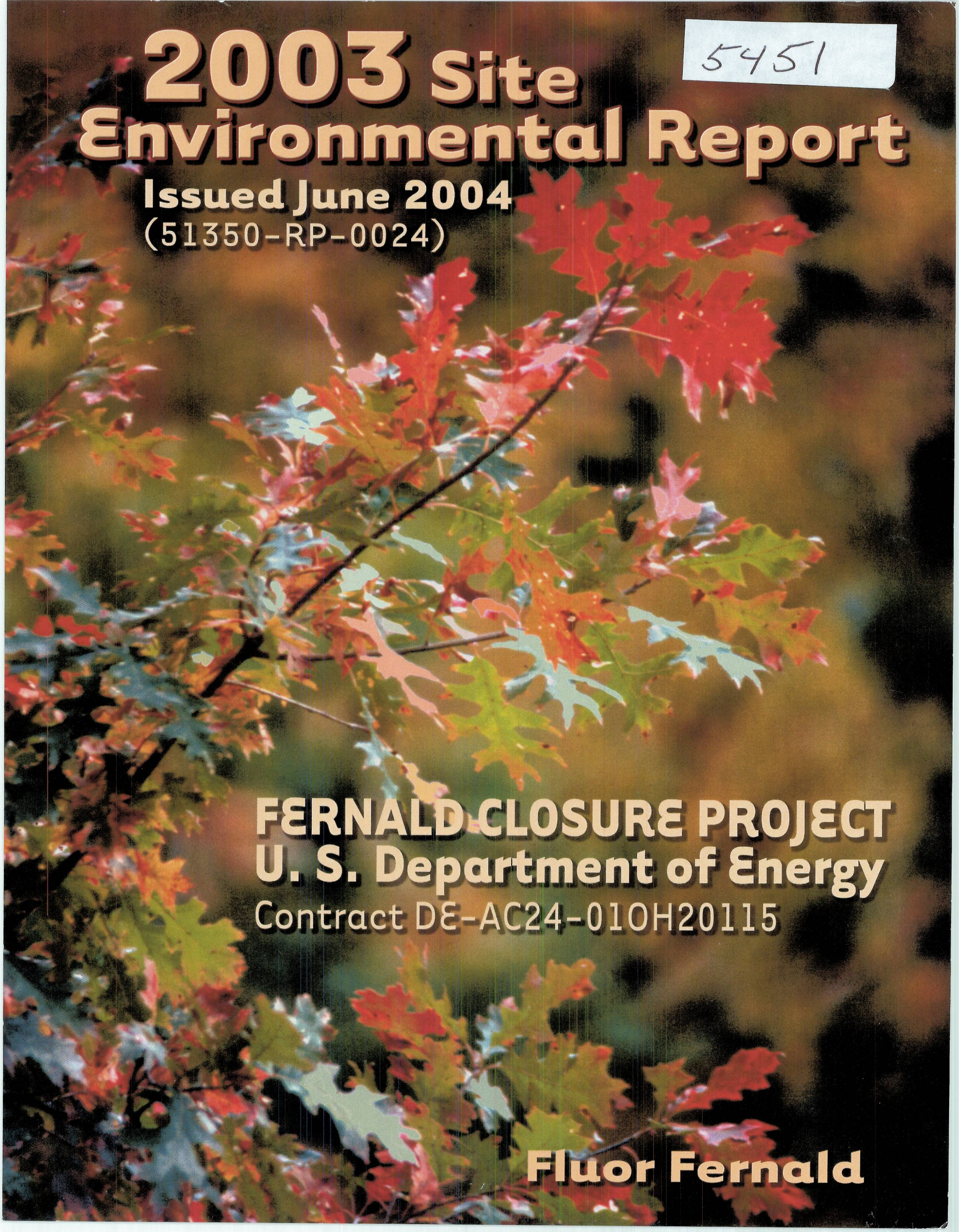

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2003 Site Environmental Report

Issued June 2004

(51350-RP-0024)

FERNALD CLOSURE PROJECT
U. S. Department of Energy

Contract DE-AC24-01OH20115

Fluor Fernald

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Additional information about the Fernald Closure Project is available through:

- The Fernald Closure Project
  Public Environmental Information Center
  7400 Willey Road, Trailer T-210
  Hamilton, OH 45013-9402

  Phone: (513) 648-5051
  Thursday, 7:30 a.m. to 5:00 p.m.
  (or by appointment)

- The Fernald Web Page at www.fernald.gov

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List of Acronyms

ALARA	as low as reasonably achievable
ARARs	applicable or relevant and appropriate requirements
BCG	Biota Concentration Guides
BTV	benchmark toxicity value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
CY	calendar year
DCG	derived concentration guide
DOE	U.S. Department of Energy
EHS	Extremely Hazardous Substance
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESD	Explanation of Significant Differences
FCP	Fernald Closure Project
FEMP	Fernald Environmental Management Project
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Agreement
FRL	final remediation level
ft^3	cubic feet
ft^3/sec	cubic feet per second
gpm	gallons per minute
HEPA	high-efficiency particulate air
ICRP	International Commission on Radiological Protection
IEMP	Integrated Environmental Monitoring Plan
kg	kilogram
kg/d	kilograms per day
km	kilometer
lbs	pounds
lbs/yr	pounds per year
Lpm	liters per minute
μCi	microCuries
μCi/hr	microCuries per hour
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter

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List of Acronyms (Continued)

m^3	cubic meters
M gal	million gallons
M liters	million liters
mCi/yr	milliCuries per year
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mGy/day	milliGray per day
mL	milliLiters
mrem	millirem
m^3/sec	cubic meters per second
mSv	milliSievert
NCRP	National Council on Radiation Protection
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRC	National Response Center
OEPA	Ohio Environmental Protection Agency
PCB	polychlorinated biphenyl
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
pCi/m^3	picoCuries per cubic meter
pCi/m^2/sec	picoCuries per square meter per second
person-Sv	person-Sievert
PVS	pugmill ventilation system
RCRA	Resource Conservation and Recovery Act
RCS	Radon Control System
SARA	Superfund Amendment and Reauthorization Act
TCLP	Toxicity Characteristic Leachate Procedure
TLD	thermoluminescent dosimeter
TSCA	Toxic Substance Control Act
USGS	United States Geologic Survey
UV	ultraviolet
WPP	Waste Pits Project
yd^3	cubic yards

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Units (Abbreviations) and Conversion Table

Multiply	By	To Obtain	Multiply	By	To Obtain
inches (in)	2.54	centimeters (cm)	cm	0.3937	in
feet (ft)	0.3048	meters (m)	m	3.281	ft
miles (mi)	1.609	kilometers (km)	km	0.6214	mi
pounds (lb)	0.454	kilograms (kg)	kg	2.205	lb
tons	0.9072	metric tons	metric tons	1.102	tons
gallons	3.785	liters (L)	L	0.2642	gallons
square feet (ft^2)	0.0929	square meters (m^2)	m^2	10.76	ft^2
acres	0.4047	hectares	hectares	2.471	acre
cubic yards (yd^3)	0.7646	cubic meters (m^3)	m^3	1.308	yd^3
cubic feet (ft^3)	0.02832	cubic meters (m^3)	m^3	35.31	ft^3
picocuries (pCi)	10^{-12}	curies (Ci)	Ci	1012	pCi
pCi/L	10^{-6}	microcuries per liter (µCi/L)	µCi/L	106	pCi/L
Ci	3.7×10^{10}	becquerels (Bq)	Bq	2.7×10^{-11}	Ci
pCi	0.037	Bq	Bq	27.03	pCi
millirem (mrem)	0.001	rem	rem	1000	mrem
mrem	0.01	milliSievert (mSv)	mSv	100	mrem
rem	0.01	Sievert (Sv)	Sv	100	rem
mSv	0.001	Sv	Sv	1000	mSv
person-rem	0.01	person-Sv	person-Sv	100	person-rem
rad	0.01	Gray (Gy)	Gy	100	rad
milliGray (mGy)	0.001	Gy	Gy	1000	mGy
milligrams per liter (mg/L)	1000	micrograms per liter (µg/L)	µg/L	0.001	mg/L
Fahrenheit (°F)	(°F - 32) x 5/9	Celsius (°C)	°C	(°C x 9/5) + 32	°F
For Natural Uranium in Water					
pCi/L	0.0015	mg/L	mg/L	675.7	pCi/L
pCi/L	1.48	µg/L	µg/L	0.6757	pCi/L
µg/L	0.6757	pCi/L	pCi/L	1.48	µg/L
For Natural Uranium in Soil					
pCi/g	1.48	µg/g	µg/g	0.6757	pCi/g
mg/kg	1	µg/g	µg/g	1	mg/kg

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Executive Summary

ES 1.0 Executive Summary

The 2003 Site Environmental Report provides stakeholders with the results from the Fernald site's environmental monitoring programs for 2003, along with a summary of the U.S. Department of Energy's (DOE's) progress toward final remediation of the site. In addition, this report provides a summary of the Fernald site's compliance with the various environmental regulations, compliance agreements, and DOE policies that govern site activities. All information presented in this executive summary is discussed more fully within the body of this report and the supporting appendices. This report has been prepared in accordance with DOE Order 5400.1, General Environmental Protection Program (DOE 1990a), and the Integrated Environmental Monitoring Plan (IEMP), Revision 3 (DOE 2003e). Note that in January 2003, DOE Order 450.1 went into effect, superceding DOE Order 5400.1; however, it has been determined that the intent of this order is met through existing DOE Fernald contractual requirements.

During 2003 DOE and Fluor Fernald, Inc., the prime contractor for the Fernald site, made considerable progress toward final cleanup goals established for the site. A wide range of environmental remediation activities continued during the year, including:

- Excavation and shipment of contaminated waste pit material to an off-site disposal facility (Operable Unit 1).
- Large-scale excavation of contaminated soil/materials from the waste pit area (e.g., Waste Pit 4 cap material), silos area (e.g., Silos 1 and 2 berm material), and former production area (Operable Unit 5).
- Placement of contaminated soil and debris in the on-site disposal facility (Operable Unit 2).
- Decontamination and dismantlement of former production buildings and support facilities (Operable Unit 3).
- Completion of most construction of equipment and facilities for implementation for Silos 1 and 2 remedy (Operable Unit 4).
- Extraction and treatment of contaminated groundwater from the Great Miami Aquifer (Operable Unit 5).

Several important milestones toward remediation of the Fernald site were reached in 2003. All major Operable Unit 2 remedial actions were completed. One new on-site disposal facility cell (Cell 6) was opened for waste placement. Twenty-six building structures were demolished bringing the total to 145 of 316 structures. The second phase of the South Field Module (groundwater pumping) began extracting contaminated groundwater.

The following sections highlight the results of environmental monitoring activities conducted during 2003.

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ES 1.1 Liquid Pathway Highlights

ES 1.1.1 Groundwater Pathway

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

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

During 2003 active restoration of the Great Miami Aquifer continued or was initiated within each of the following groundwater restoration modules:

- South Field Module – continued pumping from nine existing extraction wells (Phase I). During 2003 one extraction well was replaced (Extraction Well 31562 replaced by Extraction Well 33298) and four became operational (Phase II).
- South Plume/South Plume Optimization Module – continued pumping from six existing extraction wells.
- Waste Storage Area (Phase I) Module – continued pumping from three existing extraction wells that became operational in 2002.
- Re-Injection Module – continued injecting water into the aquifer for most of the year via four existing re-injection wells. During 2003 three new re-injection wells and one injection pond began operating in the South Field area.

In addition, approximately 150 monitoring wells were sampled at various frequencies to determine water quality. Water elevations were measured quarterly in approximately 170 monitoring wells. The following highlights describe the key findings from the 2003 groundwater data:

- 2,428 million gallons (9,190 million liters) of groundwater were pumped from the Great Miami Aquifer and 360 million gallons (1,363 million liters) of water were re-injected into the aquifer. As a result of these restoration activities, 1,151 pounds (523 kilograms [kg]) of uranium were removed from the aquifer.
- The results of 2003 groundwater capture analysis and monitoring for total uranium and non-uranium constituents indicate that the design of the groundwater remedy for the aquifer restoration system is appropriate for capture of the plume. Installation of additional extraction and re-injection wells was necessary to support the accelerated aquifer remediation schedule. Ongoing refinement of the wellfield configuration will continue based on new monitoring data.
- 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.

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- Pumping from the four South Field Module (Phase II) extraction wells began during 2003.

- Leak detection monitoring at Cells 1 through 5 of the on-site disposal facility indicates that all the individual cell liner systems are performing within the specifications outlined in the approved cell design.

ES 1.1.2 Surface Water and Treated Effluent Pathway

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

In 2003, 16 surface water and treated effluent locations were sampled at various frequencies and 6 sediment locations were monitored. The following highlights describe the key findings from the 2003 surface water, treated effluent, and sediment monitoring programs:

- The uranium released to the Great Miami River through the treated effluent pathway was an estimated 562 pounds (255 kg), which was below the limit of 600 pounds (272 kg) per year. Uranium released through the uncontrolled runoff pathway was estimated at 118 pounds (54 kg). Therefore, the total amount of uranium released through the treated effluent and uncontrolled surface water pathways during 2003 was estimated to be 681 pounds (309.2 kg).

- No surface water or treated effluent analytical results from samples collected in 2003 exceeded the final remediation level (FRL) for total uranium, the site's primary contaminant. FRL exceedances and benchmark toxicity value (BTV) exceedances were each limited to one constituent at one location. These occasional, sporadic exceedances are expected to occur until site remediation is complete.

- Compliance sampling, consisting of sampling for non-radiological pollutants from uncontrolled runoff and treated effluent discharges from the Fernald site, is regulated under the state-administrated National Pollutant Discharge Elimination System (NPDES) program. The current permit became effective on July 1, 2003, and expires on June 30, 2008.

- Discharges were in compliance with effluent limits identified in the NPDES Permit well over 99 percent of the time during 2003.

- The 2003 sediment results were consistent with data collected in previous years with the exception of one thorium-230 result from Paddys Run just above the Storm Sewer Outfall Ditch confluence (new maximum of 13.6 pCi/g versus the sediment FRL of 18,000 pCi/g). There were no FRL exceedances for any sediment result in 2003.

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ES 1.2 Air Pathway Highlights

The air pathway is routinely monitored to assess the impact of Fernald site emissions of radiological air particulates, radon, and direct radiation on the surrounding public and environment. In addition, the data are used to demonstrate compliance with various regulations and DOE Orders.

ES 1.2.1 Radiological Air Particulate Monitoring

- Data collected from the network of 17 fenceline and one background air monitoring stations showed that the annual average radionuclide concentrations were all less than 1 percent of DOE-derived concentration guidelines contained in DOE Order 5400.5, Radiation Protection of the Public and the Environment (DOE 1990b).

- The maximum effective dose at the fenceline from 2003 airborne emissions (excluding radon) was estimated to be 0.82 millirem (mrem) per year and occurred at AMS-9C along the eastern fenceline of the site. This represents 8.2 percent of the limit of 10 mrem per year established in National Emission Standards for Hazardous Air Pollutants, Subpart H. For comparison, the maximum effective dose was 0.8 mrem in both 2001 and 2002.

- As in 2001 and 2002, thorium-230 continued to be the major dose contributor to the air inhalation dose in 2003. This is the result of fugitive emissions from the Waste Pits Project operations where thorium-230 is the primary isotope of concern.

ES 1.2.2 Radon Monitoring

A network of 33 continuous radon monitors was used for determining compliance with the applicable limits during 2003. The annual average radon concentration recorded at the site's property boundary ranged from 0.2 picoCuries per liter (pCi/L) to 0.6 pCi/L (inclusive of background concentrations). The annual average background concentration measured in 2003 was 0.3 pCi/L. Property boundary results were well below the DOE radon standard of 3.0 pCi/L above background concentrations.

The annual average radon concentrations in the vicinity of Silos 1 and 2 (Operable Unit 4) during 2003 were comparable to those measured in 2002 through the end of April 2003, at which time the Radon Control System (RCS) began operating on a fairly continual basis. Because of RCS operations, radon concentrations in the vicinity of the silos have decreased sharply (i.e., approximately 60 percent). Additionally, there were no exceedances of the DOE limit of 100 pCi/L during 2003; whereas, in 2002 there were 10 exceedances of this limit.

Radon concentrations within the headspace of Silos 1 and 2 during 2003 were also comparable to those measured in 2002 until the end of April 2003. Again, since the operation of the RCS, concentrations have decreased significantly (i.e., approximately 97 percent).

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ES 1.2.3 Direct Radiation Monitoring

Direct radiation measurements were continuously collected at 37 locations at the Fernald site and at background locations. As in years past, the direct radiation levels observed in 2003 indicate that the highest measurements were obtained in proximity to Silos 1 and 2. The direct radiation measurements near Silos 1 and 2 were significantly lower in 2003 than in 2002, primarily due to operation of the RCS.

ES 1.3 Estimated Dose for 2003

In 2003 the maximally exposed individual, near the western fenceline of the Fernald site, could have hypothetically received a maximum dose of approximately 7.33 mrem. For comparison purposes, in 2002 it was calculated that the maximally exposed individual living nearest the Fernald site in a west direction could have hypothetically received a maximum dose of approximately 14.8 mrem. This estimate represents the maximum incremental dose above background attributable to the site and is exclusive of the dose received from radon. The contributions to this all-pathway dose for 2003 were 0.63 mrem from air inhalation dose, 0.003 mrem from the consumption of locally grown produce, and 6.7 mrem from direct radiation. This dose can be compared to the limit of 100 mrem above background for all pathways (exclusive of radon) that was established by the International Commission on Radiological Protection and adopted by DOE.

ES 1.4 Natural Resources

Natural resources include the diversity of plant and animal life and their supporting habitats found in and around the Fernald site. During 2003 the following primary activities associated with natural resource monitoring and restoration occurred.

- The Area 2 (Phase I) Southern Waste Units Restoration Project was completed. This project expanded the riparian corridor along Paddys Run and created several open water and wetland areas within the footprint of the former Southern Waste Units. Re-vegetation focused on establishing the early stages of forest communities in upland areas.

- The Area 1 (Phase I) Northern Pine Plantation Restoration Project continued, with installation of all plants and the completion of most seeding. The new vegetation, as well as the addition of herbaceous plants and dormant cuttings, greatly enhanced the wetland and vernal pool features that were created in 2002.

- The Area 8 (Phase III) South Restoration Project commenced with approximately 700 trees and shrubs installed in a former pasture along the Paddys Run corridor. Field personnel also cleared invasive bush honeysuckle and prepared two additional fields for prairie seeding in 2004.

- The Phase II Wetland Mitigation Project was initiated. Grading was conducted to establish three shallow basins that will collect water downstream from the existing forested wetland in the northern woodlot.

- The restoration of Subareas 1 and 2 of the borrow area was completed. This effort involved grading to create several small ponds and swales, and seeding with native wetland vegetation across the project area.

Ecological restoration monitoring continued in 2003, and Sloan's crayfish turbidity monitoring in Paddys Run resumed. Also, several unexpected discoveries of cultural resources occurred during 2003 remediation activities although none were significant and no impacts to cultural resources occurred.

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Chapter 1
Site Background

1.0 Site Background

Abbreviated Timeline

1951	Construction of the Feed Materials Production Center began.
1952	Uranium production started.
1986	EPA and DOE signed the Federal Facilities Compliance Agreement, which initiated the remedial investigation/feasibility study process.
1989	Uranium production was suspended. The Fernald site was placed on the National Priorities List, which is the list of CERCLA sites most in need of cleanup.
1990	As part of the Amended Consent Agreement, the site was divided into operable units for characterization and remedy determination.
1991	Uranium production formally ended. The site mission changed from uranium production to environmental remediation and site restoration.
1996	The last operable unit's record of decision was signed, signifying the end of the 10-year remedial investigation/feasibility study process. (The Operable Unit 4 Record of Decision was later re-opened.)
1999	Excavation of the waste pits was initiated and the first rail shipment of waste material was transported to Envirocare of Utah, Inc.
2000	The Record of Decision Amendment for Operable Unit 4 Silos 1 and 2 Remedial Actions was signed by EPA.
2001	On-site disposal facility Cell 1 was capped. Remediation of the southern waste units was completed.
2002	The Silos 1 and 2 Radon Control System (RCS) began operations and successfully reduced radon levels within the silos. The off-site transfer of nuclear product material was completed. The on-site disposal facility conducted waste placement into Cells 2, 3, 4, and 5.
2003	All major Operable Unit 2 remedial actions were completed in 2003. In addition, approximately 412,000 cubic yards (yd^3) (315,015 cubic meters [m^3]) of waste were placed in Cells 3, 4, 5, and 6 of the on-site disposal facility.

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

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

CERCLA Remedial Process

In broad terms, the process of cleaning up sites under CERCLA consists of the following general phases:

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

Remedy Selection – During this phase, cleanup alternatives are developed and evaluated, and with the input of stakeholders, a remedy is selected. Activities include the feasibility study and proposed plan. After public comments are received, a remedial alternative is selected and documented in a record of decision.

Remedial Design and Remedial Action – This phase of the CERCLA process includes the detailed design and implementation of the remedy.

The CERCLA process ends with certification and site closure. A five-year review process is triggered by the onset of construction for the first operable unit remedial action that will result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. Of all the operable units, the site preparation construction to support the Waste Pits Project under the Operable Unit 1 Record of Decision (DOE 1995b) was the first such action. This construction began on April 1, 1996. The First Five-Year Review Report for the site was submitted to and approved by the EPA in 2001. These reviews ensure that the remedy remains effective and continues to be protective of human health and the environment.

Long-term Stewardship will take place at the Fernald site following site closure. Site closure is defined in the current contract between Fluor Fernald and DOE as the physical completion of the scope of work required by the five Records of Decision with the exception of groundwater remedy. DOE's Office of Legacy Management will assume the long-term surveillance monitoring and maintenance of the FCP after site closure in order to ensure continued protection of human health and the environment, and continued operation of the groundwater remedy. The previously mentioned five-year review process will continue in order to provide stakeholders with information on the remedy performance as well as long-term stewardship information.

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) as amended. The site was renamed the Fernald Environmental Management Project (FEMP). Today the site is called the Fernald Closure Project (FCP) to reflect the current mission. Fluor Fernald, Inc. manages the remediation and restoration of the site under the terms of a prime contract with DOE. Regulatory oversight is provided by Region V of the U.S. Environmental Protection Agency (EPA) and the Southwest District Office of the Ohio Environmental Protection Agency (OEPA).

In the 1980s environmental monitoring activities began at the site. The goal was 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. The goal was to continuously measure the levels of contaminants associated with uranium production operations, and report this information to the regulatory agencies and stakeholders.

Since the conclusion of the site's uranium production mission and completion of the CERCLA remedy selection process, the focus is on the safe and efficient implementation of environmental remediation activities and facility decontamination and dismantling operations. In recognition of this shift in emphasis toward remedy implementation, the environmental monitoring program was revised in 1997 to align with the remediation activities planned for the Fernald site. The site's environmental monitoring program for 2003 is described in the Integrated Environmental Monitoring Plan (IEMP), Revision 3 (DOE 2003e). The IEMP is updated at a minimum of every two years to keep pace with the site's monitoring needs as remediation progresses.

This 2003 Site Environmental Report summarizes the findings from the IEMP monitoring program and provides a status on the progress toward final site restoration. This report consists of the following:

Summary Report The summary report (Chapters 1 through 7) documents the results of environmental monitoring activities at the Fernald site in 2003. It includes a discussion of remediation activities and summaries of environmental data from groundwater, surface water and treated effluent, sediment, air, and natural resources monitoring programs. It also summarizes the information contained in the appendices.

Appendices The detailed appendices provide the 2003 environmental monitoring data for the various media, primarily in the form of graphs and tables. The National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 Code of Federal Regulations 61 Subpart H) (EPA 1985) compliance report is also included. The appendices are generally distributed only to the regulatory agencies. However, a complete copy of the appendices is available at the Public Environmental Information Center, which is located near the access point for the site in Trailer 210, and is open Thursdays or by appointment.

The remainder of this introductory chapter provides:

- An overview of the current environmental remediation operations and a description of its current cleanup mission, organization, and major remediation activities
- A description of environmental monitoring activities at the Fernald site
- A description of the physical, ecological, and human characteristics of the area.

1.1 The Path to Site Closure

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

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Following approval of the initial records of decision, work began on the design and implementation of the operable unit remedies. In order to align sitewide responsibilities and regulatory obligations of each operable unit and to most efficiently execute remedial design and remedial action, the site established integrated project organizations in 1996. Realignment into project organizations reflected the actual work processes and operations necessary to complete remediation while meeting the requirements of the records of decision. Table 1-1 describes each operable unit and its associated remedy, and provides a crosswalk between each operable unit and the project organizations responsible for implementing each remedy. When a project organization is mentioned in this document, references to the applicable operable unit are included, as identified in the Table 1-1 description. Note that in mid-2003 several reorganizations and project name changes occurred. These changes are reflected in Table 1-1 and are comprised of the following:

- The Waste Pits Remedial Action Project became the Waste Pits Project.
- The Soil and Disposal Facility Project combined with the Decontamination and Demolition Project to form the Demolition, Soil, and Disposal Project.
- The Aquifer Restoration/Wastewater Project was divided: the operations portion went to the Operations and Support Organization, and the hydrogeology portion went to the Demolition, Soil, and Disposal Project. (For simplification purposes this report will still refer to Aquifer Restoration/Wastewater Project.)

1.2 Environmental Monitoring Program

Exposure Pathways

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

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

Refer to Chapter 6 of this report for information pertaining to 2003 dose calculations from all pathways.

In the 1980s an environmental monitoring program was initiated to assess the impact of past operations on the environment and monitor potential exposure pathways to the local community. Additionally, characterization activities were conducted at the Fernald site for nearly 10 years through the remedial investigation phase of the CERCLA process. The initial environmental evaluations performed during the remedial investigation/feasibility study process were used to select the final remedy for Operable Unit 5, which addressed contamination in soil, groundwater, surface water, sediment, air, and biota (produce) – 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 both removing the contamination that might be released through these exposure pathways, and monitoring these pathways to measure the site's continuing impact on the environment as remediation progresses. The characterization data used to develop the final remedy were also used to focus and develop the environmental monitoring program documented in the IEMP. Following are descriptions of the IEMP's key elements:

- The IEMP defines monitoring activities for environmental media, such as groundwater, surface water and treated effluent, sediment, air (including air particulate, radon, and direct radiation), produce, and natural resources. In general, the primary exposure pathways (liquid and air) are monitored and the program focuses on assessing the collective effect of sitewide emissions on the surrounding environment.

TABLE 1-1
OPERABLE UNIT REMEDIES AND ASSOCIATED PROJECT ORGANIZATION RESPONSIBILITIES

Operable Unit	Description	Remedy Overview	Project Organization Responsibilities
1	- Waste Pits 1–6 - Clearwell - Burn pit - Berms, liners, caps, and soil within the boundary	Record of Decision Approved: March 1995 Record of Decision 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), off-site disposal at a permitted facility, and FCP remediation.	Waste Pits Project is responsible for rail upgrades; excavation of Operable Unit 1 waste units; pre-treatment of wastewater as necessary to meet Aquifer Restoration Project waste water acceptance criteria; waste processing and drying; and loading, rail transport, and off-site disposal of all waste pit waste, as well as any contaiminted soil contaminated soil and debris that exceed the waste acceptance criteria for the on-site disposal facility. (Note: Some of the activities with this project are being performed by Shaw Environmental.) Demolition, Soil, and Disposal Project is responsible for the excavation and certification of contaminated soil beneath the waste pits, as well as at- and below-grade remediation facilities and is responsible for decontamination and dismantling of Operable Unit 1 remediation facilities. Aquifer Restoration/Wastewater Project is responsible for final treatment of contaminated runoff, perched water collected during waste pit excavation, and processing wastewater discharges. Each project is responsible for transporting remediation wastewater to the head works of the advanced wastewater treatment facility for treatment.
2	- Solid waste landfill - Inactive flyash pile - Active flyash pile (now inactive) - North and south Lime Sludge Ponds - Other South Field disposal areas - Berms, liners, and soil within the operable unit boundary	Record of Decision Approved: May 1995 Post-Record of Decision Fact Sheet Approved: April 1999 Excavation of all materials with constituents of concern above FRLs, treatment for size reduction and moisture control as required, on-site disposal in the on-site disposal facility, and off-site disposal of excavated material that exceeds the waste acceptance criteria for the on-site disposal facility.	Demolition, Soil, and Disposal Project is responsible for excavating and disposing of waste from all Operable Unit 2 subunits and certifying the footprints. This project is also responsible for the ongoing design, construction and maintenance, and closure of the on-site disposal facility that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil and debris, and Operable Unit 3 debris. Waste Acceptance Organization is responsible for field oversight of soil excavations, for reviewing and signing manifests for impacted material delivered to the on-site disposal facility for placement, and for rejecting any unacceptable shipments. Aquifer Restoration/Wastewater Project is responsible for treating contaminated runoff and perched water collected during excavation of Operable Unit 2 subunit wastes. This project is responsible for leachate and leak detection monitoring at the on-site disposal facility and for treating leachate from the on-site disposal facility. Each project is responsible for transporting remediation wastewater to the head works of the advanced wastewater treatment facility for treatment.
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 - Scrap metals piles - Drums, tanks, solid waste, waste product, feedstocks, and thorium	Record of Decision Approved: September 1996 Adoption of Operable Unit 3 Interim Record of Decision; alternatives to disposal through the unrestricted or restricted release of materials, as economically feasible for recycling, reuse, or disposal; treatment of material for on- or off-site disposal; required off-site disposal for process residues, product materials, process-related metals, acid brick, concrete from specific locations, and any other material exceeding the on-site disposal facility waste acceptance criteria; and on-site disposal for material that meets the on-site disposal facility waste acceptance criteria.	Demolition, Soil, and Disposal Project is responsible for decontamination and dismantling of all above-grade portions of buildings and facilities at the Fernald site. *This project is responsible for excavation and certification of soil beneath facilities* and for removal of at- and below-grade structures. This project is also responsible for design, construction, and closure of the on-site disposal facility that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil, and Operable Unit 3 debris. Waste Acceptance Organization is responsible for reviewing facility decontamination and dismantling planning documents. This organization is also responsible for field oversight of debris sizing, segregation of on-site disposal facility material categories, and prohibited items; completing field tracking logs; completing manifests for material bound for the on-site disposal facility; and compiling final records of decontamination and dismantling debris placed in the on-site disposal facility. Aquifer Restoration/Wastewater Project is responsible for treating decontamination and other wastewaters during decontamination and dismantling activities and processing wastewater discharges. Each decontamination and dismantling project is responsible for *transporting remediation wastewater to the head works of the advanced wastewater* treatment facility for treatment.

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TABLE 1-1
(Continued)

Operable Unit	Description	Remedy Overview	Project Organization Responsibilities
4	- Silos 1 and 2 (containing K-65 residues) - Silo 3 (containing cold metal oxides) - Silo 4 (empty and never used) - Decant tank system - Berms and soil within the operable unit boundary	Record of Decision Approved: December 1994 Record of Decision Amendment for Silos 1 and 2 Approved: July 2000 Explanation of Significant Differences for Silo 3 Approved: March 1998 Explanation of Significant Differences for Silos 1 and 2 Approved: November 2003 Record of Decision Amendment for Silo 3 Approved: September 2003 Removal of Silo 3 materials for treatment (to the extent implementable) and off-site disposal (amendment to the Record of Decision). Removal of Silos 1 and 2 residues and decant sump tank sludges with on-site stabilization of materials, residues, and sludges followed by off-site disposal; and decontamination and demolition to the extent possible, of silos and remediation facilities. Excavation of silos area contaminated above the FRLs with on-site disposal for contaminated soils and debris that meet the on-site disposal facility waste acceptance criteria; and site restoration. Concrete from Silos 1 and 2, and contaminated soil and debris that exceed the on-site disposal facility waste acceptance criteria will be disposed of off site.	Silos 1 and 2 Project is responsible for transfer of Silos 1 and 2 residues to temporary transfer tanks, treatment, and transport off site. Waste treatment systems will be completed to support the final remediation of the silos. Silo 3 Project is responsible for Silo 3 content removal, treatment, and transport off site. Demolition, Soil, and Disposal Project is responsible for certification, excavation, and disposition of contaminated soil beneath the silos and for removal of subsurface structures (i.e., sub-grade silo decant system). The project is responsible for design, construction, and closure of the on-site disposal facility that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil, and Operable Unit 3 debris. This project is also responsible for decontamination and dismantling of all Operable Unit 4 remediation facilities and associated above-ground piping. Aquifer Restoration/Wastewater Project is responsible for the ultimate treatment and discharge of wastewater generated from Advanced Waste Retrieval activities and Silo 1, 2, and 3 remediation activities. Once silos projects are complete, the Project will provide treatment of decontaimination wastewater from demolition activities. Each project is responsible for capturing and transporting remediation wastewater to the headworks of the advanced wastewater treatment facility for treatment.
5	- Groundwater - Surface water and sediments - Soil not included in the definitions of Operable Units 1 through 4 - Flora and fauna	Record of Decision 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 (μg/L) 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 presents an unacceptable threat, through contaminant migration, to the underlying aquifer. On-site disposal of contaminated soil and sediment that meet the on-site disposal facility waste acceptance criteria. Soil and sediment that exceed the waste acceptance criteria for the on-site disposal facility will be treated, when possible, to meet the on-site disposal facility waste acceptance criteria or will be disposed of at an off-site facility. Also includes site restoration, institutional controls, and post-remediation maintenance.	Aquifer Restoration/Wastewater Project is responsible for designing, installing, and operating the extraction/re-injection systems for Great Miami Aquifer groundwater restoration. This project is responsible for groundwater monitoring in the Great Miami Aquifer; reporting on the progress of aquifer restoration; designing, constructing, and operating all treated effluent discharge systems; and treating and discharging contaminated groundwater, storm water, and remediation wastewaters at the Fernald site. This project is also responsible for operation, maintenance, and monitoring of the on-site disposal facility leachate collection system and leak detection system. Demolition, Soil, and Disposal Project is responsible for certification of sitewide soil; excavation and disposition of contaminated soil, sediment, perched groundwater and at- and below-grade structures; and final site restoration. The project is responsible for design, construction, maintenance, and closure of the on-site disposal facility that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil, and Operable Unit 3 debris. This project is also responsible for decontamination and dismantling of all Operable Unit 5 remediation facilities necessary through the site completion phase following the completion of the aquifer remediation. Waste Acceptance Organization is responsible for reviewing Soils and Disposal Facility Project planning documents. This project is also responsible for oversight of field excavations; segregating on-site disposal facility material categories and segregating prohibited items; completing field tracking logs; completing manifests for material bound for the on-site disposal facility; and compiling final records of soil and at- and below-grade debris placed in the on-site disposal facility.

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- The IEMP establishes a data evaluation and decision-making process for each environmental medium. Through this process, environmental conditions at the site as a whole are continuously evaluated. These evaluations sometimes affect decisions made about the implementation of remediation activities. For example, environmental data are routinely evaluated to identify any significant trends that may indicate the potential for an unacceptable future impact to the environment if action is not taken. This information is communicated to the appropriate remediation project organizations so that corrective actions can be taken before conditions become unacceptable.
- Recognizing that the type and pace of remediation activities will change over the life of the cleanup effort, the IEMP was developed as a "living document," allowing for adjustment of the program as site remediation progresses. The IEMP is reviewed annually and revised every two years to ensure that the monitoring program adequately addresses changing remediation activities.
- The IEMP consolidates routine reporting of environmental data into mid-year data summary reports and a comprehensive annual report.

1.3 Characteristics of the Site and Surrounding Area

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

1.3.1 Land Use and Demography

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

Downtown Cincinnati is approximately 18 miles (29 km) southeast of the Fernald site, as shown in Figure 1-1. The cities of Fairfield and Hamilton are 6 and 8 miles (10 and 13 km) to the east and northeast, respectively, as shown in Figure 1-2. Scattered residences and several villages including Fernald, New Baltimore, New Haven, Ross, and Shandon are located near the site. Based on the 2000 U.S. Census, there is an estimated population of 20,000 within 5 miles (8 km) of the Fernald site and an estimated 2.8 million within 50 miles (80 km).

1.3.2 Geography

Figure 1-3 depicts the location of the major physical features of the site, such as the buildings and supporting infrastructure. The former production area and various administrative buildings dominate this view. The former production area occupies approximately 136 acres (55 hectares) in the center of the site. The waste pit area and K-65 Silos are located adjacent to the western edge of the former production area. The Great Miami River cuts a terraced valley to the east of the site while 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 between vegetated bedrock outcroppings to the north, southeast, and southwest.

