schedules, and discharge limitations. The Fernald Preserve submits monthly reports on NPDES activities to Ohio EPA demonstrating compliance with stipulated discharge limits.

The current NPDES permit for the site took effect on March 1, 2015. There were no instances of noncompliance at any of the permitted outfalls in 2017. Required storm water inspections were conducted and no issues were identified. A permit-to-install was granted by Ohio EPA to proceed with the Fernald Preserve wastewater optimization project that is downsizing the wastewater treatment capacity. There will be no changes to discharge sampling or reporting schedules or discharge limitations.
Figure 9. Uncertified Areas and Subgrade Utility Corridors
2.2.3 **Clean Air Act**

Ohio EPA is authorized to enforce the State of Ohio’s air standards for particulate matter at the Fernald Preserve. DOE maintains compliance by implementing the Fugitive Dust Control Policy negotiated between DOE and Ohio EPA 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 Ohio EPA, to the local emergency planning committees of Hamilton and Butler counties, and to the Crosby Township Fire Department on February 26, 2018, stating that the Fernald Preserve was not required to submit the SARA Title III Section 312 Emergency and Hazardous Chemical Inventory Report for 2017. During 2017, 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 used or 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 usage or releases have exceeded the threshold for several years at the Fernald Preserve, and no chemical exceeded a reporting threshold during 2017.

Also under SARA Title III, any offsite 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. DOE evaluates and documents all releases that might occur at the Fernald Preserve 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. During 2017, there were no releases at the Fernald Preserve that met the reporting criteria.

2.2.5 **Other Environmental Regulations**

In addition to those described above, the Fernald Preserve is also required to comply with other environmental laws and regulations. Table 2 summarizes compliance with each of these requirements for 2017.
### Table 2. Compliance with Other Environmental Regulations

<table>
<thead>
<tr>
<th>Regulation and Purpose</th>
<th>Background Compliance Issues</th>
<th>2017 Compliance Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Toxic Substances Control Act</strong></td>
<td>EPA Region 5 conducted the last routine Toxic Substances Control Act (7 USC 136 et seq.) inspection of the Fernald Preserve’s program on September 21, 1994. No violations of PCB regulations were identified during the inspection.</td>
<td>No PCB liquids or items were used, stored, or shipped in 2017.</td>
</tr>
<tr>
<td><strong>Ohio Solid Waste Act</strong></td>
<td>The Fernald Preserve was registered with Ohio EPA as a generator of infectious waste (generating more than 50 lb per month) until December 6, 1999, when Ohio EPA concurred with the Fernald Preserve’s qualification as a small quantity generator.</td>
<td>No infectious waste was generated in 2017.</td>
</tr>
<tr>
<td><strong>Federal Insecticide, Fungicide, and Rodenticide Act</strong></td>
<td>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 of the mandated Act.</td>
<td>Pesticide applications at the Fernald Preserve were conducted according to federal and state regulatory requirements.</td>
</tr>
<tr>
<td><strong>National Environmental Policy Act</strong></td>
<td>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 the National Environmental Policy Act, Title 10 Code of Federal Regulations Section 1021. The assessment requires DOE to consult the public before making any decisions on land use; it includes previous DOE commitments.</td>
<td>No National Environmental Policy Act activities were required in 2017.</td>
</tr>
</tbody>
</table>
| **Endangered Species Act**                                                             | 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 onsite:  
  - Cave salamander (*Eurycea lucifluga*), state endangered, marginal habitat—small limestone outcrops and streams—none found.  
  - Sloan’s crayfish (*Orconectes sloanii*), state-threatened—found on northern sections of Paddys Run.  
  - Indiana bat (*Myotis sodalis*), federally endangered—found in northern wooded areas along Paddys Run.  
  - Northern long-eared bat (*Myotis septentrionalis*), federally threatened—potential habitat within northern wooded areas along Paddys Run—none found.  
  - Running buffalo clover (*Trifolium stoloniferum*), federally endangered—potential habitat on disturbed areas along Paddys Run—none found.  
  - Spring coral root (*Corallorhiza wisteriana*), state-threatened—potential habitat within northern wooded areas—none found.  
  - American burying beetle (*Nicrophorus americanus*), federally endangered—potential habitat within a variety of restored areas—released as part of ongoing recovery efforts—two found in Former Production Area. | A survey for running buffalo clover was conducted in May 2017, prior to the Wetland Mitigation Phase I erosion repair project, with none found. A survey for running buffalo clover and spring coral root was also conducted in May 2017 prior to tree and shrub clearing in the northern portion of the site, with none found. Potential impacts to Sloan’s crayfish, Indiana bat and northern long-eared bat were avoided by delaying the timing of field activities.  
  DOE signed a five-year Cooperative Agreement with the U.S. Fish and Wildlife Service and the Cincinnati Zoo to introduce the federally endangered American burying beetle to the Fernald Preserve through 2018 (DOE 2012a). A release of 115 pairs of beetles occurred in June and July 2017. The cooperative agreement was renewed in October 2017, extending annual releases through 2022 (DOE 2017). |
Table 2 (continued). Compliance with Other Environmental Regulations

<table>
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<th>Regulation and Purpose</th>
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</thead>
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<td><strong>National Historic Preservation Act</strong></td>
<td>The Fernald Preserve is located in an area of sensitive historic and prehistoric cultural resources that are eligible for or are listed on the National Register of Historic Places. These cultural resources include historic structures, buildings, and bridges, plus Native American villages and campsites.</td>
<td>No archaeological surveys were required in 2017. No unexpected cultural discoveries were identified in 2017.</td>
</tr>
<tr>
<td><strong>Native American Graves Protection and Repatriation Act</strong></td>
<td>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.</td>
<td>No Native American remains were discovered or repatriated to Native American nations, tribes, or groups in 2017.</td>
</tr>
</tbody>
</table>
Table 2 (continued). Compliance with Other Environmental Regulations

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<tr>
<td><strong>Natural Resource Requirements Under CERCLA and Executive Order 12580</strong></td>
<td>DOE and the other trustees, which include Ohio EPA 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 Community Alliance, which is a stakeholder organization that works to promote the Fernald Preserve as an asset to the community. In November 2008, the State of Ohio and DOE reached a settlement of the 1986 natural resource injury claim at the Fernald site. While the components of restoration had been established through a 2001 Memorandum of Understanding (DOE 2001d), the State of Ohio and DOE settled outstanding issues such as the payment of monetary penalties, establishment of environmental covenants, and a mutually agreed-upon “Natural Resource Restoration Plan” (NRRP), which is Appendix B of the Consent Decree Resolving Ohio’s Natural Resource Damage Claim against DOE (State of Ohio 2008). In 2009, activities commenced as required in the final NRRP.</td>
<td>Activities in 2017 included continuation of functional monitoring and wetland mitigation monitoring, as required by the Fernald Preserve Wetland Mitigation Monitoring Report (DOE 2012c). Functional monitoring in 2017 involved an evaluation of wetland, prairie, and forest communities across the southern and eastern portions of the site. Section 5.0 provides a summary of Trustee activities and monitoring data.</td>
</tr>
</tbody>
</table>
2.2.6 Permits and Licenses

Certain environmental regulations are implemented through permits. The Fernald Preserve’s permit for discharging water under NPDES regulations is discussed in Section 2.2.2. In addition, the Fernald Preserve maintains permits administered through the U.S. Fish and Wildlife Service and the Ohio Department of Natural Resources for collection of wildlife specimens. A permit is also in place to remove Canada goose nests, if necessary. Burn-ban waivers and permits are secured for prescribed burning activities as well. Site personnel maintain a commercial pesticide applicator license in order to apply herbicide at the Fernald Preserve. These activities are discussed in Section 5.0.

2.2.7 Federal Facility 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 EPA, Ohio EPA, and the Ohio Department of Health. The sampling program conducted to address this requirement has been modified over the years and is currently governed by an agreement reached with EPA and Ohio EPA on May 1, 1996. These data are reported in Appendix A.

• Maintain a continuous sample collection program for radiological constituents at the effluent discharge point and report the results to EPA, Ohio EPA, 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 Ohio EPA that became effective May 1, 1996 (DOE 1996a). These data are reported in Appendix B. Appendix B also includes a discussion associated with the proposed elimination of radium-228 sampling and analysis in the site’s effluent. Radium-228 was added to the effluent monitoring program in 1997 in the first IEMP for the site (DOE 1997b).

2.3 Split Sampling Program

Since 1987, DOE has participated in the split sampling program with Ohio EPA. 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 close as possible to being identical. The split samples are then submitted to two analytical laboratories; this allows for an independent comparison of data to ascertain quality assurance for laboratory analysis and field sampling methods. Ohio EPA occasionally performs independent sampling in addition to split sampling.

In 2017, DOE and Ohio EPA cooperated in the split sampling program. Table 3 provides the analytical results of split groundwater samples and Figure 10 shows the split sample locations.
### Table 3. 2017 DOE and Ohio EPA Groundwater Split Sampling Comparison

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>2017 Sample Date</th>
<th>Constituent</th>
<th>DOE Result (µg/L)</th>
<th>Ohio EPA Result (µg/L)</th>
<th>FRL (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2060</td>
<td>May</td>
<td>Total Uranium</td>
<td>27.9</td>
<td>27.4</td>
<td>30</td>
</tr>
<tr>
<td>2060</td>
<td>November</td>
<td>Total Uranium</td>
<td>33.2</td>
<td>35.7</td>
<td>30</td>
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<tr>
<td>13</td>
<td>May</td>
<td>Total Uranium</td>
<td>3.02</td>
<td>3.85</td>
<td>30</td>
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<tr>
<td>13</td>
<td>November</td>
<td>Total Uranium</td>
<td>2.86</td>
<td>4.29</td>
<td>30</td>
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<tr>
<td>14</td>
<td>May</td>
<td>Total Uranium</td>
<td>3.96</td>
<td>2.49</td>
<td>30</td>
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<tr>
<td>14</td>
<td>November</td>
<td>Total Uranium</td>
<td>3.83</td>
<td>4.02</td>
<td>30</td>
</tr>
</tbody>
</table>

* Refer to Figure 10 for groundwater split sample locations.

µg/L = micrograms per liter.