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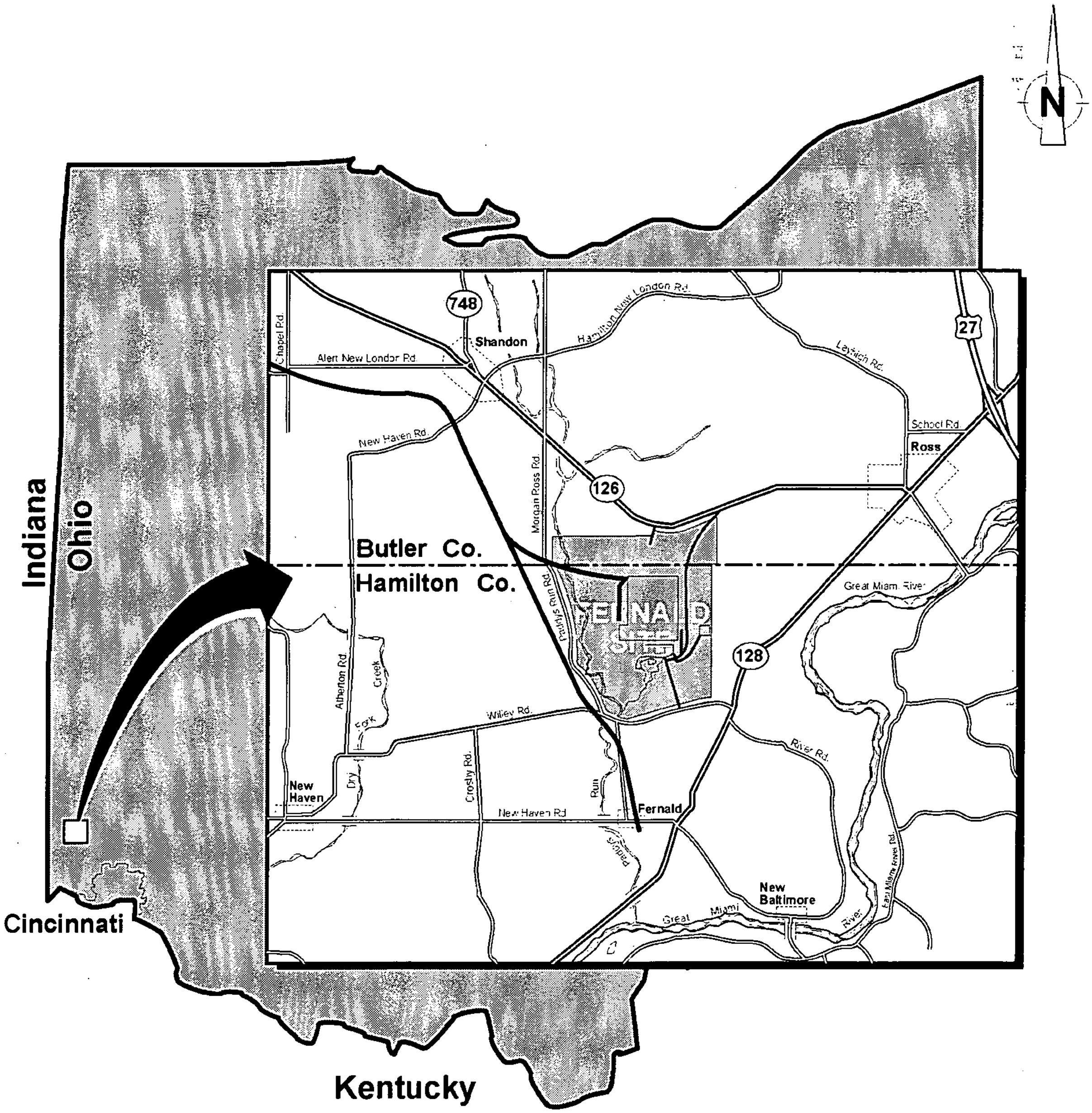

The Fernald site covers about 1,050 acres (425 hectares).

Figure 1-1. Fernald Site and Vicinity

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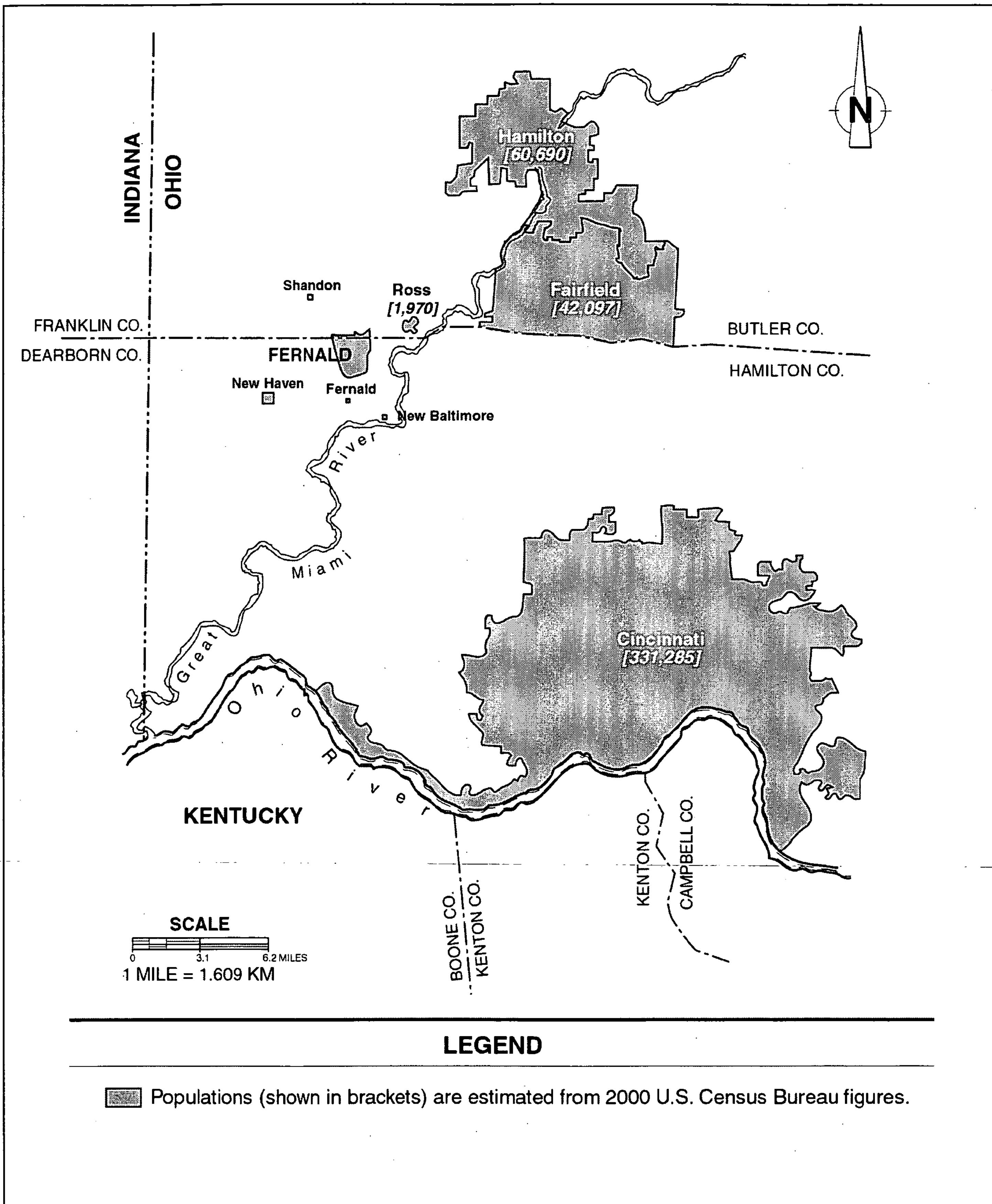

Figure 1-2. Major Communities in Southwestern Ohio

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Figure 1 - 3. Fernald Site 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 (61 meters) 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 an impermeable mixture of clay and silt with minor amounts of sand and gravel deposited across the land surface, called glacial overburden. The site is situated on a layer of glacial overburden that overlies portions of a 2- to 3-mile-wide (3- to 5-km) 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 define the edges and bottom of the New Haven Trough confine 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 significant portions of the glacial overburden and exposed the underlying sand and gravel of the Great Miami Aquifer. Thus, in some areas, precipitation and surface water runoff can easily migrate into the underlying Great Miami Aquifer, permitting contaminants to be transported to the aquifer as well. Natural and man-made breaches of the glacial overburden were key pathways where contaminated water entered the aquifer, causing the groundwater plumes that are being addressed by aquifer restoration activities. Figure 1-4 provides a glimpse into the structure of subsurface deposits in the region along an east-west cross section through the site, while Figure 1-5 presents the regional groundwater flow patterns in the Great Miami Aquifer.

1.3.4 Surface Hydrology

The site is located in the Great Miami River drainage basin (refer to Figure 1-6). Natural drainage from the site to the Great Miami River occurs primarily via Paddys Run. This intermittent stream begins losing flow to the underlying sand and gravel aquifer south of the waste pit area. Paddys Run empties into the Great Miami River 1.5 miles (2.4 km) south of the site.

In addition to natural drainage through Paddys Run, surface water runoff from the former production area, the waste pit area, and other selected areas is collected, treated, and discharged to the Great Miami River. Since January 1995, the majority of this runoff has been treated for uranium removal in the advanced wastewater treatment facility before being discharged. The Great Miami River, 0.6 mile (1 km) east of the Fernald site, runs in a southerly direction and flows into the Ohio River about 24 miles (39 km) downstream of the site. The segment of the river between the Fernald site and the Ohio River is not used as a source of public drinking water.

The average flow volume for the Great Miami River in 2003 was 5,805 cubic feet per second (ft^3/sec) (164.4 cubic meters per second [m^3/sec]). This is based on daily measurements collected at the United States Geologic Survey (USGS) Hamilton stream gauge (USGS 3274000) approximately 10 river miles (16 river km) upstream of the site's effluent discharge.

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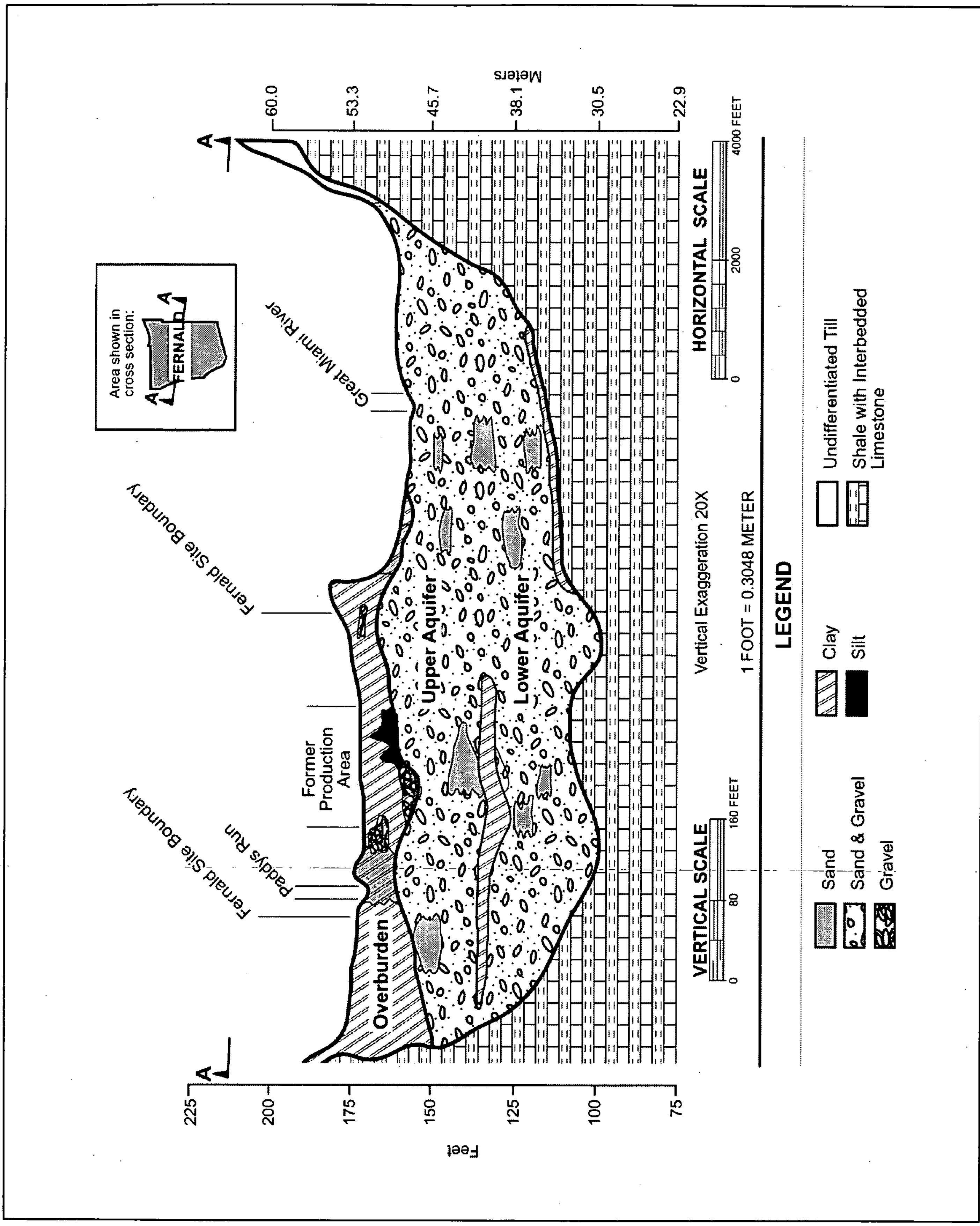

Figure 1-4. Cross Section of the New Haven Trough, Looking North

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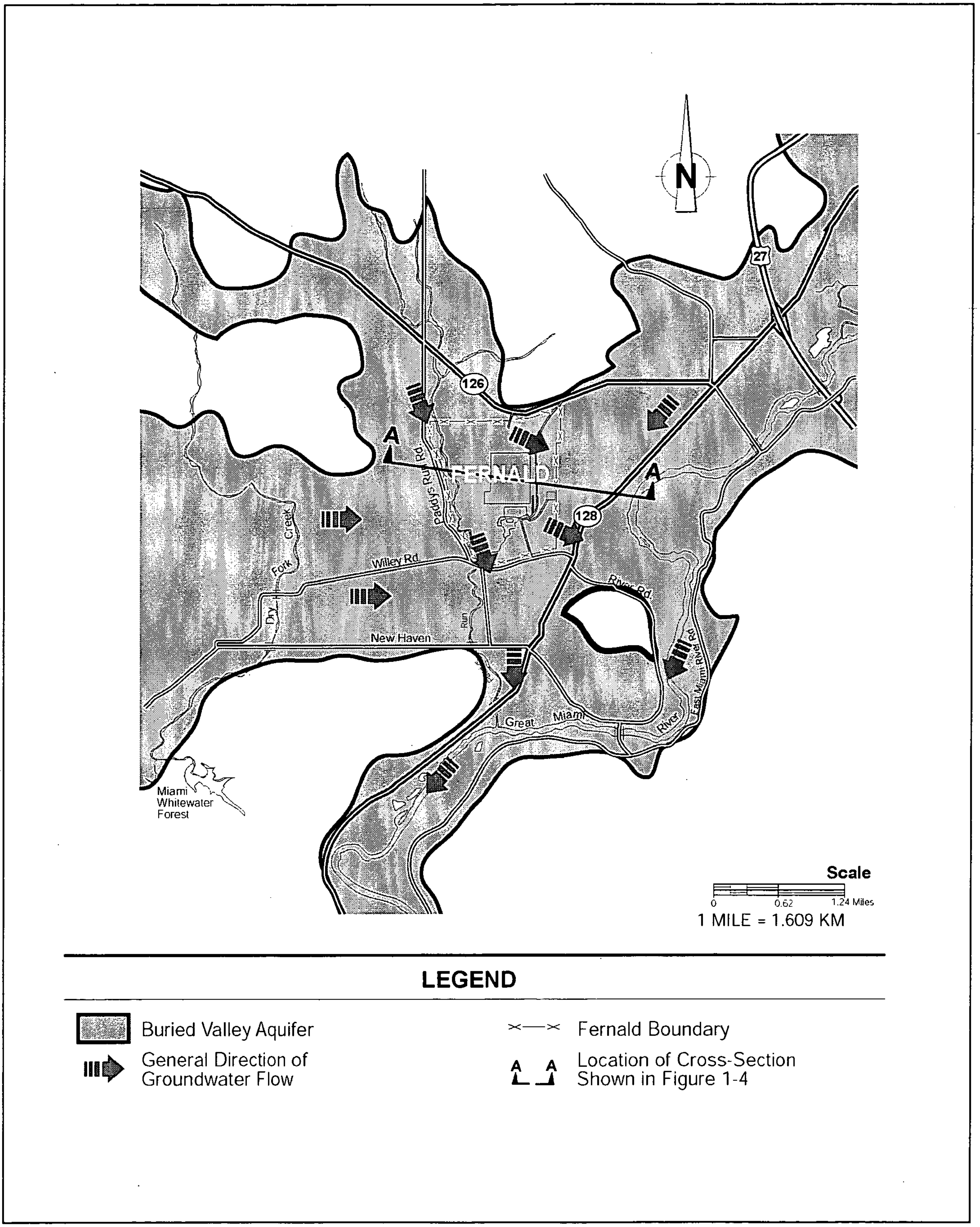

Figure 1-5. Regional Groundwater Flow in the Great Miami Aquifer

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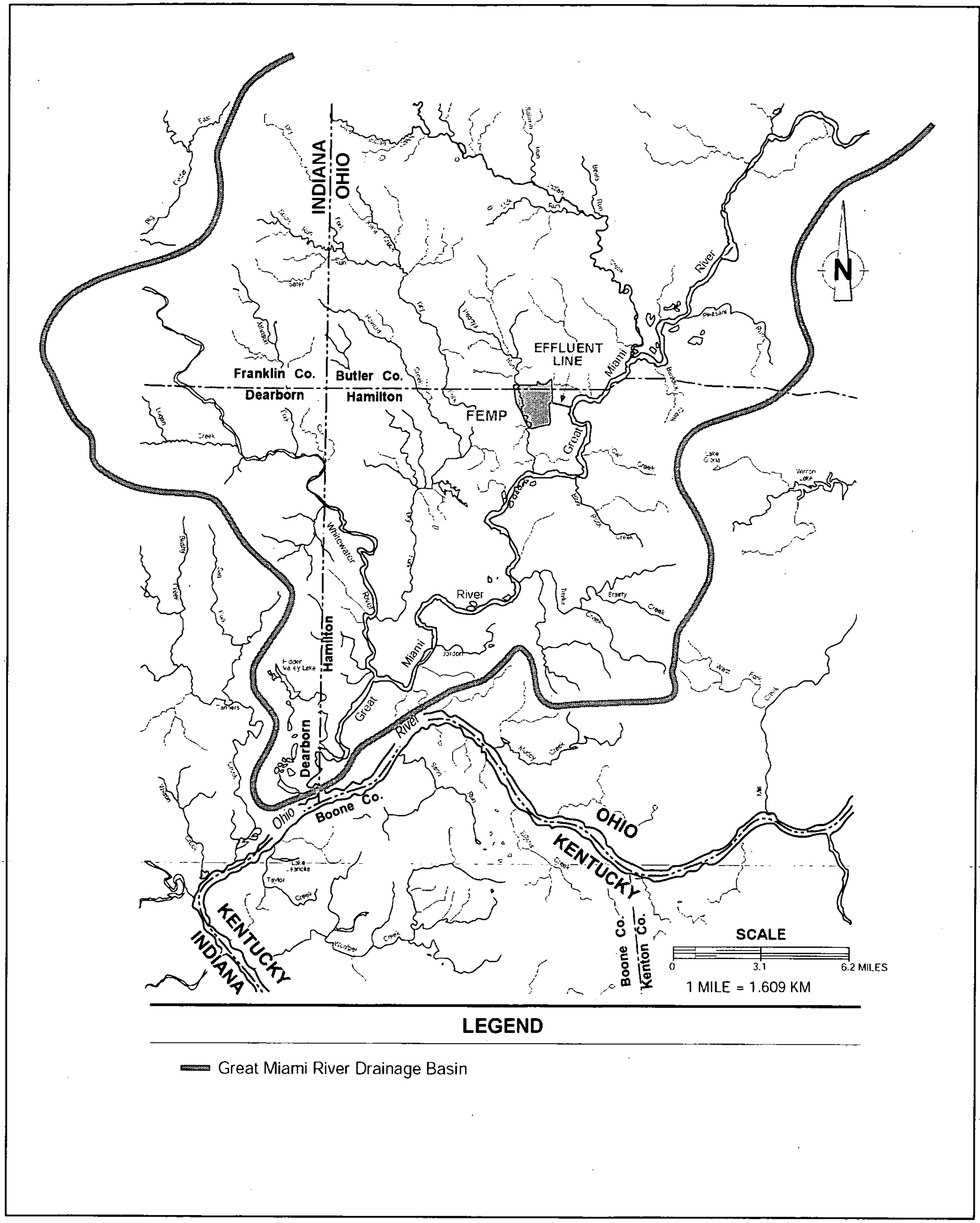

Figure 1-6. Great Miami River Drainage Basin

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1.3.5 Meteorological Conditions

Meteorological data are gathered at the Fernald site and used to evaluate site-specific climatic conditions. The environmental monitoring program uses atmospheric models to determine how airborne effluents are mixed and dispersed. These models are then used to assess the impact of operations on the surrounding environment, in accordance with DOE requirements. Airborne pollutants are subject to weather conditions. Wind speed and direction, precipitation, and atmospheric stability play a key role in predicting how pollutants are distributed in the environment and in interpreting environmental data.

Figures 1-7 and 1-8 illustrate the average wind speed and general direction for 2003 measured at the 33-foot (10-meter) and 197-foot (60-meter) levels, respectively, in wind rose format. The prevailing winds were from the southwest 47 percent of the time at the 10-meter height, and 42 percent of the time from the 60-meter height. Tables in Appendix C, Attachment C.5, of this report present meteorological data for 2003, including wind direction and average speed.

In 2003, 44.66 inches (113.4 centimeters [cm]) of precipitation were measured at the Fernald site. This is higher than the average annual precipitation of 41.17 inches (104.6 cm) for 1951 through 2002. Figure 1-9 shows 2003 total precipitation for the area in relation to the average annual precipitation amounts recorded from 1991 through 2003. Figure 1-10 shows 2003 precipitation by month at the site compared to the Cincinnati area average precipitation by month from 1951 through 2002.

1.3.6 Natural Resources

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

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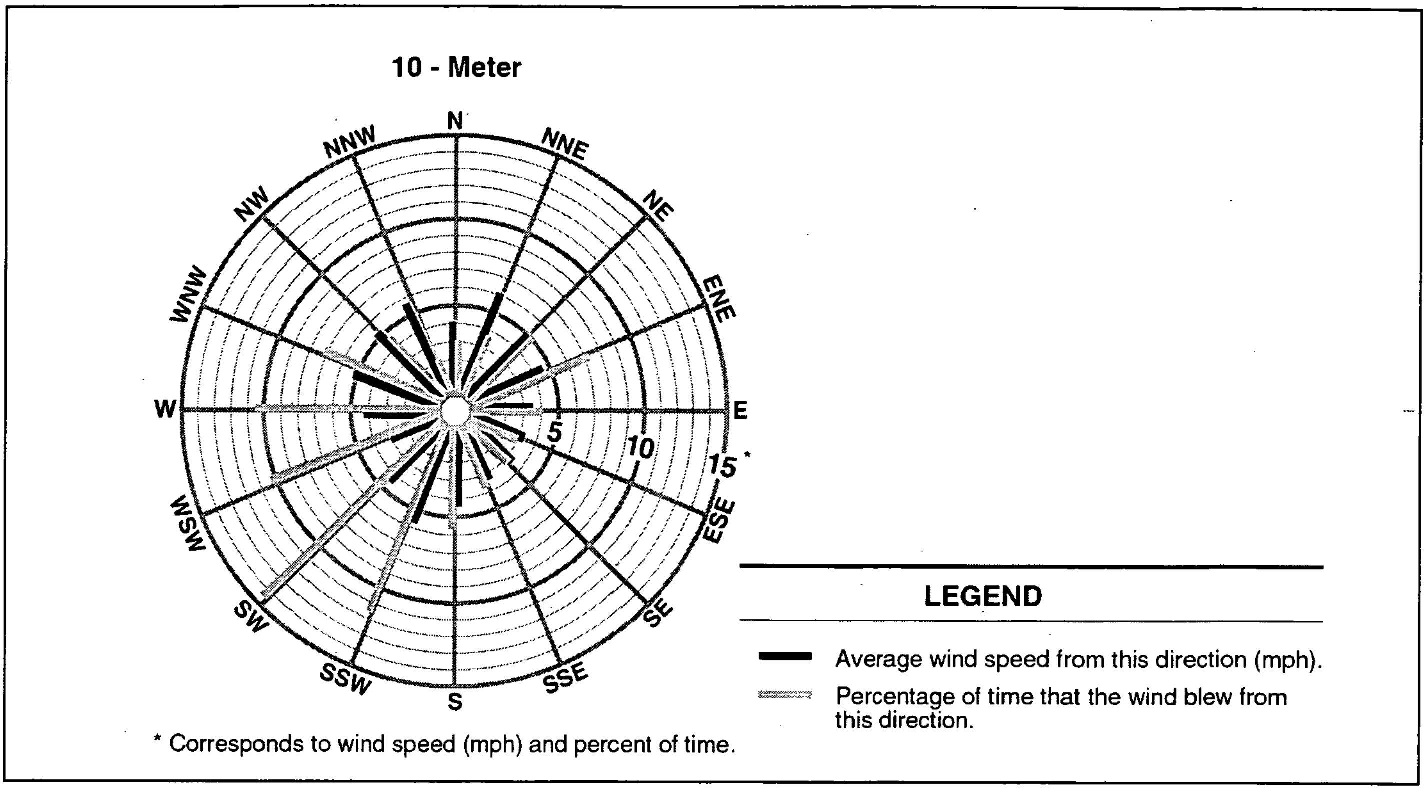

Figure 1-7. 2003 Wind Rose Data, 33-Foot (10-Meter) Height

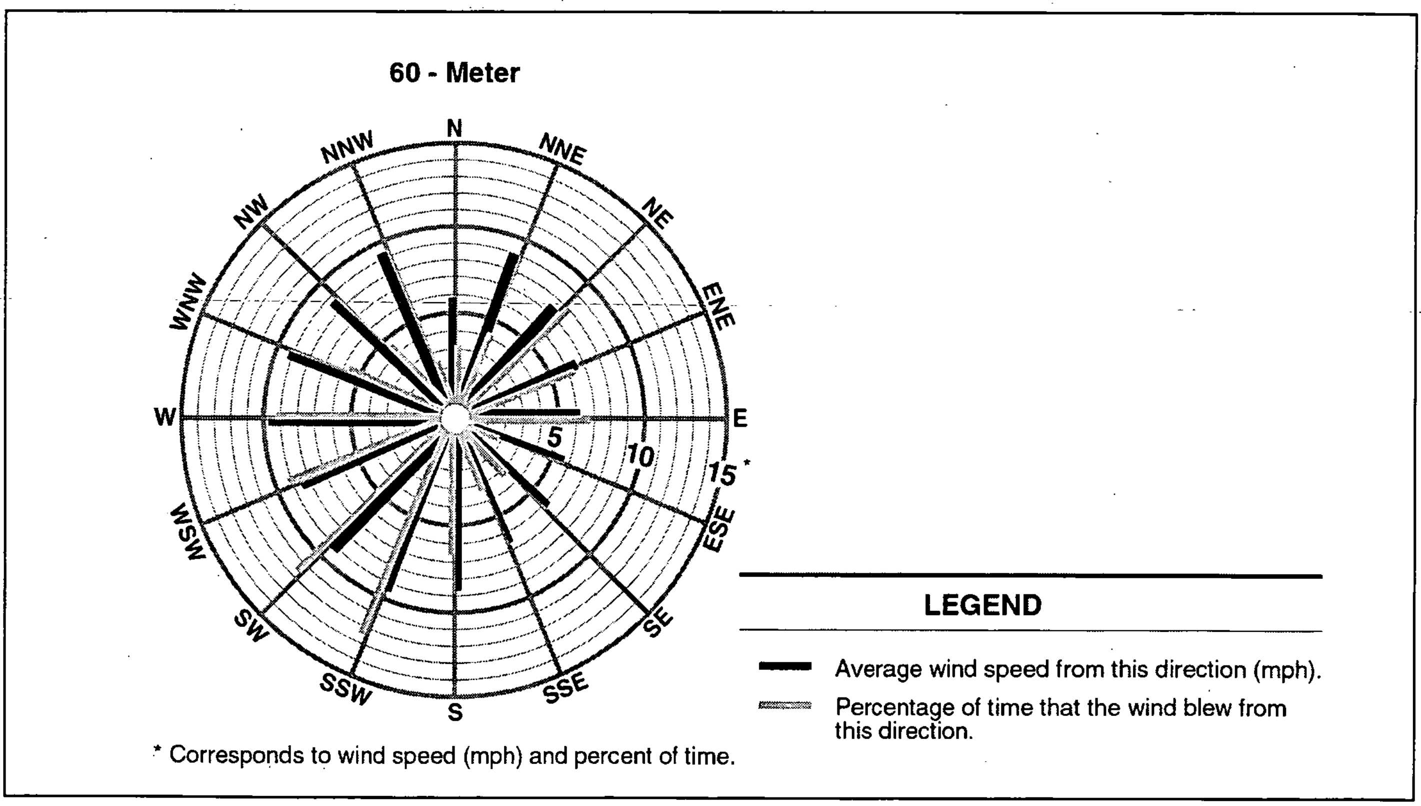

Figure 1-8. 2003 Wind Rose Data, 197-Foot (60-Meter) Height

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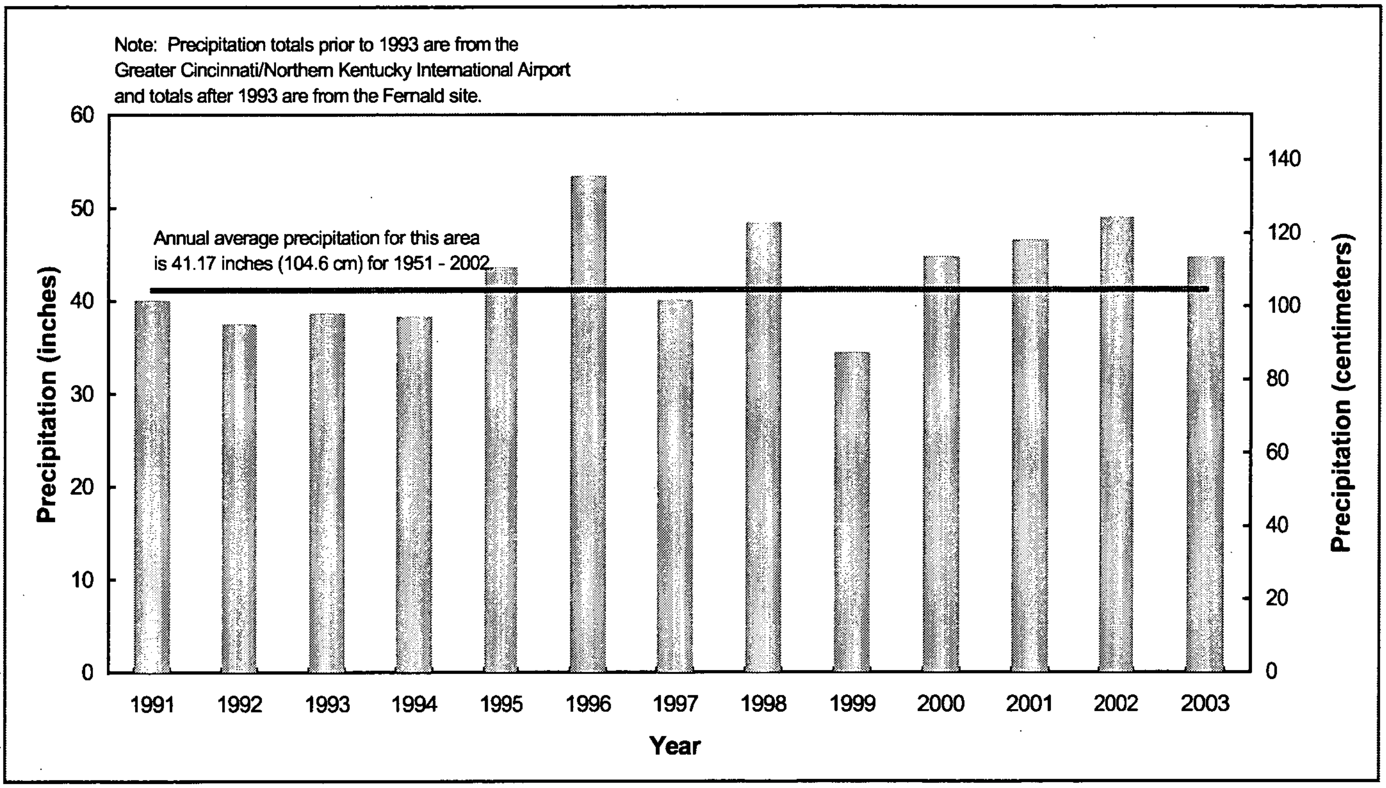

Figure 1-9. Annual Precipitation Data, 1991-2003

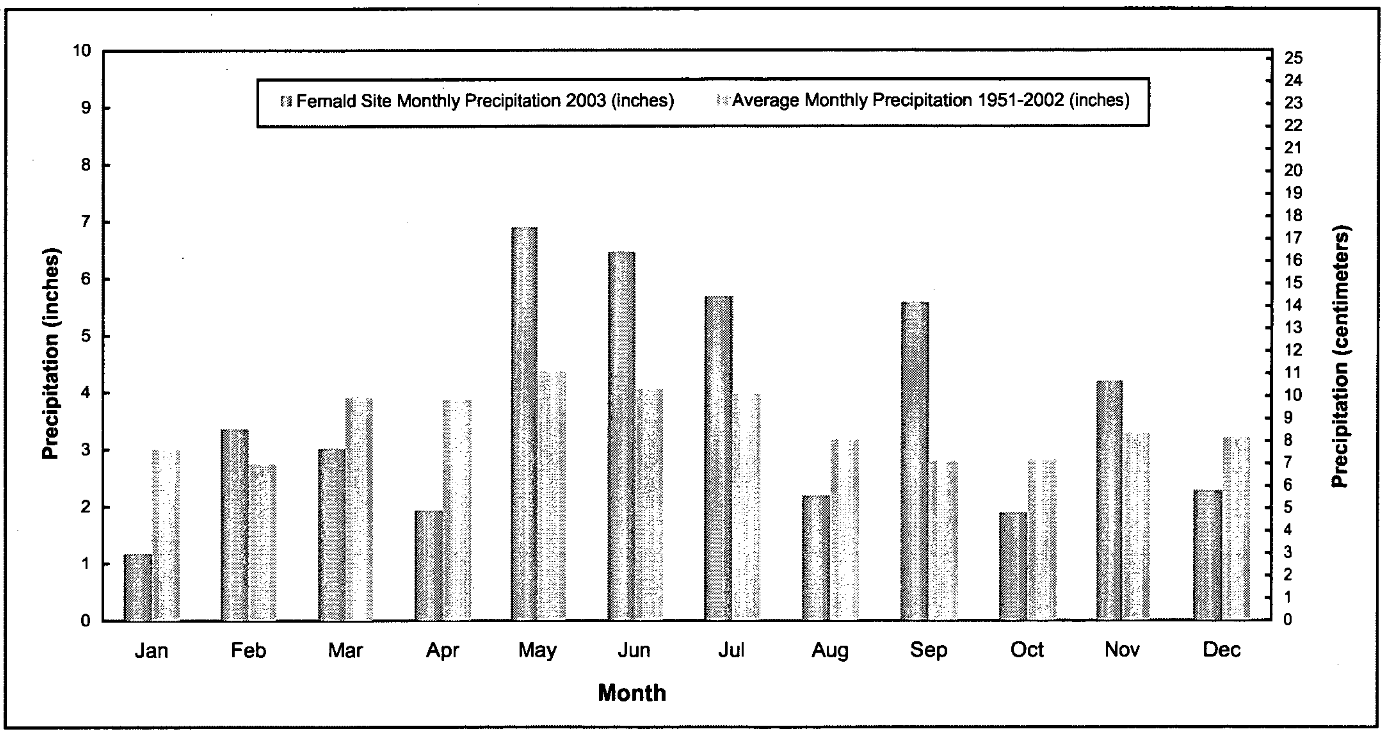

Figure 1-10. Monthly Precipitation, 2003 and 1951-2002

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Chapter 2
Remediation Status and Compliance Summary

2.0 Remediation Status and Compliance Summary

This chapter provides a summary of CERCLA remediation activities in 2003 for each project, and summarizes compliance activities with other applicable environmental laws, regulations, and legal agreements. CERCLA, the "Superfund Act," is the primary driver for environmental remediation of the Fernald site.

The EPA and OEPA enforce the environmental laws, regulations, and legal agreements governing work at the Fernald site. The 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 site. Region V of the EPA has regulatory oversight of the CERCLA process at the Fernald site, with active participation from OEPA.