* The groundwater pathway and final remediation levels (FRLs) are discussed in Section 3.0.
Figure 10. DOE and Ohio EPA Groundwater Split Sample Locations
### 3.0 Groundwater Pathway

<table>
<thead>
<tr>
<th>Results in Brief: 2017 Groundwater Pathway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Groundwater Remedy</strong></td>
</tr>
<tr>
<td>Since 1993</td>
</tr>
<tr>
<td>• 46,128 Mgal of water have been pumped from the Great Miami Aquifer.</td>
</tr>
<tr>
<td>• 13,733 net lb of uranium have been removed from the Great Miami Aquifer.</td>
</tr>
<tr>
<td><strong>During 2017</strong></td>
</tr>
<tr>
<td>• 2,462 Mgal of water were pumped from the Great Miami Aquifer.</td>
</tr>
<tr>
<td>• 503 lb of uranium were removed from the Great Miami Aquifer.</td>
</tr>
</tbody>
</table>

**Groundwater Monitoring Results**—Data collected in 2017 show continued progress in reducing uranium concentrations and that the pumping wells were capturing the uranium plume. Between 2016 and 2017:

- The footprint of the greater than or equal to 30 µg/L total uranium plume was reduced by 10.6 acres (10.1%).
- The footprint of the greater than or equal to 50 µg/L total uranium plume was reduced by 5.5 acres (8.8%).
- The footprint of the greater than or equal to 100 µg/L total uranium plume was reduced by 2.4 acres (7.6%).

During 2017, the wellfield underwent an annual planned shutdown that lasted for 29 days (May 15, 2017, to June 12, 2017).

**OSDF Monitoring**—In 2017, Great Miami Aquifer wells of each of the 8 cells were sampled semiannually for 13 parameters. The leachate collection system, leak detection system, and horizontal till well of each cell was sampled semiannually for uranium, boron, sodium, and sulfate. Flow data from the 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 2017.

This section 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 2017.

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 be monitored following remediation according to the [Fernald Groundwater Certification Plan](DOE 2006a).

#### 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/locaton 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 once EPA and Ohio EPA concurrence is obtained. Monitoring data are then collected after the changes to verify whether model predictions were correct. If model predictions prove to be incorrect, modifications may be made to the model to improve its predictive capabilities.

The Remedial Investigation Report for Operable Unit 5 (DOE 1995d) described the nature and extent of groundwater contamination from operations at the Fernald site and evaluated the risk to human health and the environment from those contaminants. 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 (PPDD), and the old drainage ditch from the Plant 1 Pad. 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.
Figure 11 shows the worst case (most conservative) footprint of the 30 micrograms per liter (µg/L) uranium plume within the aquifer from the second half of 2017 as well as the current active restoration modules involved in the groundwater remedy. The current active restoration modules are represented by the cross-hatched areas on the figure as well as the extraction wells that belong to each module.

### 3.2 Selection and Design of the Groundwater Remedy

While a remedial investigation/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 11 shows South Plume Module extraction wells 3924, 3925, 3926, and 3927. These extraction wells have successfully stopped further southward migration of the uranium plume beyond the wells and have contributed to significantly reducing total uranium (i.e., sum of all of the isotopes of uranium, measured in µg/L) 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 1995d), various remediation technologies were evaluated in the *Feasibility Study Report for Operable Unit 5* (DOE 1995a). Remediation cost 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. Groundwater modeling suggested that the 28 extraction wells pumping at a combined rate of 4,000 gallons per minute (gpm) would remediate the aquifer within 27 years.

The recommended groundwater remedy, which included EPA, Ohio EPA, and community acceptance, was presented in the *Proposed Plan for Operable Unit 5* (DOE 1995c) 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 1996b) was issued. The OU5 ROD formally defines the selected groundwater remedy and establishes final remediation levels (FRLs) for all constituents of concern.
Figure 11. Extraction Wells Active in 2017
Reinjection at the Fernald Site

From 1998 to 2004, reinjection 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 reinjection wells. Groundwater pumped from the aquifer was treated via ion exchange to remove contaminants and then reinjected into the aquifer at strategic well locations. Because the treatment process was not 100% efficient, a small amount of uranium was reinjected into the aquifer with the treated water. The reinjected 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 reinjection 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 1997a).

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

Evolution of the enhanced groundwater remedy has been documented through a series of approved designs. These designs are:

- Operable Unit 5 Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) (DOE 1997a)
- Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2001a)
- Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module (DOE 2002)
- Groundwater Remedy Evaluation and Field Verification Plan (DOE 2004)
- Waste Storage Area Phase II Design Report and Addendum (DOE 2005b)
- Operational Design Adjustments-1, WSA Phase-II Groundwater Remediation Design, Fernald Preserve (DOE 2014)

The enhanced groundwater remedy commenced in 1998 with the startup of the South Field (Phase I), the South Plume Optimization, and the Reinjection 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 yearlong reinjection demonstration that began in September 1998. Through the years, extraction and reinjection wells have been added and removed from these initial restoration modules.

In 2001, EPA and Ohio EPA approved the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2001a). 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 PPDD 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 (well 32761) was installed in 2000 to support an aquifer pumping test to help determine the restoration wellfield design. The remaining two Phase I wells (well 33062 and well 33063) were installed in summer 2001 after EPA and Ohio EPA approved the design. All three wells became operational on May 8, 2002. Well 33063 was abandoned in 2004 to facilitate site remediation work. A replacement well (well 33334) was installed and began operating in 2006. Figure 11 shows the existing well locations.

The Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2001a) 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 (well 2389) in the area having sporadic total uranium FRL exceedances. Figure 12 shows the location of monitoring well 2389.

In 2002, EPA and Ohio EPA approved the next planned groundwater restoration design document, the Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module (DOE 2002). The Phase II design presents an updated interpretation of the uranium plume in the South Field area along with recommendations on how to proceed with remediation in the area, based on the updated plume interpretation. Installation of Phase II components began 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, DOE held initial discussions 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 Ohio EPA 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 2004, EPA and Ohio EPA approved the decision to reduce the size of the advanced wastewater treatment facility and in June 2004 approved the decision to discontinue the use of well-based reinjection. Reducing the size of the advanced wastewater treatment facility provided the opportunity to dismantle and dispose of approximately 90% 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 reinjection 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
Figure 12. Locations for Semiannual Total Uranium Monitoring
input. The updated modeling also indicated that continued use of the groundwater reinjection wells would shorten the aquifer remedy by approximately 3 years. Therefore, the benefit of continuing reinjection did not justify the cost. Well-based reinjection was discontinued in September 2004 to support construction of the CAWWT facility. All reinjection wells remain in place as potential groundwater remedy performance monitoring locations.

In 2005, the *Waste Storage Area Phase II Design Report* (DOE 2005b) was issued. Comments received from EPA and Ohio EPA resulted in the issuance of an addendum to the report in December 2005. The design consisted of the installation of one more extraction well (well 33347) in the former Waste Storage Area, near the Former Silos Area. Figure 11 shows the location of well 33347.

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 to obtain the overall infiltration rate along the SSOD. Findings from the test were included in the *Storm Sewer Outfall Ditch Infiltration Test Report* (DOE 2005a). The decision was made that pumped, clean groundwater would supplement natural storm water flow into the SSOD. This activity continued from 2006 through 2012, when DOE concluded that enough data had been collected to document infiltration rates through the base of the SSOD. Under normal flow conditions, potential infiltration to the aquifer from within the monitored portion of the SSOD (while flowing at or near 500 gpm) is approximately 109–129 gpm. With Ohio EPA and EPA concurrence, supplemental pumping of clean groundwater to the ditch was stopped and the flumes were removed in 2013 to allow water to flow down the SSOD unencumbered by the flumes. The rapid movement of water through the ditch during storm events will help to scour the ditch channel of fine-grained sediment and is expected to increase the potential for infiltration.

The *Fernald Groundwater Certification Plan* (DOE 2006a) 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 Ohio EPA. Approved by EPA and Ohio EPA, the *Fernald Groundwater Certification Plan* 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 construction brought the total number of extraction wells in the former Waste Storage Area to four (wells 32761, 33062, 33334, and 33347). These four well locations are shown in Figure 11.

In 2014, with approval from EPA and Ohio EPA, DOE implemented operational changes to the groundwater remedy. Three wells no longer providing benefit to the groundwater remediation were shut down. The freed-up pumping budget was reallocated to the South Plume and South Field to accelerate cleanup of those areas. The operational changes were based on groundwater modeling results reported in 2014 (DOE 2014). The new 2014 design is referred to in this report as the current Operational Design and was implemented on July 1, 2014. Figure 11 shows the extraction well locations. The following subsections present the operational information associated with these modules.
3.3 Groundwater Monitoring Highlights for 2017

For this annual Site Environmental 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.

As part of the comprehensive groundwater monitoring program specified in the current IEMP, 94 wells were monitored for water quality in 2017. Figure 12 identifies the location of the current water quality sampling locations for uranium. Figure 13 is a diagram of a typical groundwater monitoring well. Figure 14 illustrates relative monitoring well depths and screen locations. Figure 15 indicates the locations for non-uranium monitoring. In addition to water quality monitoring, 178 wells are used to measure groundwater elevations to verify groundwater flow direction. Figure 16 depicts the routine water-level (groundwater elevation) monitoring wells.

Figure 14 illustrates that there are six different types of monitoring wells (i.e., Type 1, 2, 3, 4, 6, and 8). Monitoring well types 1, 2, 3, 4, and 6 are single-level monitoring wells with a well screen that is either 10 or 15 ft in length. Type 8 monitoring wells are multi-channel monitoring wells that contain 3 to 6 individual 10 ft screens. The Type 8 multi-channel monitoring wells provide for sampling a depth profile at a single location. The single-level wells monitor a single 10 ft depth. As summarized below, the location of the monitoring depth is identified by the first digit in the well identification number.

- **Type 1** – Screen positioned in perched groundwater in the glacial overburden
- **Type 2** – Screen positioned at the water-table zone of the Great Miami Aquifer
- **Type 3** – Screen positioned above a clay layer in the Great Miami Aquifer
- **Type 4** – Screen positioned below a clay layer in the Great Miami Aquifer
- **Type 6** – Screen positioned at a depth that is between a Type 2 and Type 3

Additionally, 27 locations were sampled using a direct-push sampling tool in 2017. Results are provided in Appendix A, Attachment A.2.

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

**Reporting:** All data are reported in the annual Site Environmental Reports.
Figure 13. Diagram of a Typical Groundwater Monitoring Well

- Locking Cap and Padlock
- Vent Hole
- Protective Casing
- Inner Well Cap
- Weep Hole
- Ground Surface
- Casing
- Grout (prevents surface water infiltration and holds and protects casing)
- Plug (prevents grout from entering sandpack)
- Sandpack
- Screen (allows formation water to enter well, holds back sandpack)
- Coupling
- Sump (collects fine-grain sediment)
- Bottom Cap

* Not Drawn to Scale
Figure 14. Monitoring Well Screen Locations
Figure 15. Locations for Non-Uranium Monitoring
Figure 16. Groundwater Elevation Monitoring Wells
3.3.1 Restoration Monitoring

The OU 5 ROD (DOE 1996b) states that “areas of the Great Miami Aquifer exceeding final remediation levels will be restored through extraction methods.” Uranium is the primary constituent of concern for groundwater. The groundwater FRL for total uranium is 30 µg/L. The background total uranium concentration for unfiltered groundwater samples from the Great Miami Aquifer near the Fernald Preserve is 1.2 µg/L (DOE 1994). Both the area of the aquifer targeted for remediation and the statistical procedures that will be used to verify that the aquifer cleanup objectives have been achieved are presented in the Fernald Groundwater Certification Plan (DOE 2006a).

In general, restoration monitoring tracks the progress of the pump-and-treat stage of the groundwater remedy and water quality conditions. Operations are evaluated throughout the year to determine the progress of aquifer remediation. Total uranium concentration maps are developed from analytical data and compared with groundwater elevation maps to show the status of remediation progress and to verify capture of the total uranium plume.

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

CAWWT
As presented in the Fernald Preserve 2015 Site Environmental Report (DOE 2016a), the CAWWT system had become oversized and reached the end of its useful life. Additionally, equipment corrosion and corrective maintenance had become ongoing issues for facility operations.

In March 2015, a CAWWT Condition Assessment Report was finalized (Whitman, Requardt & Associates 2015) confirming that many of the treatment system components were at or nearing the end of their useful life. A decision was made to replace the CAWWT treatment system with a 50 gpm system inside the CAWWT building. DOE received concurrence on a path forward in July 2015 from EPA and Ohio EPA and in August 2015 from the Fernald Community Alliance. Planning for the project began in August 2015.

The project was initiated in 2016 and implemented in three steps:
1. Treatment media removal and demolition of existing piping and tanks to allow room for the new system in the existing building
2. Design of the new system
3. Construction, installation, and commissioning of the new system

Step 1 was completed in January 2017. Four multimedia filters, four of the six existing ion-exchange vessels, and associated piping were removed to provide space for installation of the new system. The two remaining existing ion-exchange vessels and associated piping remained to be available to handle treatment needs until the new system was operational. The current CAWWT building remains to house the smaller treatment system, laboratory, operations control room office, and maintenance shop and to provide storage space.
Step 2, design of the new system was completed in the spring of 2017. The system was designed to meet the site’s wastewater treatment needs through 2039.

Step 3 was started in September 2017. The new system is scheduled to be operational in the spring of 2018.

Pulse Pumping

In September 2012, with concurrence from EPA and Ohio EPA, a pulse-pumping exercise began at extraction wells 31550, 31560, 31561, and 33061. These four wells are equipped with pumps and motors that operate most efficiently at rates of approximately 300 gpm. The Waste Storage Area (Phase II) Design called for a target pumping rate of 100 gpm for each of these wells. The 100 gpm rate was being achieved by throttling back on the flow from each of the wells; however, this type of operation was not energy efficient.

To become more energy efficient, the wells are being pumped at a higher rate for a shorter period of time each day to remove the daily volume of water prescribed by the Waste Storage Area (Phase II) Design (DOE 2005b). Specifically, the wells are being pumped for 300 gpm for 8 hours a day (a total of 144,000 gallons per day) rather than 100 gpm for 24 hours a day (a total of 144,000 gallons per day). Flow and particle path monitoring predictions indicate that the new pumping schedule will maintain capture of the total uranium plume. With implementation of the current Operational Design in July of 2014, the target pumping rate of extraction well 31561 was increased from 100 to 200 gpm, so pulse pumping was stopped at this well. Pulse pumping continues for the other three wells.

Figure 11 shows the extraction well locations associated with the restoration modules operating in 2017. Also shown in Figure 11 are the three extraction wells that were shut down in April of 2014 (33266, 33265, and 33334). Table 4 summarizes the mass of total uranium removed and the volume of groundwater pumped during 2017. Additional details are provided in the module operational summaries in Sections 3.3.1.2 through 3.3.1.4. Figure 17 identifies the yearly and cumulative mass of total uranium removed from the Great Miami Aquifer from 1993 through 2017.

Since 1993:

- 46,128 Mgal of water have been pumped from the Great Miami Aquifer. 1,936 Mgal of treated water were reinjected into the Great Miami Aquifer.
- 13,733 net lb 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.
<table>
<thead>
<tr>
<th>Modules and Restoration Wells</th>
<th>Target Design Pumping Rate</th>
<th>Volume Pumped</th>
<th>Uranium Removed</th>
</tr>
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<tbody>
<tr>
<td><strong>South Plume</strong></td>
<td>1,400</td>
<td>629</td>
<td>96</td>
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<td>Optimization Module:</td>
<td></td>
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<td>3924, 3925, 3926, 3927,</td>
<td>1,400</td>
<td>629</td>
<td>96</td>
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<tr>
<td>32308, 32309</td>
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<tr>
<td><strong>South Field Module</strong></td>
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<td>32446, 32447, 33061, 33262,</td>
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<td>33264, 33298, 33326</td>
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<td><strong>Waste Storage Area Module</strong></td>
<td>800</td>
<td>402</td>
<td>75</td>
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<td>32761, 33062, 33347</td>
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<tr>
<td><strong>Aquifer Restoration System Total</strong></td>
<td>5,075</td>
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Figure 17. Yearly and Cumulative Mass of Uranium Removed from the Great Miami Aquifer, 1993–2017

<table>
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<tr>
<th>Year</th>
<th>Yearly Mass</th>
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<tr>
<td>2009</td>
<td>673</td>
<td>12,034</td>
</tr>
<tr>
<td>2010</td>
<td>586</td>
<td>12,617</td>
</tr>
<tr>
<td>2011</td>
<td>551</td>
<td>13,168</td>
</tr>
<tr>
<td>2012</td>
<td>544</td>
<td>13,712</td>
</tr>
<tr>
<td>2013</td>
<td>508</td>
<td>14,220</td>
</tr>
<tr>
<td>2014</td>
<td>471</td>
<td>14,691</td>
</tr>
<tr>
<td>2015</td>
<td>516</td>
<td>15,207</td>
</tr>
<tr>
<td>2016</td>
<td>519</td>
<td>15,726</td>
</tr>
<tr>
<td>2017</td>
<td>410</td>
<td>16,136</td>
</tr>
</tbody>
</table>
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 18 illustrates the southern extent of capture observed for the South Plume/South Plume Optimization Module in the fourth quarter of 2017.

During 2017, the South Plume/South Plume Optimization Module removed 629 Mgal of groundwater and 96 lb of total uranium from the Great Miami Aquifer. Based on analysis of the data collected in 2017, the module continues to meet its primary objectives as demonstrated by the following:

- Southward movement of the total uranium plume beyond the southernmost extraction wells has not been detected.
- Active remediation of the central portion of the off-property total uranium plume continues to reduce plume concentration. Nearly the entire off-property total uranium plume concentration is now below 100 µg/L. When pumping began in 1993, areas in the off-property total uranium plume had concentrations of over 300 µg/L.
- Paddys Run Road Site plume (contamination not attributed to Fernald site operations), located south of the extraction wells, is not being pulled toward the South Plume extraction wells.

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 2017, 11 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 (31562, 31563, 31564, 31565, 31566, 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, total uranium concentrations in that region of the aquifer were low. In addition, soil remediation was underway in the area around the wells.
- 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 reinjection 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.
Figure 18. Total Uranium Plume in the Aquifer with Concentrations Greater Than 30 µg/L at the End of 2017
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 2002), which was issued in May 2002. The design provided an updated characterization of the total 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 total uranium plume (extraction wells 33264, 33265, and 33266).
- One additional reinjection well in the former Southern Waste Units area (reinjection well 33263).
- An extraction well (31563) that was converted into a reinjection well.
- An injection pond that was located in the western portion of the former Southern Waste Units excavations.

In September 2004, the South Field Module reinjection components were shut down.

In 2014, operational changes were made to wells in the South Field following recommendations made in a modeling study that was released in 2014 (DOE 2014). On April 14, 2014, extraction wells 33265 and 33266 were shut down because the data indicated that they were no longer providing benefit to the groundwater remedy.

During 2017, the South Field Module removed 1,431 Mgal of groundwater and 332 lb of total uranium from the Great Miami Aquifer.

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 total uranium plume in the PPDD area, according to the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2001a). 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.

In 2014, operational changes were made to wells in the Waste Storage Area following recommendations made in a modeling study that was released in 2014 (DOE 2014). On
April 14, 2014, extraction well 33334 was shut down because the data indicated that it no longer provided a benefit to the groundwater remedy.

During 2017, 402 Mgal of groundwater and 75 lb of uranium were removed from the Great Miami Aquifer through the Waste Storage Area Module.

### 3.3.1.5 Monitoring Results for Total Uranium

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 18 shows the mapped outline of the total uranium plumes in the aquifer through the end of 2017. The total uranium plumes identified on the figure represent the interpreted size of the maximum total uranium plume in which concentrations are at or above the 30 µg/L groundwater FRL for total uranium.

Data collected in 2017 indicate that total uranium concentrations in the aquifer continue to decrease in response to pumping, as described below:

- In 2017, the mapped footprint of the total uranium plume decreased in size by 10.6 acres (10.1%). The area at or above 30 µg/L in 2016 was mapped as being 105 acres, and the area above 30 µg/L in 2017 was mapped as being 94.4 acres.
- In 2017, the area of the total uranium plume above a concentration of 50 µg/L decreased in size by 5.5 acres (8.8%). The area at or above 50 µg/L in 2016 was mapped as being 62.8 acres, and the area above 50 µg/L in 2017 was mapped as being 57.3 acres.
- In 2017, the area of the total uranium plume above a concentration of 100 µg/L decreased in size by 2.4 acres (7.6%). The area at or above 100 µg/L in 2016 was mapped as being 31.4 acres, and the area above 100 µg/L in 2017 was mapped as being 29 acres.