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

2.1 CERCLA Remediation Status

The process for remediating sites under CERCLA consists of three phases: site characterization, remedy selection, and implementation. The FCP has completed the first two phases, as the regulatory agencies have approved remedy selection documents (i.e., records of decision) for all operable units, as well as several amendments to these documents.

The FCP is currently involved in the implementation phase of CERCLA remediation, which includes remedial design, remedial action (construction and implementation of the remedy), certification of soil and groundwater to verify that the remedy was effective, and ultimately site closure. Remediation activities, documents, and schedules are identified in each operable unit's remedial design and remedial action work plan.

Each phase of the CERCLA remediation process requires documentation. The documents produced reflect the input of stakeholders who have helped form the remediation strategy at the Fernald site. Many documents that describe specific remediation activities were issued or approved in 2003, as mentioned throughout this report. All cleanup-related CERCLA documentation, including a copy of the Administrative Record, is available to the public at the Public Environmental Information Center located at the Fernald site. A copy of the Administrative Record is also located at EPA's Region V office in Chicago, Illinois. The progress made by each remedial project toward CERCLA cleanup is summarized later in this chapter.

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

Cleanup levels at the Fernald site for surface water, sediment, and groundwater were established in the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996). These FRLs were established for constituents of concern or those constituents at the Fernald site determined, through risk assessment, to present potential risk to human health or the environment. Table 2-1 lists FRLs identified for constituents in groundwater, surface water, and sediment; these constituents are all monitored under the IEMP. FRLs represent the maximum allowable residual levels (the maximum concentrations which may remain in the environment following remediation), and these levels drive excavation and cleanup.

On November 30, 2001, the EPA approved an Explanation of Significant Differences to the Operable Unit 5 Record of Decision. This document formally adopts the EPA's Safe Drinking Water Act Maximum Contaminant Level for uranium of 30 μg/L as both the FRL for groundwater remediation and the monthly average uranium effluent discharge limit to the Great Miami River.

Benchmark Toxicity Values originated from the Operable Unit 5 Sitewide Ecological Risk Assessment. These concentrations for sediment and surface water are used to determine if a constituent may have a detrimental effect on a particular ecological receptor. For surface water and sediment, ecological receptors include fish and animals that inhabit the surface water body or use surface water as a source of drinking water.

Acceptable levels for constituents of ecological concern were established in the Operable Unit 5 Sitewide Ecological Risk Assessment (Appendix B of the Operable Unit 5 Remedial Investigation Report). The Sitewide Ecological Risk Assessment established benchmark toxicity values (BTVs) for protection of ecological receptors. Through the BTV screening process presented in Appendix C of the final Sitewide Excavation Plan (DOE 1998c), three constituents of ecological concern (barium, cadmium, and silver) were selected for evaluation in the surface water pathway to be protective of aquatic receptors. Chapter 4 discusses BTVs for surface water.

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TABLE 2-1
FINAL REMEDIATION LEVELS
FOR GROUNDWATER, SURFACE WATER, AND SEDIMENT

Constituent	FRL[a] Groundwater	Surface Water	Sediment
General Chemistry	**(mg/L)**	**(mg/L)**	**(mg/kg)[b]**
Cyanide	NA[c]	0.012	NA
Fluoride	4[d]	2.0	NA
Nitrate[e]	11	2,400	NA
Inorganics	**(mg/L)**	**(mg/L)**	**(mg/kg)**
Antimony	0.0060	0.19	NA
Arsenic	0.050	0.049	94
Barium	2	100	NA
Beryllium	0.0040	0.0012	33
Boron	0.33	NA	NA
Cadmium	0.014	0.0098	71
Chromium VI[e]	0.022	0.010	3,000
Cobalt	0.17	NA	36,000
Copper	1.3	0.012	NA
Lead	0.015[d]	0.010	NA
Manganese	0.900	1.5	410
Mercury	0.0020	0.00020	NA
Molybdenum	0.10	1.5	NA
Nickel	0.10	0.17	NA
Selenium	0.050	0.0050	NA
Silver	0.050	0.0050	NA
Thallium	NA	NA	88
Vanadium	0.038	3.1	NA
Zinc	0.021	0.11	NA
Radionuclides	**(pCi/L)**	**(pCi/L)**	**(pCi/g)**
Cesium-137	NA	10	7.0
Neptunium-237	1.0	210	32
Lead-210	NA	11	390
Plutonium-238	NA	210	1,200
Plutonium-239/240	NA	200	1,100
Radium-226	20	38	2.9
Radium-228	20	47	4.8
Strontium-90	8.0	41	7,100
Technetium-99	94	150	200,000
Thorium-228	4.0	830	3.2
Thorium-230	15	3500	18,000
Thorium-232	1.2	270	1.6
	(µg/L)	**(µg/L)**	**(mg/kg)**
Total Uranium[f]	30[g]	530	210

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TABLE 2-1
(Continued)

Constituent	FRL[a] Groundwater	Surface Water	Sediment
Organics	**(μg/L)**	**(μg/L)**	**(μg/kg)**
Alpha-chlordane	2.0	0.31	NA
Aroclor-1254	0.20	0.20	670
Aroclor-1260	NA	0.20	670
Benzene	5.0	280	NA
Benzo(a)anthracene	NA	1.0	190,000
Benzo(a)pyrene	NA	1.0	19,000
Benzo(b)fluoranthene	NA	NA	190,000
Benzo(k)fluoranthene	NA	NA	1,900,000
Bis(2-chloroisopropyl)ether	5.0	280	NA
Bis(2-ethylhexyl)phthalate	6.0	8.4	5,000,000
Bromodichloromethane	100	240	NA
Bromoform	NA	NA	160,000
Bromomethane	2.1	1300	NA
Carbazole	11	NA	63,000
Carbon disulfide	5.5	NA	NA
Chloroethane	1.0	NA	NA
Chloroform	100	79	NA
Chrysene	NA	NA	19,000,000
Dibenzo(a,h)anthracene	NA	1.0	NA
3,3'-Dichlorobenzidene	NA	7.7	NA
1,1-Dichloroethane	280	NA	NA
1,1-Dichloroethene	7.0	15	NA
1,2-Dichloroethane	5.0	NA	NA
Dieldrin	NA	0.020	NA
Di-n-butylphthalate	NA	6,000	NA
Di-n-octylphthalate	NA	5.0	NA
Methylene chloride	5.0	430	NA
4-Methylphenol	29	2,200	NA
4-Methyl-2-pentanone	NA	NA	2,100,000
4-Nitrophenol	320	7,400,000	NA
N-nitrosodiphenylamine	NA	NA	260,000
Octachlorodibenzo-p-dioxin	0.0001	NA	NA
Phenanthrene	NA	NA	3
2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.010	NA	NA
Tetrachloroethene	NA	45	NA
1,1,1-Trichloroethane	NA	1.0	NA
1,1,2-Trichloroethane	NA	230	NA
Trichloroethene	5.0	NA	NA
Vinyl Chloride	2.0	NA	NA

[a]From Record of Decision for Remedial Actions at Operable Unit 5, Tables 9-4 through 9-6, January 1996.
[b]mg/kg = milligrams per kilogram
[c]NA = not applicable. No FRL was required for this constituent in this particular environmental media.
[d]The groundwater FRLs for fluoride and lead were changed from 0.89 milligrams per liter (mg/L) and 0.002 mg/L, respectively, to be consistent with the FRL selection process outlined in the Operable Unit 5 Feasibility Study. The changes were documented in the Operable Unit 5 Record of Decision by change pages.
[e]Because of holding time considerations, nitrate/nitrite is analyzed for nitrate and total chromium is analyzed for hexavalent chromium. Total chromium and nitrate/nitrite provide a more conservative result.
[f]Uranium consists of several isotopes (uranium-234, 235, 236 and 238). This report interchangeably uses the terms uranium and total uranium, both defined as the sum of the various isotopic components.
[g]The total uranium groundwater FRL was changed to 30 μg/L in 2001 to reflect the EPA's adopted Safe Drinking Water Act Final Maximum Contamination Level for uranium.

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2.1.1 Waste Pits Project

The Waste Pits Project (Operable Unit 1) is responsible for the excavation, drying (as required), loading, and rail transport of the contents of Waste Pits 1 through 6, the burn pit, and the clearwell to an off-site disposal facility. Sampling and analysis of the waste pit material and the off-site disposal of contaminated soil and debris from other remedial projects that exceed the waste acceptance criteria (physical, chemical, and radiological standards) for the on-site disposal facility are part of this scope of work. The project is also responsible for collecting wastewater and storm water associated with the Waste Pits Project activities and, as needed, pre-treating and discharging this remediation water to the advanced wastewater treatment facility. In addition, the project is responsible for implementing dust control measures, and for implementing point source emission controls for dryer operations.

The Waste Pits Project involves the pre-treatment (e.g., crushing, sorting, and shredding) of waste pit materials, drying (as required), and the loadout of railcars with pit material for shipment to Envirocare of Utah, Inc. During 2003, 31 unit trains left the Fernald site carrying approximately 203,000 tons (184,162 metric tons) of material. From April 1999, when the first rail shipment left the Fernald site, through December 2003, the Waste Pits Project shipped 105 unit trains carrying approximately 670,500 tons (608,278 metric tons) of material to Envirocare of Utah, Inc. for disposal. At the end of 2003, remediation of Waste Pits 1 and 4 was nearly complete, and Waste Pits 2, 3, and 5 were approximately 50 percent, 80 percent, and 85 percent complete, respectively. The total project was over 75 percent complete at the end of 2003.

In 2002 discussions were initiated with OEPA, EPA, and stakeholders concerning the placement of Waste Pit 4 soil cover material into the on-site disposal facility, and the alignment of surface and subsurface soil FRLs between the Operable Unit 1 and Operable Unit 5 Records of Decision. This process continued during 2003 and the Draft Proposed Plan for an amendment to the Operable Unit 1 Record of Decision was submitted to EPA and OEPA for review. Upon completion of the EPA/OEPA review and approval process, the proposed plan was submitted for formal public review in 2003. After completion of the public review, a Record of Decision Amendment was prepared and subsequently approved by the EPA on November 24, 2003 documenting the remedy changes. These changes include the alignment of surface and subsurface soil FRLs found in the Operable Unit 1 Record of Decision with the approved FRLs for soil in the Operable Unit 5 Record of Decision, placement of Waste Pit 4 soil cover materials into the on-site disposal facility, aligning the final cover design for the waste pit area with current site restoration plans, as well as clarification of terminology.

Waste Pit 5, the northern-most and second-largest of seven waste pits from which a total of 97,900 cubic yards of radioactive waste is being removed. 000038

2.1.2 Demolition, Soil, and Disposal Project

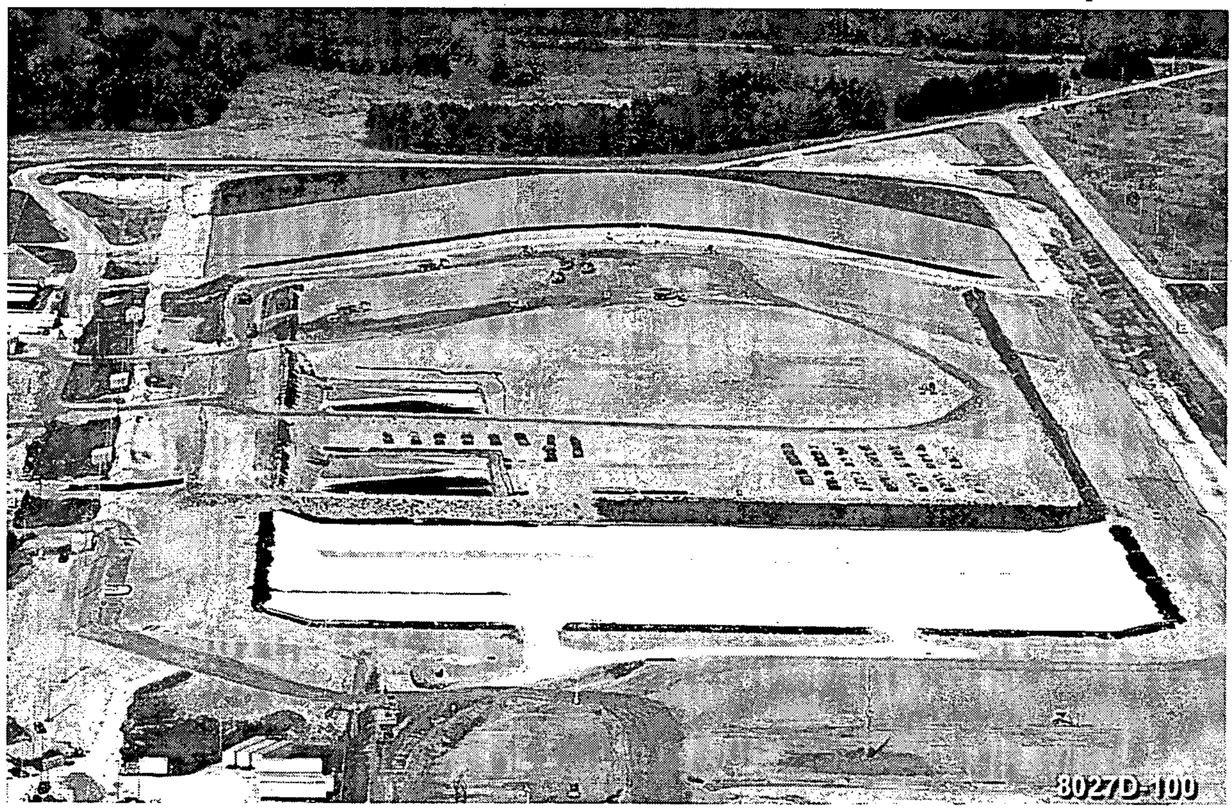
The activities associated with this project will be discussed in the following two subsections: Section 2.1.2.1, Soil and Disposal Facility Project, and Section 2.1.2.2, Decontamination and Demolition Project.

2.1.2.1 Soil and Disposal Facility Project

The Soil and Disposal Facility Project, which includes components of both Operable Units 2 and 5, is responsible for characterizing the extent of contamination in the soil, soil sampling, excavation of contaminated soil and at- and below-grade structures, treatment of soil if necessary, certifying that the soil meets the final remediation levels established in the Operable Units 2 and 5 Records of Decision, natural resource restoration, and the construction of on-site disposal facility cells and waste placement into those cells. (The on-site disposal facility's leachate and leak detection monitoring, as well as operation, maintenance, and monitoring of the leachate transmission system, are the responsibility of the Aquifer Restoration/Wastewater Project.)

For purposes of excavating contaminated soil, the Fernald site has been divided into nine separate soil remediation areas based on land use history and known contamination levels (refer to Figure 2-1). Area 9 includes all off-site soil that must be evaluated during remediation and/or certification. In addition, portions of the site's stream corridors (including Paddys Run) along with other potentially contaminated corridors will require remediation and are considered unique areas. Other utility corridors and access roads are not included with the remediation areas. These corridors will be addressed later in site remediation after completion of the aquifer restoration.

Prior to soil remediation, real-time scanning and soil sampling are performed to gather information related to the extent of surface and subsurface contamination, and to identify the impacted materials that meet the waste acceptance criteria for the on-site disposal facility. Engineering personnel use this information to design soil and debris excavations. Materials that cannot be placed in the on-site disposal facility are stockpiled and/or containerized, monitored, and tracked for off-site disposal.



By the end of 2003, over 1.3 million yd^3 (993,980 million m^3) of soil and debris had been placed into the on-site disposal facility.

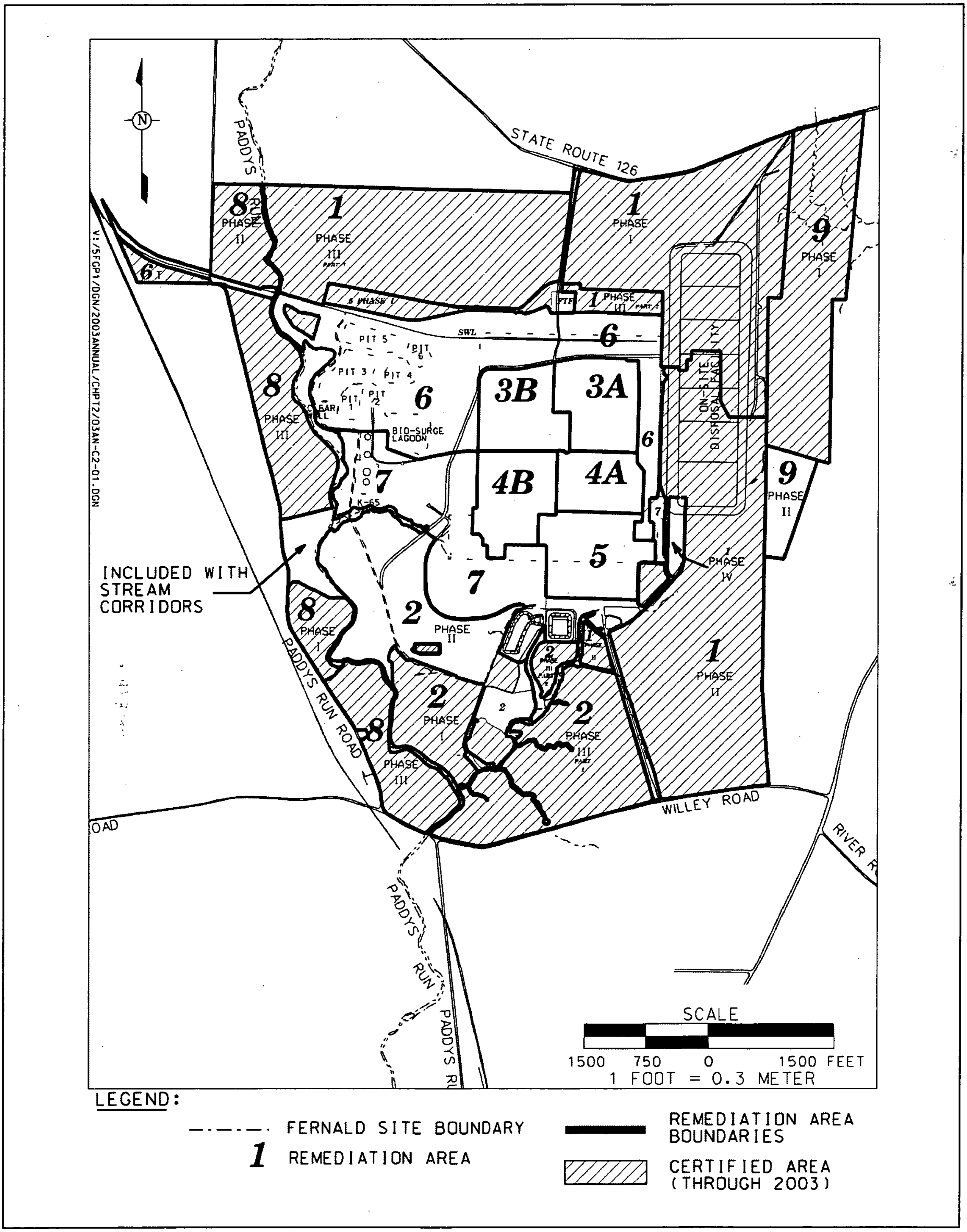


Figure 2-1. Sitewide Soil Remediation Areas and Certified Areas

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Volume Descriptions: Bank and In-Place

Soil/debris can be described as "bank" (in the ground before excavation) or "in-place" (placed and compacted in the on-site disposal facility). When soil is excavated or a structure is demolished, broken down, and /or sheared, volume is added to the debris by air in void space in the pile of disturbed materials. Compaction during the OSDF placement process will reduce the volume back to near the original size by eliminating the void space.

In 2003 the Soil and Disposal Facility Project continued soil and debris excavations. Approximately 434,000 bank yd^3 (331,836 m^3) were excavated in 2003. By the end of the year, over 1.3 million in-place yd^3 (993,980 million m^3) of soil and debris (including above-grade decontamination and demolition debris) had been excavated and placed into the on-site disposal facility since remediation began, and the planned soil remediation activities at the site were about 45 percent complete. The following soil remedial excavation activities took place in 2003:

- Area 3A/4A. Large-scale remedial excavations mostly completed on the east side of the former production area, approximately 237,000 yd^3 (181,210 m^3) of material excavated.
- Area 3B/4B. Large-scale remedial excavations began on the west side of the former production area, approximately 105,000 yd^3 (80,283 m^3) of material excavated.
- Area 6. Remedial excavations began between the waste pit operations and the former Plant 1 Pad and the solid waste landfill as well as a portion of the Waste Pit 4 cap, approximately 72,000 yd^3 (55,051 m^3) of material excavated.
- Area 7. Excavations in support of silos infrastructure and sections of the berms surrounding Silos 1 and 2, approximately 20,000 yd^3 (15, 292 m^3) of material excavated.

When contaminated soil and debris have been excavated from each area, pre-certification real-time scanning and certification sampling are performed to demonstrate that the residual levels of the constituents of concern for that area are below the site's FRLs. After statistical analyses of the laboratory results are reviewed to confirm that contaminants of concern are demonstrated to be below the site's FRLs, a certification report is submitted to EPA and OEPA, and upon their approval the area is certified as meeting the soil remediation goals.

During 2003 the following areas of the Fernald site were certified or were in the process of certification:

- Area 2 (Phase II). Approximately 57 acres (23 hectares) of the area southwest of the former production area were in the process of certification.
- Area 6 (Phase I). Approximately 16 acres (6 hectares) of the north of the waste pits area were certified.
- Area 8 (Phase III) North. Approximately 38 acres (15 hectares) of the area west of Paddys Run were certified.

Also in 2003, Area 9 (Phase II) was in the process of certification. Area 9 (Phase II) mainly includes the off-property land adjacent to the central portion of the eastern site boundary, and represents the remaining off-property area to be certified. Figure 2-1 identifies all remediation areas that have been certified as of December 31, 2003.

As of December 31, 2003, approximately 55 percent of the Fernald site had been certified. After an area of the site is certified, natural resource restoration activities can begin. Chapter 7 discusses the specific natural resource restoration activities that took place in 2003.

During 2003 approximately 412,000 in-place yd^3 (315,015 m^3) of waste (including some excavated material, debris, etc.) were placed in Cells 3, 4, 5, and 6 of the on-site disposal facility. Cell 2 was capped according to construction drawings, and it should be noted that a small amount (approximately 2,600 in-place yd^3) of material was placed in this cell to meet fill requirements. Cell 3 has reached approximately 98 percent of its impacted material storage capacity. The remaining 2 percent of capacity in Cell 3 will be filled in the spring of 2004. Cell 4 has reached approximately 55 percent of its capacity. Cell 5 has reached approximately 9 percent of its capacity. Cell 6, which was constructed during 2003, has reached approximately 9 percent of its capacity.

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Other activities regarding the on-site disposal facility included placement of protective and select material on the Cell 6 floor and side slopes, and placement of select material in the Cell 3 cap and the Cell 5 liner, in accordance with the Impacted Material Placement Plan (GeoSyntec 1996). A discussion of the ongoing performance monitoring of the on-site disposal facility is provided in Chapter 3.

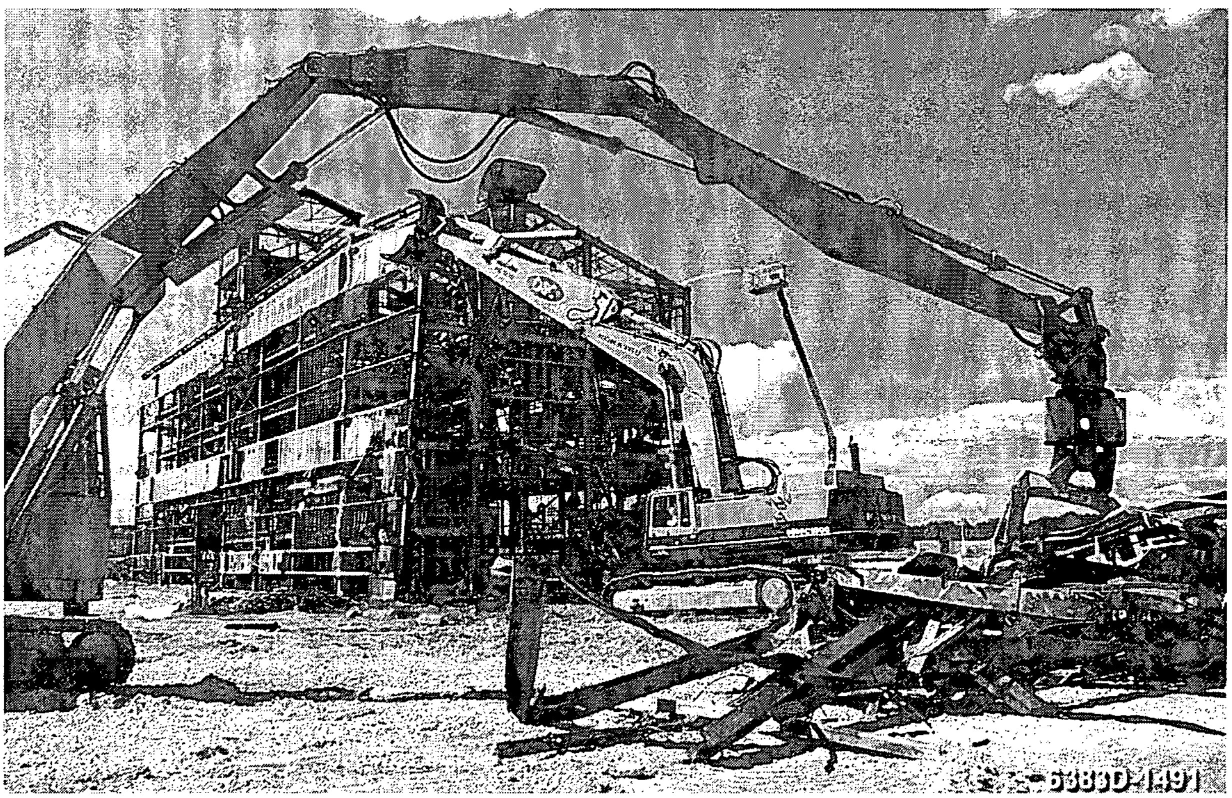
2.1.2.2 Decontamination and Demolition Project

The Decontamination and Demolition Project (Operable Unit 3) is responsible for decontaminating and dismantling the above-grade structures and facilities associated with production operations and remedial actions. This includes decontamination of facilities; isolation of utilities; demolition of buildings, equipment, and other facilities; removal of uranium and other material from former processing equipment; and shipment of material and equipment off site. The scope includes the collection and proper management of associated decontamination wastewater. In September 2003, the MACTEC, Inc. contract was discontinued and Fluor Fernald became responsible for self-performing all remaining above-grade demolition of structures at the Fernald site.

During 2003 decontamination and demolition activities were completed at the following facilities:

- 1B Plant 1 Storage Building
- 2A Ore Refinery Plant
- 2D Metal Dissolver Building
- 8G Trash Compactor Area
- 13D Pilot Plant Thorium Tank Farm
- 16N N93-1 Substation (Plant 1)
- 18D Biodenitrification Towers
- 20A Pump Station and Power Center
- 20G Well House #3
- 22B Storm Sewer Lift Station
- 22D Scale House and Weigh Scale
- 26A Pump House – HP Fire Protection
- 26B Elevated Water Storage Tank
- 30A Chemical Warehouse
- 30D Sampling Line Processing
- 37 Pilot Plant Annex
- 45A Maintenance Machine Shop Building
- 56A CP Storage Warehouse
- 68 Pilot Plant Warehouse
- 71 General In-Process Warehouse
- 80 Plant 8 Warehouse
- TS-004 Tension Support Structure #4
- TS-005 Tension Support Structure #5
- TS-006 Tension Support Structure #6
- TS-010 Nuclear Mat'l Packaging Station #1
- TS-011 Nuclear Mat'l Packaging Station #2

Demolition of these 26 structures brings the total number of structures demolished at the Fernald site to 145 out of a total of 316 structures.



Structural demolition of building 2A, Ore Refinery Plant.

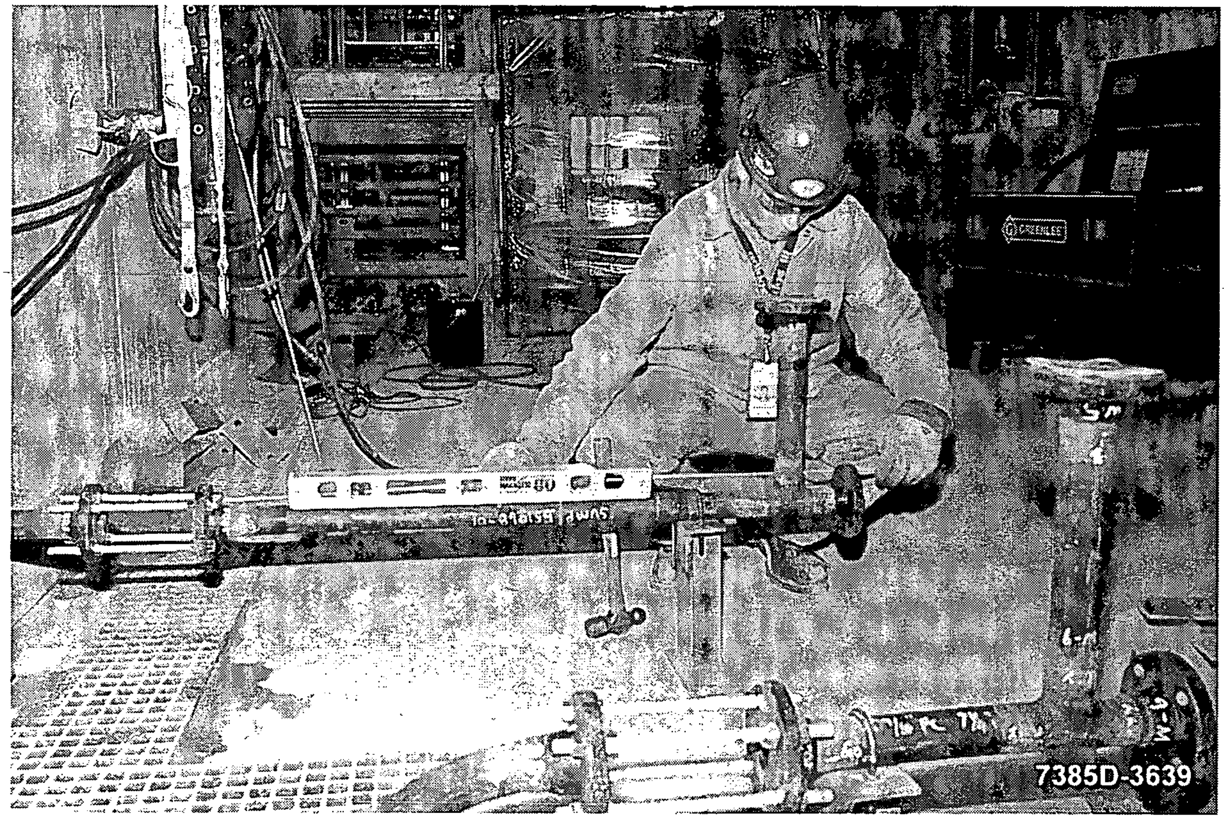
2.1.3 Silos Projects

The Silos Project (Operable Unit 4) includes Silos 1 and 2 (also known as the K-65 Silos), Silos 3 and 4, and several nearby structures. Silos 1 and 2 contain radium-bearing residues from the processing of uranium ore and ore concentrates during the 1950s. Silo 3 contains cold metal oxides generated from uranium recovery operations, and Silo 4 has never been used. The Silos Project remediation activities will include the retrieval, processing, and off-site disposal of the residues stored in the silos, as well as decontamination and dismantling of the silo structures and associated facilities.

In 1997 DOE, EPA, and OEPA reached the decision to separate the remediation of Silo 3 material from the remediation of Silos 1 and 2 material, and to re-evaluate the treatment remedies for both materials. In addition, the Silos 1 and 2 Accelerated Waste Retrieval Project was initiated to provide control of radon in Silos 1 and 2 headspaces and treatment facilities, and safe storage of the Silos 1 and 2 material during the interim period until treatment and disposal can be implemented. Following is a summary of each project's major activities during the year.

2.1.3.1 Silos 1 and 2 Remediation

An Explanation of Significant Differences (ESD) document was approved by the EPA, after completion of formal public review, in November 2003. The ESD documented two minor changes to the approved remedy for Silos 1 and 2. These changes consisted of allowing disposal of treated Silos 1 and 2 material at an appropriately permitted commercial facility in addition to the DOE Nevada Test Site, and removing the RCRA Toxicity Characteristic Leachate Procedure (TCLP) test as a performance criterion for the chemical stabilization process. The remedy for Silos 1 and 2 material still requires on-site chemical stabilization of the Silos 1 and 2 material followed by off-site disposal. The majority of the construction of the necessary equipment and facilities for implementation of the revised remedy for Silos 1 and 2 was completed during 2003.



A section of process piping in the Silos 1 and 2 waste processing facility is adjusted.

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The Silos 1 and 2 Project initiated the Accelerated Waste Retrieval Project in 1998. The purpose of this project is to address the increasing radon concentrations in the Silos 1 and 2 headspace, as well as issues regarding silo integrity and heterogeneity of the material for the final treatment facility. The project scope includes design, construction, testing, and operation of interim storage facilities to hold the Silos 1 and 2 material until treatment is implemented. The project also includes design, construction, and startup of the Radon Control System (RCS) to provide control of radon emissions during the construction and operation phases of the Accelerated Waste Retrieval Project, as well as during interim storage and operation of the Silos 1 and 2 full-scale treatment facility. Construction startup testing and readiness activities for the RCS were completed during 2002. Continuous Phase 1 Operation of the RCS to reduce radon concentrations in the Silos 1 and 2 headspaces was initiated April 25, 2003 and continued through the end of the year. Construction activities completed during 2003 include erection of the retrieval bridges and riders over the domes of Silos 1 and 2, and installation of most of the major equipment required for transfer of the Silos 1 and 2 material from the silos to the four 750,000-gallon tanks in the Transfer Tank Area. The tanks will be used to receive and store the material from Silos 1 and 2 pending transfer to the remediation facility.

2.1.3.2 Silo 3 Project

In 2001 re-evaluation of alternatives for implementation of Silo 3 remediation was initiated with input from DOE, regulators, and stakeholders to identify the optimal path forward for remediation of the Silo 3 material. This process continued during 2003 and the Draft Revised Proposed Plan for Silo 3 (DOE 2002d) was submitted to the EPA and OEPA for review. Upon completion of the EPA/OEPA review and approval process, the proposed plan was submitted for formal public review in 2003. After completion of the public review, a Record of Decision Amendment was prepared and subsequently approved by the EPA on September 24, 2003 documenting the revised remedy, which consists of retrieval, conditioning to the extent practical to reduce dispersability and mobility, and off-site disposal. Construction of facilities for retrieval, conditioning, and packaging of the Silo 3 material was completed during 2003.

2.1.3.3 Supplemental Environmental Projects

As a result of missed Operable Unit 4 enforceable milestones in 1996, the dispute resolution agreement with the EPA required DOE to do the following supplemental environmental projects:

- Perform ecological restoration research
- Create a wild bird/wildflower habitat area
- Develop railroad track recycling
- Develop structural steel debris recycling.

The last of these was completed in 2002. The final report for the last of the ecological research projects was submitted to the regulatory agencies on May 11, 2003. All of the supplemental environmental projects are now complete.

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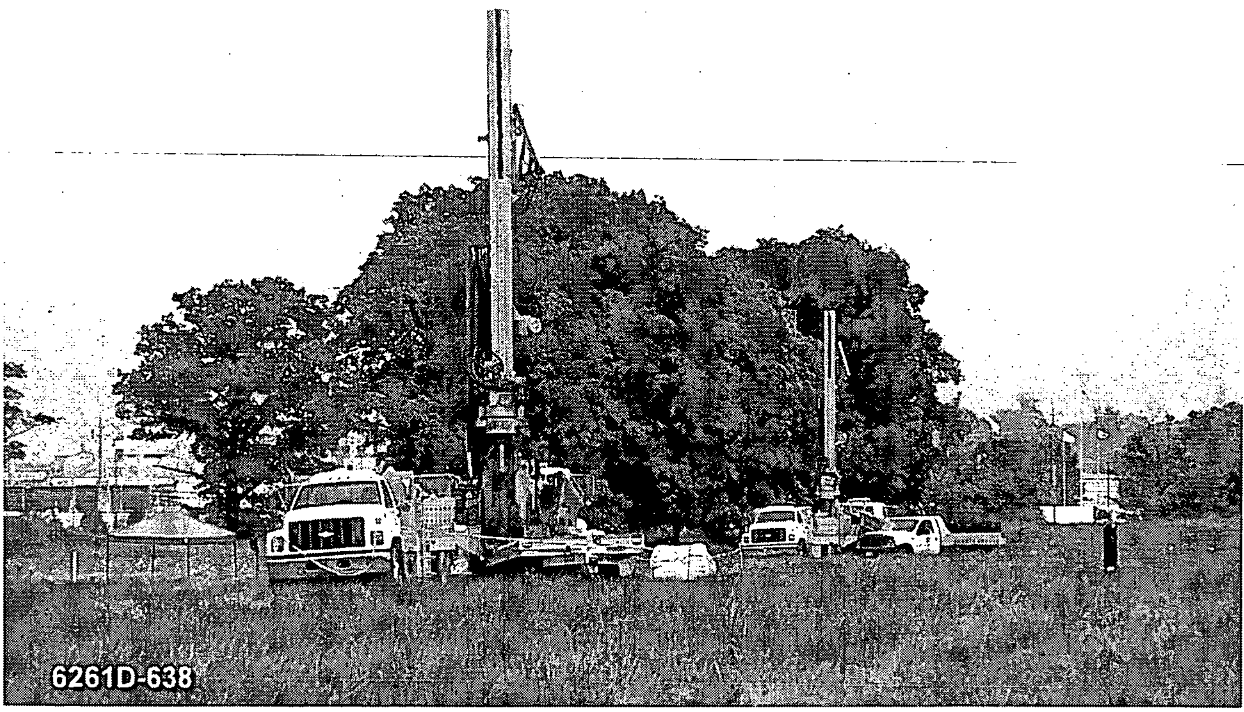
2.1.4 Aquifer Restoration/Wastewater Project

The Aquifer Restoration/Wastewater Project (Operable Unit 5) is responsible for the restoration of water quality in the affected portions of the Great Miami Aquifer, and for treating the site's extracted groundwater, storm water, sanitary wastewater, and remediation wastewater. These activities include the design, construction, operation, monitoring, and reporting of the groundwater restoration and wastewater treatment systems at the Fernald site. This project is also responsible for managing the on-site disposal facility's leachate and leak detection monitoring program, as well as operation, maintenance, and monitoring of the leachate transmission system.