Figure 18 identifies hydraulic capture observed during the fourth quarter of 2017 for the active restoration modules and also presents regional groundwater flow directions. The map indicates that the existing extraction system is hydraulically capturing the South Plume and preventing further movement of uranium to the south beyond the extraction wells. Figure 18 also depicts the time-of-travel remediation footprint that was predicted by modeling the current operational design.

Appendix A, Attachment A.2, provides detailed total uranium plume maps for 2017. Appendix A, Attachment A.3, provides quarterly groundwater elevation maps and capture interpretations, along with graphical displays of groundwater elevation data. Highlights for 2017 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 depth intervals without installing a permanent monitoring well. Direct-push employs the weight of the vehicle the tool is mounted on and percussive force (hammering) to push the tool 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:** This area includes the PPDD plume. In 2017, direct-push samples were collected from six locations in the former Waste Storage Area to supplement routine sampling of monitoring wells.

In 2017, the mapped footprint of the 30 µg/L total uranium plume decreased in size by 3.9 acres. The area above 30 µg/L in 2016 was mapped as being 18.2 acres, and the area above 30 µg/L in 2017 was mapped as being 14.3 acres. Figure 18 shows the outline of the maximum total uranium plumes in the former Waste Storage Area, as measured during the second half of 2017. Data are presented in Appendix A, Attachment A.2.

**Former Plant 6 Area:** Plans for a restoration module in the former Plant 6 Area were abandoned 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 2001a). The design data indicated that the total uranium plume in the former Plant 6 Area was no longer present. EPA and Ohio EPA concurred with this decision. Monitoring in the area continues.

Monitoring well 2389 is the only well remaining in the area. Total uranium FRL exceedances were detected at this well again in 2017. As discussed in past reports, FRL exceedances occur in this area when the water-table elevation exceeds 515 ft above mean sea level. The two samples collected in 2017 at monitoring well 2389 had total uranium concentrations above 30 µg/L. Both samples were collected when the water table had an elevation above 515 ft above mean sea level. The former Plant 6 area will continue to be targeted for additional direct-push sampling when the water table is high to determine if the total uranium groundwater FRL exceedance is dissipating over time. This location is within the capture zone of the pump-and-treat system.

**South Field and South Plume Areas:** In 2017, direct-push samples were collected at 21 locations in the South Field and South Plume areas to supplement routine sampling of monitoring wells. Direct-push data for 2017 are presented in Appendix A, Attachment A.2.

In 2017, the mapped footprint of the 30 µg/L total uranium plume in the South Field and South Plume decreased by 6.7 acres. The area above 30 µg/L in 2016 was mapped as being 86.8 acres, and the area above 30 µg/L in 2017 was mapped as being 80.1 acres.

In 2017, the area of the total uranium plume in the South Field and South Plume above a concentration of 50 µg/L decreased by 3.7 acres. The area above 50 µg/L in 2016 was mapped as being 50.9 acres, and the area above 50 µg/L in 2017 was 47.2 acres.

In 2017, the area of the total uranium plume in the South Field and South Plume above a concentration of 100 µg/L decreased in size by 1.9 acres. The area above 100 µg/L in 2016 was mapped as being 23.4 acres, and the area above 100 µg/L in 2017 was 21.5 acres.
3.3.1.6 Monitoring Results for Non-Uranium Constituents

Although the groundwater remedy is primarily targeting remediation of the total uranium plume, other FRL constituents within the total uranium plume are also being monitored. Figure 19 identifies the locations of the wells that had non-uranium FRL exceedances. Table 5 shows the number of wells with non-uranium constituents exceeding FRLs in 2017, the number of wells with constituents exceeding FRLs outside the current Operational Design Remediation Footprint, the groundwater FRLs, and the range of 2017 data inside and outside the current Operational Design Remediation Footprint.

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Number of Wells Exceeding the FRL</th>
<th>Groundwater FRL&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Range of 2017 Data Inside the Current Operational Design Remediation Footprint</th>
<th>Range of 2017 Data Outside the Current Operational Design Remediation Footprint&lt;sup&gt;a,b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Chemistry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrate + Nitrite</td>
<td>7</td>
<td>11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>12.0 to 53.5</td>
<td></td>
</tr>
<tr>
<td>as Nitrogen</td>
<td></td>
<td>(mg/L)</td>
<td>(mg/L)</td>
<td>(mg/L)</td>
</tr>
<tr>
<td>Inorganics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>2</td>
<td>0.90</td>
<td>0.10</td>
<td>0.286 to 0.423</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>1</td>
<td>0.10</td>
<td>0.286 to 0.423</td>
<td></td>
</tr>
<tr>
<td>Radionuclides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technetium-99</td>
<td>3</td>
<td>94</td>
<td>115 to 305</td>
<td></td>
</tr>
<tr>
<td>Organics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>1</td>
<td>5.0</td>
<td>6.41</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> mg/L = milligrams per liter, µg/L = micrograms per liter, pCi/L = picocuries per liter
<sup>b</sup> NA = not applicable
<sup>c</sup> FRL is based on nitrate from OU5 ROD, Table 9-4; however, the sampling results are for nitrate + nitrite as nitrogen.

During 2017, five non-uranium constituents had FRL exceedances. One location was outside the current Operational Design Remediation Footprint. No plumes were identified for the non-uranium constituents above FRLs at the locations outside the current Operational Design Remediation Footprint in the extensive groundwater characterization efforts evaluated as part of the Remedial Investigation Report for Operable Unit 5 (DOE 1995d).
Figure 19. Non-Uranium Constituents with 2017 Results Above FRLs
Non-uranium constituents with FRL exceedances at the well locations outside the current Operational Design 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. In past years, many of the exceedances identified as persistent became nonpersistent in later years.

In 2017, the persistent exceedance for manganese at monitoring well 22204 continued. A change in the design of the aquifer remedy to address the persistent exceedance at monitoring well 22204 is not planned. Additional sampling for manganese near the OSDF was conducted in 2008 (and reported in the *Fernald Preserve 2008 Site Environmental Report*, DOE 2009a) to determine if a localized manganese plume was present. Results did not support the presence of a localized manganese plume.

The manganese FRL is 0.90 milligram per liter (mg/L) and is based on background values in the aquifer. Unconsolidated glaciofluvial aquifers in Ohio have relatively high manganese concentrations naturally. Manganese is found in shale, which is a major component of bedrock in the area. The background value upon which the groundwater FRL is based may not be representative of the aquifer.

**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. This section provides additional details on the two compliance monitoring activities.

The three private wells (2060, 13, and 14) located along Willey Road are monitored under the IEMP to assist in the evaluation of the total uranium plume migration. 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. When the public water supply became available, DOE discontinued monitoring at many off-property private wells. Data from the three private wells sampled under the IEMP are detailed in Section 2.3 and were incorporated into the uranium plume map shown in Figure 18.

During 2017, 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 offsite. 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 2017 and were incorporated into the total uranium plume maps shown in Figure 18 and in Appendix A, Attachment A.2. Non-uranium data from these wells are included in Section 3.3.1.6.

As indicated in Section 2.0, Ohio EPA 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 Ohio EPA approval), without issuance of a new Director’s Order. As determined by Ohio EPA, the IEMP will remain in effect following remediation.

3.4 Groundwater Remediation Assessment

Data collected in 2017 indicate that total uranium concentrations within the footprint of the maximum total uranium plume continue to decrease in response to pumping. Table 6 provides a summary.

### Table 6. Comparison of 2016 and 2017 Maximum Total Uranium Plume Footprint Areas

<table>
<thead>
<tr>
<th>Year</th>
<th>Area Greater Than 30 µg/L Acres</th>
<th>Area Greater Than 50 µg/L Acres</th>
<th>Area Greater Than 100 µg/L Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>105.0</td>
<td>62.8</td>
<td>31.4</td>
</tr>
<tr>
<td>2017</td>
<td>94.4</td>
<td>57.3</td>
<td>29.0</td>
</tr>
<tr>
<td>Difference</td>
<td>10.6</td>
<td>5.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Difference (%)</td>
<td>10.1</td>
<td>8.8</td>
<td>7.6</td>
</tr>
</tbody>
</table>

Groundwater elevations measured in 2017 continue to indicate that the pumping wells are maintaining capture of the uranium plume by enhancing and modifying natural groundwater flow directions within the aquifer. Appendix A, Attachment A.3 provides additional information concerning capture of the total uranium plume.

Data collected in 2017 continue to show that the mass of uranium being removed from the aquifer is in close agreement with groundwater model predictions, indicating that the pumping system remains effective in removing uranium from the aquifer. Appendix A, Attachment A.1 provides additional information concerning the mass of uranium removed from the aquifer.

A comparison of the average model-predicted uranium concentration for the end of 2017 to the average actual uranium concentration for the extraction wells in December 2017 shows that the two remain in close agreement (18.5 and 22 µg/L, respectively). As was the case in 2016, the average actual concentration is higher than the average model-predicted concentration, indicating that the model is slightly over-predicting actual cleanup progress. Additional detail is provided in Appendix A.1.

3.5 OSDF Monitoring

Monitoring of the OSDF is conducted in the leachate collection system (LCS), leak detection system (LDS), glacial till (perched water), and the Great Miami Aquifer. Figure 20 identifies the OSDF footprint and monitoring well locations for Cells 1 through 8. Flow is being monitored within the LCS and LDS to determine if the facility is operating as designed. Water quality is being monitored in the LCS, LDS, glacial till, and the Great Miami Aquifer to identify any potential water quality changes that could have resulted from leakage from the facility.
LCS and LDS flow data collected in 2017 indicate that engineered features within the OSDF continue to perform as designed. Leachate flow continues to diminish as expected and LDS flow volumes indicate that the cell liners are performing well within design specifications.

A comparison of water quality data collected in 2017 from within the facility (LCS and LDS) to water quality data collected beneath the facility (perched groundwater in the glacial till and groundwater in the Great Miami Aquifer) indicates that a leak from the facility is not occurring. Table 7 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 in 2017. The majority of total uranium concentrations measured in 2017 fell within the historical range of concentrations previously measured for that monitoring horizon. New high and new low concentrations measured in 2017 are identified in bold on Table 7.

As shown in Table 7, two new high total uranium concentrations were detected in 2017. One was in the LCS horizon, and one was in the LDS horizon.

- LCS of Cell 3: A new high of 181 µg/L was measured. The previous high was 174 µg/L.
- LDS of Cell 6: A new high of 70.8 µg/L was measured. The previous high was 43.7 µg/L. The second sample collected in 2017 was 67.6 µg/L. In 2016, the two samples collected had uranium concentrations of 41.7 µg/L and 41.5 µg/L, respectively. The cause for the increase between 2016 and 2017 is not known. Bivariate plots from Cell 6 indicate that the sampling horizons remain independent of each other. At this time, continued routine sampling is the recommended action.

The concentration of manganese continued to exceed the groundwater FRL in OSDF aquifer monitoring well (well 22204) in 2017. Appendix A, Attachments A.4 and A.5 provide additional information on non-uranium groundwater FRL exceedances and on the groundwater, LDS, and LCS sampling results for the OSDF.
Figure 20. OSDF Footprint and Monitoring Well Locations
Table 7. OSDF Groundwater, Leachate, and LDS Monitoring Summary

<table>
<thead>
<tr>
<th>Cell (Waste Placement Start Date)</th>
<th>Monitoring Location</th>
<th>Monitoring Zone</th>
<th>Date Sampling Started</th>
<th>Total Number of Samples</th>
<th>Range of Total Uranium Concentrations$^a$ (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell 1 (Dec. 1997)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12338C</td>
<td>LCS</td>
<td>Feb. 17, 1998</td>
<td>68</td>
<td>ND–206</td>
<td></td>
</tr>
<tr>
<td>12338D</td>
<td>LDS</td>
<td>Feb. 18, 1998</td>
<td>37</td>
<td>1.5–37.0</td>
<td></td>
</tr>
<tr>
<td>12338 Glacial Till</td>
<td></td>
<td>Oct. 30, 1997</td>
<td>77</td>
<td>ND–19</td>
<td></td>
</tr>
<tr>
<td>22201 Great Miami Aquifer</td>
<td></td>
<td>Mar. 31, 1997</td>
<td>84</td>
<td>ND–11.9</td>
<td></td>
</tr>
<tr>
<td>22198 Great Miami Aquifer</td>
<td></td>
<td>Mar. 31, 1997</td>
<td>128</td>
<td>0.540–15.2</td>
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</tr>
<tr>
<td>12339C</td>
<td>LCS</td>
<td>Nov. 23, 1998</td>
<td>64</td>
<td>4.51–686</td>
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</tr>
<tr>
<td>12339D</td>
<td>LDS</td>
<td>Dec. 14, 1998</td>
<td>29</td>
<td>4.08–25.6$^b$</td>
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</tr>
<tr>
<td>12339 Glacial Till</td>
<td></td>
<td>Jun. 29, 1998</td>
<td>88</td>
<td>ND–36.9</td>
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</tr>
<tr>
<td>22200 Great Miami Aquifer</td>
<td></td>
<td>Jun. 30, 1997</td>
<td>79</td>
<td>ND–1.93</td>
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</tr>
<tr>
<td>22199 Great Miami Aquifer</td>
<td></td>
<td>Jun. 25, 1997</td>
<td>105</td>
<td>ND–12.1</td>
<td></td>
</tr>
<tr>
<td>12340D</td>
<td>LDS</td>
<td>Aug. 26, 2002</td>
<td>20</td>
<td>8.9–27.7$^c$</td>
<td></td>
</tr>
<tr>
<td>12340 Glacial Till</td>
<td></td>
<td>Jul. 28, 1998</td>
<td>81</td>
<td>ND–58.5</td>
<td></td>
</tr>
<tr>
<td>22203 Great Miami Aquifer</td>
<td></td>
<td>Aug. 24, 1998</td>
<td>74</td>
<td>ND–15.4</td>
<td></td>
</tr>
<tr>
<td>22204 Great Miami Aquifer</td>
<td></td>
<td>Aug. 24, 1998</td>
<td>100</td>
<td>ND–22.9</td>
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</tr>
<tr>
<td>12341C</td>
<td>LCS</td>
<td>Nov. 04, 2002</td>
<td>48</td>
<td>4.41–171</td>
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<tr>
<td>12341D</td>
<td>LDS</td>
<td>Nov. 04, 2002</td>
<td>36</td>
<td>5.74–21.3</td>
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<tr>
<td>12341 Glacial Till</td>
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<td>Feb. 26, 2002</td>
<td>61</td>
<td>4.26–7.91</td>
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<tr>
<td>22206 Great Miami Aquifer</td>
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<td>Nov. 06, 2001</td>
<td>65</td>
<td>ND–5.78</td>
<td></td>
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<tr>
<td>22205 Great Miami Aquifer</td>
<td></td>
<td>Nov. 05, 2001</td>
<td>87</td>
<td>0.446–19.7</td>
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</tr>
<tr>
<td>12342C</td>
<td>LCS</td>
<td>Nov. 04, 2002</td>
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<td>12342D</td>
<td>LDS</td>
<td>Nov. 04, 2002</td>
<td>40</td>
<td>2.93–27.1</td>
<td></td>
</tr>
<tr>
<td>22207 Great Miami Aquifer</td>
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<td>Nov. 06, 2001</td>
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<td>22208 Great Miami Aquifer</td>
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<td>Nov. 05, 2001</td>
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<td>ND–2.1</td>
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<td>12343C</td>
<td>LCS</td>
<td>Oct. 27, 2003</td>
<td>47</td>
<td>8.03–197</td>
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<tr>
<td>12343D</td>
<td>LDS</td>
<td>Oct. 27, 2003</td>
<td>46</td>
<td>3.1–70.8$^d$</td>
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</tr>
<tr>
<td>12343 Glacial Till</td>
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<td>Mar. 14, 2003</td>
<td>54</td>
<td>ND–24.2</td>
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<tr>
<td>22209 Great Miami Aquifer</td>
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<td>Dec. 16, 2002</td>
<td>60</td>
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<td>81</td>
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<td>Sep. 02, 2004</td>
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<td>12344 Glacial Till</td>
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<td>22214 Great Miami Aquifer</td>
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<td>Aug. 22, 2005</td>
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<td>ND–16.4</td>
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<td>22217 Great Miami Aquifer</td>
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<td>Aug. 22, 2005</td>
<td>42</td>
<td>ND–18.3</td>
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</tbody>
</table>

$^a$ ND = not detected; **bold text indicates a new high or low detected in 2017.**

$^b$ Some data are not considered representative of LDS in Cell 2 (December 14, 1998, through May 23, 2000, data set) due to malfunction in Cell 2 leachate pipeline and resulting mixing of individual flows. It is suspected that some November 2004 samples were switched (i.e., 12339C with 12339D and 12340C with 12340D). If data from these events were included above, maximum total uranium concentrations would be 71 µg/L for 12339D and 72.4 µg/L for 12340D. It is suspected that samples were switched in 2014 (i.e., 12344D with the field duplicate for 12345C). If the data point from this sampling event was not included above, maximum total uranium concentration for 12344D would be 37.6 µg/L.

$^c$ 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.
4.0 Surface Water and Effluent Pathway

This section presents the 2017 monitoring activities and results for surface water and effluent 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: 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 pathway will continue to be monitored.

4.1 Summary of Surface Water and Effluent Pathway

The 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 treatment operations. Effluent is currently composed of treated and untreated groundwater, treated leachate from the OSDF, and storm water associated with the footprint of the outdoor processing activities at the wastewater treatment facility. Groundwater is no longer routinely treated to meet discharge limits. It is treated occasionally on an as-needed basis and is blended with other wastewater stored in the CAWWT backwash basin when that water is treated.

The volume and flow rate of uncontrolled runoff depend on the amount of precipitation within a given period of time. Figure 8 in Section 1.0 shows monthly precipitation totals for 2017. Figure 21 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 21 indicate the general flow direction of uncontrolled runoff as 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 21. Uncontrolled Surface Water Areas and 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 CAWWT and ecological restoration activities conducted throughout the property, including repairing areas of erosion.

Now that surface remediation has been completed and the groundwater remedy continues, the restored areas of the Fernald Preserve are the primary focus relative to uncontrolled runoff. Controls to mitigate sediment leaving the site are 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 total uranium concentrations. The location of elevated uranium 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 Waste Storage Area runoff control basin known as the “cement pond.” This area does not drain directly to Paddys Run. A streambank stabilization project was conducted in 2014 and 2015 to ensure that Paddys Run does not erode into this area.

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 (Figure 22). These two locations are sampled weekly when water is present. In 2017, surface water volume was sufficient to collect 20 samples at SWD-05 and 35 samples at SWD-09.

Demolition and waste-management activities associated with treatment system optimization at CAWWT occurred in 2017. Maintenance activities at the CAWWT backwash basin resulted in an unplanned release of 100,000 gallons of wastewater until repairs could be made. The release was reported to the regulators. The analytical results of the samples collected during the release are discussed in Appendix B. Results indicate the release did not adversely affect surface water quality at the Fernald Preserve.

4.3 Surface Water and Effluent Monitoring Program

Surface water and effluent 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 drainage areas and analyzed for various radiological and nonradiological constituents. Effluent is sampled prior to discharge into the Great Miami River.

The key elements of the surface water and 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 22). Surface water is monitored for six FRL constituents.

- **Data Evaluation:** The integrated data evaluation process focuses on tracking and evaluating data and comparing analytical results with background and historical ranges, FRLs, and NPDES permit limits. This information is used to assess impacts on surface water due to site
remediation activities affecting uncontrolled runoff or effluent. The assessment also includes identifying the potential for impacts from surface water to groundwater in the Great Miami Aquifer. The ongoing data evaluation is designed to support remedial action decision making.

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

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 effluent program are used to assess the collective effectiveness of site remediation in preventing unacceptable impacts to the surface water and groundwater. Compliance monitoring includes sampling at storm water and 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 22 depicts IEMP and NPDES surface water and effluent sample locations.

### 4.3.1 Surveillance Monitoring

Surveillance monitoring in 2017 was based on an evaluation of analytical results from samples collected during the year. This evaluation indicated that during 2017, there were no exceedances of total uranium in any of the effluent samples analyzed. Nineteen surface water analytical results from sampling location SWD-09 exceeded the surface water FRL for total uranium in 2017. There were no surface water FRL exceedances at SWD-05 in 2017. SWD-05 and SWD-09 are surface water monitoring locations established to monitor the area west of the former Waste Pits Area where elevated uranium concentrations have been detected. Appendix B provides additional details. Monitoring for total uranium will continue at these locations.