In 2003 the Aquifer Restoration/Wastewater Project continued to operate the South Plume Module (including the South Plume Optimization Module), the South Field Module, the Waste Storage Area Module, and the Re-Injection Module. In addition, four new extraction wells, two re-injection wells, and one Injection Pond were placed into operation in July 2003 as part of the South Field Module. Also, one new re-injection well began operating in the Re-Injection module, located on the southern property boundary.

In 2003 a total of 2,428 million gallons (9,190 million liters) of groundwater were extracted from the Great Miami Aquifer, 1,162 net pounds (528 kg) of uranium were removed from the aquifer, and 360 million gallons (1,363 million liters) of water were re-injected into the aquifer. Chapter 3 discusses groundwater monitoring.

Phases I and II of the advanced wastewater treatment facility and the interim advanced wastewater treatment facility provide final treatment of contaminated storm water and wastewater. The advanced wastewater treatment facility Phase III and the South Plume interim treatment facility are dedicated to treatment of contaminated groundwater associated with groundwater remediation.



Monitoring well installation drill rigs.

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2.2 Summary of Compliance with Other Requirements

CERCLA requires compliance with other laws and regulations as part of remediation of the Fernald site. These other requirements are referred to as applicable or relevant and appropriate requirements, or ARARs. ARARs that are pertinent to remediation of the site are specified in the record of decision for each operable unit. This section highlights some of the major requirements related to environmental monitoring and waste management, and how the FCP complied with these requirements in 2003.

The regulations discussed in this section have been identified as ARARs within the records of decision. The FCP must comply with these regulations while site remediation under CERCLA is underway; EPA and OEPA enforce compliance. Some of these requirements include permits for controlled releases, which are also discussed in this section.

2.2.1 Resource Conservation and Recovery Act (RCRA)

RCRA as amended regulates treatment, storage, and disposal of hazardous waste and the hazardous part of mixed waste (mixed waste contains both radioactive and hazardous waste components). Hazardous and mixed waste now generated at the site results from such activities as CERCLA remedial actions and maintenance activities. The Fernald site also has an inventory of mixed waste generated from former production activities. These wastes are regulated under RCRA and Ohio hazardous waste management regulations; therefore, the site must comply with legal requirements for managing hazardous and mixed wastes. OEPA has been authorized by EPA to enforce its hazardous waste management regulations in lieu of the federal RCRA program. In addition, hazardous waste management is subject to the 1988 Consent Decree and the 1993 Stipulated Amendment between the State of Ohio and DOE, as well as a series of Director's Final Findings and Orders issued by OEPA.

The FCP completed several administrative activities related to mixed waste storage and treatment during 2003, including:

- Submittal of the 2002 RCRA Annual Report (DOE 2003b), which describes hazardous waste activities for 2002.
- Submittal of the Fiscal Year 2003 Annual Update to the Site Treatment Plan (DOE 2003d) as required in the 1992 Federal Facility Compliance Act and the implementing Director's Findings and Orders issued by OEPA in October 1995.

Additional details on projects involving treatment of mixed wastes are provided in subsection 2.2.1.4, Mixed Waste Treatment.

2.2.1.1 RCRA Property Boundary Groundwater Monitoring

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

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2.2.1.2 RCRA Closures

The 1993 Stipulated Amendment to Consent Decree required that DOE identify all hazardous waste management units at the site. As a result, burners, incinerators, furnaces, stills, process equipment, tank units, dust collectors, and other potential waste containment units were evaluated in the early 1990s to determine if they were hazardous waste management units or solid waste management units. This evaluation was completed in 1994. In 1996 OEPA issued a Director's Findings and Orders to integrate RCRA closure requirements with CERCLA response actions for FCP hazardous waste management units. In 2003 the FCP initiated or completed field activities to remediate 14 units: Fire Training Facility, Nitric Acid Recovery System, Box Furnace, Oxidation Furnace #1, Plant 1 Pad, Waste Pit 4, Waste Pit 5, Pilot Plant Warehouse (Building 68), Tank Farm Sump, Uranyl Nitrate Tanks (three units), Butler Building (Building 56), and the Plant 8 Warehouse (Building 80).

2.2.1.3 Thorium Management

A thorium management strategy to improve the storage of thorium materials at the Fernald site, and a schedule to complete RCRA determinations of thorium materials, were developed as part of the Stipulated Amendment to the Consent Decree signed in 1991. This strategy is based on three primary objectives:

- To maintain environmentally stable interim storage of the thorium inventory while minimizing personnel radiation exposure.
- To implement actions required to complete RCRA evaluations of the thorium materials.
- To implement long-term storage and disposal alternatives.

The Thorium Overpacking Project was completed in 1997. It was under this project that the FCP removed 3,400 containers of thorium material and shipped 10,875 drum-equivalents (or 80,480 cubic feet (ft^3) [2,279 m^3]) of thorium material to the Nevada Test Site for disposal. The characterization documentation and formal RCRA waste determinations for the remaining estimated 8,500 containers of thorium legacy waste resumed in 1999. Through the end of 2003, over 8,400 of these containers were shipped off-site for treatment, with subsequent disposal at the Nevada Test Site. Those containers sent off-site for treatment and subsequent disposal included all RCRA hazardous thorium legacy waste that had a scheduled milestone of December 5, 2003. This shipping effort removed approximately 1,500,000 pounds (681,000 kg) of thorium from the total site thorium inventory. The remaining thorium inventory of approximately 100 containers has been evaluated. Of this remaining inventory, approximately 90 containers are non-RCRA, low-level radioactive waste and 10 are RCRA hazardous waste. The following activities are planned for the future:

- Low-level radioactive, non-RCRA thorium legacy waste will continue to be prepared and shipped to the Nevada Test Site for disposal.
- The thorium waste determined to be hazardous under RCRA and requiring off-site treatment will be prepared and shipped by September 30, 2004 for treatment to meet land disposal restrictions. The RCRA hazardous thorium inventory amenable to treatment on-site will be dispositioned by June 30, 2004.

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2.2.1.4 Mixed Waste Treatment

The FCP stores mixed wastes that are subject to RCRA land disposal restrictions. These restrictions currently prohibit the storage of certain hazardous waste streams for longer than one year, unless OEPA approves an extension.

The 1992 amendment to RCRA, the Federal Facility Compliance Act, provided DOE with an exemption from enforcement under the land disposal restrictions storage prohibition as long as DOE sites complied with the plans and schedules for mixed waste treatment. This is identified in the Site Treatment Plan, and the implementing Director's Findings and Orders issued by OEPA on October 4, 1995. The FCP submitted the first Site Treatment Plan Annual Update to OEPA in December 1996. These updates are due by December 31 of each year. Since then, seven additional annual updates have been submitted. The annual update describes the status of mixed waste treatment projects developed under the Site Treatment Plan. It also adds newly generated and newly identified mixed waste streams, and certifies that the FCP met all regulatory milestone dates for the treatment of mixed wastes identified in the plan and in the implementing Director's Findings and Orders.

Mixed waste is defined under RCRA as waste containing both a hazardous waste subject to RCRA, and a source, special nuclear, or radioactive byproduct material subject to the Atomic Energy Act as amended. RCRA liquid mixed wastes at the Fernald site are stored in consolidation tanks until they are shipped to the incinerator at Oak Ridge, Tennessee. The consolidation tanks at the Fernald site hold approximately 20,000 gallons of material, which constitutes a "batch." Batches may contain oils, solvents, or a combination of the two.

The Mixed Waste Project is one of many sub-projects under the Waste Management Project. (Other sub-projects include Low-Level Waste, Operations, and Shipping.) Collectively these projects function to remove waste from the Fernald site. In 2003, 7,050 gallons (26,684 liters) of liquid waste under the Mixed Waste Project were bulked into the Batch 14 consolidation tank for later shipment. The following mixed wastes were shipped during 2003:

- 11,999 gallons (45,416 liters) of liquid mixed waste from Batch 13 were shipped to the K-25 Toxic Substances Control Act Incinerator in Oak Ridge, Tennessee for treatment.
- 28 ft^3 (0.79 m^3) of waste under the Mixed Waste Project were shipped to Materials and Energy Corporation in Oak Ridge, Tennessee for treatment.
- 3,895 ft^3 (110.3 m^3) of waste under the Mixed Waste Project were shipped to Waste Control Specialists in Andrews, Texas for treatment.
- 12,156 ft^3 (344.3 m^3) of waste under the Mixed Waste Project were shipped to Envirocare of Utah, Inc. for treatment.
- 8,758 gallons (33,149 liters; under specific Waste Management Project treatment campaigns) of liquid aqueous low-level radioactive and mixed wastes meeting National Pollutant Discharge Elimination System (NPDES) Permit requirements were treated at the advanced wastewater treatment facility.

2.2.2 Clean Water Act

Under the Clean Water Act as amended, the FCP is governed by NPDES regulations that require the control of discharges of non-radiological pollutants to waters of the State of Ohio. The NPDES Permit, issued by the State of Ohio, specifies discharge and sample locations, sampling and reporting schedules, and discharge limitations. The FCP submits monthly reports on NPDES activities to OEPA. The Fernald site's current NPDES Permit, Permit No. 1IO00004*GD, became effective on July 1, 2003. Chapter 4 discusses the surface water and treated effluent information in detail.

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2.2.3 Clean Air Act

NESHAP Subpart H imposes a limit of 10 millirem (mrem) per year on the effective dose equivalent to the maximally exposed individual as a result of all air emissions (with the exception of radon) from the facility in a single year. For 2003 the FCP was in compliance with the NESHAP dose limit as determined by ambient air monitoring at the site's fenceline boundary.

EPA regulates the Fernald site's radionuclide emission sources through NESHAP; OEPA has authority to enforce the State of Ohio's air standards including particulate, chemical, and toxic emission sources. In 2003 the FCP complied with all emissions standards, as discussed in Chapter 5. The NESHAP Annual Report for 2003 is included as Appendix D of this report.

Several remediation activities, including the waste pits remediation, decontamination and dismantling, soil excavation, and on-site disposal facility construction and waste placement, may result in the generation of fugitive dust, which is also regulated by OEPA. Compliance is accomplished by implementing the Fugitive Dust Control Policy negotiated between DOE and OEPA in 1997. This policy is implemented in the Best Available Technology Determination for Remedial Construction Activities on the Fernald Environmental Management Project (DOE 1997b), the requirements of which are incorporated into each operable unit's remedial design and remedial action deliverables. The policy allows for visual observation of fugitive dust and implementation of dust control measures to determine compliance during remediation activities.

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 "Superfund" requirements. SARA Title III is also known as the Emergency Planning and Community Right-to-Know Act (EPCRA).

The SARA Title III, Section 312, Emergency and Hazardous Chemical Inventory Report for 2003 was submitted to OEPA and other local emergency planning/response organizations in February 2004. This report lists the amounts and locations of hazardous chemicals and substances stored or used in amounts greater than the minimum reporting threshold at any time during the previous year. For 2003 several chemicals, which had been reported in previous years, no longer exceeded reportable thresholds due to their use or disposition through transfers to other DOE sites, sales, or shipment off site for treatment and disposal. However, two chemicals (absorbents and kerosene) increased above reportable thresholds due to their use in remediation operations.

A SARA Title III, Section 313, Toxic Chemical Release Inventory Report (Form R) is required if the Fernald site meets certain criteria and an applicable threshold for any SARA 313 chemical is reached. If required, the Toxic Chemical Release Inventory Report lists routine and accidental releases, as well as information about the activities, uses, and waste for each reported toxic chemical. An evaluation to determine if any chemicals used at the FCP exceed reporting thresholds will be completed and will be reported, if required, to EPA and OEPA prior to the July 1, 2004 compliance date. Should reporting criteria not be exceeded, a letter to this effect will be forwarded to the appropriate agencies.

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Also under SARA Title III, any off-site release meeting or exceeding a reportable quantity as defined by SARA Title III, Section 304, requires immediate notifications be made to local emergency planning committees and the state emergency response commission. Notifications are also made to the National Response Center (NRC) and other appropriate federal, state, and local regulatory entities. All releases occurring at the Fernald site are evaluated and documented to ensure that proper notifications are made in accordance with SARA, and under CERCLA Section 103, RCRA, the Toxic Substances Control Act, the Clean Air Act, the Clean Water Act, and Ohio environmental laws and regulations.

In 2003 there was only one release at the Fernald site that met the reporting criteria under CERCLA. This was a release of 1.6 pounds (.73 kg) of friable asbestos from a damaged utility pipe. Asbestos is not an Extremely Hazardous Substance (EHS) and did not reach off site; thus, it was not reportable under SARA Title III. Notification was made only to the NRC because it was only a CERCLA, not a SARA, release. Other informational notifications (such as to EPA, Region V; OEPA Southwest District Office; Division of Hazardous Waste Management; Ohio Emergency Response Commission; and Crosby Township Fire Department) were made as deemed appropriate.

2.2.5 Other Environmental Regulations

The FCP is also required to comply with other environmental laws and regulations in addition to those described above. Table 2-2 summarizes compliance with each of these requirements for 2003.

2.2.6 Other Permits

Permits are the means by which certain environmental laws are implemented. The FCP has permits for controlled releases to surface water and air. The FCP's permit for discharging water under NPDES regulations is discussed in subsection 2.2.2, Clean Water Act. The active Permits to Install remaining for the wastewater treatment system include those for the Storm Water Retention Basin and Bio-Surge Lagoon. Permits to Install govern the installation (and to a lesser degree, the operation) of specific wastewater treatment and control devices.

As of December 31, 2003, all sources previously covered by air Permits to Operate or Install have either been eliminated or are being addressed through the CERCLA remediation process. Due to this, the FCP has withdrawn all active air Permits to Operate. Therefore, the site no longer has any air permits associated with its operations.

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TABLE 2-2
COMPLIANCE WITH OTHER ENVIRONMENTAL REGULATIONS

Regulation and Purpose	Background Compliance Issues	2003 Compliance Activities
Toxic Substances Control Act (TSCA)		
Regulates the manufacturing, use, storage, and disposal of toxic materials, including polychlorinated biphenyl (PCBs) and PCB items.	The last routine TSCA inspection of the FCP's program was conducted by EPA Region V on September 21, 1994. No violations of PCB regulations were identified during the inspection.	Non-radiologically contaminated PCBs and PCB items are shipped to TSCA-approved commercial disposal facilities for incineration on an as-needed basis. Radiologically contaminated PCB liquids were bulked for shipment to the TSCA-permitted DOE incinerator in Oak Ridge, Tennessee. Radiologically contaminated PCB solids were shipped off-site for treatment by a commercial facility.
Ohio Solid Waste Act		
Regulates infectious waste.	The Fernald site was registered with OEPA as a generator of infectious waste (generating more than 50 pounds [23 kg] per month) until December 6, 1999, when OEPA concurred with the Fernald site's qualification as a small quantity generator.	All infectious wastes generated in the medical department were transported to a licensed treatment facility for incineration.
Federal Insecticide, Fungicide, and Rodenticide Act		
Regulates the registration, storage, labeling, and use of pesticides (such as insecticides, herbicides, and rodenticides).	The last inspection of the Federal Insecticide, Fungicide, and Rodenticide Act program conducted by EPA Region V on September 21, 1994, found the Fernald site to be in full compliance with the requirements mandated by Federal Insecticide, Fungicide, and Rodenticide Act.	Pesticide applications at the Fernald site were conducted according to Federal and State regulatory requirements.
National Environmental Policy Act (NEPA)		
Requires the evaluation of environmental, socio-economic, and cultural impacts before any action, such as a construction or cleanup project, is initiated by a federal agency.	An environmental assessment for proposed final land use was issued for public review in 1998. It was prepared under DOE's guidelines for implementation of NEPA, 10 Code of Federal Regulations 1021. The assessment requires consulting the public before any decisions on land use are made; it includes previous DOE commitments.	No NEPA activities were required in 2003.
Endangered Species Act		
Requires the protection of any threatened or endangered species found at the site as well as any critical habitat that is essential for the species' existence.	Ecological surveys conducted by Miami University and DOE, in consultation with the Ohio Department of Natural Resources and the U.S. Fish and Wildlife Service, have established the following list of threatened and endangered species and their habitats existing on site: Cave salamander, state-listed endangered — marginal habitat, none found; Sloan's crayfish, state-listed threatened — found on northern sections of Paddys Run; Indiana brown bat, federally listed endangered — found in riparian areas along Paddys Run.	No endangered species surveys were conducted in 2003. Turbidity observations for the protection of Sloan's crayfish in Paddys Run resumed in November 2003. No instances of increased sediment loading were observed.

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TABLE 2-2
(Continued)

Regulation and Purpose	Background Compliance Issues	2003 Compliance Activities
Floodplains/Wetlands Review Requirements		
DOE regulations require a floodplain/wetland assessment for DOE construction and improvement projects.	A wetlands delineation of the FCP, completed in 1992 and approved by the U.S. Army Corps of Engineers in August 1993, identified 36 acres (15 hectares) of freshwater wetland on the Fernald site property. Updated delineations are conducted approximately every five years.	No assessments were performed in 2003.
National Historic Preservation Act		
Establishes a program for the protection, maintenance, and stewardship of federal prehistoric and historic properties.	The FCP is located in an area of sensitive historic and prehistoric cultural resources that are eligible for or on the National Register of Historic Places. These cultural resources include historic structures, buildings, and bridges, plus Native American villages and campsites.	Cultural resource surveys were conducted to locate and address impacts on resources eligible for listing on the National Register of Historic Places (refer to Chapter 7).
Native American Graves Protection and Repatriation Act		
Establishes a means for Native American Indians to request the return or "repatriation" of human remains and other cultural items. Federal agencies must return human remains, associated funerary objects, sacred objects, and objects of cultural patrimony to the Indian Nations or Tribes with cultural affiliation to the remains or material.	Native American Indian remains have been discovered during remediation activities at the FCP. Native American Indian remains and artifacts have been removed or left in place, with consultation from Native American Indian Nations, Tribes, and Groups.	No Native American remains were discovered or repatriated to Native American Indian Nations, Tribes, or Groups in 2003.
Natural Resource Requirements Under CERCLA and Executive Order 12580		
Requires DOE to act as a Trustee (i.e., guardian) for natural resources at its federal facilities.	DOE and the other Trustees, which include the U.S. Department of the Interior, the U.S. Fish and Wildlife Service, OEPA, the Ohio Attorney General's Office, and EPA, meet regularly to discuss potential impact to natural resources and to coordinate Trustee activities. The Trustees also interact with the Fernald Citizens Advisory Board and Community Reuse Organization.	In 2003 the Trustees and stakeholders continued to discuss the scope of Natural Resource Restoration activities at the Fernald site. While the components of restoration have been established through a Memorandum of Understanding, the Trustees continue to negotiate regarding a future endpoint to a settlement agreement.

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2.2.7 Pollution Prevention and Source Reduction

The FCP is actively involved in an effort to reduce solid, hazardous, radioactive, and mixed-waste generation, and eliminate or minimize pollutant releases to all environmental media during site remediation. As part of the Annual Waste Reduction Report under DOE Order 5400.1 (DOE 1990a), the FCP submitted the site's summary of waste generated and pollution prevention progress (DOE 2002a), which is available from the DOE's pollution prevention web site (http://www.eh.doe.gov/p2). This report includes 2003 data on waste quantities generated and avoided, as well as narrative text describing pollution prevention and waste minimization efforts and their effectiveness.

Various waste streams were recycled during 2003, including corrugated cardboard (approximately 9 tons [8 metric tons]), aluminum cans (approximately 2 tons [2 metric tons]), toner cartridges (approximately 1 ton [.91 metric ton]), and scrap metal (approximately 300 tons [272 metric tons]). Additionally, the following approximate amounts of hazardous wastes were shipped to approved recycle centers or treatment facilities in 2003:

- 1,200 pounds (545 kg) of lead acid batteries for recycle
- 1,000 pounds (454 kg) of nickel-cadmium batteries for recycle
- 8,000 pounds (3,632 kg) of lab packs for treatment
- 4,000 pounds (1,816 kg) of electrical waste (fluorescent light tubes) for recycle
- 700 pounds (318 kg) of photochemicals for silver recovery.

The FCP's affirmative procurement program involves source reduction and the use of EPA-designated materials to increase the market for recovered materials. In accordance with Executive Order 13101, Greening of the Government Through Waste Prevention, Recycling and Federal Acquisition, the FCP generates an annual report demonstrating compliance with this order.

2.2.8 Site-Specific Regulatory Agreements

2.2.8.1 Federal Facility Compliance Agreement

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

- Maintain a continuous sample collection program for radiological constituents at the treated effluent discharge points and report the results semi-annually to EPA, OEPA, and the Ohio Department of Health. The sampling program to address this requirement has been modified over the years and is currently governed by an agreement reached with EPA and OEPA that became effective May 1, 1996. This agreement requires sampling at the Parshall Flume (PF 4001), the point where treated effluent leaves the FCP, and the Storm Water Retention Basin spillway for radiological constituents. These data are reported through mid-year and annual reports (refer to Appendix B of this report) under the IEMP.
- Maintain a sampling program for daily flow and total uranium at the South Plume extraction wells and report the results semi-annually to the EPA, OEPA, and Ohio Department of Health. The sampling program conducted to address this requirement has also been modified over the years and is currently governed by the agreement reached with EPA and OEPA on May 1, 1996.

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2.2.8.2 Federal Facility Agreement, Control and Abatement of Radon-222 Emissions

The Federal Facility Agreement (FFA) between DOE and EPA, signed in November of 1991, ensures that DOE takes all necessary actions to control and abate radon-222 emissions at the Fernald site, under the authority of 40 Code of Federal Regulations 61, Subpart Q. This agreement acknowledges that Silos 1 and 2 exceed the radon flux rate of 20 picoCuries per square meter per second (pCi/m^2/sec). But it allowed the FCP to address this exceedance by implementing a removal action (installation of a bentonite cap in 1991) to bring radon emissions from the silos to a level as low as reasonably achievable (ALARA), and to attain the NESHAP Subpart Q standard upon completion of final remediation. The FFA also requires demonstration of compliance with the Subpart Q standard upon completion of remedial actions for the waste pits, clearwell, and any other sources found to contain radium-226 in sufficient concentrations to emit radon in excess of 20 pCi/m^2/sec. Chapter 5 further discusses the results of the Radon Monitoring Program for 2003.

2.3 Split Sampling Program

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

In 2003 DOE and OEPA cooperated in the program. This time, samples of groundwater and produce were split. The data show reasonable agreement between DOE and OEPA results for groundwater. However, a greater degree of variability exists between DOE and OEPA results for produce samples. This is not unusual for this type of sample matrix based on the potential variability within the samples themselves. In addition, variability in the sample results may be a result of incomplete sample homogenization (mixing) in the field, differences in sample preparation and analytical methods, and the use of different laboratories.

The slight differences in DOE and OEPA sample results presented for 2003 do not impact the site's compliance with federal or state regulations. The detailed results for the 2003 split samples are presented in Appendix E of this report.

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Chapter 3
Groundwater Pathway

Chapter 3

3.0 Groundwater Pathway

Results in Brief: 2003 Groundwater Pathway

Groundwater Remedy – During 2003 active restoration of the Great Miami Aquifer continued at the following five groundwater restoration modules:

- South Plume Module, which became operational on August 27, 1993
- South Field Extraction (Phase I) Module, which became operational on July 13, 1998
- South Plume Optimization Module, which became operational on August 9, 1998
- Re-Injection Module, which became operational on September 2, 1998
- Waste Storage Area Module, which became operational on May 8, 2002.

Additionally, Phase II components of the South Field Module became operational in July 2003.

Since 1993

- 14,240 million gallons (53,898 million liters) of water have been pumped from the Great Miami Aquifer
- 1,607 million gallons (6,082 million liters) of water have been re-injected into the Great Miami Aquifer
- 5,599 net pounds (2,542 kg) of uranium have been removed from the Great Miami Aquifer.

During 2003

- 2,428 million gallons (9,190 million liters) of water were pumped from the Great Miami Aquifer
- 360 million gallons (1,363 million liters) of water were re-injected into the Great Miami Aquifer
- 1,151 net pounds (523 kg) of total uranium were removed from the Great Miami Aquifer.

Groundwater Monitoring Results – Uranium concentrations within the 10-year, time-of-travel remediation footprint of the 30 µg/L uranium plume are decreasing significantly.

- Groundwater sampling in the Plant 6 Area indicates that total uranium FRL exceedances detected in 2002 were not present in the second half of 2003. No groundwater remediation module is planned for the Plant-6 Area.
- Groundwater FRL exceedances for uranium occurred in the Waste Storage Area near the southeast corner of the clearwell for the first time. This area will be considered in the design of the Waste Storage Area (Phase II) Module.
- Four new extraction wells, three new re-injection wells, and one injection pond began operating in the South Field Area.

Work was initiated to determine and implement a groundwater remediation approach that results in the most cost-effective groundwater remedy infrastructure, including the wastewater treatment facility, which will remain after site closure. A decision regarding the future aquifer restoration and wastewater treatment approach is anticipated in 2004, following regulatory and stakeholder input to the decision-making process.

On-Site Disposal Facility Monitoring – Leak detection monitoring continued in 2003 for Cells 1 through 6. For those constituents monitored to meet on-site disposal facility requirements, there were no exceedances of groundwater FRLs for either the horizontal till wells or the Great Miami Aquifer wells. Data collected from the cells indicate that the liner systems are performing well within the specifications outlined in the approved cell design.

This chapter provides background information on the nature and extent of groundwater contamination in the Great Miami Aquifer due to past operations at the Fernald site and summarizes:

- Aquifer restoration progress
- Groundwater monitoring activities and results for 2003.

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

3.1 Summary of the Nature and Extent of Groundwater Contamination

Groundwater Modeling at the Fernald Site

The Fernald site uses a computer model to make predictions about how the contaminants in the aquifer will look in the future. Because the model contains simplifying assumptions about the aquifer and the contaminants, the predictions about future behavior must be verified with field measurements obtained from groundwater monitoring activities.

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

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

Contamination of the groundwater resulted from infiltration through the bed of Paddys Run, the Storm Sewer Outfall Ditch, and the Pilot Plant Drainage Ditch. In these areas, the glacial overburden is eroded, and the sand and gravel of the aquifer are in direct contact with uranium-contaminated surface water from the site. To a lesser degree, groundwater contamination also resulted where past excavations (such as the waste pits) removed some of the protective clay contained in the glacial overburden and exposed the aquifer to contamination.

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3.2 Selection and Design of the Groundwater Remedy

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

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

The recommended groundwater remedy was presented to EPA, OEPA, and stakeholders in the Proposed Plan for Operable Unit 5 as the Preferred Groundwater Remedy (DOE 1995b). Once the Proposed Plan was approved, the Operable Unit 5 Record of Decision was presented to stakeholders and subsequently approved by EPA and OEPA in January 1996. The Operable Unit 5 Record of Decision (DOE 1996) formally defines the selected groundwater remedy and establishes FRLs for all constituents of concern.

Re-Injection at the Fernald Site

Re-injection is an enhancement to the groundwater remedy. Groundwater pumped from the aquifer is treated to remove contaminants and then re-injected into the aquifer at strategic locations. Because the treatment process is not 100 percent efficient, a small amount of uranium is re-injected into the aquifer with the treated water. The re-injected groundwater increases the speed at which dissolved contaminants move through the aquifer and are pulled by extraction wells, thereby decreasing the overall remediation time.

The Operable Unit 5 Record of Decision 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 re-injection technology, the remedy could potentially be reduced to 10 years. EPA and OEPA approved the enhanced groundwater remedy that relies on pump-and-treat and re-injection technology. As discussed below, the enhanced groundwater remedy is being used to conduct a concentration-based cleanup of the Great Miami Aquifer.

Evolution of the enhanced groundwater remedy has been documented through a series of approved designs. Specifically, they are: The 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), and Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module (DOE 2002c).

The enhanced groundwater remedy commenced in 1998 with the start-up of the South Field (Phase I), South Plume Optimization, and Re-Injection Demonstration Modules. It focuses primarily on the removal of uranium, but has also been designed to limit the further expansion of the plume, achieve removal of all targeted contaminants to concentrations below designated FRLs, and prevent undesirable groundwater drawdown impacts beyond the site's boundary.

Start-up of the enhanced groundwater remedy included a year-long re-injection demonstration that was initiated in September 1998. The Re-Injection Demonstration Test Report (DOE 2000) details the demonstration and recommends its incorporation into the site's aquifer restoration strategy. Based on the results of the demonstration, re-injection is continuing at the site. Through the years, additional extraction and re-injection wells have been added to these initial restoration modules.

In 2001 the EPA and OEPA approved the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas. 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 (Phase I) to address contamination in the Pilot Plant Drainage Ditch plume and two extraction wells (Phase II) to address the remaining contamination after the waste pit excavation is completed. One of the three Waste Storage Area (Phase I) wells was installed in 2000 to support an aquifer pumping test to help determine the restoration well field design. The remaining two Phase I wells were installed in the summer of 2001 after the design was approved by EPA and OEPA. All three wells became operational on May 8, 2002.

The Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas also provided data indicating that the uranium plume in the Plant 6 Area was no longer present. It was believed that the uranium plume had dissipated to concentrations below the FRL as a result of the shut-down of plant operations in the late 1980s and the pumping of highly contaminated perched water as part of the Perched Water Removal Action #1 in the early 1990s. Because a uranium plume with concentrations above the groundwater FRL was no longer present in the Plant 6 Area at the time of the design, a restoration module for the area was determined to be unnecessary. Groundwater monitoring continued in the Plant 6 Area with one well in the area having total uranium FRL exceedances in 2002; however, in 2003 uranium concentrations were once again below the total uranium FRL. Direct-push sampling will be conducted in the Plant 6 Area to document the vertical profile at the location where the 2002 total uranium FRL exceedances occurred. (Uranium plume maps will continue to show a small uranium plume in the Plant 6 Area until direct-push sampling has been conducted.)

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

During 2003 active remediation of the Great Miami Aquifer continued at the South Plume/South Plume Optimization, South Field, Waste Storage Area, and Re-Injection Modules. Figure 3-1 depicts the current extraction and re-injection well locations. The operational information associated with these modules is presented in subsequent subsections. In 2003 South Field (Phase II) Module components installed in 2002 became operational for the first time. The new components consist of four new extraction wells (Extraction Wells 33262 or 15a, 33264 or EW-30, 33265 or EW-31, and 33266 or EW-32), one new re-injection well (Re-Injection Well 33263 or IW-29), conversion of an existing extraction well into a re-injection well (Re-Injection Well 31563 or IW-16), and installation of a re-injection pond. Figure 3-2 identifies current and future extraction and re-injection well locations. At the end of 2003, the only remaining planned enhanced groundwater remedy module component, pending design and installation, was the Phase II component of the Waste Storage Area Module (to become operational in 2006). Design and installation of this remaining component is pending completion of the waste pit excavations.

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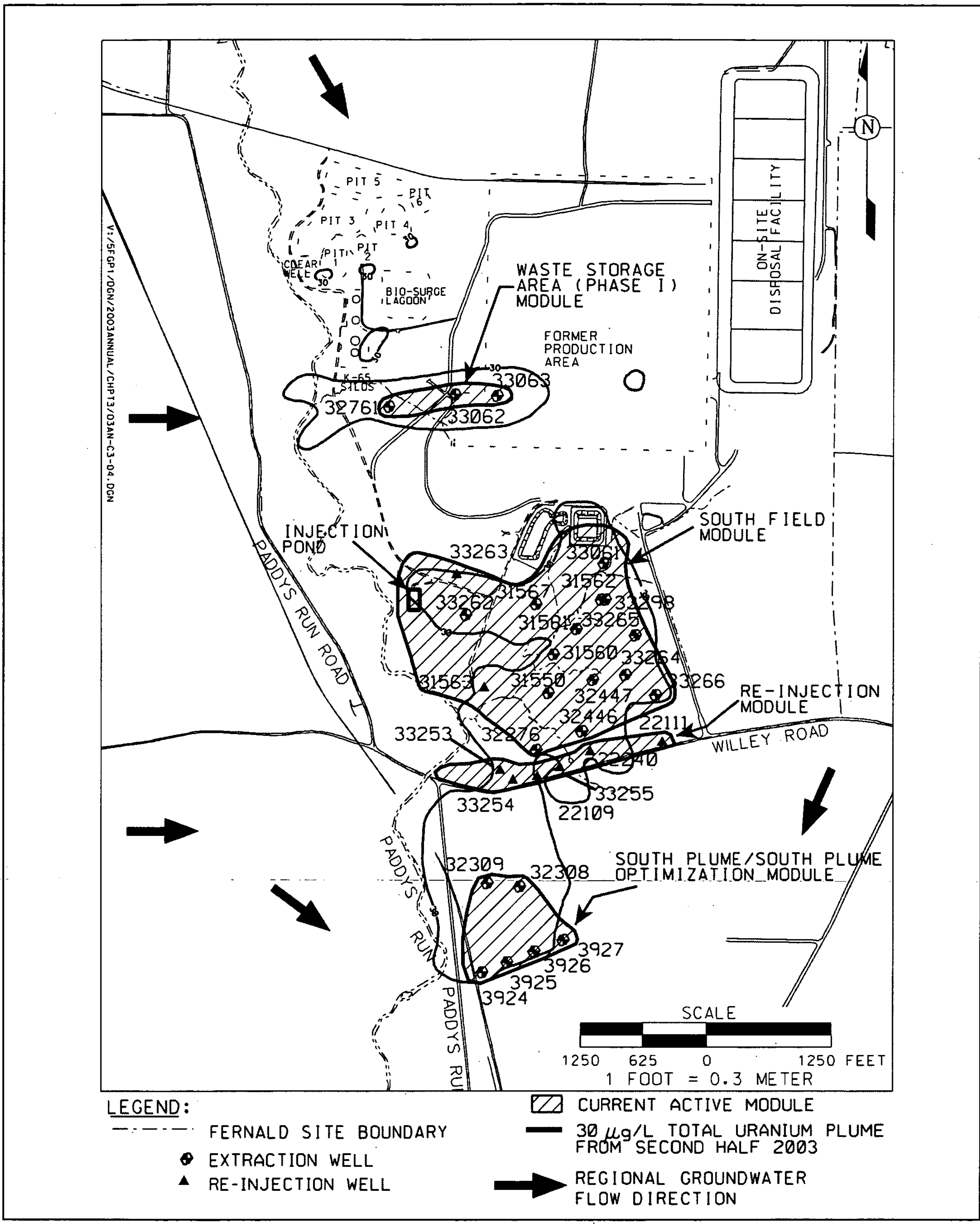

Figure 3-1. Current Extraction and Re-Injection Wells

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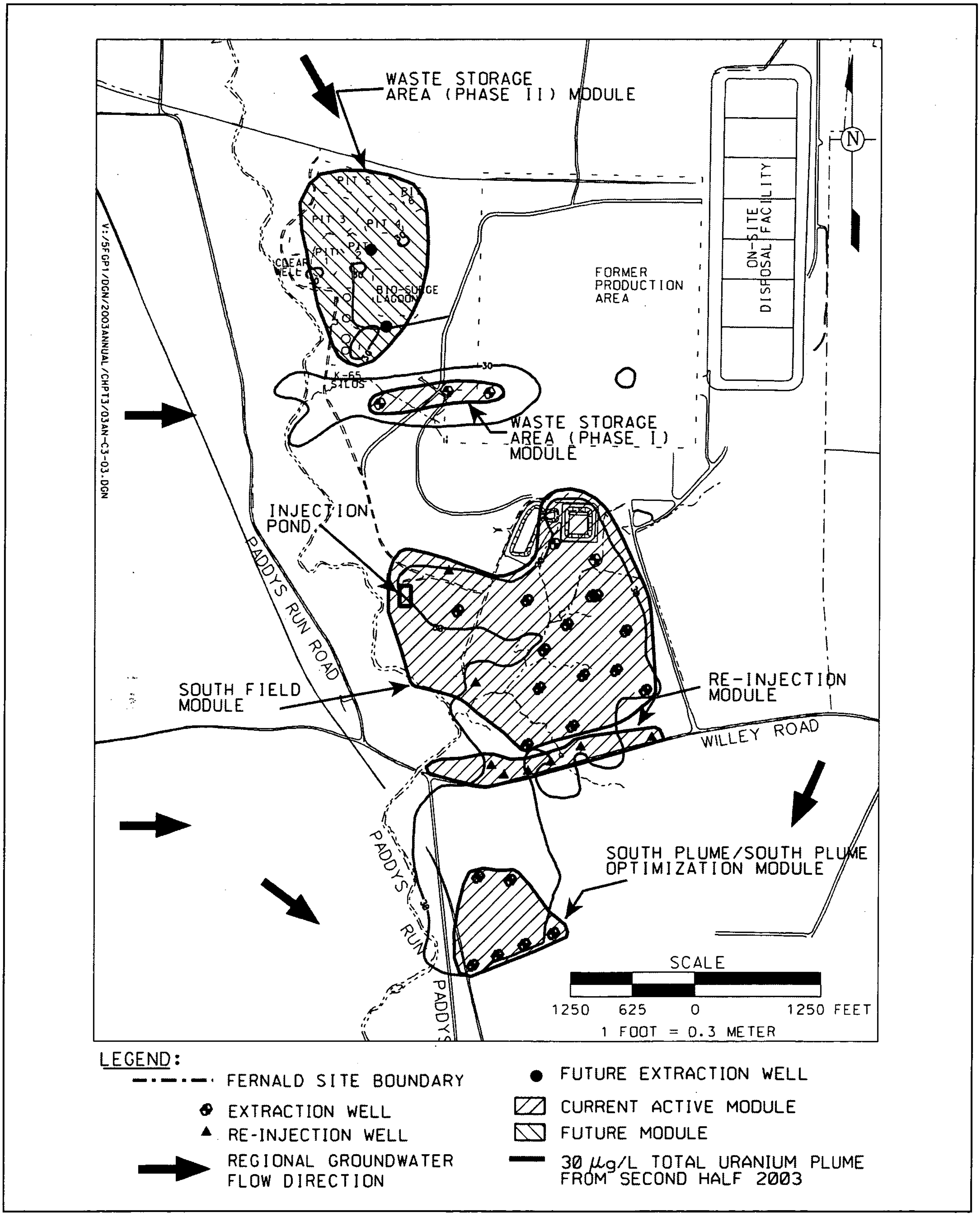

Figure 3-2. Current and Future Extraction and Re-Injection Wells for the Groundwater Remedy

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Work was initiated in 2003 to determine and implement a groundwater remediation approach that results in the most cost-effective groundwater remedy infrastructure, including the wastewater treatment facility, which will remain after site closure. An evaluation of the alternatives was contained within a draft report titled, Comprehensive Groundwater Strategy Report (DOE 2003c). In October 2003 initial discussions were held with the regulators and the public concerning the various alternatives identified in the report. These discussions culminated in an identified path forward to work collaboratively with the Fernald Citizens Advisory Board, EPA, and OEPA to determine the most appropriate course of action for the ongoing aquifer restoration and water treatment activities at the FCP. A decision regarding the future aquifer restoration and wastewater treatment approach is anticipated in 2004, following regulatory and stakeholder input to the decision-making process.