The following two key sample locations represent points where surface water or 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 effluent line leading to the Great Miami River

No total uranium results exceeded the surface water FRL during 2017 at these two locations.

The maximum total uranium concentration at SWP-03 during 2017 was 2.0 µg/L, well below the surface water total uranium FRL of 530 µg/L. Figure 23 shows the annual average total uranium concentration in Paddys Run at Willey Road for the period 1985 through 2017. This figure illustrates the decrease of the total uranium concentration in Paddys Run from 1985 through 2017. The large decrease in concentration in 1987 is attributable to the installation of the storm water retention basin in 1986, which greatly reduced the volume of contaminated runoff flowing into Paddys Run from the Former Production Area.
Figure 22. IEMP/NPDES Surface Water and Effluent Sample Locations
Figure 23. Annual Average Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03) Sample Location, 1985–2017

Note: The surface water FRL for total uranium is 530 µg/L.
In 2015, DOE conducted an assessment of the scope of the surface water quality monitoring program. The assessment concluded that the scope of the program could be reduced. With approval from EPA, Ohio EPA, and local stakeholders, DOE implemented these reductions in 2017. The current surface water program is presented in the IEMP (Attachment D of the LMICP [DOE 2018]).

Samples collected at PF 4001 are used in the surveillance evaluation because this is the last point where effluent is sampled prior to discharge to the Great Miami River. The maximum daily total uranium concentration at PF 4001 in 2017 was 28.3 µg/L, below the drinking water standard (30 µg/L) and far below the surface water total uranium FRL of 530 µg/L. Data collected from this location cannot directly be compared to the FRL without considering the effect of the effluent waters mixing with the Great Miami River. A mixing equation (discussed further in Appendix B) is used to account for the actual flow rate in the Great Miami River and the discharge flow rate at PF 4001 when the maximum uranium concentration was detected. The resulting concentration in the river after mixing was estimated to be 2.79 µg/L.

Surface water data are also evaluated to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer. In areas where glacial overburden is absent, 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 SWD-03, SWD-04, SWD-05, SWD-07, SWD-08, and STRM 4005.

In 2017, sample results from surface water cross-media impact locations SWD-04 and SWD-05 exceeded the total uranium groundwater FRL of 30 µg/L. Sampling at these locations will continue to provide an assessment of the cross-media impact. Appendix B presents additional details of the FRL exceedances. SWD-04 is located in the Waste Storage Area and SWD-05 is located within a swale in the northwest corner of the former Waste Storage Area. Both of these locations are within the capture zone of the aquifer remediation system. Appendix A, Attachment A.2 provides additional information concerning the impact of surface water infiltrating into the Great Miami Aquifer.

4.3.2 Compliance Monitoring

4.3.2.1 FFCA and OU5 ROD Compliance

The Fernald Preserve is required to monitor 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 (DOE 1996b). 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 per year. The OU5 ROD and the subsequent Explanation of Significant Differences for Operable Unit 5 (DOE 2001b) also require that the monthly average total uranium concentration in the effluent not exceed 30 µg/L, the EPA-established drinking water standard.

Figure 24 shows that the cumulative mass of total uranium discharged to the Great Miami River through PF 4001 during 2017 was 500 lb, which is below the annual discharge limit of 600 lb.
Figure 25 shows that the monthly average total uranium concentration in water discharged through PF 4001 was below the 30 µg/L discharge limit every month during 2017.

### 4.3.2.2 NPDES Permit Compliance

Compliance sampling, consisting of sampling for nonradiological pollutants from uncontrolled runoff and effluent discharges from the Fernald Preserve, is regulated under the state-administered NPDES program. Until March 1, 2015, the site operated under the permit that took effect on April 1, 2009, and expired on March 31, 2014. A new permit took effect on March 1, 2015.

There were no instances of noncompliance at any of the permitted outfalls in 2017.

### 4.3.3 Uranium Discharges in Surface Water and Effluent

As identified in Figure 24, 500 lb of uranium in effluent were discharged to the Great Miami River through PF 4001 in 2017. In addition to the effluent, uncontrolled runoff is also contributing to the amount of uranium entering surface water. Figure 26 presents the mass of uranium from the uncontrolled runoff and controlled discharges from 1993 through 2017.

A loading term is used to estimate the pounds of uranium discharged to Paddys Run via uncontrolled runoff. This loading term was last 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 as a result of significant improvements in the capture of contaminated storm water and remediation of site soil. The loading term is 2.1 lb of uranium per inch of precipitation. During 2017, 46.93 inches of precipitation fell at the Fernald Preserve; therefore, an estimated 98.6 lb 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 effluent discharges and uncontrolled runoff, was approximately 599 lb.

Because the CERCLA remedy of the Fernald Preserve has progressed significantly since 2004, a new loading term is being proposed based on changes in site drainage and total uranium concentrations that have further decreased. Details are provided in Appendix B. Pending approval from EPA, Ohio EPA, and stakeholders, a new loading term will be used for the 2018 Site Environmental Report.
The Operable Unit 5 Record of Decision established an annual discharge limit of 600 pounds for uranium.

Figure 24. Mass of Uranium Discharged to the Great Miami River Through the Parshall Flume (PF 4001) in 2017
On November 30, 2001, the monthly average discharge limit became 30 µg/L.

Figure 25. 2017 Monthly Average Total Uranium Concentration in Water Discharged Through the Parshall Flume (PF 4001) to the Great Miami River
Figure 26. Uranium Discharged via the Surface Water Pathway, 1993–2017
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5.0 Natural Resources

This section provides background information on the natural resources associated with the Fernald Preserve and summarizes the activities in 2017 relating to these resources. Included in this section is a discussion of the following:

- Ecological restoration activities
- Site and OSDF inspections
- Affected habitat areas
- Threatened and endangered species
- Cultural resources

Much of the 1,050 acres 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 27 shows the restoration project areas that have been completed. Some of these areas provide habitat for state and federally endangered species. These endangered species are identified in Section 5.4. Cultural resources, such as prehistoric archaeological sites have also been surveyed. The Fernald Preserve’s mission of long-term stewardship under LM includes establishing, managing, and monitoring ecologically restored areas across the site.

Monitoring of these natural and cultural resources is addressed in the “Natural Resource Monitoring Plan,” which is included as Appendix A of Attachment D of the LMICP (DOE 2018). 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 approach for monitoring and maintenance of ecologically restored areas was expanded in 2009. DOE and Ohio EPA signed a Consent Decree in November 2008 that settled a long-standing natural resource damage claim under Section 107 of CERCLA. As a result, the Fernald Natural Resource Trustees (DOE, Ohio EPA, and the U.S. Department of Interior) finalized the “Natural Resource Restoration Plan” (NRRP), which is Appendix B of the Consent Decree Resolving Ohio’s Natural Resource Damage Claim against DOE (State of Ohio 2008). The NRRP specifies an ecological monitoring program for restored areas at the site. This includes an enhanced wetland mitigation monitoring program and a functional monitoring program that evaluates restored communities. An implementation monitoring program is also in place and is used to determine whether revegetation efforts are successful following construction activities.
Figure 27. Restoration Project Areas
Ecological monitoring in 2017 focused on functional monitoring of wetland, prairie, and forest communities in southern and eastern portions of the site. Implementation monitoring took place following completion of the North Woodlot Enhancement Natural Resource Trustee Project. The site and OSDF inspection process also continued in 2017, as specified in the LMICP.

The NRRP also specifies creation of a Restored Area Maintenance Plan (RAMP). This document details the approach for managing ecologically restored areas across the site. The RAMP includes provisions for planting and seeding, control of invasive species, management of wetland water levels, erosion control, nuisance animal control, and maintenance of public amenities (DOE 2012b). Field personnel use this plan to conduct the restoration activities described in this section.

The sequencing of restored area management and monitoring has evolved over the last several years. In 2014, a review of 2013 functional monitoring results showed reduced quality in a number of prairie areas. To address this, a revised approach for management and monitoring of ecologically restored areas was implemented starting in 2015. Management and monitoring activities are now conducted on an area-specific basis so that restored areas are managed on a 3-year rotation. The site has been divided into three management areas, identified as Management Areas A, B, and C in Figure 28. Grassland habitats are designated as Priority Grassland Areas or Managed Field Areas. In general, Priority Grassland Areas are maintained as prairies, while Managed Field Areas may be allowed to transition to forest communities over time.

5.1 Ecological Restoration Activities

For 2017, erosion repair was completed in the Wetland Mitigation Phase I (WM1) project area. Maintenance in ecologically restored areas included prescribed burns in prairie areas and on the OSDF, repair and removal of deer exclosure fence, and control of invasive plants, shrubs, and trees in both prairie and forested areas. Figure 29 shows the location of 2017 restoration projects and maintenance activities, which are also discussed in the following sections.

5.1.1 Ecological Restoration Projects

The WM1 Project is one of the oldest ecological restoration projects at the Fernald Preserve. It was constructed in 1999 and consists of eight basins along the northeastern boundary of the site (Figure 29). Erosion in areas between several basins and the drainage that leads offsite was observed in 2015. It is suspected that crayfish accelerated the erosion by burrowing around the concrete dams between basins that were designed to control water elevations. In 2017, the concrete dams were removed and replaced with rock channels. Following completion of the project, wetland water levels were restored to elevations observed prior to 2015.

In August 2017, DOE partnered with the U.S. Geological Survey and the U.S. Army Corp of Engineers to evaluate innovative technologies for assessing the success of ecological restoration projects. The goal of this effort is to compare remote-sensing technologies to traditional field surveys to develop optimal monitoring strategies for restoration projects. Field personnel used a multi-tier approach, which included simultaneous evaluation of plant communities from a large landscape perspective to precise species scale. Several field crews were involved in data collection. Ground-based teams collected traditional species-level metrics in forests and
Figure 28. Ecological Restoration Management Areas
Figure 29. 2017 Ecological Restoration Projects and Maintenance Activities
grasslands. An unmanned aircraft system team implemented a variety of flight plans, using several different sensors including hyper-spectral imaging and light detection and ranging (LIDAR) survey methods. A fixed-wing airplane and a satellite were also used to collect landscape-scale information. The Fernald Preserve is an ideal candidate for this type of evaluation because the site has undergone extensive forest and grassland restoration and has a traditional restoration monitoring program already in place. Data analysis and reporting is anticipated in late 2018.

5.1.2 Restored Area Maintenance and Repair

The focus of 2017 restored area maintenance included conducting prescribed burns and removal of invasive species. Management Areas A and C and the southern third of the OSDF were addressed in 2017; a total of 74 acres of prairie were burned. Field personnel plan prescribed burns during the fall burning season; any areas within the management area that were not burned in the fall are then scheduled to be burned the following spring. If weather or field conditions do not allow for a burn in the spring, then the area is mowed, raked, and baled in late spring before grassland birds begin to nest. In Management Areas A and C, approximately 48.6 acres of Priority Grassland Areas were burned in 2017 (Figure 29). The Management Area C burn took place in March 2017. The remaining Priority Grassland Area in Management Area C was mowed in May 2017. Prescribed burns in Management Area A took place in November 2017. The remaining Priority Grasslands Areas in Management Area A will be addressed in Spring 2018.

A prescribed burn was also used in 2017 to manage the 25 acres of vegetation on the southern third of the OSDF cap. The first prescribed burn of the vegetated cap of the OSDF occurred in March of 2016 when 25 acres on Cells 4, 5, and 6 were successfully burned following discussions with stakeholders. As described in the LMICP (DOE 2018), prescribed burning is the preferred method for management of the OSDF prairie cap. The native grasses and wildflowers regrow quickly and burning eliminates the need to handle large hay bales following mowing. The burns also allow for an additional inspection of the cap prior to regrowth of vegetation. Vegetation on the OSDF Cells 7 and 8 was safely burned on March 9, 2017. Follow-up inspections and monitoring showed that native grasses were quickly reestablished and the number of invasive tree seedlings was reduced. Cells 1, 2, and 3 are planned to be burned in spring 2018 to complete the 3-year rotation of prescribed burns of the vegetation on the cap of the OSDF.

In addition to the prescribed burn and mowing efforts, spot spraying with herbicide continued in 2017 to control noxious weeds in restored areas. Invasive woody vegetation continues to be physically removed or treated with herbicide across the site and on the OSDF cap. Trees and shrubs are not permitted to become established on the OSDF cap, so they are removed or treated with herbicide once discovered. Control of woody invasive species such as Amur honeysuckle (Lonicera maackii) continued in 2017. Heavy infestation of honeysuckle crowds out native species, prevents sunlight from reaching the ground, and prevents seedling development of desirable vegetation. Field personnel began a fall foliar herbicide application program in 2015. A characteristic of honeysuckle is that it does not go dormant until several weeks after most other vegetation. Timing herbicide application after nearby plants have gone dormant in the fall allows the use of herbicide to treat honeysuckle while avoiding harm to surrounding vegetation. The technique has been used for a number of years by local parks and has proven to be an
effective means of control. Approximately 19 acres of honeysuckle were treated with herbicide in Fall 2017 (Figure 29).

Additional 2017 maintenance activities included:

- Follow-up from site and OSDF inspections, including sign and fence repair and debris removal. Deer exclosure fencing was removed from one area (Figure 29) and repaired in other locations.

- Several boulders were replaced on an in-stream crossvane at the Paddys Run Streambank Stabilization project area in October 2017 (Figure 29). Two crossvanes were installed in the streambed in 2014 and 2015 to stabilize the streambank. Erosion of Paddys Run streambank could have eventually reached the area where high uranium concentrations in surface water occur (DOE 2016a). The boulders in one of the crossvanes became dislodged during a flood in 2016. The repair work was delayed due to several flood events in Paddys Run. Field personnel will continue to monitor the area during site inspections.

- Tree and shrub clearing took place in several areas along the site boundary and access roads (Figure 29). This maintenance was needed to remove hazard trees and ensure safe access and protection of perimeter fencing. Much of the vegetation removed was invasive honeysuckle.

- A portion of the Weapons to Wetlands trail was paved in order to provide easier access for visitors.

Goose hazing has not been needed since 2014, due to establishment of vegetation and an increase in natural predators. Site personnel continue to monitor the Canada goose population each year. The site maintains a permit to remove nests, if nest removal is necessary.
5.1.3 Ecological Restoration Monitoring

Ecological Monitoring Parameters

There are a number of ways to evaluate the type and quality of habitats within an area. At the Fernald Preserve, ecological monitoring focuses on determining the extent of native species composition and calculating a Floristic Quality Assessment Index (FQAI). The FQAI process is described in the Floristic Quality Assessment Index (FQAI) for Vascular Plants and Mosses for the State of Ohio (Andreas et al. 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 native to Ohio. The updated Ohio Vascular Plant Database is used to determine whether a species is native (Gara 2013).
- **Percent Native Species**: The number of native species divided into the total number of species. Relative frequency of native species is also used. 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. Wetland communities are surveyed differently, so relative cover is calculated instead of relative frequency.
- **Average Coefficient of Conservatism (CC)**: The CC is a number between 0 and 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 its habitat requirements. 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 7–10 range. The updated Ohio Vascular Plant Database (Gara 2013) 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 average CC value divided by the square root of the total number of species for a given area.
- **Amphibian Index of Biotic Integrity (AIBI)**: A scoring system using amphibians as a means of assessing the quality of wetland communities.
- **Vegetation Index of Biotic Integrity–Floristic Quality (VIBI-FQ)**: A scoring system for wetland habitats that is based on the diversity and quality of wetland vegetation.

Monitoring of restored areas consists of 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 mortality counts and herbaceous cover estimates that are conducted after a restoration project is completed. The NRRP established goals for vegetation establishment of 50% native species and 90% total cover. For woody vegetation, the goal is 80% survival (State of Ohio 2008). Herbaceous and woody vegetation surveys of the North Woodlot Enhancement Natural Resource Trustee project were conducted in 2017.

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 NRRP, which was finalized in 2008 (State of Ohio 2008), reintroduced the use of functional-phase monitoring as a means of evaluating restored communities. Functional monitoring in 2017 focused on prairie, wetland, and forest communities in Management Area C, the southern and eastern portions of the site (Figure 30).

Additional wetland monitoring was further specified in the Fernald Preserve Wetland Mitigation Monitoring Report (DOE 2012c). Most wetland mitigation monitoring activities were completed in 2011. However, amphibian monitoring and collection of hydrologic data continued in 2017. Figure 30 shows the amphibian monitoring wetland areas and the piezometers monitored for hydrologic data in 2017.

5.1.3.1 Functional Monitoring

Functional monitoring 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. Wetlands were evaluated in 2003, prairie communities in 2004, and forest habitats in 2005. This 3-year rotation resumed in 2009 and continued until 2014. Monitoring efforts shifted from sitewide community types to an area-based approach in 2015 and continued in 2017. Figure 30 shows the 2017 wetland, prairie,
and forest functional monitoring areas. Appendix C provides a more detailed discussion regarding ecological monitoring results, including the use of Floristic Quality Assessment Index (FQAI) and Vegetation Index of Biotic Integrity–Floristic Quality (VIBI-FQ) to assess the condition of restored areas.

The 2017 wetland functional monitoring results indicate that native vegetation is fully established across all the areas surveyed, with percent native species and percent relative cover of native species above the goal of 50% in all basins. There were some interesting results in 2017. The floating aquatic, carnivorous species common bladderwort (*Utricularia vulgaris*) was found in a number of site wetlands. Also, several new native species were confirmed at the site, including queen of the prairie (*Filipendula rubra*), water parsnip (*Sium suave*) and Riddell’s goldenrod (*Solidago riddellii*). Additional wetland mitigation monitoring activities are discussed in Section 5.1.3.2 and Appendix C.

The 2017 prairie functional monitoring results indicated that native vegetation has been established, goals have been met, and there is much improvement over baseline conditions in the surveyed areas. Continued control of invasive species is needed, given the presence of Canada thistle (*Cirsium arvense*), teasel (*Dipsacus species*), and crown vetch (*Coronilla varia*).

The 2017 forest functional monitoring results also showed that restoration goals have been met in the surveyed areas. Woody vegetation monitoring indicates that Amur honeysuckle is an ongoing concern. DOE will continue to clear honeysuckle and other invasive vegetation as part of restored area maintenance.

### 5.1.3.2 Wetland Mitigation Monitoring

Pursuant to the *Fernald Preserve Wetland Mitigation Monitoring Report* (DOE 2012c), limited wetland monitoring continued in 2017. Activities included amphibian surveys to calculate Amphibian Index of Biotic Integrity (AIBI) and hydrologic monitoring using shallow wells (piezometers).

In the spring of 2017, amphibian monitoring was conducted using funnel traps in selected basins within mitigation wetlands (Figure 30). In general, the 2017 results were similar to those of previous years. Ambystomatid salamanders, also known as mole salamanders, continue to be observed in northern wetlands across the site and in the more recent wetland construction projects along Paddys Run Road. Mole salamanders are key indicators of high quality wetlands. Appendix C provides additional details.

Water elevations in piezometers from 11 basins were recorded daily in 2017. Wetlands are dependent on extended periods of saturated conditions. The 2017 patterns of water levels were similar to those of past years, with saturated conditions observed through the winter and spring, followed by drier conditions in the summer and fall. These findings are also similar to those at other emergent wetlands in Ohio. The results are compared to the performance standards established in the *Fernald Preserve Wetland Mitigation Monitoring Plan* (DOE 2009b). There was an overall improvement in the hydrologic monitoring results for 2017 when compared to 2016 results (Appendix C). This is most likely due to increased precipitation totals for the year.
Wetland hydrologic data has been collected from mitigation wetlands since 2010. Basins are eliminated from the monitoring program once results demonstrated that performance standards are met over 5 years. Monitoring was discontinued in 13 basins in 2014 (DOE 2015), and an additional 2 basins in 2015 (DOE 2016a). No wetland basins were eliminated in 2016. A review of the 2017 results shows that while not all performance standards are met across remaining basins, the annual patterns of saturation are consistent with similar natural wetlands. These results and field observations show that water elevations have stabilized and are providing adequate conditions to maintain a wetland community. This conclusion is reinforced by the results of wetland vegetation and amphibian monitoring discussed above. DOE plans to discontinue hydrologic monitoring for the remaining wetland mitigation areas in 2019. Additional discussion regarding the status of hydrologic monitoring is provided in Appendix C.