3.3 Groundwater Monitoring Highlights for 2003

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

The key elements of the Fernald site groundwater monitoring program design are described below. Note that with the implementation of the IEMP, Revision 3, in 2003, the groundwater monitoring approach was streamlined to focus on areas where exceedances (total uranium and non-uranium) were occurring while continuing to meet compliance requirements.

- **Sampling** – Sample locations, frequency, and the constituents were selected to address operational assessment, restoration assessment, and compliance requirements. Selected wells are monitored for up to 50 groundwater FRL constituents. Monitoring is conducted to ascertain groundwater quality and groundwater flow direction. Figure 3-3 shows a typical groundwater monitoring well at the site and Figure 3-4 identifies the relative placement depths of groundwater monitoring wells at the site. As part of the comprehensive IEMP groundwater monitoring program, approximately 150 wells were monitored for water quality in 2003. Figures 3-5 (total uranium monitoring) and 3-6 (non-uranium monitoring) identify the locations of the current IEMP water quality monitoring wells. In addition to water quality monitoring, approximately 170 wells were monitored quarterly for groundwater elevations. Figure 3-7 depicts the IEMP routine water level (groundwater elevation) monitoring wells, including extraction wells.

- **Data Evaluation** – The integrated data evaluation process involves looking at the data collected from wells to determine capture and restoration of the uranium plume; capture and restoration of non-uranium FRL constituents; water quality conditions in the aquifer that indicate a need to modify the design and installation of restoration modules; and the impact of ongoing groundwater restoration on the Paddys Run Road Site plume (a separate contaminant plume south of the Fernald site along Paddys Run Road resulting from independent industrial activities in the area).

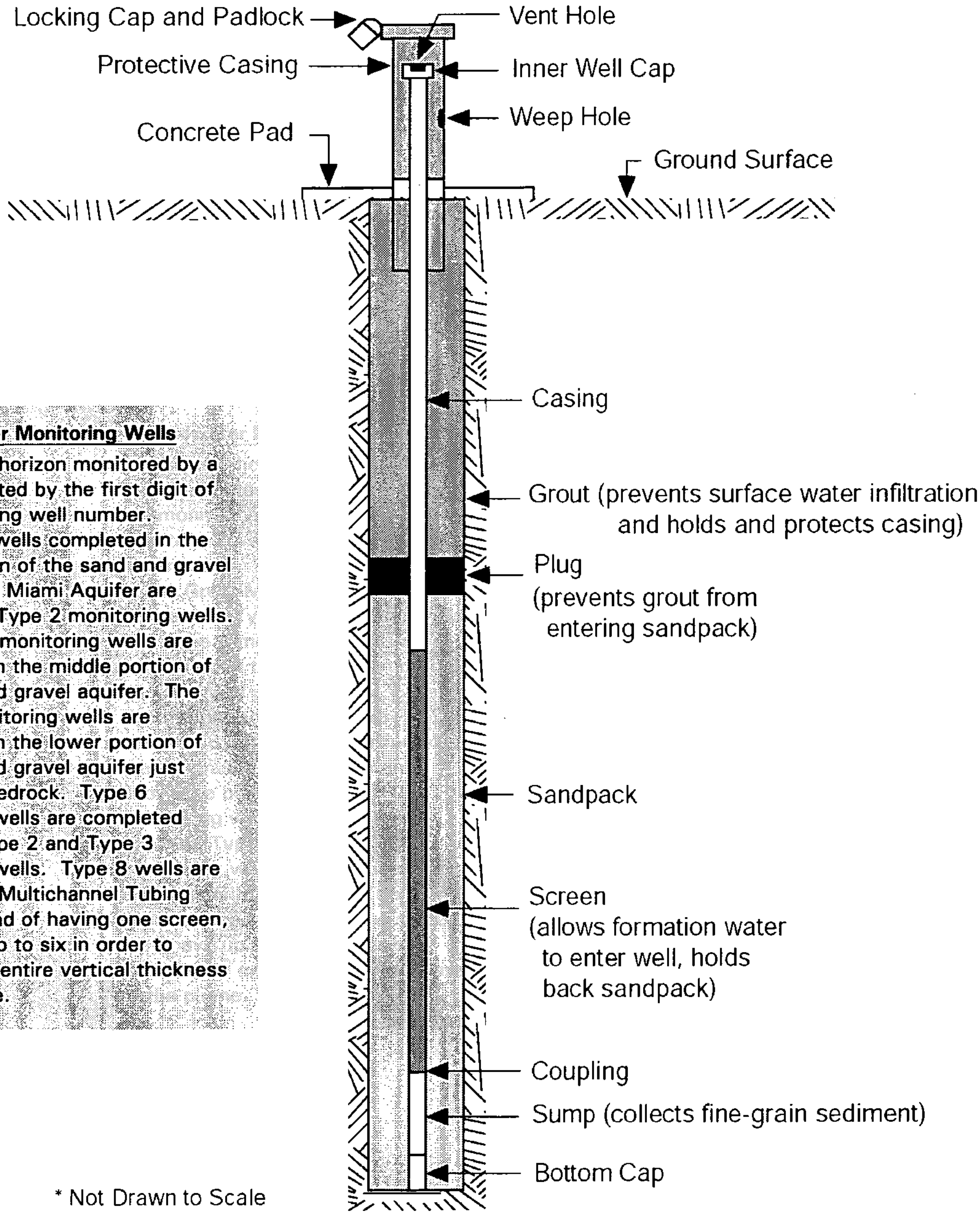
- **Reporting** – All data are reported through the IEMP program mid-year data summary and annual site environmental reports.

3.3.1 Restoration Monitoring

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

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

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



Groundwater Monitoring Wells

The aquifer horizon monitored by a well is denoted by the first digit of the monitoring well number. Monitoring wells completed in the upper portion of the sand and gravel of the Great Miami Aquifer are denoted as Type 2 monitoring wells. The Type 3 monitoring wells are completed in the middle portion of the sand and gravel aquifer. The Type 4 monitoring wells are completed in the lower portion of the sand and gravel aquifer just above the bedrock. Type 6 monitoring wells are completed between Type 2 and Type 3 monitoring wells. Type 8 wells are Continuous Multichannel Tubing wells; instead of having one screen, they have up to six in order to monitor the entire vertical thickness of the plume.

Figure 3-3. Diagram of a Typical Groundwater Monitoring Well

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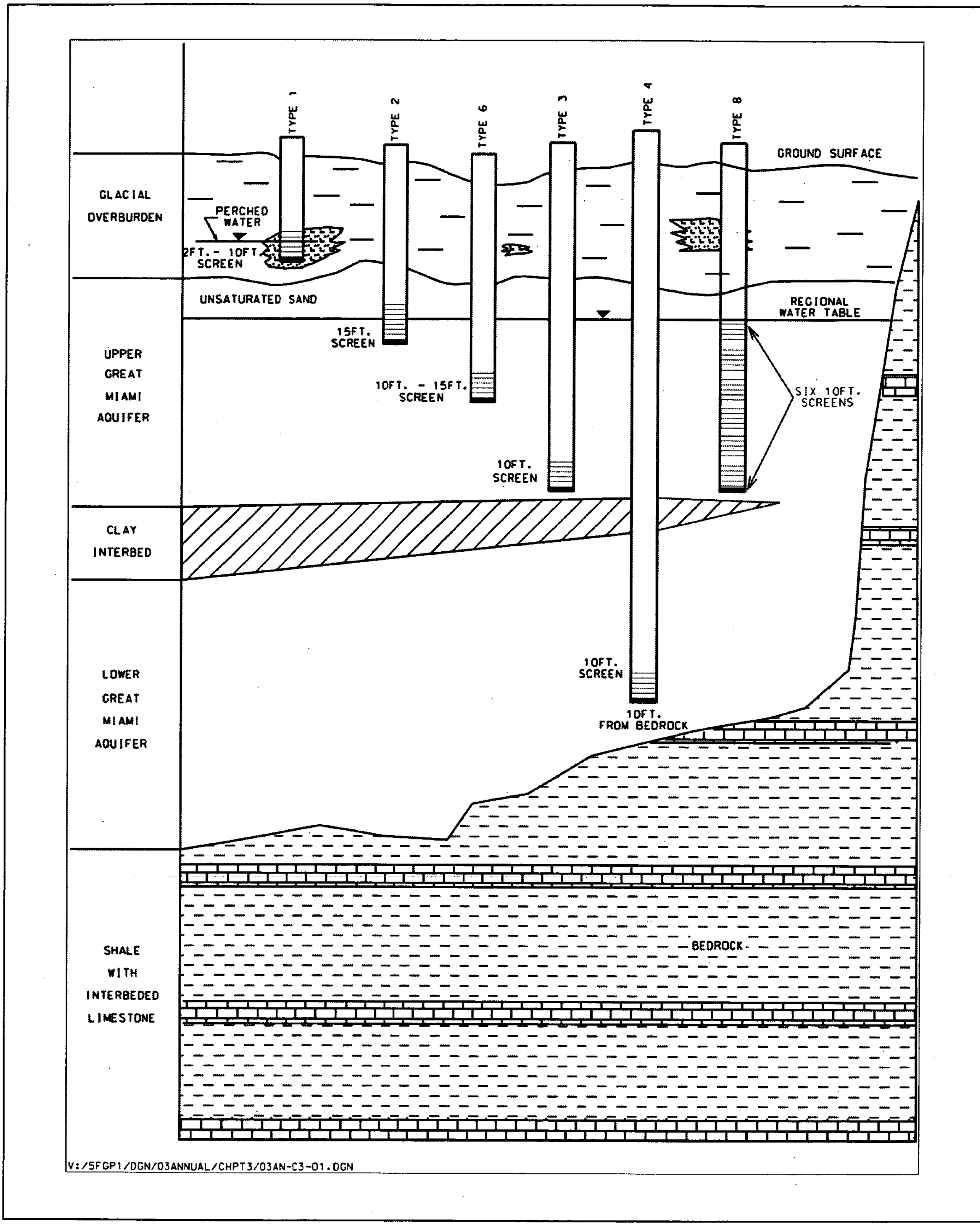

Figure 3-4. Monitoring Well Relative Depths and Screen Locations

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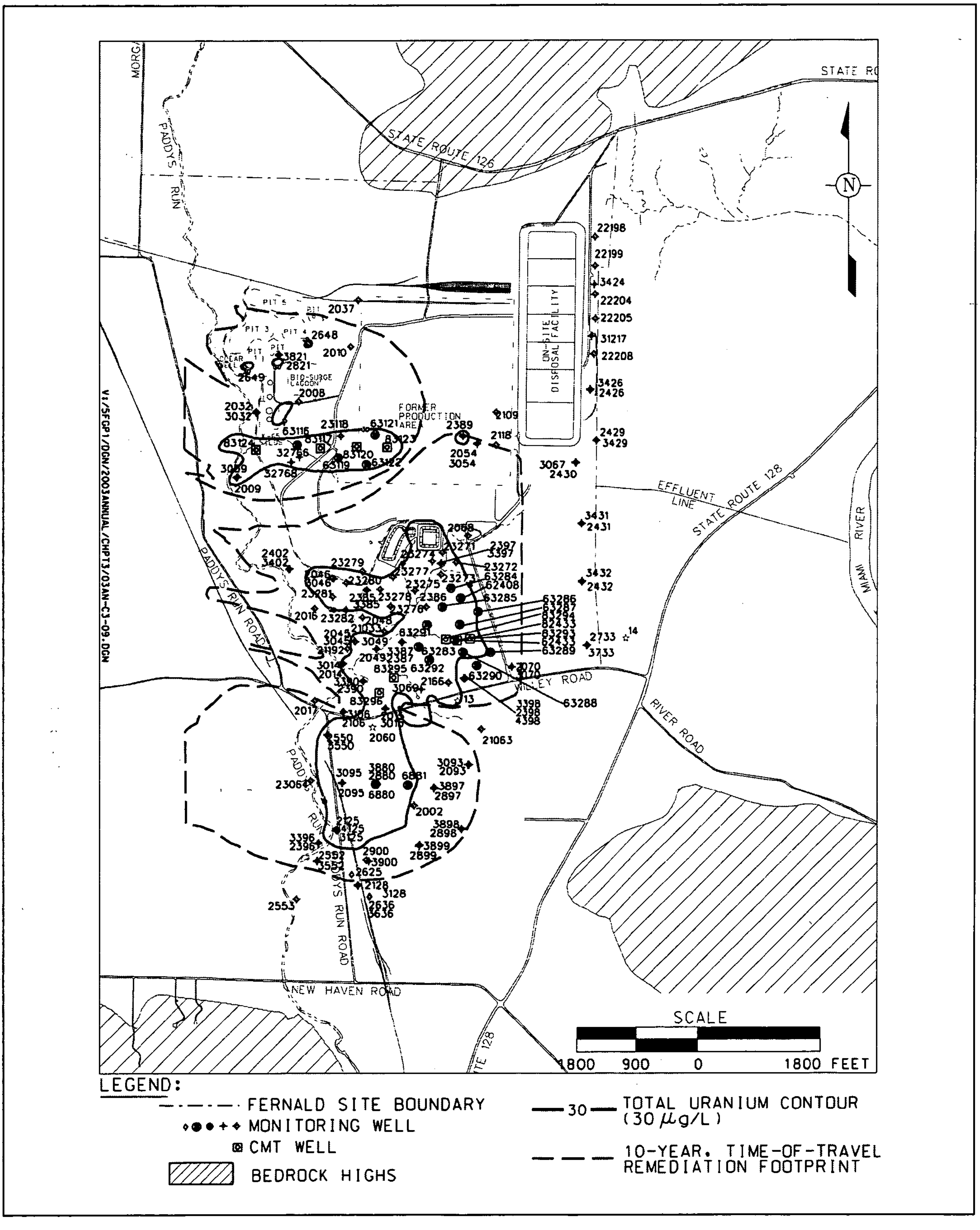

Figure 3-5. Locations for Semi-Annual Total Uranium Monitoring

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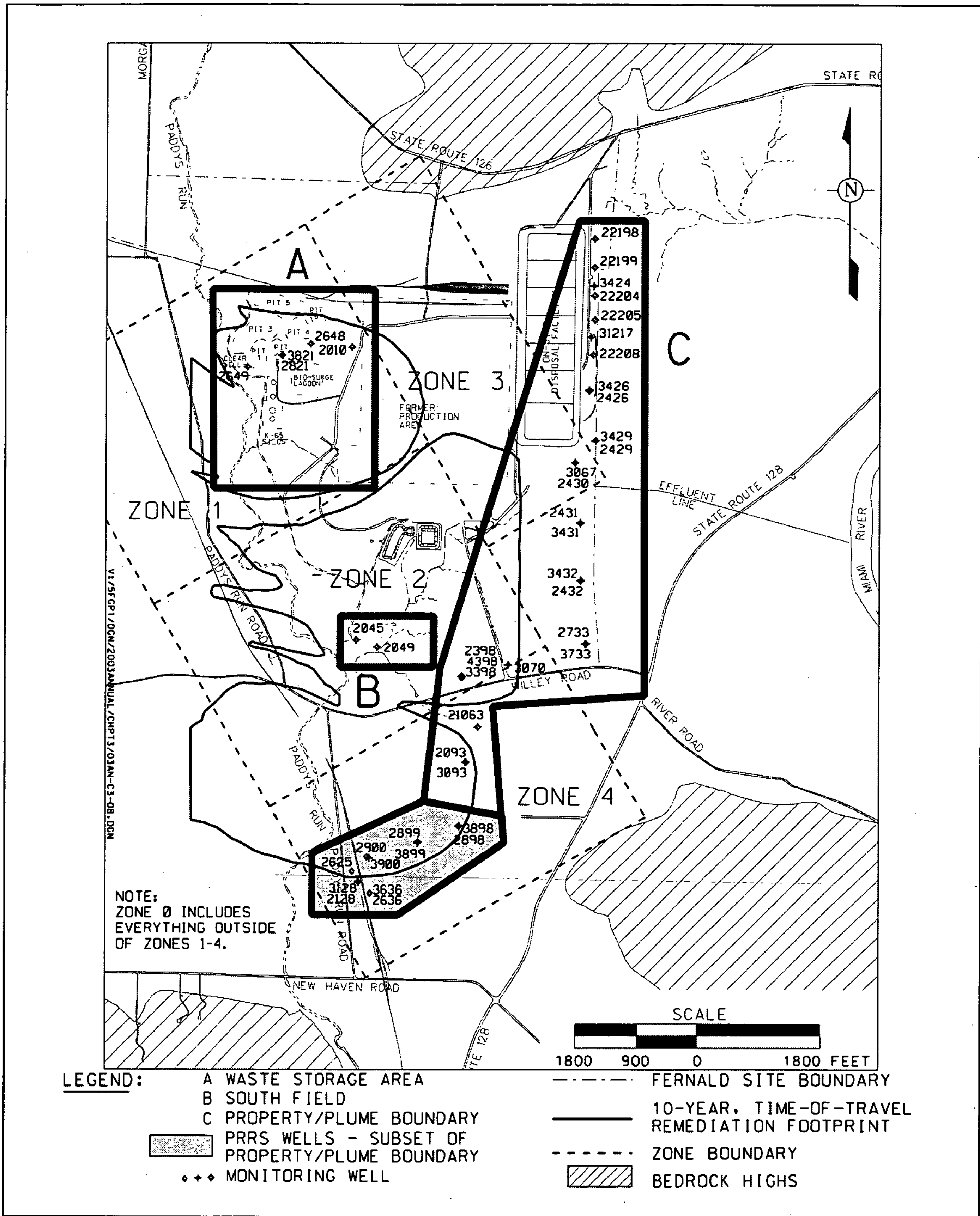

Figure 3-6. Locations for Semi-Annual Non-Uranium Monitoring

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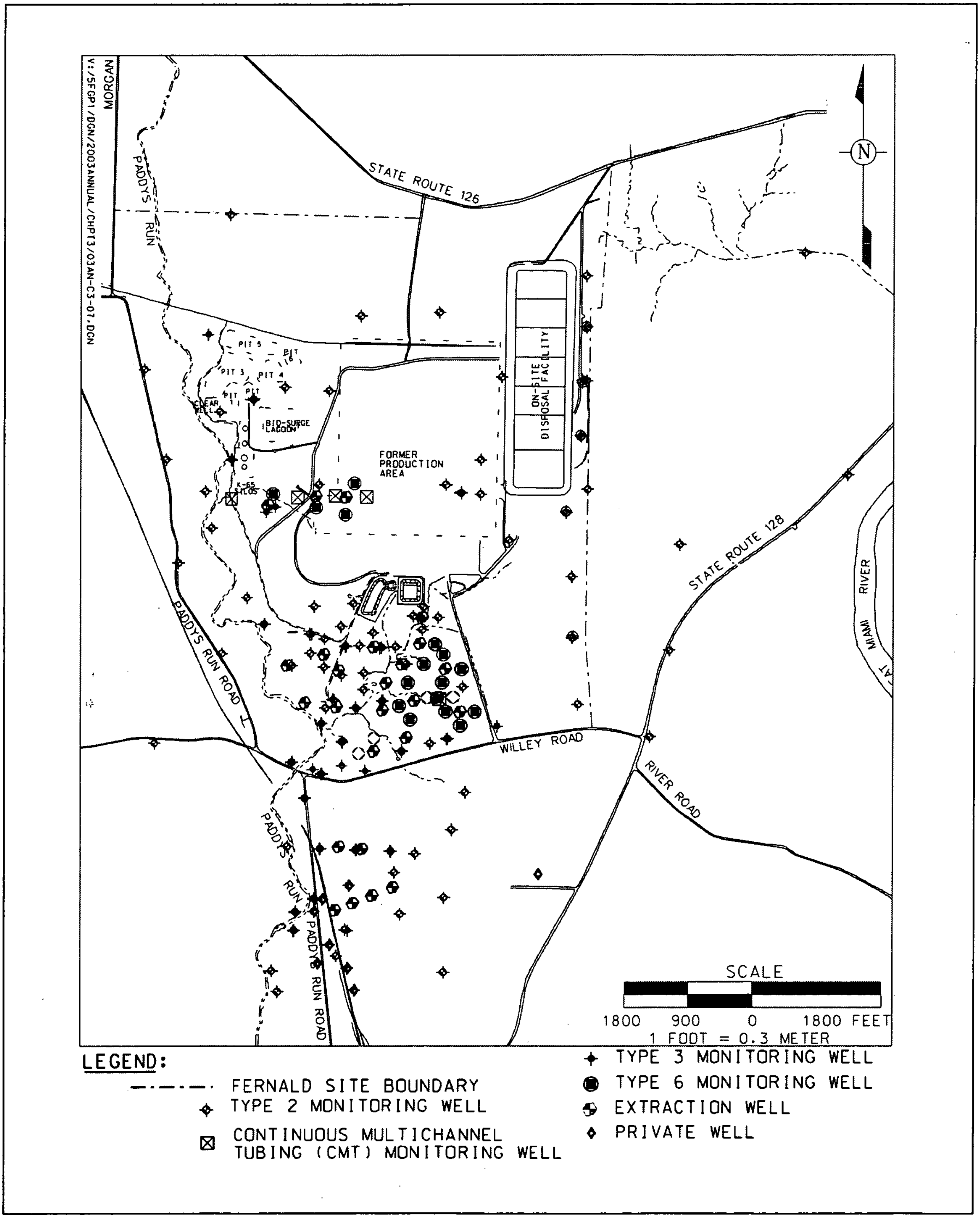

Figure 3-7. IEMP Groundwater Elevation Monitoring Wells

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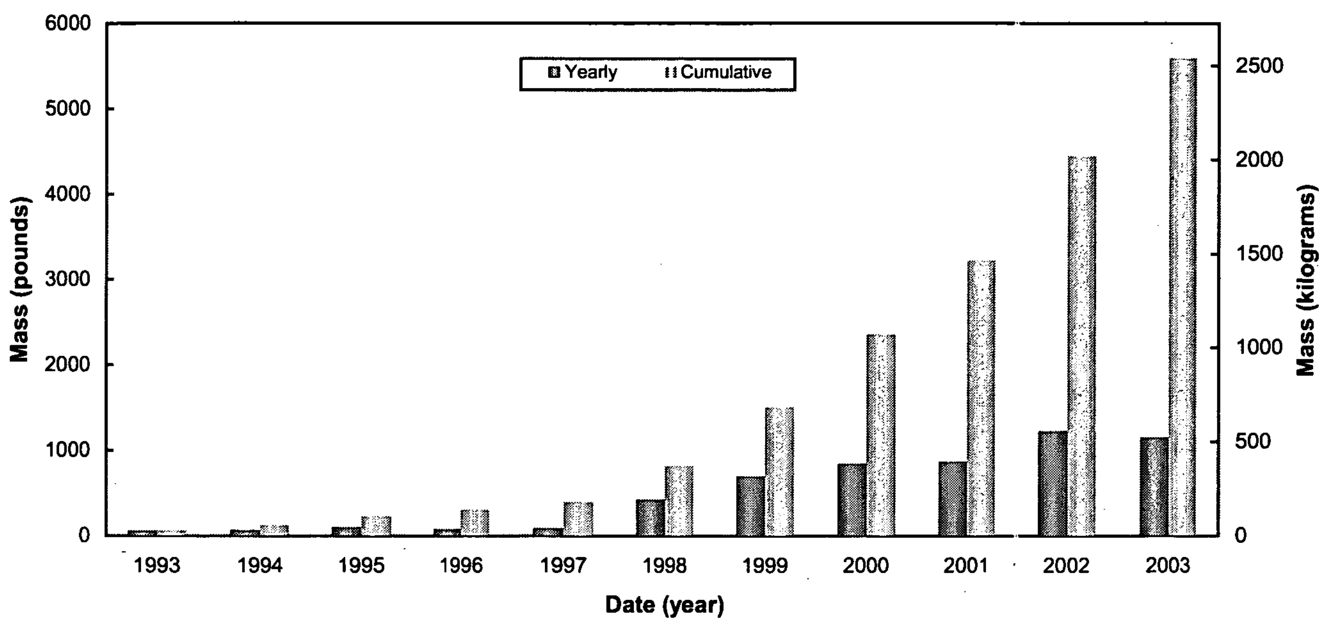

Figure 3-8. Net Pounds of Uranium Removed from the Great Miami Aquifer, 1993-2003

3.3.1.1 Operational Summary

Figure 3-1 shows the extraction and re-injection well locations associated with the current restoration modules. With the exception of the Waste Storage Area, all wells currently planned for the enhanced groundwater remedy have been installed. Table 3-1 summarizes the pounds of uranium removed, amount of groundwater pumped, pounds of uranium re-injected, and amount of treated groundwater re-injected by the active restoration modules during 2003. For reporting purposes, operational data for the re-injection wells located in the South Field as well as the Injection Pond (which is also located in the South Field) are tabulated with the Re-Injection Module operational data in Table 3-1. Figure 3-8 identifies the yearly and cumulative pounds of uranium removed from the Great Miami Aquifer from 1993 through 2003. Since 1993:

- 14,240 million gallons (53,898 million liters) of water have been pumped from the Great Miami Aquifer
- 1,607 million gallons (6,082 million liters) of treated water have been re-injected into the Great Miami Aquifer
- 5,599 net pounds (2,542 kg) of total uranium have been removed from the Great Miami Aquifer.

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

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TABLE 3-1
GROUNDWATER RESTORATION MODULE STATUS FOR 2003

Module	Restoration Wells	Target Pumping Rate		Gallons Pumped/ (Gallons Re-Injected)		Uranium Removed/ (Re-Injected)	
		gpm	Lpm	M gal	M liters	lbs	kg
South Plume/ South Plume Optimization Module	3924 3925 3926 3927 32308 32309	1,900	7,192	799	3,024	177	80
South Field Module	31550 31560 31561 31562[a] 31563[b] 31564[c] 31565[d] 31566[e] 31567 32276 32446 32447 33061 33298 33262 33264 33265 33266	3,365[j]	12,737	1,081	4,092	622	282
Waste Storage Area Module	32761 33062 33063	1,100	4,164	548	2,074	363	165
Re-Injection Module and South Field Re-Injection Wells and Pond	22107[f] 22108[g] 22109 22240 33253 33254 33255 33263[h] 31563[h] Injection Pond[i]	(1,425)	(5,394)	(360)	(1,363)	(10.58)	(4.80)
Aquifer Restoration System Totals							
pumped		6,365	24,093	2,428	9,190	1,162	527
(re-injected)		(1,425)	(5,394)	(360)	(1,363)	(10.58)	(4.80)
net		4,940	18,699	2,068	7,827	1,151	523

[a]Extraction Well 31562 began operating in July 1998. It was removed from service in March 2003 and was replaced by Extraction Well 33298 which became operational on July 29, 2003.
[b]Extraction Well 31563 began operating in July 1998. It was removed from service in December 2002.
[c]Extraction Well 31564 began operating in July 1998. It was removed from service in December 2001.
[d]Extraction Well 31565 began operating in July 1998. It was removed from service in May 2001.
[e]Extraction Well 31566 began operating in July 1998. It was removed from service in August 1998.
[f]Re-injection Well 22107 began operating in August 1998. It was replaced by Re-Injection Well 33253 in November 2002.
[g]Re-injection Well 22108 began operating in August 1998. It was replaced by Re-Injection Well 33254 in November 2002.
[h]Re-Injection Wells 33263 and 31563 are located in the South Field.
[i]Injection Pond is located in the South Field.
[j]Target pumping rate as of July when South Field (Phase II) Module components came online. Prior to July, the target pumping rate was 2,365 gpm (8,952 Lpm).

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3.3.1.2 South Plume/South Plume Optimization Module Operational Summary

The four extraction wells of the South Plume Module (Extraction Wells 3924, 3925, 3926, and 3927) began operating in August 1993. The two extraction wells of the South Plume Optimization Module (Extraction Wells 32308 and 32309) began operating in August 1998. Figure 3-9 illustrates the uranium plume capture observed for the South Plume/South Plume Optimization Module in the fourth quarter of 2003. During 2003, 799 million gallons (3,024 million liters) of groundwater and 177 pounds (80 kg) of uranium were removed from the Great Miami Aquifer by the South Plume/South Plume Optimization Module. Based on analysis of the data in 2003, the module continues to meet its primary objectives as demonstrated by the following:

- Southward movement of the uranium plume beyond the southern most extraction wells has not been detected.
- Active remediation of the central portion of the off-property uranium plume continues to reduce plume concentration. Nearly the entire off-property uranium plume concentration is now below 100 µg/L. At the start of pumping in 1993, areas in the off-property uranium plume had concentrations over 300 µg/L.
- Paddys Run Road Site plume, located south of the extraction wells, is not being adversely affected by the pumping.

3.3.1.3 South Field Module Operational Summary

The South Field Module was constructed in two phases. Phase I began operating in July 1998 and Phase II began operating in July 2003. The 10 original extraction wells installed under Phase I were 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276. Four of the original 10 wells have been shutdown (31564, 31565, 31566, and 31563). Extraction Wells 31564 and 31565 were shut down in December 2001 and May 2001, respectively, to accommodate soil remedial activities. Extraction Well 31566 was shut down in August 1998, and was replaced by Extraction Well 33262, which was installed as part of South Field (Phase II) Module. Extraction Well 31563 was shut down in December 2002 and converted to a re-injection well that began operating in 2003. With the exception of Extraction Well 31563, the locations of the extraction wells that were shut down were all upgradient of the current uranium plume where concentrations in the Great Miami Aquifer are now below the associated FRL.

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

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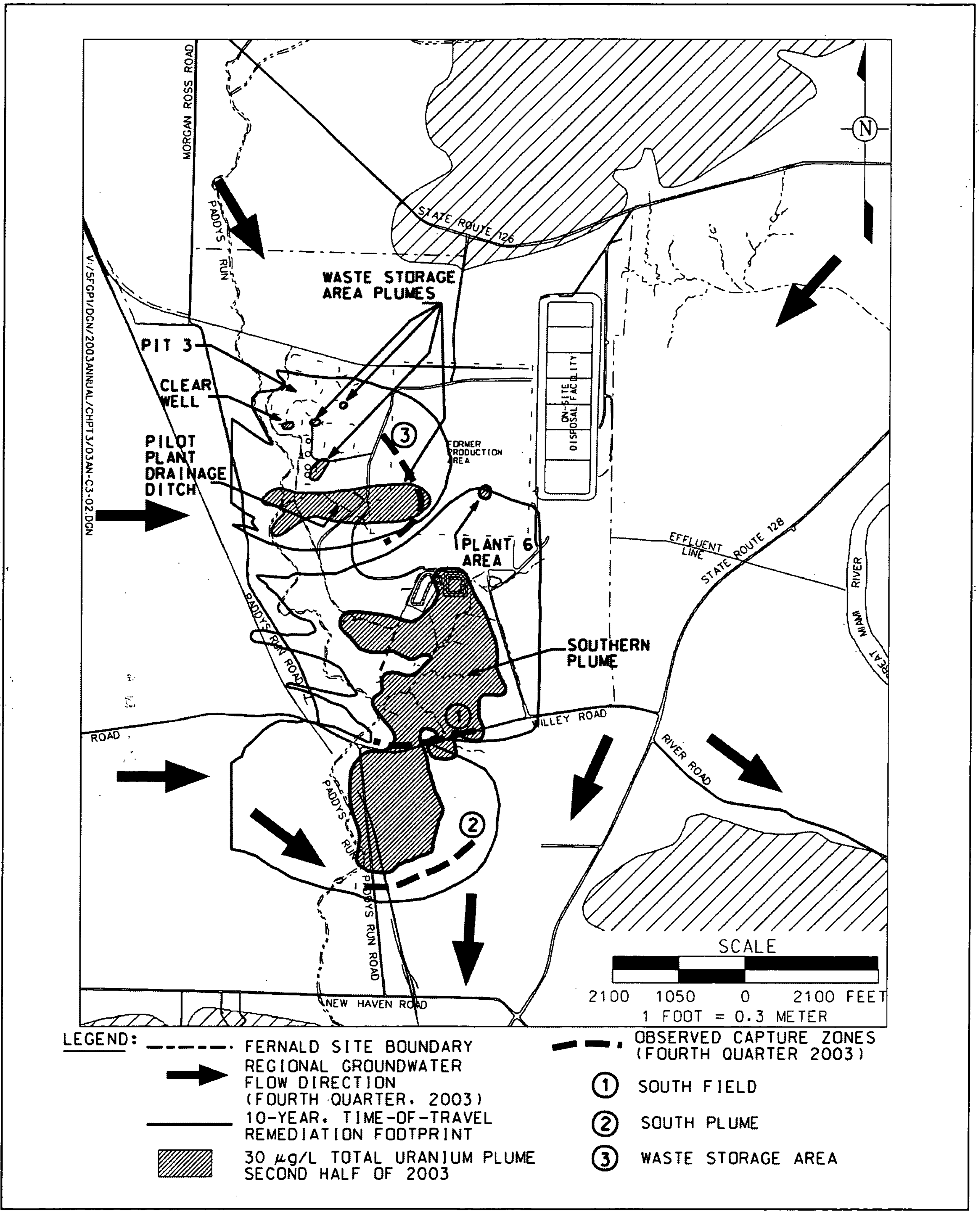

Figure 3-9. Total Uranium Plume in the Aquifer with Concentrations Greater than 30 μg/L at the End of 2003

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

- Four additional extraction wells, one in the southern waste unit area (Extraction Well 33262), and three along the eastern edge of the on-property portion of the southern uranium plume (Extraction Wells 33264, 33265, and 33266).
- One additional re-injection well in the southern waste unit area (Re-Injection Well 33263).
- A converted extraction well (Extraction Well 31563), which was converted into a re-injection well.
- An injection pond, which is located in the western portion of the Southern Waste Units Excavations.

Figure 3-9 illustrates the capture zone observed for the South Field Module in the fourth quarter of 2003. During 2003, 1,081 million gallons (4,092 million liters) of groundwater and 622 pounds (282 kg) of uranium were removed from the Great Miami Aquifer by the South Field Module.

3.3.1.4 Re-Injection Module Operational Summary

The use of re-injection at the FCP began with a demonstration test that was conducted from September 2, 1998 to September 2, 1999. The demonstration indicated that re-injection was a viable technology for the aquifer remedy. Based on the success of the demonstration, it was decided to incorporate re-injection technology into the aquifer remedy. A Re-Injection Demonstration Test Report (DOE 2000) detailing the demonstration was issued to EPA and OEPA on May 30, 2000.

The original Re-Injection Module consisted of five re-injection wells (Re-Injection Wells 22107, 22108, 22109, 22111, and 22240). Residual plugging of the re-injection wells became a concern in the last half of 2000. During 2001 the re-injection wells were subjected to the new treatment method and this new process was economically viable in three of the five original wells (Re-Injection Wells 22109, 22111, and 22240). It was determined that it was more cost-effective to replace the other two wells (Re-Injection Wells 22107 and 22109) rather than attempt another treatment.

Re-Injection Well 22107 was replaced by Re-Injection Well 33253. Re-Injection Well 22108 was replaced by Re-Injection Well 33254. These two new replacement wells began operating in November 2002. In addition to the two new replacement wells, a sixth re-injection well was added to the module (Re-Injection Well 33255). This new re-injection well is located half way between Re-Injection Wells 22109 and 22240, and began operating on May 22, 2003. During 2003, 360 million gallons (1,363 million liters) of groundwater and 10.58 pounds (4.8 kg) of uranium were re-injected into the Great Miami Aquifer by the Re-Injection Module wells and re-injection wells, and the Injection Pond in the South Field Module.

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3.3.1.5 Waste Storage Area (Phase I) Operational Summary

The Waste Storage Area Module became operational on May 8, 2002, nearly 17 months ahead of the Operable Unit 5 Remedial Action Work Plan established start date of October 1, 2003. The module consists of three extraction wells: 32761, 33062, and 33063. These three wells were installed to remediate a uranium plume in the Pilot Plant Drainage Ditch area, according to the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2001a). Figure 3-9 illustrates the capture zone observed for the Waste Storage Area Module in the fourth quarter of 2003. During 2003, 548 million gallons (2,074 million liters) and 363 pounds (165 kilograms) of uranium were removed from the Great Miami Aquifer by the Waste Storage Area Module.

3.3.1.6 Monitoring Results for Total Uranium

The 10-year, time-of-travel remediation footprint is an updated model prediction. It illustrates how far a particle of water will travel in response to pumping over a 10-year time period using current pumping locations and target pumping rates for 2003. It replaces the 10-year, uranium-based restoration footprint that was prepared several years ago based on previous model predictions using previous pumping locations and rates that are no longer relevant.

Total uranium is the primary FRL constituent because it is the most prevalent site contaminant and has impacted the largest area of the aquifer. Figure 3-9 shows general groundwater flow directions observed during the fourth quarter of 2003 and the interpretation of the uranium plume in the aquifer updated through the second half of 2003. The shaded areas represent the interpreted size of the maximum uranium plume that is above the 30 µg/L groundwater FRL for total uranium. As of December 31, 2003, approximately 179 acres (72 hectares) of the Great Miami Aquifer were contaminated above the 30 µg/L groundwater FRL for total uranium. Capture zones observed during the fourth quarter of 2003 for the active restoration modules are also identified on Figure 3-9. These capture zones indicate that the southern plume is being captured by the existing system and that further movement of uranium to the south of the extraction wells is being prevented. Figure 3-9 also depicts the 10-year, time-of-travel remediation footprint that was predicted using 2003 target pumping rates.

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

Waste Storage Area – In 2003 FRL exceedances for uranium were detected in the Great Miami Aquifer near the southeast corner of the clearwell. Prior to 2003 the maximum uranium concentration at this location was 15.3 µg/L. The concentration on January 30, 2003 was 35.2 µg/L, and on July 14, 2003 it was 34.7 µg/L. These changing conditions will be considered in the design for the Waste Storage (Phase II) Groundwater Restoration Module.
Two Type 8 monitoring wells in the Pilot Plant Drainage Ditch Plume had uranium concentrations that were considerably higher than previously measured maximum concentrations. Both of these monitoring wells are within capture of the nearby operating Waste Storage Area Extraction Wells. Additional information can be found in Appendix A, Attachment A.2.

Plant 6 Area – Data collected for the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2001a) indicated that the uranium plume in the Plant 6 Area was no longer present. Therefore, no restoration wells are planned for the Plant 6 Area. However, groundwater monitoring in 2002 detected total uranium FRL exceedances at Monitoring Well 2389, which is located in the Plant 6 Area. On June 12, 2002 the uranium concentration at Monitoring Well 2389 was 40.9 µg/L, and on October 21, 2002 the uranium concentration was 36.7 µg/L. In 2003, however, the uranium concentration at Monitoring Well 2389 decreased below the groundwater FRL. On June 12, 2003 the uranium concentration was 30 µg/L, and on October 13, 2003 the uranium concentration was 11.8 µg/L. A small uranium plume will remain on the uranium plume maps in the Plant 6 Area until direct-push samples can be collected from the area next to Monitoring Well 2389 to document that no FRL exceedances are present through a vertical profile of the aquifer.

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South Field and South Plume Areas – In addition to uranium concentration data collected in 2003 from the monitoring well network, 25 different locations were sampled using direct-push methods (six locations in the South Field, seven locations along Willey Road, and 12 locations in the off-property South Plume).

Data collected in 2003 indicate that uranium concentrations continue to decrease in the South Field and South Plume Areas in response to remediation activities. Six direct-push sampling locations in the South Field were revisited in 2003 to measure changes in uranium concentrations. The results document that uranium concentrations have decreased at the sampling locations. The most dramatic decrease was just north of Willey Road where the measured uranium concentration between 1996 and 2003 dropped 488 µg/L in response to pumping and re-injection. Direct-push sampling at 12 locations in the off-property South Plume reveals that uranium concentrations for most of the area are now below 100 µg/L.

Appendix A, Attachment A.2, of this report provides individual monitoring well total uranium results and detailed uranium plume maps for 2003. Appendix A, Attachment A.3, of this report provides quarterly groundwater elevation maps and capture zone interpretations, along with graphical displays of groundwater elevation data.

3.3.1.7 Monitoring Results for Non-Uranium Constituents

Although the enhanced groundwater remedy is primarily targeting remediation of the uranium plume, other FRL constituents contained within the uranium plume are also being monitored. Figure 3-10 identifies the locations of the wells that had non-uranium FRL exceedances , and Table 3-2 summarizes the results of monitoring for non-uranium FRL exceedances. Table 3-2 shows the number of wells exceeding the FRL in 2003; the number of wells exceeding the FRL outside the 10-year, time-of-travel remediation footprint; the groundwater FRL; and the range of 2003 data inside or outside the 10-year, time-of-travel remediation footprint.

TABLE 3-2
NON-URANIUM CONSTITUENTS WITH RESULTS ABOVE FINAL REMEDIATION LEVELS DURING 2003

Constituent	Number of Wells Exceeding the FRL	Number of Wells Exceeding the FRL Outside the 10-Year, Time-of-Travel Remediation Footprint	Groundwater FRL	Range of 2003 Data Inside the 10-Year, Time-of-Travel Remediation Footprint[a]	Range of 2003 Data Outside the 10-Year, Time-of-Travel Remediation Footprint[a]
General Chemistry			**(mg/L)**	**(mg/L)**	**(mg/L)**
Nitrate/Nitrite	3	0	11[b]	17.5 to 90.5	NA
Inorganics					
Antimony	3	3	0.0060	NA	0.00601 to 0.00629
Manganese	5	3	0.90	1.01 to 2.7	0.973 to 1.57
Molybdenum	1	0	0.10	0.422 to 0.494	NA
Zinc	4	4	0.021	NA	0.0215 to 0.0397
Volatile Organics			**(µg/L)**	**(µg/L)**	**(µg/L)**
Trichloroethene	1	0	5.0	41.7 to 62.4	NA
Radionuclides			**(pCi/L)**	**(pCi/L)**	**(pCi/L)**
Technetium-99	3	0	94	111 to 940	NA

[a]NA = not applicable

[b]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4; however, the sampling results are for nitrate/nitrite.

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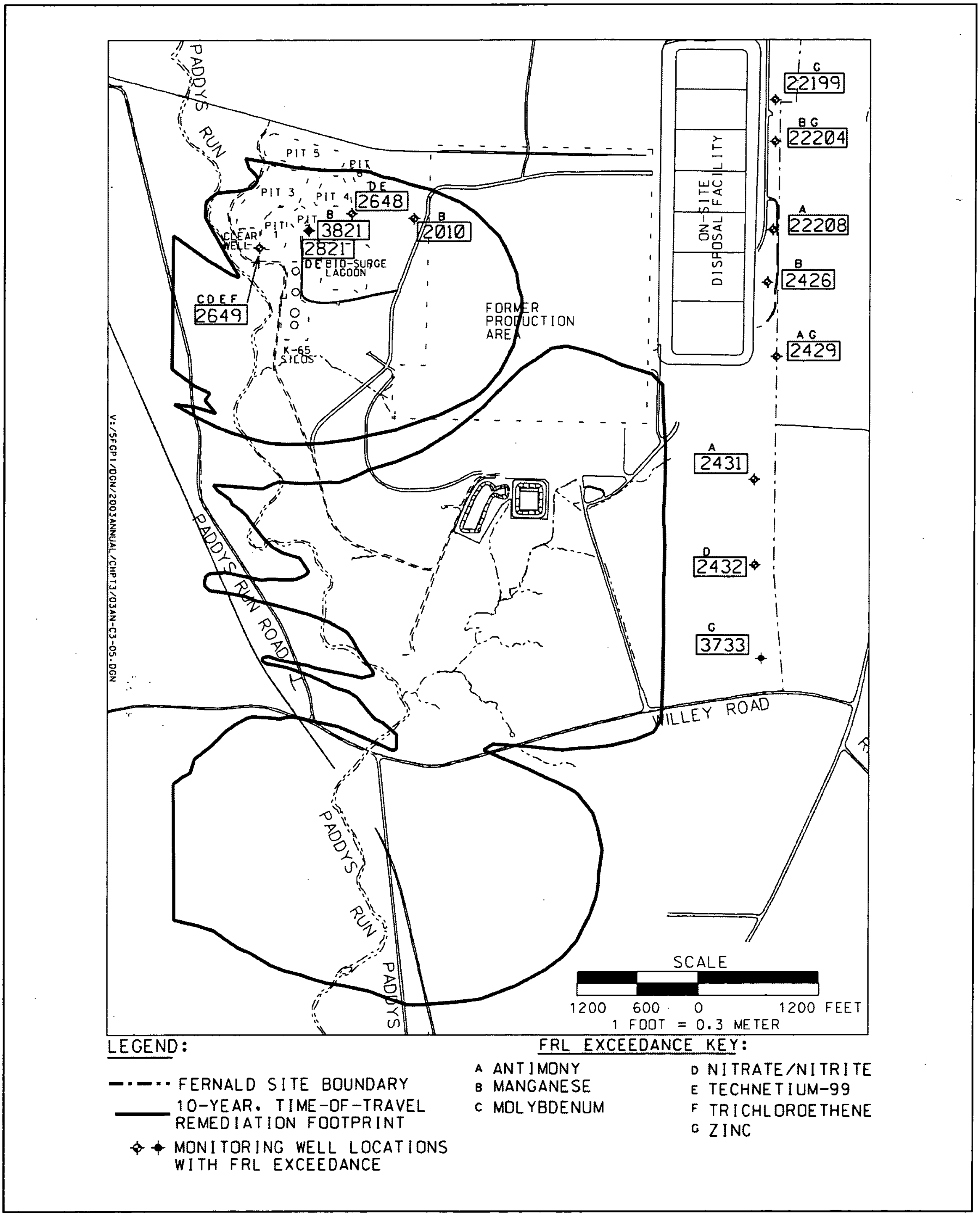

Figure 3-10. Non-Uranium Constituents with 2003 Results Above Final Remediation Levels

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During 2003 non-uranium FRL exceedances were observed at 13 monitoring well locations as shown in Figure 3-10. A total of seven non-uranium FRL constituents exceeded FRLs in 2003. The Waste Storage Area exceedances will be further evaluated in the design of the Waste Storage Area (Phase II) Module. The exceedance locations along the eastern Fernald site boundary are outside the 10-year, time-of-travel remediation footprint. No plumes for the above-FRL constituents at the locations outside the 10-year, time-of-travel remediation footprint were identified in the extensive groundwater characterization efforts evaluated as part of the Remedial Investigation Report for Operable Unit 5 (DOE 1995c).

The constituents with FRL exceedances at the well locations outside the 10-year, time-of-travel remediation footprint were further evaluated to determine whether they were random events or if they were persistent according to criteria discussed in Appendix A, Attachment A.4, of this report. Only one of the exceedances in 2003 was classified as persistent (manganese at Monitoring Well 2426). All constituents formerly having persistent exceedances are no longer considered persistent since exceedances have not continued with subsequent sampling. Appendix A, Attachment A.4, of this report provides detailed information on non-uranium FRL exceedances and the persistence of these exceedances.

3.3.2 Other Monitoring Commitments

Two other groundwater monitoring activities are included in the IEMP:

- Private well monitoring
- Property boundary monitoring

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

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

The availability of the public water supply resulted in the plugging and abandonment of many private wells in the affected off-property areas where groundwater is being remediated. Data from the three private wells sampled under the IEMP were incorporated into the uranium plume map shown in Figure 3-9.

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During 2003 Property/Plume Boundary Monitoring was comprised of 38 monitoring wells located downgradient of the Fernald site, along the eastern and southern portions of the property boundary. Twenty-seven Type 2 and 3 wells were monitored along the eastern Fernald site boundary and slightly downgradient of the South Plume to determine if any contaminant excursions were occurring. Eleven Type 2 and 3 wells were monitored in the Paddys Run Road Site 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 2003 and were incorporated into the uranium plume maps shown Figure 3-9 and in Attachment A.2. Non-uranium data from these wells were included above in the section on monitoring results for non-uranium constituents.

Director's Findings and Orders were issued by OEPA on September 7, 2000. These orders specify that the site's groundwater monitoring activities will be implemented in accordance with the IEMP. The revised language allows modification of the groundwater monitoring program as necessary, via the IEMP revision process (subject to OEPA approval), without issuance of a new Director's Order. As determined by OEPA, the IEMP will remain in effect throughout the duration of remedial actions.

3.4 On-Site Disposal Facility Monitoring

Groundwater monitoring for the cells of the on-site disposal facility is conducted in the glacial till (perched water) and in the Great Miami Aquifer. Groundwater monitoring in support of the on-site disposal facility continued in 2003. This monitoring program is designed to accomplish the following:

- Establish a baseline of groundwater conditions in both the perched groundwater and the Great Miami Aquifer beneath each cell of the on-site disposal facility. The baseline data will be used to evaluate future changes in perched groundwater and Great Miami Aquifer groundwater quality to help determine if the changes are due to on-site disposal facility operations.
- Continue routine groundwater sampling following waste placement and cell capping as part of the comprehensive leak detection monitoring program for the on-site disposal facility. This information will be used to help verify the ongoing performance and integrity of the on-site disposal facility.

Table 3-3 summarizes the groundwater monitoring information associated with the on-site disposal facility. Table 3-3 also summarizes leachate collection system and leak detection system monitoring information. Sampling of the leachate collection system and the leak detection system is generally initiated after waste placement, while groundwater sampling is initiated before waste is placed in a particular cell. Table 3-3 provides information for Cells 1 through 6 along with sample information and range of total uranium concentrations. No constituents sampled to meet on-site disposal facility monitoring requirements exceeded groundwater FRL exceedances; however, several non-uranium constituents (antimony, manganese, and zinc), which are sampled to meet IEMP requirements exceeded their respective FRLs as identified in Section 3.3.1.7 (Monitoring Wells 22199, 22204, and 22208).

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TABLE 3-3

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

Cell (Waste Placement Start Date)	Monitoring Location	Monitoring Zone	Date Sampling Started	Total Number of Samples	Range of Total Uranium Concentrations[a] (µg/L)
Cell 1 (December 1997)	22201	Great Miami Aquifer	March 31, 1997	39	ND - 8.33
	22198	Great Miami Aquifer	March 31, 1997	58	0.557 - 11.5
	12338	Glacial Till	October 30, 1997	44	ND - 19
	12338C	Leachate Collection System	February 17, 1998	24	ND - 142.186
	12338D	Leak Detection System	February 18, 1998	23	1.5 - 23.2
Cell 2 (November 1998)	22200	Great Miami Aquifer	June 30, 1997	34	ND - 1.11
	22199	Great Miami Aquifer	June 25, 1997	35	ND- 12.1
	12339	Glacial Till	June 29, 1998	43	ND - 7.34
	12339C	Leachate Collection System	November 23, 1998	21	4.51 - 68.6
	12339D	Leak Detection System	December 14, 1998	21	8.69 - 71[b]
Cell 3 (November 1999)	22203	Great Miami Aquifer	August 24, 1998	32	ND - 7.92
	22204	Great Miami Aquifer	August 24, 1998	33	ND - 5.924
	12340	Glacial Till	July 28, 1998	36	ND - 29.3
	12340C	Leachate Collection System	October 13, 1999	18	9.27 - 83.7
	12340D	Leak Detection System	August 26, 2002	5	15.1 - 27.3
Cell 4 (November 2002)	22205	Great Miami Aquifer	November 5, 2001	20	0.446 - 19.7
	22206	Great Miami Aquifer	November 6, 2001	19	ND - 5.78
	12341	Glacial Till	February 26, 2002	15	4.89 - 7.91
	12341C	Leachate Collection System	November 4, 2002	3	4.41 - 55.1
	12341D	Leak Detection System	November 4, 2002	4	5.74 - 15.7
Cell 5 (November 2002)	22207	Great Miami Aquifer	November 6, 2001	19	ND - 4.48
	22208	Great Miami Aquifer	November 5, 2001	20	ND - 0.803
	12342	Glacial Till	February 26, 2002	16	10.3 - 21.1
	12342C	Leachate Collection System	November 4, 2002	5	3.39 - 97.5
	12342D	Leak Detection System	November 4, 2002	4	2.93 - 14.3
Cell 6 (November 2003)	22209	Great Miami Aquifer	December 16, 2002	13	ND - 2.38
	22210	Great Miami Aquifer	December 16, 2002	13	ND - 1.02
	12343	Glacial Till	March 14, 2003	10	ND - 10.9
	12343C	Leachate Collection System	October 27, 2003	2	8.03 - 78.6
	12343D	Leak Detection System	October 27, 2003	1	3.1

[a]ND = not detectable

[b]Data not considered representative of true leak detection system uranium concentrations in Cell 2 (December 14, 1998 through May 23, 2000 data set) due to malfunction in the Cell 2 leachate pipeline and the resultant mixing of individual flows.

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During 2002 the Technical Memorandum for establishing baseline groundwater conditions for Cells 1 through 3 was issued and approved by the OEPA and EPA. Data in the memorandum establish initial groundwater conditions to be compared with future sampling results as part of the leak detection data evaluation process. As part of the memorandum process, changes to the sampling protocol for Cells 1 through 3 were recommended. The new sampling protocol for these cells was approved and implemented in the second half of 2002. Additionally in 2003, baseline sampling for Cells 4, 5, and 6 continued in the Great Miami Aquifer wells.

Placement of contaminated soil and debris in Cell 1 concluded at the end of December 2000 (Cell 1 was 100 percent full), and cap material was placed on Cell 1 through November 2001. Placement of contaminated soil and debris in Cell 2 concluded at the end of October 2002 (Cell 2 was 100 percent full), and cap material was placed on Cell 2 through October 2003. In 2003 soil and debris placement continued in Cells 3, 4, and 5, and began in Cell 6 in November 2003. At the end of December 2003, Cell 3 was approximately 98 percent full, Cell 4 was approximately 55 percent full, Cell 5 was approximately 9 percent full, and Cell 6 was approximately 9 percent full. Based on 2003 on-site disposal facility leak detection flow monitoring data collected from Cells 1 through 5, the liner systems are performing within the specifications outlined in the approved cell design.

Figure 3-11 identifies the on-site disposal facility footprint and monitoring well locations for Cells 1 through 6. For additional information on the groundwater, leak detection and leachate sampling results for the on-site disposal facility, refer to Appendix A, Attachment A.5, of this report.

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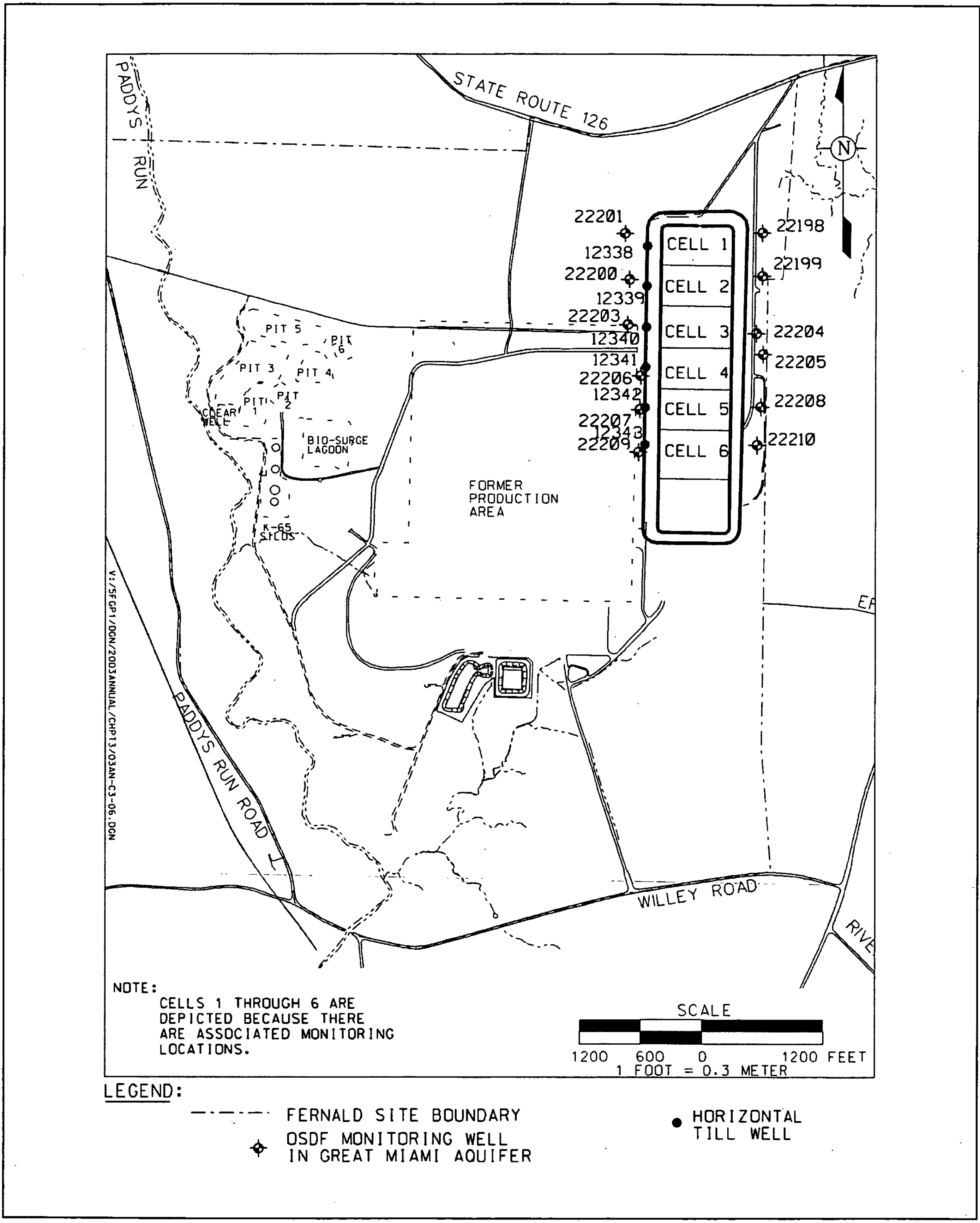

Figure 3-11. On-Site Disposal Facility Footprint and Monitoring Well Locations

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Chapter 4
Surface Water and Treated Effluent Pathway

4.0 Surface Water and Treated Effluent Pathway

Results in Brief: 2003 Surface Water and Treated Effluent Pathway

Surveillance Monitoring — No surface water or treated effluent analytical results from samples collected in 2003 exceeded the surface water FRL for total uranium, the primary site contaminant. FRL exceedances that may be attributable to the Fernald site were limited to one constituent and one location, while benchmark toxicity value (BTV) exceedances that may be attributable to the Fernald site were limited to one constituent at one location. Occasional, sporadic FRL and BTV exceedances are to be expected until site remediation is complete.

Uranium Discharges — In 2003, 562 pounds (255 kg) of uranium were discharged in treated effluent to the Great Miami River. Approximately 118 pounds (54 kg) of uranium were released to the environment through uncontrolled storm water runoff. The estimated total pounds of uranium released through the surface water and treated effluent pathway (approximately 681 pounds [308.7 kg]) increased 4.3 percent from the 2002 estimate.

Sediment — There were no FRL exceedances for any sediment result in 2003.

This chapter presents the 2003 monitoring activities and results for surface water, treated effluent, and sediment to determine the effects of remediation activities on the surface water pathway.

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

4.1 Summary of Surface Water and Treated Effluent Pathway

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

- **Controlled runoff** is contaminated storm water that is collected and, under normal circumstances, treated and discharged to the Great Miami River as treated effluent.
- **Uncontrolled runoff** is storm water that is not collected for treatment, but enters the site's natural drainages.
- **Treated effluent** is water from numerous sources at the site, which is treated through one of the site's wastewater treatment facilities, then discharged to the Great Miami River.
- **Surface water** is water that flows within natural drainage features.

The treated effluent pathway is comprised of those flows discharged to the Great Miami River via the Parshall Flume (PF 4001). Discharges through this point are considered under the control of wastewater operations. Under normal operation this combined flow is comprised of:

- Storm water runoff collected from the former production area and the waste pit area
- Treated and untreated groundwater from the South Plume, South Field, and Waste Storage Area Aquifer Restoration Modules
- Treated remediation wastewater, such as on-site disposal facility leachate, decontamination rinse water generated during building decontamination and dismantling activities, and wastewater generated from pit dewatering and the operation of the Waste Pits Project dryer facility
- Treated sanitary wastewater from the sewage treatment plant.

During periods of heavy and/or sequential rainfall events when the Storm Water Retention Basin is close to overflowing, untreated storm water is bypassed directly to the Great Miami River in order to minimize or prevent the Storm Water Retention Basin from overflowing into Paddys Run.

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The volume and flow rate of uncontrolled runoff depends on the amount of precipitation within any given period of time. Figure 1-10 in Chapter 1 shows monthly precipitation totals for 2003. Figure 4-1 shows the site's natural drainage features and defines the areas from which runoff is either controlled or uncontrolled. The site's natural surface water drainages include several tributaries to Paddys Run (e.g., Pilot Plant Drainage Ditch and Storm Sewer Outfall Ditch) as well as the northeast drainage that flows to the Great Miami River. The arrows on Figure 4-1 indicate the general flow direction of uncontrolled runoff that is determined from the topography. Uncontrolled runoff from the Fernald site leaves the property via two drainage pathways: Paddys Run and the northeast drainage.

4.2 Remediation Activities Affecting Surface Water Pathway

Major remediation activities in 2003 that affected (or had the potential to affect) the surface water pathway include:

- Construction activities associated with the on-site disposal facility including excavation, screening, and hauling activities in the on-site disposal facility borrow area
- Waste hauling and placement activities associated with the on-site disposal facility
- Soil excavation activities conducted by the Soil and Disposal Facility Project (refer to Chapter 2)
- Activities associated with the Waste Pits Project including dryer operation, pit excavation and waste material handling, and railcar loading
- Construction activities associated with the Accelerated Waste Retrieval; RCS; and Silos 1 and 2, and Silo 3 Projects.

To minimize the effects of remediation on the environment, engineered and administrative controls are used at the Fernald site to reduce the amount of sediment entering the surface water drainages during rainfall events. As water flows over soil, contaminants typically move with the water either by being adsorbed to sediment eroded from the land surface or dissolved in the water itself. The chosen sediment control method varies based on the contaminants expected during excavation, the topography of the area, and the size and duration of the excavation.

Engineered sediment controls can include the construction of sedimentation basins (lined or unlined), silt fences, check dams, and permanent or temporary seeding. Diversion ditches are also constructed as an engineered control to divert clean water from upgradient areas away from areas of remediation. Ditches are sometimes lined with riprap (large rocks) and/or synthetic liners to control erosion. Administrative controls include limiting the duration of open excavations, as well as routinely inspecting each of the engineered controls used.

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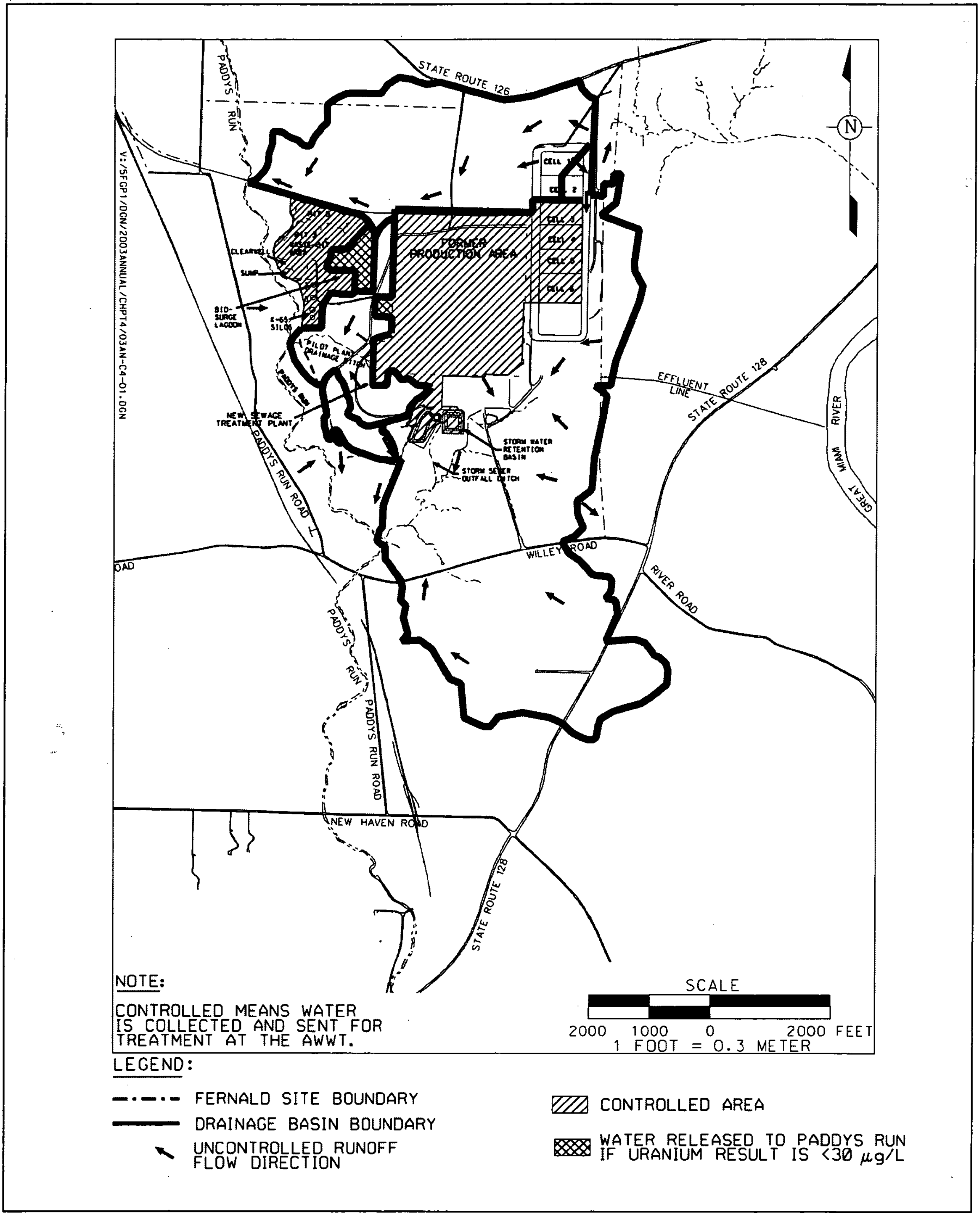

Figure 4-1. Controlled Surface Water Areas and Uncontrolled Runoff Flow Directions

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Each remediation project is responsible for constructing and maintaining the engineered control structures required under its remedial design. All engineered sediment and surface water controls are inspected at least once a week, and within 24 hours of any rain event measuring greater than 0.5 inch (1.3 cm) of rain in a 24-hour period. Discharge points for uncontrolled runoff to Paddys Run are also inspected periodically to assess the effectiveness of upgradient controls in preventing significant impacts to Paddys Run. Minor maintenance activities (e.g., silt fencing repairs and reseeding of eroded areas) were performed in 2003 as a result of these inspections. Though no new storm water controls were installed in 2003, many engineered controls installed during previous years were still used and maintained.

4.3 Surface Water, Treated Effluent, and Sediment Monitoring Program for 2003

Surface water, treated effluent, and sediment are sampled to determine the effect of the Fernald site's remediation activities on the environment. Surface water is sampled at several locations in the site's drainages and analyzed for various radiological and non-radiological constituents. Treated effluent is sampled prior to discharge into the Great Miami River. Sediment is sampled for radiological constituents in the major site drainages (i.e., Paddys Run and Storm Sewer Outfall Ditch), and in the Great Miami River.

Following is a description of the key elements of the surface water and treated effluent program design:

- **Sampling** – Sample locations, frequency, and constituents were selected to address the requirements of the NPDES Permit, FFCA, and the Operable Unit 5 Record of Decision, and to provide a comprehensive assessment of surface water quality at 16 key locations including two background locations (refer to Figures 4-2 and 4-3). Surface water is monitored for up to 55 FRL constituents (refer to Table 2-1 in Chapter 2) and three BTV constituents (barium, cadmium, and silver).
- **Data Evaluation** – The integrated data evaluation process focuses on tracking and evaluating data compared with background and historical ranges, FRLs, BTVs, and NPDES limits. This information is used to assess impacts on surface water due to site remediation activities affecting uncontrolled runoff or treated effluent. The assessment also includes identifying the potential for impacts from surface water to the groundwater in the underlying Great Miami Aquifer. The ongoing data evaluation is designed to support remedial action decision-making by providing timely feedback to the remediation project organizations on the effectiveness of storm water runoff controls and treatment processes.
- **Reporting** – Surface water and treated effluent data are reported under the IEMP program and annual site environmental reports. Monthly discharge monitoring reports required by the NPDES Permit are submitted to OEPA.

The IEMP sediment monitoring program includes an annual sampling program with data reported through annual site environmental reports.