5.1.3.3 Implementation Monitoring

Implementation monitoring in 2017 consisted of herbaceous survey and woody survival counts for the North Woodlot Enhancement Natural Resource Trustee restoration project, which was completed in the fall of 2016. Forest and wetland restoration areas were evaluated in this area in 2017.

Results of herbaceous monitoring show that the seeded areas met both native species and total cover goals. The percent native species was 63% in restored forest areas and 68% in the wetland area, and the relative frequency of native species was between 67% and 73%. Total cover was estimated at 92% for forest restoration areas. For the wetland area, total cover was 69%. This lower total cover appeared to be more due to the nature of wetlands, where some areas were inundated with standing water, rather than a failure to establish vegetation.

Woody vegetation plantings in the North Woodlot Enhancement project consisted of larger container-grown sapling trees, along with smaller seedling-size container trees and shrubs. Plants were divided into four different planting areas: three existing old field areas and the constructed wetland area. Overall survival of the sapling plantings was 89%. For the smaller trees and shrubs, it was difficult to determine survival because of the dense vegetation that was present within the old field planting areas. Field observations indicated that trees and shrubs have been established, along with “volunteer” trees that were not planted but rather grew on their own within deer exclosure fencing.

5.2 Fernald Preserve Site, OSDF, and Trail Inspections

The LMICP describes the routine inspection process for both the site and the OSDF. Inspections are conducted quarterly with joint participation from 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, presence of potentially contaminated debris, and signs of damage from nuisance animals. Quarterly inspection reports are posted on the Office of Legacy Management website at https://www.lm.doe.gov/fernald/Sites.aspx. The quarterly inspection reports can also be viewed online at the Fernald Preserve Visitors Center or by contacting the site at (513) 648-6000. Appendix C presents inspection findings from all 2017 quarterly site and
OSDF inspections. In addition to quarterly inspections, the public trails and overlooks are inspected weekly to ensure that they are safe and usable.

5.2.1 Site Inspections

As with recent years, site inspection findings in 2017 consisted mostly of the presence of weeds and deer exclosure fencing that was damaged by fallen trees and limbs. The presence of individual tree cages that are no longer protecting vegetation was also a regular finding. The invasive vegetation areas described in Section 5.1.2 were identified during the site inspection process.

Debris also continues to be found, primarily in the Former Production Area and Former Waste Pits Area. During remediation and restoration of the Fernald Preserve, every effort was made to remove and dispose of all demolition debris. However, weather, erosion, and earth-moving activities occasionally reveal small pieces of debris that were not visible during remediation and restoration efforts. Examples of construction debris include pieces of concrete, rebar, clay tile, and metal. Debris is discovered during site inspections and construction activities and by personnel during field activities. In 2017, 574 pieces of debris were discovered. Of those, three pieces were found to have fixed radiological contamination above background levels. These debris pieces were removed from the field and stored for disposal. Debris accumulated through 2017 was shipped for offsite disposal as discussed in Section 2.2.1.2. Two of the three contaminated pieces of debris were found in areas of the site that are not open to the public. One piece of contaminated concrete was found near the main access road, adjacent to the north side of the storm water retention basin valve house. Appendix C provides an annual total debris counts.

5.2.2 OSDF Inspections

For inspections of the OSDF, inspectors perform a quarterly walk-down of the perimeter and toe, and an annual walk-down and evaluation of the vegetated cap to verify its integrity. Trees, shrubs, 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 2017, there were no signs that the integrity of the cap had been compromised in any way. Findings consisted mainly of woody vegetation, noxious weeds, and animal burrows. The post-burn OSDF inspection following the March 2017 prescribed burn of the vegetated cap of Cells 7 and 8 (Section 5.1.2) indicated that the burn was successful in maintaining prairie grass and helpful in preventing establishment of invasive trees.

5.2.3 Trail Inspections

During the weekly trail inspections in 2017, two areas of concern were identified (Figure 29). An eroded wash-out was discovered along the lower portion of the Sycamore Trail. The wash-out is a result of flooding in the area from Paddys Run. Further inspection indicated additional erosion along a gravel stretch of the same trail that leads to the lower basin area. This erosion was repaired in 2017. The wash-out and lower basin erosion will be repaired in 2018. The second area of concern is located along the Hickory Trail near the Wetland Mitigation Phase II basins. Beaver activity resulted in flooding across the trail, causing extensive erosion and requiring a temporary re-route of the trail for part of the year. Repairs of this area are planned in 2018.
5.3 Affected Habitat Findings

The potential for unanticipated habitat impacts is low but may occur during construction or site maintenance activities. In 2017, impacts were minor. Limited vegetation clearing was needed for the erosion repairs at the Wetland Mitigation Phase I project and for the Weapons to Wetlands trail paving project. For the tree and shrub clearing, field personnel avoid removing dead trees unless necessary for safety. Standing dead trees provide habitat for a variety of wildlife. Trees are removed only if they pose a hazard to visitors, site personnel, or infrastructure. Tree removal was also delayed until after bat breeding season concluded, as discussed below.

A portion of the aesthetic barrier, located along Willey Road, falls within a public utility right of way. Trees in this area were cleared by a public utility in spring 2017 (Figure 29) as part of a regional effort to clear vegetation from the power-line corridors. DOE worked with the public utility to minimize impacts to the aesthetic barrier. Wood resulting from the removal was kept onsite for reuse as mulch and compost. Site personnel seeded the area following the tree clearing by the utility company.

Beavers were very active at the site in 2017, resulting in changes to water elevations and vegetation in several site wetlands and ponds. Beavers are native, and their presence is evidence of continued development of restored communities. However, they are capable of causing damage to site roads and trails, and they may alter the landscape by flooding upland areas, raising water levels in wetlands, and clearing trees. These naturally occurring changes are expected to continue in the years to come.
5.4 Threatened and Endangered Species and Species Inventories

The Endangered Species Act requires the protection of any federally threatened or endangered species and any habitat critical for the species’ existence. Several Ohio laws mandate the protection of state 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 endangered Indiana bat and the state threatened Sloan’s crayfish have been found on the property. In addition, suitable habitat exists for the federally endangered running buffalo clover and northern long-eared bat, the state-threatened spring coral root, and the state-endangered cave salamander. None of these species have been found on the site, but their habitat ranges encompass the Fernald Preserve. Figure 31 shows the potential habitats for these species. According to provisions in the LMICP (DOE 2018), Section 6, “Natural Resource Monitoring Plan,” threatened or endangered species habitat will be surveyed as needed prior to any construction activities. If threatened or endangered species are identified, appropriate avoidance or mitigation efforts will be taken.
Figure 31. Threatened and Endangered Species Habitat Areas
Several activities took place in 2017 to address endangered species. A survey for running buffalo clover was conducted prior to the WM1 Erosion Repair project, with no species found. A survey for running buffalo clover and spring coral root took place prior to the tree and shrub clearing along the north fence line, with no species found. Repairs to the Paddys Run Streambank crossvane were completed when the streambed was dry to avoid impacts to the state-threatened Sloan’s crayfish. Lastly, as discussed above, large trees were not removed until after October 1, to ensure that there were no impacts to the federally endangered Indiana bat.

In 2012, the Fernald Preserve was identified as a candidate for introduction of the American burying beetle (*Nicrophorus americanus*). DOE signed a 5-year Cooperative Agreement with the U.S. Fish and Wildlife Service and the Cincinnati Zoo (DOE 2012a) to introduce the federally endangered beetle to the Fernald Preserve. This effort is part of the recovery plan for the beetle, which involves release and monitoring of beetles raised at the Cincinnati Zoo. Field personnel released 115 pairs of beetles in June and July 2017. DOE, the U.S. Fish and Wildlife Service, and the Cincinnati Zoo agreed to extend participation in the recovery program for an additional 5 years. In 2017, the parties signed a Memorandum of Agreement to continue releases at the Fernald Preserve through 2022 (DOE 2017).

### 5.5 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 diverse cultural resources. In summary, 148 prehistoric and 40 historic sites have been identified within 1.2 miles 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 (Title 43 Code of Federal Regulations Part 10) requires that prehistoric human remains and associated artifacts be identified and returned to the appropriate Native American tribe. Compliance with these laws is addressed through a Programmatic Agreement between DOE and the Ohio State Historic Preservation Office (DOE 2012d), which was updated in 2012.

To comply with these laws and the Programmatic Agreement, DOE conducted archaeological surveys prior to remediation activities in undeveloped areas of the Fernald Preserve. Figure 32 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.

No archaeological surveys were conducted in 2017, and no unexpected discoveries were encountered during field activities. All ground-disturbing activities took place in previously disturbed or surveyed areas.
Figure 32. Cultural Resource Survey Areas
6.0 References


33 USC 1251 et seq. “Clean Water Act” (Federal Water Pollution Control Act), as amended, United States Code.


42 USC 7401 et seq. “Clean Air Act,” as amended, United States Code.


7.0 Glossary

*Amphibian Index of Biotic Integrity (AIBI):* A scoring system that uses amphibians as a means of assessing the quality of wetland communities.

*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 that a selected remedy must attain 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.

*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 total 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.

*crossvane:* A U-shaped structure of boulders built across a stream channel to reduce water velocity and energy along the streambank.

*effluent:* Water from numerous areas at the site that is routed through the site’s wastewater treatment facility and discharged to the Great Miami River.

*Floristic Quality Assessment Index (FQAI):* A method of evaluating an ecosystem based on the type and quality of plants present.

*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.
**mixed waste**: Hazardous waste (as defined by RCRA) that has been contaminated with low-level radioactive materials.

**piezometer**: Shallow monitoring well that is used to measure water elevations in wetlands.

**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.

**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 (RI/FS)**: 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. A removal action is performed in response to a release or the imminent threat of release of hazardous substances into the environment.

**surface water**: Water that is flowing within natural drainage features.

**uncontrolled runoff**: Storm water that is not collected by the site for treatment but enters the site’s natural drainages.

**Vegetation Index of Biotic Integrity (VIBI)**: A scoring system that uses vascular plants as a means of assessing the quality of a given plant community.

**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 of in that facility. These are known as waste acceptance criteria. Offsite disposal facilities such as the Nevada National Security Site (formerly called the 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.