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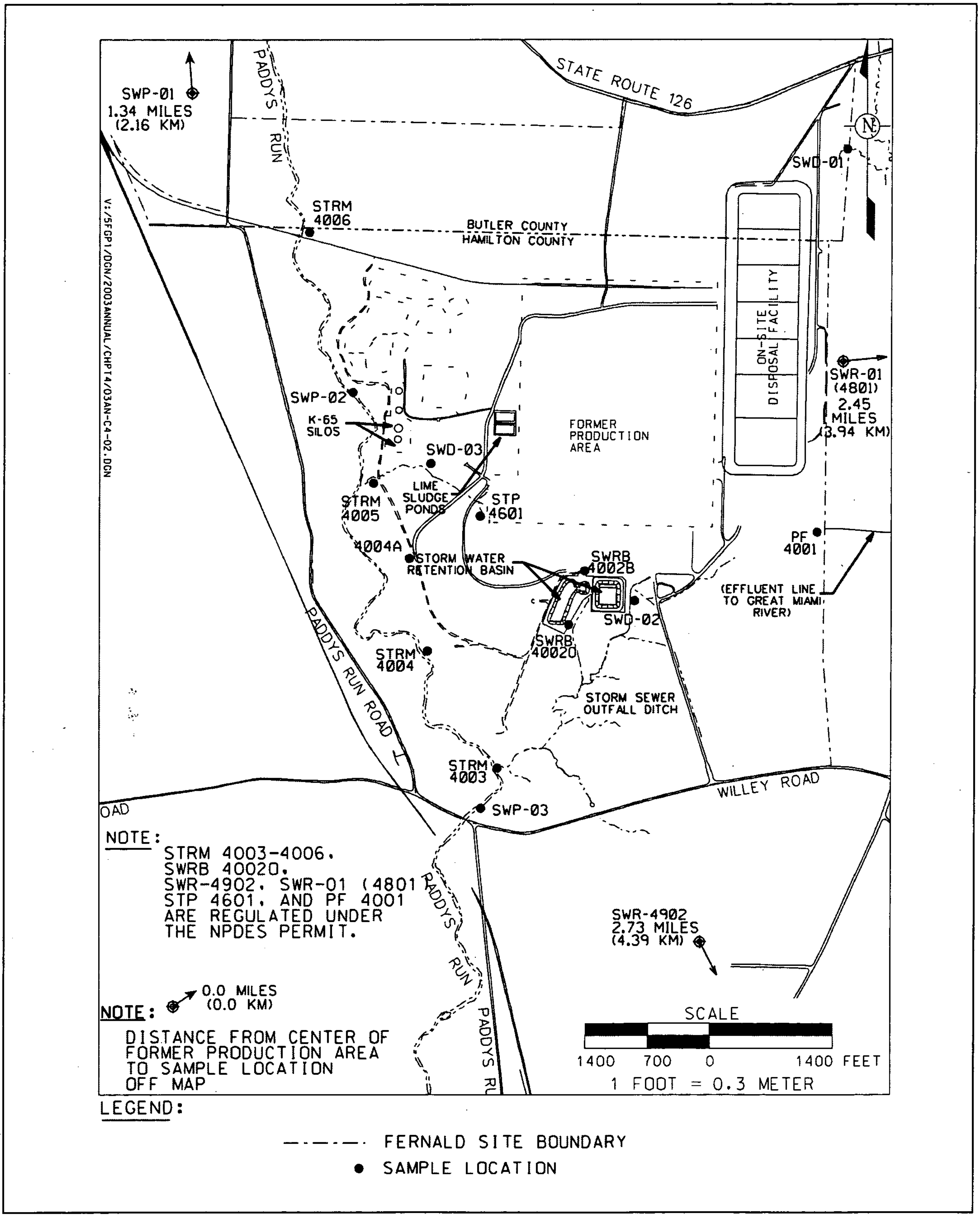

Figure 4-2. IEMP/NPDES Surface Water and Treated Effluent Sample Locations

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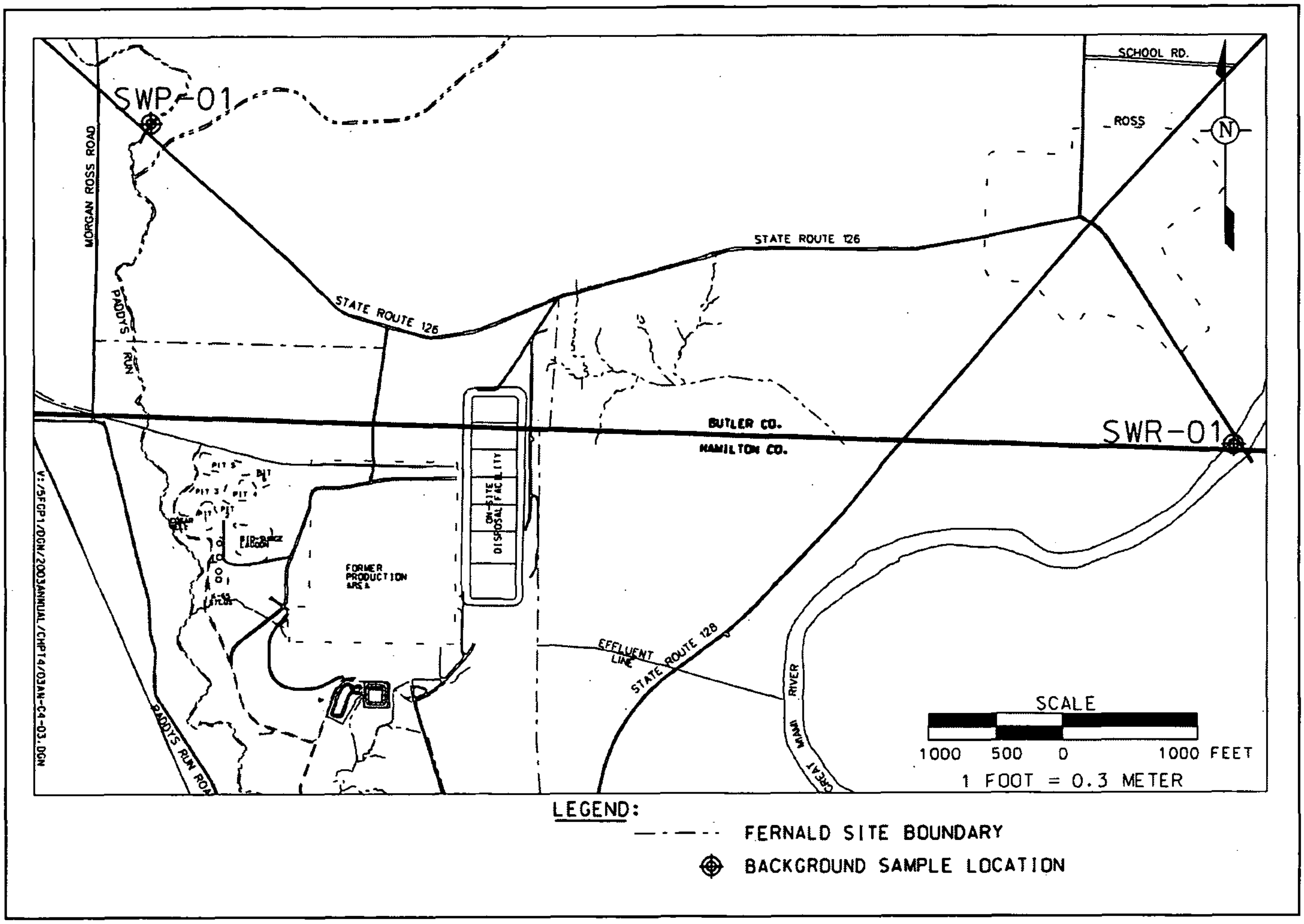

Figure 4-3. IEMP Background Surface Water Sample Locations

Data from samples collected under the IEMP are used to fulfill both surveillance and compliance monitoring functions. Surveillance monitoring results of the IEMP surface water and treated effluent program are used to assess the collective effectiveness of site storm water controls and wastewater treatment processes in preventing unacceptable impacts to the surface water and groundwater pathways. Compliance monitoring includes sampling at storm water and treated effluent discharge points into the surface water, and is conducted to comply with provisions in the NPDES Permit, the FFCA, and the Operable Unit 5 Record of Decision. The data are routinely evaluated to identify any unacceptable trends and to trigger corrective actions when needed to ensure protection of these critical environmental pathways. Figure 4-2 depicts IEMP/NPDES surface water and treated effluent sample locations, while Figure 4-3 shows IEMP background sample locations.

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Treated effluent is discharged to the Great Miami River through the effluent line identified on Figure 4-1. Samples of the treated effluent are collected at the Parshall Flume (PF 4001). The resulting data are used to calculate the concentration of each FRL constituent after the effluent water mixes with the water in the Great Miami River.

4.3.1 Surveillance Monitoring

Data resulting from 2003 sampling efforts were evaluated to provide surveillance monitoring of remediation activities. This evaluation showed that during 2003, there were no exceedances of the surface water total uranium FRL (530 µg/L) detected in any of the surface water and treated effluent samples. There were two non-uranium constituents with FRL exceedances, and one constituent with a BTV exceedance. Table 4-1 summarizes these exceedances and Figure 4-4 identifies the locations of these exceedances.

There was one FRL exceedance in 2003 at location SWP-01 for mercury. There were no BTV exceedances at this location. Locations SWP-01 (and SWR-01) are background monitoring locations, and are situated upstream and outside the influence of Fernald site discharges. The background data are used to distinguish impacts from site activities against upstream water quality conditions. Therefore, concentrations at the background locations (Great Miami River [SWR-01] and Paddys Run [SWP-01]) are not attributable to the Fernald site.

TABLE 4-1
CONSTITUENTS WITH RESULTS ABOVE SURFACE WATER FRLs OR BTVs DURING 2003

Constituent	Number of Locations Exceeding FRL	Number of Locations Exceeding BTV[a]	Surface Water FRL	Surface Water BTV[a]	Range of 2003 Data Above FRL[a]	Range of 2003 Data Above BTV[a]
Inorganics			(mg/L)	(mg/L)	(mg/L)	(mg/L)
Cadmium	0	1	0.0098	0.0035	NA	0.00679 to 0.0124[b]
Chromium	1	NA	0.010[c]	NA	0.0142	NA
Mercury	1	NA	0.00020	NA	0.000214	NA

[a]NA = not applicable
[b]The cadmium BTV exceedances in the Great Miami River for the Parshall Flume (PF 4001) occurred because the mixing equation uses the background number of 0.0098 mg/L, which is equal to the associated FRL and above the associated BTV.
[c]FRL based on hexavalent chromium, from Operable Unit 5 Record of Decision, Table 9-5. However, due to holding time considerations, total chromium is analyzed which is acceptable because total chromium provides a more conservative result.

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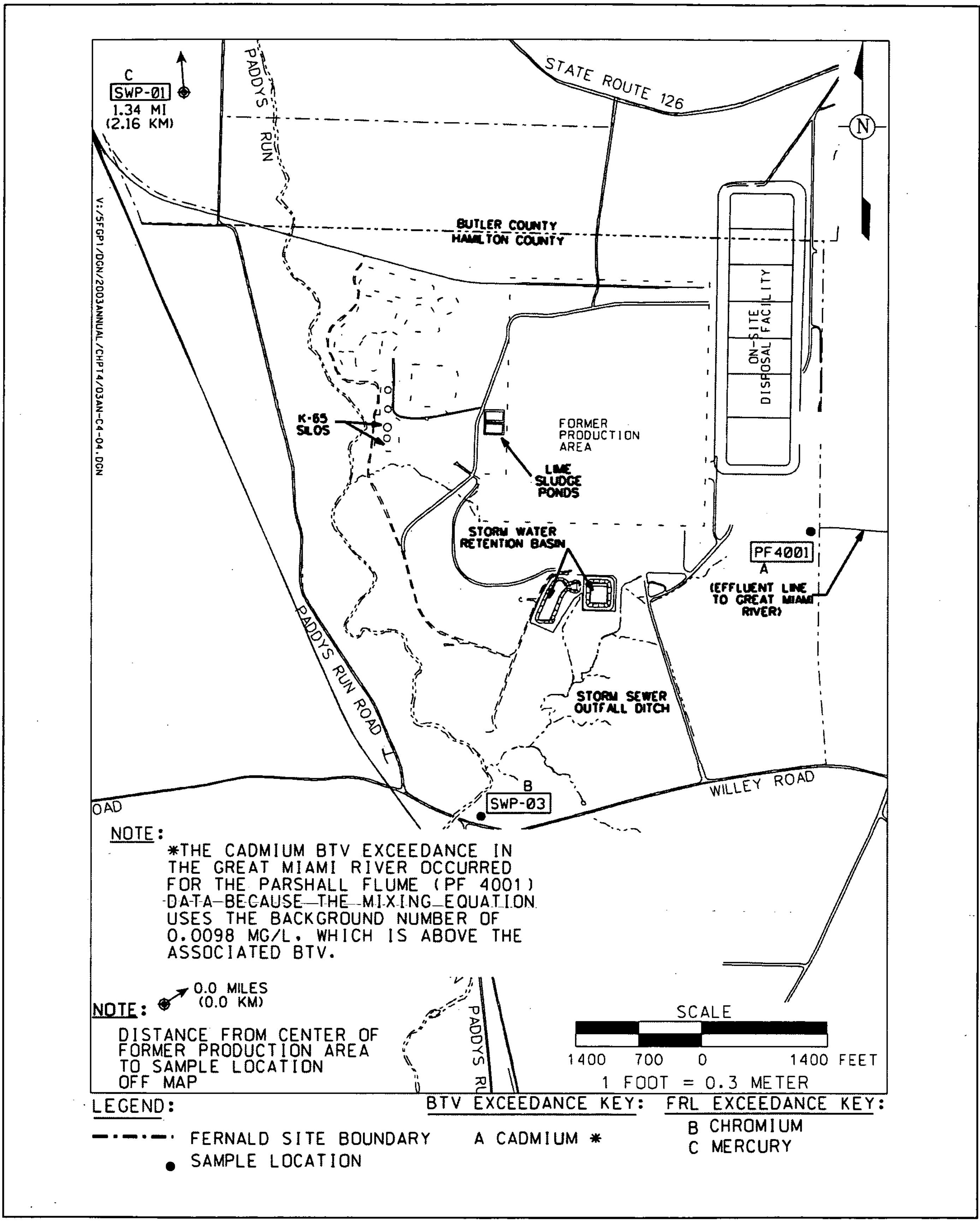

Figure 4-4. Constituents with 2003 Results Above FRLs or BTVs

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The remaining FRL and BTV exceedances, which may be attributable to Fernald site activities, were sporadic in nature and do not indicate any significant impacts to the environment or operational problems with the Fernald site's storm water and sediment control systems. There was one FRL exceedance at location SWP-03 for chromium and there were two exceedances of the cadmium BTV at the Parshall Flume (PF 4001), as discussed later in this chapter.

Even with the Fernald site's implementation of storm water and sediment controls, sporadic FRL and BTV exceedances can be expected until final remediation of contaminated source areas (soils and sediments) are complete. A Mann-Kendall statistical test for trend was run for each 2003 FRL exceedance at each location where the exceedance occurred. No statistically significant trends were identified with the exception of chromium at location SWP-03 which has been determined to be "up significantly." The FRL and BTV exceedances will continue to be evaluated for persistence and increasing trends through the IEMP sampling program throughout remediation. This information will be used to provide feedback to the remediation projects on the collective effectiveness of their storm water and sediment controls. Additional details of the FRL and BTV exceedances are presented in Appendix B, Attachment B.1, of this report.

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

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

Evaluation of the data from these locations is especially important because the locations represent points beyond which direct exposure to the public is possible.

As indicated previously, there was one FRL exceedance at location SWP-03 for chromium. The SWP-03 sampling location measures the cumulative drainage from the several drainage basins from Fernald site property as well as drainage from areas north of the Fernald site. No specific activity has been identified as a causal event. As noted previously, the FRL is actually based on hexavalent chromium (Operable Unit 5 Record of Decision, Table 9-5). However, due to holding time considerations, total chromium is analyzed which provides a more conservative result.

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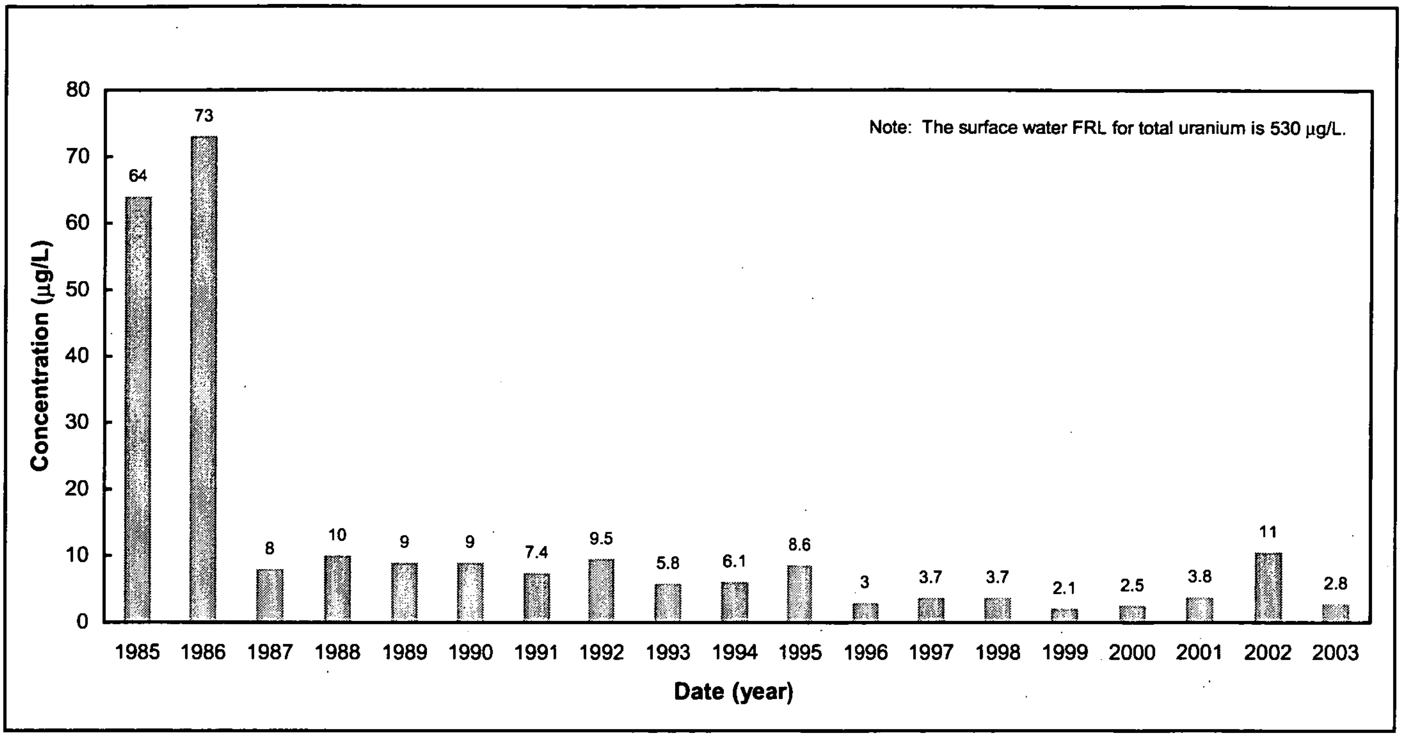

Figure 4-5. Annual Average Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03) Sample Location, 1985-2003

The maximum total uranium concentration at SWP-03 during 2003 was 3.7 µg/L, which is below the surface water total uranium FRL of 530 µg/L. Figure 4-5 shows the annual average total uranium concentration in Paddys Run at Willey Road for the period 1985 through 2003. This figure illustrates the decrease of the total uranium concentration in Paddys Run from 1986 following completion of the Storm Water Retention Basin, which collects contaminated storm water from the former production area.

Samples collected at the Parshall Flume (PF 4001) are used in the surveillance evaluation because this is the last point where treated effluent is sampled prior to discharge to the Great Miami River. Data collected from this location cannot directly be compared to the surface water FRL without considering the effect of the effluent waters mixing with the Great Miami River. This is done through the use of a mixing equation. After applying the mixing equation, there were no FRL exceedances at the Parshall Flume (PF 4001) but there were two BTV exceedances, for cadmium, as mentioned previously. The FRL for cadmium is based on the background number of 0.0098 mg/L (milligrams per liter), and the BTV is 0.0035 mg/L, which is lower than the FRL. The cadmium BTV exceedance in the Great Miami River occurred after using the mixing equation (from the Parshall Flume [PF 4001] data), but note that the mixing equation uses the background number which is above the associated BTV.

There were no surface water FRL exceedances for uranium in the Great Miami River outside the Fernald site mixing zone during 2003. The maximum daily total uranium concentration at the Parshall Flume (PF 4001) prior to discharge through the effluent line to the Great Miami River was 152.7 µg/L. After the water from the Parshall Flume (PF 4001) mixed with the water in the Great Miami River, the concentration would have been approximately 1.04 µg/L. Both concentrations, those from the Parshall Flume (PF 4001) and after mixing with the Great Miami River, were well below the surface water total uranium FRL of 530 µg/L. Contaminant concentrations observed at the Parshall Flume (PF 4001) in 2003 are discussed further in the compliance monitoring section.

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Evaluation of surface water data is also performed in order to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer. In areas where there is no glacial overburden, a direct pathway exists for contaminants to reach the aquifer. This contaminant pathway to the aquifer was considered in the design of the groundwater remedy, and 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. This includes locations SWP-02, SWD-02, SWD-03, STRM 4005, and the Storm Water Retention Basin overflow (SWRB 4002O).

During 2003 three of the five surface water locations evaluated (STRM 4005, SWRB 4002O, and SWD-03) had results that exceeded the total uranium groundwater FRL of 30 µg/L. Table 4-2 summarizes the total uranium cross-media exceedances. Of the locations evaluated, only SWD-03 had results that exceeded the groundwater FRL for a constituent other than uranium. The SWD-03 zinc results of 0.0996 mg/L and 0.0228 mg/L from samples collected on March 13 and April 21, 2003, respectively, exceeded the groundwater FRL for zinc of 0.021 mg/L.

TABLE 4-2
SURFACE WATER TOTAL URANIUM RESULTS EXCEEDING THE GROUNDWATER FRL AT CROSS-MEDIA IMPACT LOCATIONS DURING 2003

Location	Number of Surface Water Results Exceeding the Groundwater FRL for Total Uranium[a]	Total Number of Samples	Range of 2003 Data above FRL (µg/L)
STRM 4005	4	4	40.0 – 157.9
SWD-03	1	1	41.6
SWRB 4002O	1	1	309.3

[a]The surface water result is compared to the groundwater FRL of 30 µg/L for the purpose of evaluating potential cross-media impacts.

Under the IEMP, both surface water and groundwater data from monitoring wells will continue to be collected at these sensitive areas to address the cross-media concern. Additional details concerning the cross-media impacts are presented in Appendix B, Attachment B.1, of this report.

4.3.2 Compliance Monitoring

4.3.2.1 FFCA and Operable Unit 5 Record of Decision Compliance

The FCP is required to monitor treated effluent discharges at the Parshall Flume (PF 4001) for total uranium mass discharges and total uranium concentrations. This requirement is identified in the July 1986 FFCA and the Operable Unit 5 Record of Decision. The Operable Unit 5 Record of Decision requires treatment of effluent so that the mass of total uranium discharged to the Great Miami River through the Parshall Flume (PF 4001) does not exceed 600 pounds (272 kg) per year. The Operable Unit 5 Record of Decision and subsequent approval of the Explanation of Significant Differences also require that the monthly average total uranium concentration in the effluent must be at or below 30 µg/L.

The Operable Unit 5 Record of Decision allows the Fernald site to discharge water from the Storm Water Retention Basin directly to the Great Miami River during periods of heavy precipitation. This is allowed in order to reduce the possibility of an overflow condition for the Storm Water Retention Basin. An overflow condition has the potential to generate cross-media impacts as described above.

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To comply with the monthly average total uranium concentration limit during these types of bypasses, the FCP is allowed to deduct these uranium concentrations from the monthly average total uranium calculation at the Parshall Flume (PF 4001) for up to 10 significant precipitation bypass days per year. However, the mass of total uranium discharged during these 10 days per year is still considered in the total discharge mass in order to ensure the discharge limit of 600 pounds (272 kg) per year is not exceeded.

In addition to significant precipitation-related bypasses, the site is also allowed to bypass water from the Storm Water Retention Basin during certain scheduled wastewater treatment plant maintenance activities. These maintenance bypasses must be pre-approved by the regulatory agencies. The total uranium concentration in the discharge related to maintenance activities may be deducted from the monthly average calculation demonstrating compliance with the total uranium monthly average concentration limit. However, the mass of total uranium discharged during these maintenance bypasses is still considered in the total discharge mass to ensure the discharge limit of 600 pounds (272 kg) per year is not exceeded.

During 2003 there were four bypass events as a result of significant precipitation, and three bypass events for maintenance activities. (The storm water bypass event of May 11 through May 12 occurred during an approved maintenance outage.) Table 4-3 summarizes these Storm Water Retention Basin treatment bypass events during 2003. Figure 4-6 shows that the cumulative mass of total uranium discharged to the Great Miami River during 2003 was 562.44 pounds (255.3 kg), which is below the annual discharge limit of 600 pounds (272 kg). Figure 4-7 shows that the total uranium monthly average concentration limit was met every month during 2003.

TABLE 4-3
2003 SIGNIFICANT PRECIPITATION AND TREATMENT PLANT MAINTENANCE BYPASS EVENTS

Event	Duration (hours)	Number of Bypass Days[a]	Cumulative Number of Bypass Days	Total Uranium Discharge (lbs)	Total Water Discharged (M gal)
Significant Precipitation Bypasses				(to Great Miami River)	(to Great Miami River)
May 11 through May 12	47.42	NA[b]	NA[b]	12.5	1.84
June 14 through June 18	98.75	4	4	12.6	4.36
July 10 through July 12	50	2	6	10.6	2.92
September 2 through September 4	42	1	7	9.42	2.27
Treatment Plant Maintenance Bypasses[c]					
May 9 through May 19	264	11	11	36.72	18.56
June 9 through June 11	72	3	14	19.8	6.1
July 21 through July 23	72	3	17	17.15	6.29

[a]Days are counted according to the definition provided in the Operations and Maintenance Master Plan for the Aquifer Restoration/Wastewater Treatment Project.

[b]NA = not applicable. The May storm water bypass occurred during an approved scheduled maintenance bypass; therefore, the days do not count against the allowable 10 days.

[c]Typically during planned maintenance outages, pumping and treatment systems are taken off-line in stages and returned to service in stages. There were portions of all four days where pumping and/or treatment systems were off-line due to a major electrical outage for the Silos Project in support of office trailer relocation and to allow relocation of a power pole in preparation for the Silos 1 and 2 rail upgrade (EPA and OEPA were notified in advance of this scheduled outage). The information is provided for these four days in total.

Appendix B, Attachment B.1, of this report provides more detail on the bypass days deleted from the monthly average calculation to determine compliance with the monthly average total uranium concentration limit.

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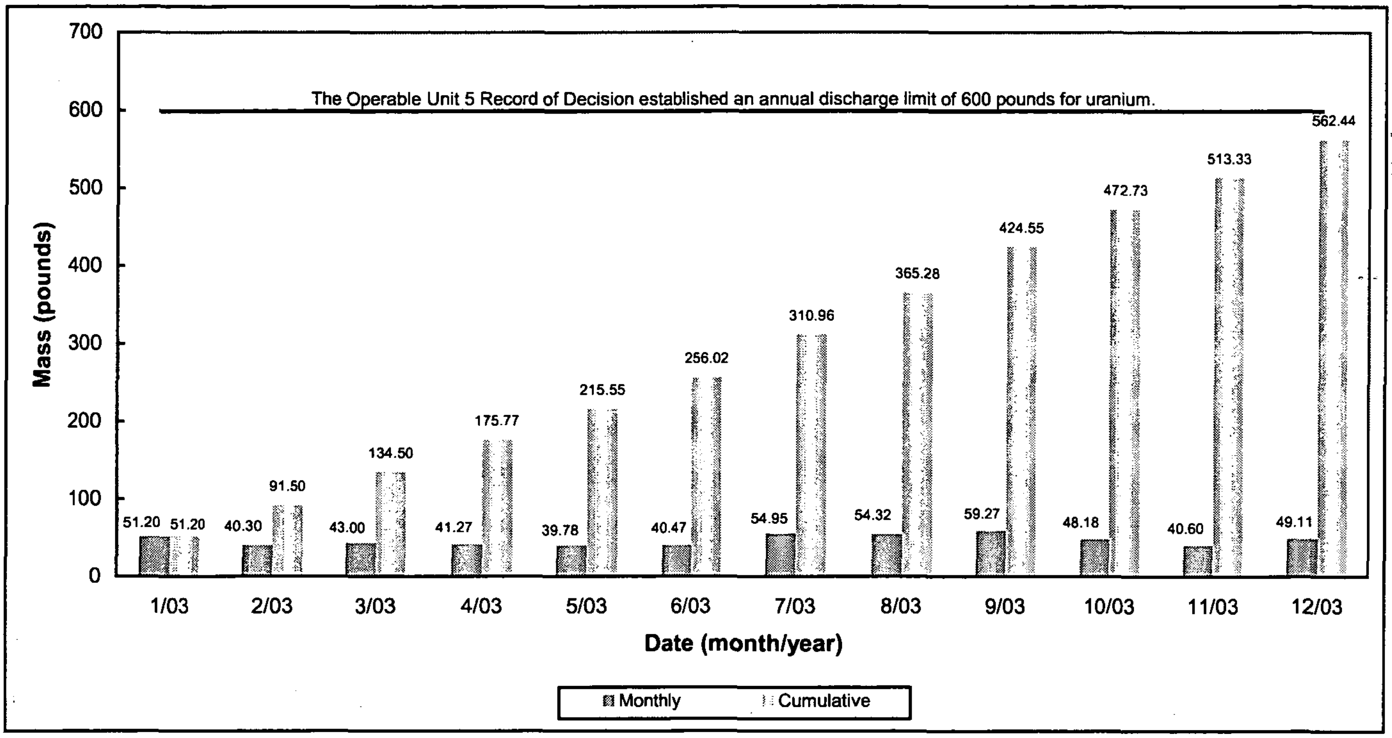
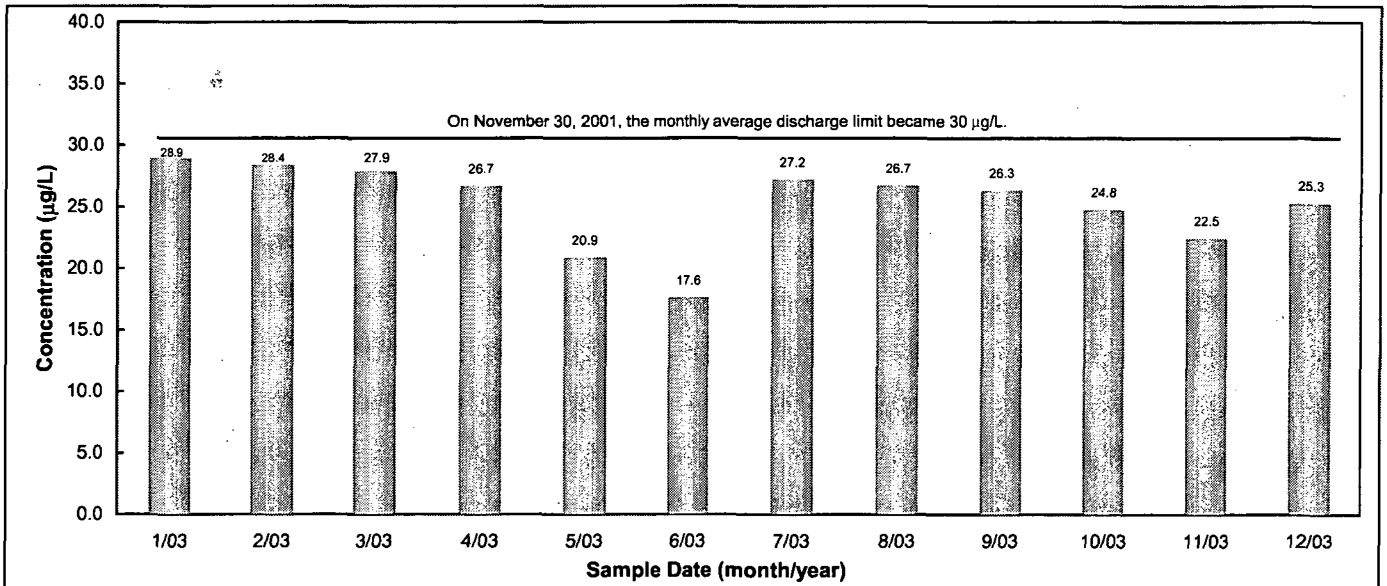


Figure 4-6. Pounds of Uranium Discharged to the Great Miami River from the Parshall Flume (PF 4001) in 2003



[a]The monthly average for May of 20.9 µg/L was calculated by accounting for eleven maintenance bypass days during maintenance activities that occurred from May 9 through May 19, 2003.
[b]The monthly average for June of 17.6 µg/L was calculated by accounting for four storm water bypass days during the storm water bypass event of June 14 through June 18 and three maintenance bypass days during maintenance activities from June 9 through June 11, 2003.
[c]The monthly average for July of 27.2 µg/L was calculated by accounting for two storm water bypass days during the storm water bypass event of July 10 through July 12 and three maintenance bypass days during maintenance activities from July 21 through July 23, 2003.
[d]The monthly average for September of 26.3 µg/L was calculated by accounting for one storm water bypass day which occurred during the storm water bypass event of September 2 through September 4, 2003.

Figure 4-7. 2003 Monthly Average Total Uranium Concentration in Water Discharged from the Parshall Flume (PF 4001) to the Great Miami River

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4.3.2.2 NPDES Permit Compliance

Compliance sampling, consisting of sampling for non-radiological pollutants from uncontrolled runoff and treated effluent discharges from the Fernald site, is regulated under the state-administrated NPDES program. The current permit became effective on July 1, 2003, and expires on June 30, 2008. The permit specifies discharge and sample requirements, as well as discharge limits for several constituents. Figure 4-2 identifies NPDES sample locations. A total of 16 non-compliances were reported to OEPA pursuant to the terms of the NPDES Permit, as summarized in Table 4-4.

TABLE 4-4

EXCEEDANCES OF THE NPDES PERMIT DURING 2003

Date/ Month	Location	Parameter	Permit Limit	Actual Result	Possible Cause	Corrective Action
1/26	PF 4001 (Parshall Flume Treated Effluent)	Oil and Grease	105 kg/d	237.37 kg/d	Unknown	None. Continue to monitor and observe.
2/6	STP 4601 (Sewage Treatment Plant Effluent)	Total Suspended Solids	40 mg/L	146 mg/L	Low biological activity	None. Continue to monitor and observe.
2/11	STP 4601 (Sewage Treatment Plant Effluent)	Total Suspended Solids	40 mg/L	142 mg/L	Low biological activity	Addition of biological cultures
2/14	STP 4601 (Sewage Treatment Plant Effluent)	Total Suspended Solids	40 mg/L	76 mg/L	Low biological activity	Addition of biological cultures
2/17	STP 4601 (Sewage Treatment Plant Effluent)	Total Suspended Solids	40 mg/L	52 mg/L	Low biological activity	Addition of biological cultures
February	STP 4601 (Sewage Treatment Plant Effluent)	Total Suspended Solids (avg.)	20 mg/L	64.5 mg/L	Low biological activity	Addition of biological cultures
3/17	PF 4001 (Parshall Flume Treated Effluent)	Oil and Grease	10 mg/L	10.6 mg/L	Unknown	None. Continue to monitor and observe.
3/17	PF 4001 (Parshall Flume Treated Effluent)	Oil and Grease	105 kg/d	208.2 kg/d	Unknown	None. Continue to monitor and observe.
March	STP 4601 (Sewage Treatment Plant Effluent)	Total Suspended Solids (avg.)	20 mg/L	27 mg/L	Fluctuating ambient temperatures	None. Continue to monitor and observe.
4/23	PF 4001 (Parshall Flume Treated Effluent)	Oil and Grease	10 mg/L	12.8 mg/L	Unknown	None. Continue to monitor and observe.
4/23	PF 4001 (Parshall Flume Treated Effluent)	Oil and Grease	105 kg/d	276.1 kg/d	Unknown	None. Continue to monitor and observe.
6/11	STP 4601 (Sewage Treatment Plant Effluent)	Fecal Coliform	2000 colonies/ 100 mL	31,875	Malfunction of ultraviolet (UV) disinfection units	Cleaned and repaired UV units
6/15	SWRB 4002O (Storm Water Retention Basin Overflow)	Total Suspended Solids	50 mg/L	112 mg/L	Storm Water Bypass	None. Continue to monitor and observe.
6/24	PF 4001 (Parshall Flume Treated Effluent)	Oil and Grease	105 kg/d	164.2 kg/d	Unknown	None. Continue to monitor and observe.
June	STP 4601 (Sewage Treatment Plant Effluent)	Total Suspended Solids (avg.)	20 mg/L	20.65	Unknown	None. Continue to monitor and observe.
8/18	STP 4601 (Sewage Treatment Plant Effluent)	Total Suspended Solids	40 mg/L	43 mg/L	Low biological activity	Addition of biological cultures

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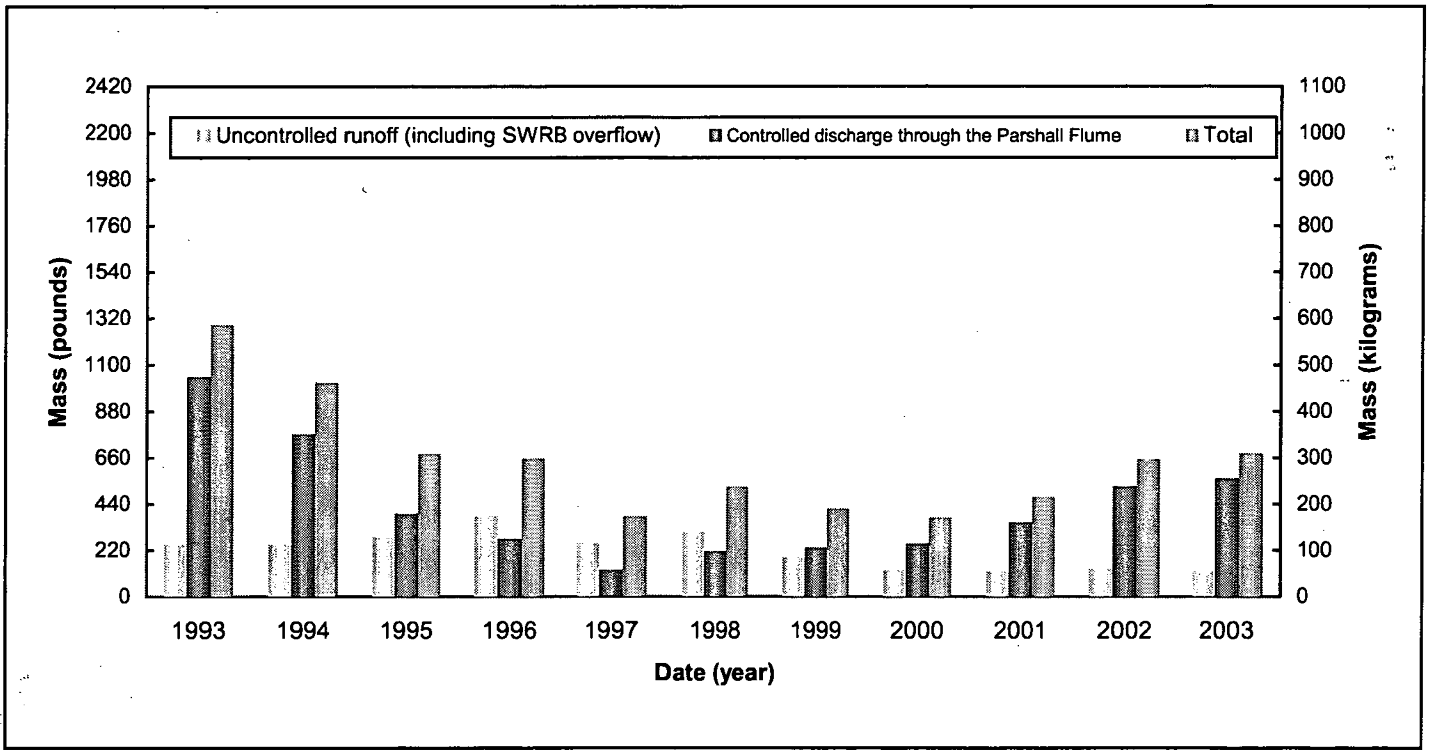

Figure 4-8. Uranium Discharged Via the Surface Water Pathway, 1993-2003

4.3.3 Uranium Discharges in Surface Water and Treated Effluent

As identified in Figure 4-6, 562.44 pounds (255.3 kg) of uranium in treated effluent were discharged to the Great Miami River through the Parshall Flume (PF 4001) in 2003. In addition to the treated effluent, uncontrolled runoff is also contributing to the amount of uranium entering the environment. Figure 4-8 presents the pounds of uranium from the uncontrolled runoff and controlled discharges from 1993 through 2003.

Beginning in 1999, estimates of uncontrolled runoff have been calculated using a loading term of 2.6 pounds (1.2 kg) of uranium discharged to Paddys Run for every inch (2.54 cm) of rainfall. This term was revised in 1999 based on analytical data reflecting the decreasing total uranium concentrations measured at points discharging to Paddys Run. Total uranium concentrations have been decreasing due to significant improvements in the capture of contaminated storm water by the Pilot Plant Drainage Sump, southern waste unit source removal, and excavation and placement of contaminated soils into the on-site disposal facility.

During 2003, 44.66 inches (113.4 cm) of precipitation fell at the Fernald site; therefore, an estimated 116.12 pounds (52.7 kg) of uranium entered the environment through uncontrolled runoff. In addition, the Storm Water Retention Basin experienced one overflow during 2003. On June 15, 2003 approximately 835,000 gallons overflowed which resulted in approximately 2.15 pounds (0.98 kg) of uranium being discharged to the environment. Therefore, a total of 118.27 pounds (53.7 kg) of uranium was discharged through uncontrolled runoff.

The estimated total amount of uranium discharged to the surface water pathway for the year, including both controlled treated effluent discharges and uncontrolled runoff, was approximately 680.71 pounds (309 kg).

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4.4 Sediment Monitoring

Sediment is a secondary exposure pathway and is monitored annually to assess the impact of remediation activities on sediments deposited along surface water drainages. Sediment is collected at strategic locations to ensure that the most recently deposited sediment is collected.

Sediment samples were collected in December 2003 at 16 locations along Paddys Run, the Storm Sewer Outfall Ditch, and the Great Miami River (refer to Figure 4-9). All of these samples were analyzed for total uranium. Samples collected from the Storm Sewer Outfall Ditch, Paddys Run, and the Paddys Run background location were also analyzed for radium-226, radium-228, thorium-228, thorium-230, and thorium-232.

Figure 4-9 illustrates specific sediment sample locations, summarized as follows:

- Storm Sewer Outfall Ditch – Five samples collected along the Storm Sewer Outfall Ditch from its confluence with Paddys Run to immediately south of the Storm Water Retention Basin (D1 through D5).
- Paddys Run – Five samples collected upstream (north) of the confluence with the Storm Sewer Outfall Ditch (PN1 through PN5), three samples collected down stream (south) of the confluence (PS1 through PS3), and one background sample collected upgradient (north) of the site (P1).
- Great Miami River – One sample collected north of the effluent line (background location, G2) and one sample collected south of the effluent line (G4).

Table 4-5 presents analytical results of samples collected from the Storm Sewer Outfall Ditch, Paddys Run, and the Great Miami River in 2003. Results for all constituents were below their respective sediment FRLs. Additionally, results were consistent with data collected in previous years with the exception of one thorium-230 result from Paddys Run just above the Storm Sewer Outfall Ditch confluence (new maximum of 13.6 pCi/g versus the sediment FRL of 18,000 pCi/g).

Until final certification of the site's drainage ways, monitoring of sediment will continue under the IEMP or the soil/sediment characterization and excavation program to determine the effectiveness of the engineered controls designed to reduce erosion from the Fernald site, and sedimentation of Paddys Run and its tributaries. Appendix B, Attachment B.2, of this report contains additional details of the sediment monitoring results.

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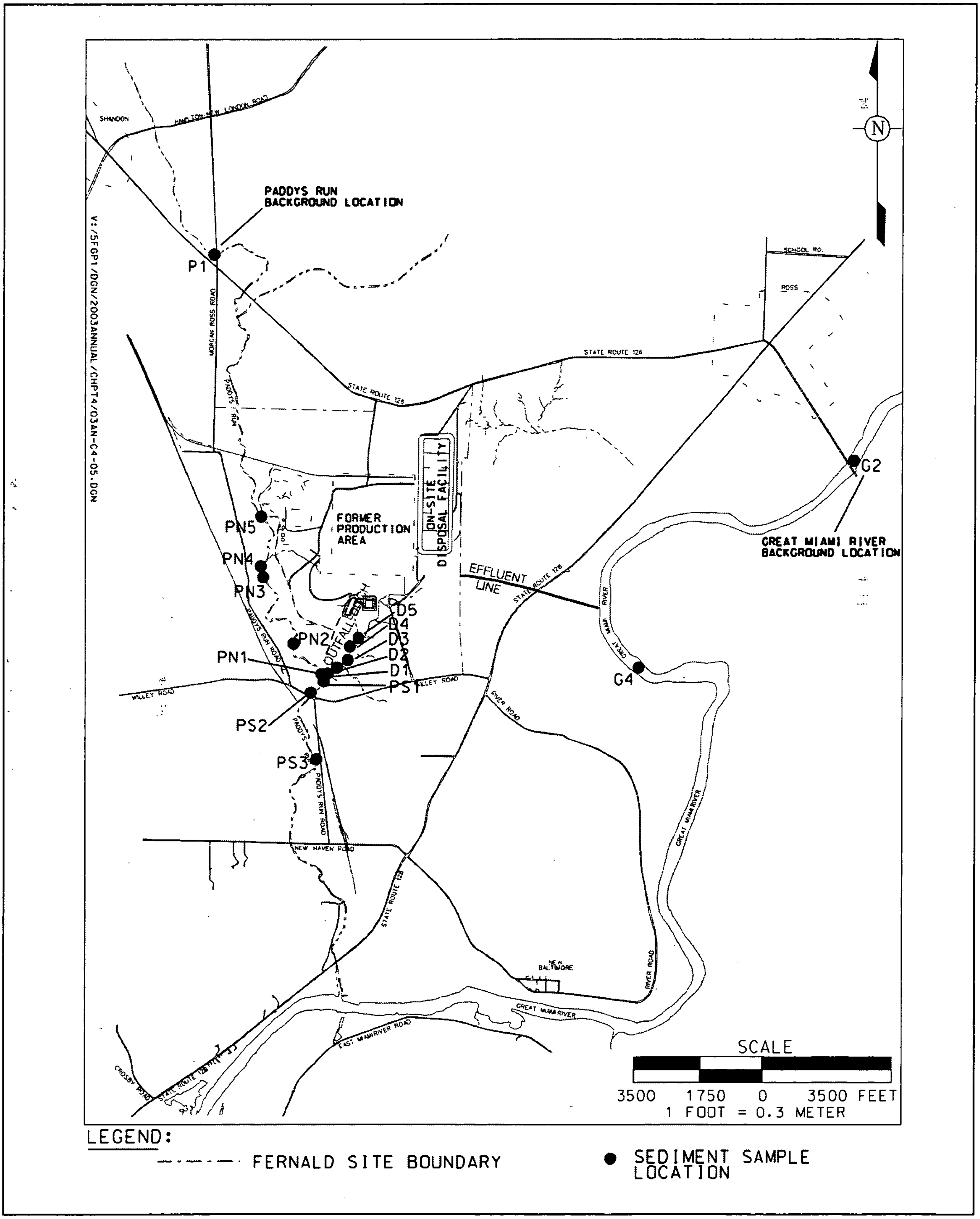

Figure 4-9. 2003 Sediment Sample Locations

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TABLE 4-5

2003 SUMMARY STATISTICS FOR SEDIMENT MONITORING PROGRAM

			2003 Results - Concentration (dry weight)			
		No. of	Minimum[a,b,c,d]		Maximum[a,b,c]	
Radionuclide	Sediment FRL	Samples[a]	(pCi/g)	(mg/kg)	(pCi/g)	(mg/kg)
Great Miami River, North of the Effluent Line (G2)						
Total Uranium	210 mg/kg	1	0.288	(0.426)	NA	NA
Great Miami River, South of the Effluent Line (G4)						
Total Uranium	210 mg/kg	1	1.90	(2.81)	NA	NA
Paddys Run Background, North of S.R. 126 (P1)						
Radium-226	2.9 pCi/g	1	0.717	NA	NA	NA
Radium-228	4.8 pCi/g	1	0.437	NA	NA	NA
Thorium-228	3.2 pCi/g	1	0.416	NA	NA	NA
Thorium-230	18,000 pCi/g	1	0.000	NA	NA	NA
Thorium-232	1.6 pCi/g	1	0.437	NA	NA	NA
Total Uranium	210 mg/kg	1	1.64	(2.43)	NA	NA
Paddys Run, North of the Storm Sewer Outfall Ditch (PN1-PN5)						
Radium-226	2.9 pCi/g	5	0.481	NA	0.871	NA
Radium-228	4.8 pCi/g	5	0.416	NA	0.602	NA
Thorium-228	3.2 pCi/g	5	0.428	NA	0.620	NA
Thorium-230	18,000 pCi/g	5	0.000	NA	13.6	NA
Thorium-232	1.6 pCi/g	5	0.416	NA	0.602	NA
Total Uranium	210 mg/kg	5	1.66	(2.46)	3.28	(4.86)
Storm Sewer Outfall Ditch (D1-D5)						
Radium-226	2.9 pCi/g	5	0.699	NA	0.809	NA
Radium-228	4.8 pCi/g	5	0.340	NA	0.496	NA
Thorium-228	3.2 pCi/g	5	0.342	NA	0.495	NA
Thorium-230	18,000 pCi/g	5	0.000	NA	0.296	NA
Thorium-232	1.6 pCi/g	5	0.340	NA	0.496	NA
Total Uranium	210 mg/kg	5	0.317	(0.468)	6.27	(9.28)
Paddys Run, South of the Storm Sewer Outfall Ditch (PS1-PS3)						
Radium-226	2.9 pCi/g	3	0.610	NA	0.677	NA
Radium-228	4.8 pCi/g	3	0.327	NA	0.513	NA
Thorium-228	3.2 pCi/g	3	0.316	NA	0.519	NA
Thorium-230	18,000 pCi/g	3	0.000	NA	0.000	NA
Thorium-232	1.6 pCi/g	3	0.327	NA	0.513	NA
Total Uranium	210 mg/kg	3	0.292	(0.432)	0.476	(0.705)

[a]If more than one sample is collected per sample location (e.g., split or duplicate), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum and maximum).
[b]If the number of samples is greater than or equal to two, then the minimum and maximum are reported. If the number of samples is equal to one, then the result is reported as the minimum.
[c]NA = not applicable
[d]Where concentrations are below the detection limit, each result used in the summary statistics is set at half the detection limit.

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Chapter 5
Air Pathway

5.0 Air Pathway

This chapter describes the air pathway monitoring program used to track and evaluate airborne emissions from the Fernald site. It includes a discussion of radiological air particulates, radon, direct radiation, and biota monitoring. In addition, this chapter provides a summary of radiological emissions from stacks and vents, as well as non-radiological emissions associated with the combustion of fossil fuel.

Results in Brief: 2003 Air Pathway

Radiological Air Particulates — Data collected from fenceline air monitoring stations show that average concentrations for each radionuclide monitored were less than 1 percent of the corresponding DOE-derived concentration guide.

Radon — There were no exceedances of the DOE standard (3 pCi/L annual average above background) at the site fenceline and off-property locations. The maximum annual average concentration at the FCP fenceline measured by continuous radon monitors was 0.3 pCi/L above background.

Direct Radiation — Direct radiation measurements decreased significantly at the site fenceline and the K-65 Silos boundary when compared to 2002. This was attributed to the operation of the RCS.

Boiler Plant — There were no opacity excursions reported during 2003.

Biota - Uranium results were less than detectable in 21 of 28 samples, with the remaining samples within historical ranges. Thorium-230 analyses also indicated results significantly less than 1 percent of the applicable standard. The results suggest there is no substantial impact from past or current FCP emissions on locally grown produce.

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

Monitoring the air pathway is critical to ensuring the continued protection of the public and the environment during the remediation process because airborne contaminants can potentially migrate beyond the Fernald site. The site's air monitoring approach (presented in the IEMP) provides an ongoing assessment of the collective emissions originating from remediation activities. The results of this assessment are used to provide feedback to remediation project organizations regarding the sitewide effectiveness of project-specific emission controls relative to DOE, EPA, and OEPA standards. In response to this feedback, project organizations modify or maintain emission controls.

5.1 Remediation Activities Affecting the Air Pathway

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

The following primary emission sources were active during 2003:

- Decontamination and demolition activities, most notably Plant 2/3 and Plant 8 (Operable Unit 3)
- Excavation of the waste pits and the associated waste processing and rail car load-out operations at the Waste Pits Project (Operable Unit 1)
- Excavation of contaminated soil and debris (Operable Unit 5)
- Construction activities associated with the on-site disposal facility including excavation, screening, and hauling activities in the on-site disposal facility borrow area (Operable Unit 2)
- Transportation and placement of contaminated material in the on-site disposal facility and interim storage at the on-site material transfer area (Operable Unit 2)
- Construction activities associated with the Silos Project (Operable Unit 4).

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Each project is responsible for designing and implementing engineered and administrative controls for each remediation activity. The fugitive emissions control policy mandates that fugitive emissions be visually monitored and controls be implemented as necessary. The following types of controls are used to keep point source and fugitive emissions to a minimum.

- **Engineered Controls** – Typical engineered controls include physical barriers, wetting agents, filtration, fixatives, sealants, dust suppressants and control, collection, and treatment systems. Engineered designs help reduce point source and fugitive emissions by using the best available technology. The selection of the best available technology for controlling project emissions is conducted during the design process and frequently includes the evaluation of several treatment alternatives.
- **Administrative Controls** – Typical administrative controls include management and control procedures; record keeping; periodic assessments; and established speed limits, control zones, and construction zones.

5.2 Air Monitoring Program Summary for 2003

The site's air monitoring program, as defined in the IEMP, is comprised of three distinct components:

- Radiological air particulate monitoring
- Radon monitoring
- Direct radiation monitoring.

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

- **Sampling** – Sample locations, frequency, and the constituents were selected to address DOE and EPA requirements for assessing radiological emissions from the Fernald site. Key considerations in the design of the sampling program included prevailing wind directions, location of potential sources of emissions, and the location of off-property receptors. The IEMP program includes monitoring radiological air particulates at 18 locations, radon measurements at 33 locations, and direct radiation at 37 locations on and off the property.
- **Data Evaluation** – The data evaluation process focuses on tracking and trending data against historical ranges and DOE, EPA, and OEPA standards. Each section in this chapter presents an evaluation of data and a comparison to applicable standards and guidelines.
- **Reporting** – All data are reported through the IEMP program and annual site environmental reports.

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5.3 Radiological Air Particulate Sampling Results

As described in the IEMP, Revision 3, a network of 18 high-volume air particulate monitoring stations is used to measure the collective contributions from all fugitive and point source particulate emissions from the site. The IEMP, Revision 3, differs from Revision 2 with regard to air monitoring because there was a reduction from two background air monitors to one background air monitor. The current monitoring network includes 16 monitoring locations on the fenceline and one background location. In addition, one thorium monitor was operated on the western fenceline. Figure 5-1 provides the locations of the IEMP air monitoring stations.

The sampling and analysis program for the 16 fenceline and background locations consists of biweekly total uranium and total particulate analyses, and monthly composites (eight times per year) for isotopic thorium analyses, in addition to a quarterly composite sample. The quarterly composite sample is analyzed for the expected major contributors (i.e., uranium, thorium, and radium) to the radiological air inhalation dose at the site's boundary. The thorium monitor includes biweekly particulate and monthly isotopic thorium analyses. Analytical data from this program are used to assess the effectiveness of the emission control practices throughout the year to ensure particulate emissions remain below health protective standards.

The radiological air particulate monitoring program is designed to demonstrate compliance with the following:

- NESHAP Subpart H requirements which stipulate that radionuclide emissions (not including radon) to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem in a year above background levels. This dose is reported in the annual NESHAP Subpart H compliance report and is included as Appendix D of this report.
- DOE Order 5400.5, Radiation Protection of the Public and Environment (DOE 1990b), guidelines for concentrations of radionuclides in air emissions. These guidelines, referred to as derived concentration guide values, are concentrations of radionuclides that, under conditions of continuous exposure for one year by one exposure mode (e.g., inhalation or ingestion), would result in a dose of 100 mrem to the public. These derived concentration guide values are not limits, but serve as reference values to assist in evaluating the radiological air particulate data.

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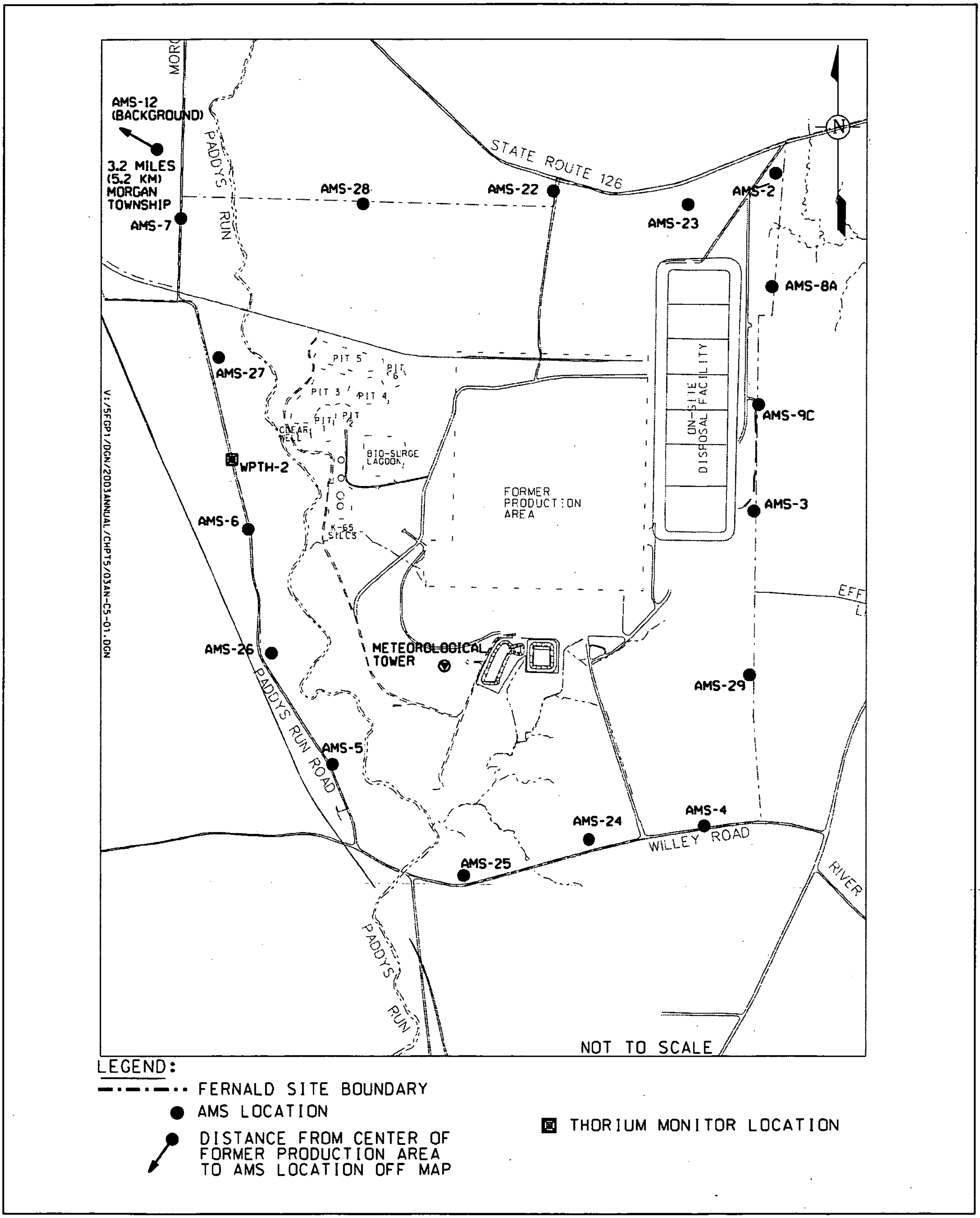

Figure 5-1. Radiological Air Monitoring Locations

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Table 5-1 presents a summary of the minimum, maximum, and average concentrations for total uranium, thorium-230, and total particulate in 2002 and 2003 based on the biweekly and monthly sample results used for monitoring air emission trends. For 2003 the annual average concentrations of total uranium at all fenceline air monitoring stations were less than 1 percent of the DOE derived concentration guide (DCG) value (0.1 picoCuries per cubic meter [pCi/m^3]). In 2003 total uranium at all air monitoring locations ranged from 3.3E-06 pCi/m^3 to a maximum concentration of 2.3E-03 pCi/m^3 at AMS-3. For comparison, the background location ranged from 3.2E-06 pCi/m^3 to 4.0 E-05 pCi/m^3.

TABLE 5-1

SUMMARY OF BIWEEKLY TOTAL URANIUM, TOTAL PARTICULATE, AND MONTHLY THORIUM-230 CONCENTRATIONS IN AIR

Location	2003 Total Uranium (pCi/m^3)	2002 Total Uranium (pCi/m^3)	2003 Total Particulate (µg/m^3)	2002 Total Particulate (µg/m^3)	2003 Thorium-230 (pCi/m^3)	2002 Thorium-230 (pCi/m^3)
Fenceline Locations						
Minimum	3.3E-06	0.0E+00	5	13	0.0E+00	0.0E+00
Maximum	2.3E-03	1.9E-03	124	94	2.1E-04	5.8E-04
Average	1.7E-04	1.1E-04	34	34	6.0E-05	6.2E-05
Background Locations						
Minimum	3.2E-06	0.0E+00	14	4	0.0E+00	0.0E+00
Maximum	4.0E-05	6.3E-05	48	100	3.6E-05	1.5E-04
Average	1.4E-05	1.8E-05	25	38	1.2E-05	1.1E-05

Biweekly thorium monitoring at the fenceline provides timely feedback on project engineered and administrative controls that are implemented to control fugitive emissions, primarily at the Waste Pits Project. The fenceline concentrations of thorium-230 (the primary thorium isotope of concern in the waste pit material being excavated) ranged from less-than-detectable to 2.1E-04 pCi/m^3, which was detected at AMS-3. For comparison, the background location ranged from less-than-detectable to 3.6E-05 pCi/m^3.

In addition to the total uranium and isotopic thorium analyses, total particulate measurements are also obtained from each filter every two weeks as summarized in Table 5-1. Total particulate concentrations at the fenceline ranged from 5 micrograms per cubic meter (µg/m^3) to a maximum of 124 µg/m^3 at AMS-26. There are no general or site-specific regulatory limits associated with total particulate measurements used in the data evaluation process.

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Total particulate, total uranium, and thorium-230 data were collectively evaluated to identify any increasing trends that may be related to remediation activities. Several temporary increases of these three constituents were observed at various monitoring locations; however, the short-lived increases did not pose a potential exceedance of the NESHAP dose limit of 10 mrem or DOE guidelines. The majority of increases in total uranium and thorium-230 concentrations were detected at some of the air monitoring stations on the eastern fenceline (AMS-3, AMS-8A, and AMS-9C) during 2003. Figures 5-2 and 5-3 show total uranium and thorium-230 concentrations, respectively, at the selected eastern fenceline locations. These temporary increases were due to the remediation activities associated with the Waste Pits Project, on-site disposal facility and its associated material transfer area, and decontamination and demolition activities. The radiological air particulate data are discussed with remediation project personnel to ensure that emission controls are operating as expected and to consider actions as necessary. Appendix C, Attachment C.1, of this report provides graphical displays of the 2003 total uranium, thorium-230, and total particulate data.

Quarterly composite air filter samples were formed from the biweekly samples at each IEMP air monitoring station during 2003 to determine the radiological air inhalation dose for each location. The samples were analyzed for isotopes of radium, thorium, and uranium. The quarterly results were used to track compliance with the NESHAP 10-mrem dose limit throughout the year and to demonstrate compliance with the limit at the end of 2003. The maximum dose associated with the quarterly composite results for 2003 was 0.82 mrem (compared to the 10-mrem limit) and occurred at AMS-9C. The composite results from the fenceline monitors show that, on average, thorium isotopes contribute 42 percent of the dose from 2003 airborne emissions. Isotopes of uranium and radium account for 39 and 2 percent of the dose, respectively. The higher percentage of dose from thorium isotopes is a result of thorium-230 becoming the major dose contributor through fugitive emissions from Waste Pits Project operations. Thorium-230 became the major dose contributor beginning in 2000 with the commencement of Waste Pits Project excavation activities. Given the methods required to excavate, transport, and process waste pit material, fugitive emissions were expected to increase the average concentration of thorium-230 at the fenceline. Although the project used several environmental compliance-based dust abatement practices and controls, some fugitive emissions were expected from the project based on the large-scale waste handling operations. Chapter 6 and Appendix D of this report provide more detailed information on the dose associated with the composite results.

The annual average radionuclide concentrations at each air monitoring station, as determined from the quarterly composite results, were compared to the DOE-derived concentration guide values. At each monitoring station, the annual average radionuclide concentrations were below 1 percent of the corresponding DOE-derived concentration guide values.

The WPTH-2 fenceline monitor was installed in late 1998 on the west property boundary to specifically monitor thorium emissions from the Waste Pits Project. Measured airborne concentrations of thorium-228 and thorium-232 were comparable to background concentrations throughout 2003. These fenceline data reflect that, in comparison to thorium-230, the concentrations of thorium-228 and thorium-232 in the waste pit material were relatively low in 2003. Appendix C, Attachment C.1, of this report provides graphical displays of the isotopic thorium data from the WPTH-2 monitor.

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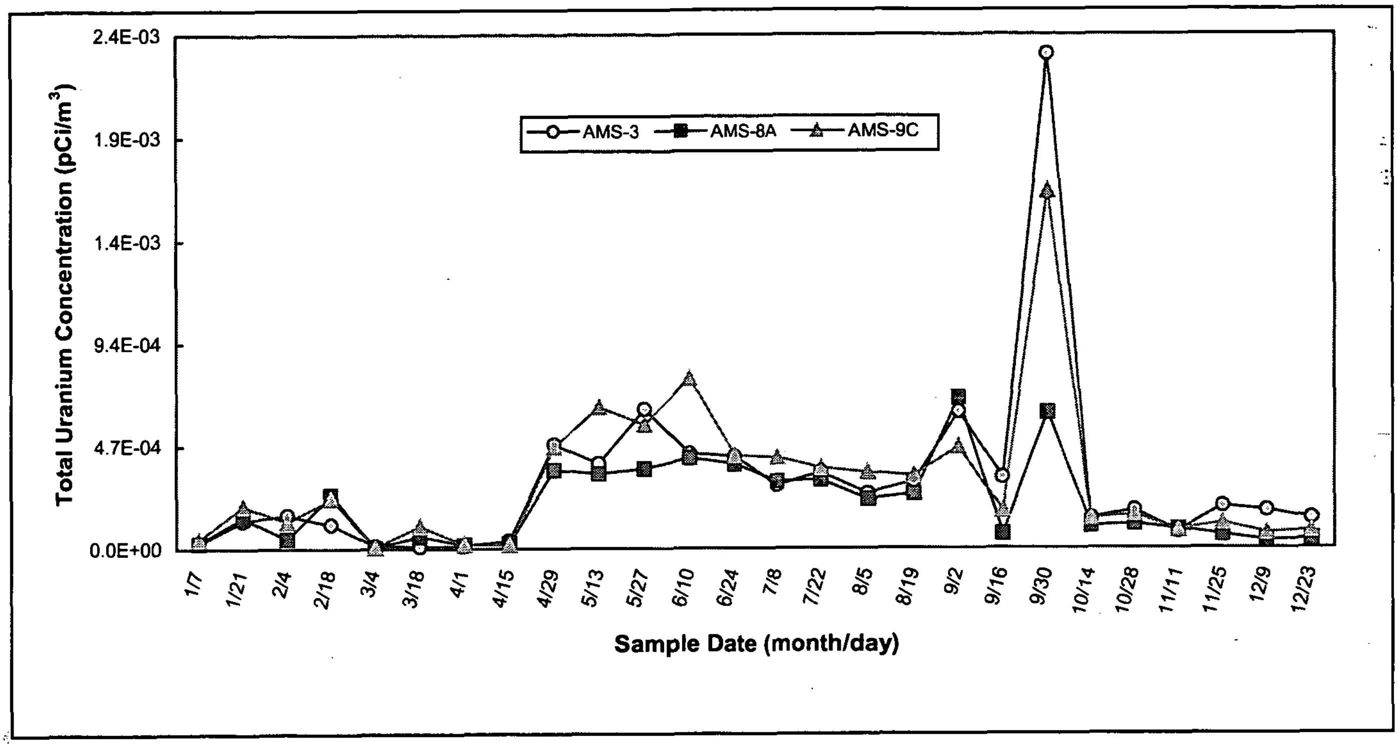

Figure 5-2. 2003 Total Uranium Concentrations in Air at Selected East Fenceline Monitors (AMS-3, AMS-8A, and AMS-9C)

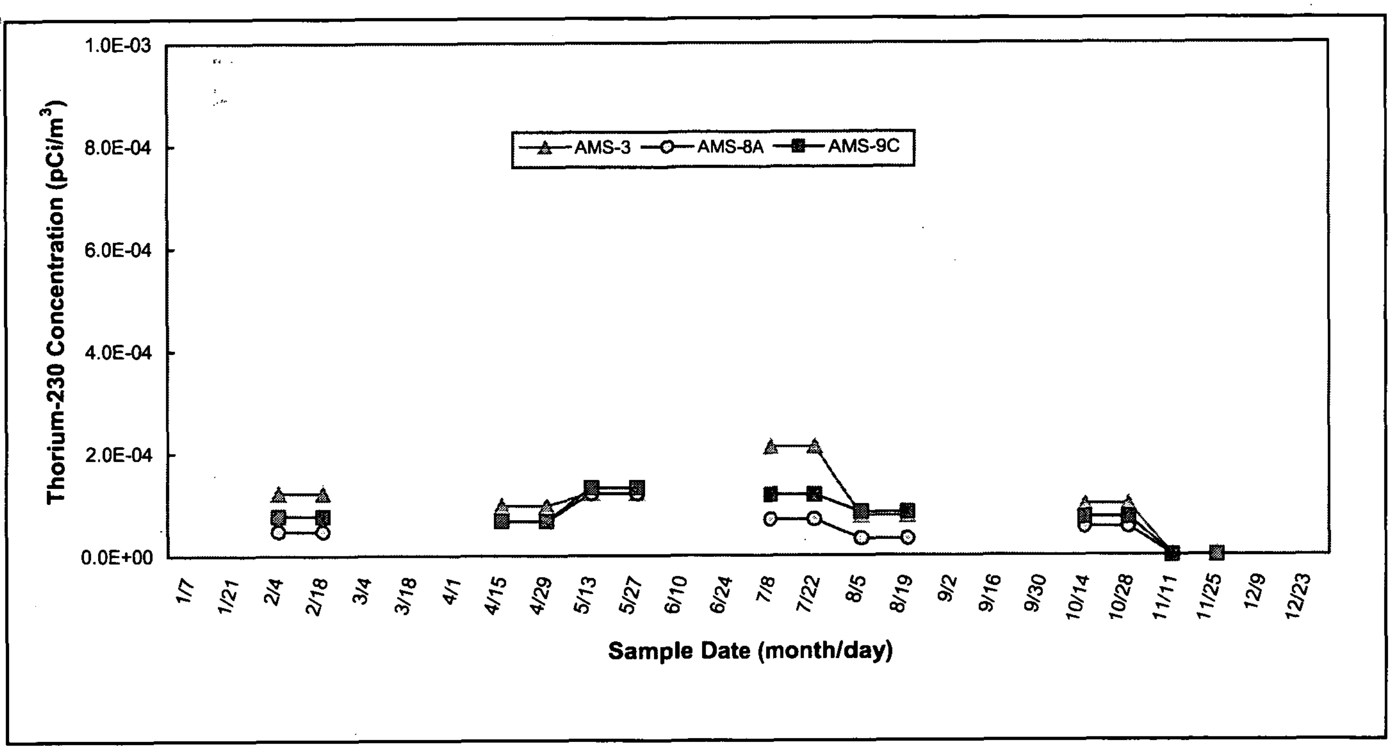

Figure 5-3. 2003 Thorium-230 Concentrations in Air at Selected East Fenceline Monitors (AMS-3, AMS-8A, and AMS-9C)

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5.4 Radon Monitoring

Radon-222 (referred to in this section as radon) is a naturally occurring radioactive gas. It is produced by radioactive decay of radium-226, which can be found in varying concentrations in the earth's crust. Radon is also chemically inert, and tends to diffuse from the earth's crust to the atmosphere. The concentration of radon in the environment is dynamic and exhibits daily, seasonal, and annual variability.

Many factors influence the concentration of radon in the environment, including the distribution of radium-226 in the ground, porosity of the soil, weather conditions, etc. For instance, radon diffusion from the ground is minimized by the presence of precipitation and snow cover. Alternatively, elevated temperatures and the absence of precipitation can produce cracks in the ground and changes in porosity that increase the rate at which radon escapes. A summary of meteorological data from 2003 is presented in Figures 1-7 through 1-10 in Chapter 1, and Appendix C, Attachment C.5, of this report.

Environmental radon concentrations are also influenced by atmospheric conditions. During periods of calm winds and temperature inversions (when the air near the earth's surface is cooler than the air above it), air is held near the earth's surface, minimizing the mixing of air. Consequently, radon's movement is limited vertically and concentrations tend to increase near the ground.

Waste material that produces radon is stored at the Fernald site. This waste was generated from uranium extraction processes performed decades ago and contains radium-226. This material is contained in K-65 Silos 1 and 2, and Silo 3 (part of the Operable Unit 4 remediation) and the waste pits (currently being remediated per the Operable Unit 1 Record of Decision).

DOE Order 5400.5 defines radiological protection requirements, guidelines for cleanup of residual radioactive material, management of resulting wastes and residues, and the release of radiological property. Radon limits at interim storage facilities (such as at the Fernald site) are also defined under DOE Order 5400.5 and must not exceed:

- 100 pCi/L at any given location and any given time
- Annual average concentration of 30 pCi/L (above background) over the facility
- Annual average concentration of 3 pCi/L (above background) at and beyond the facility fenceline.

Figure 5-4 illustrates the continuous radon monitoring network used in 2003 for determining compliance with the above limits. The continuous monitoring network provides frequent feedback to remediation projects, regulatory agencies, and stakeholders on trends in ambient radon concentrations, while providing sufficient radon monitoring to ensure compliance with DOE Order 5400.5 requirements. Access to real-time radon monitoring data from selected continuous radon monitoring locations is available at the Public Environmental Information Center.

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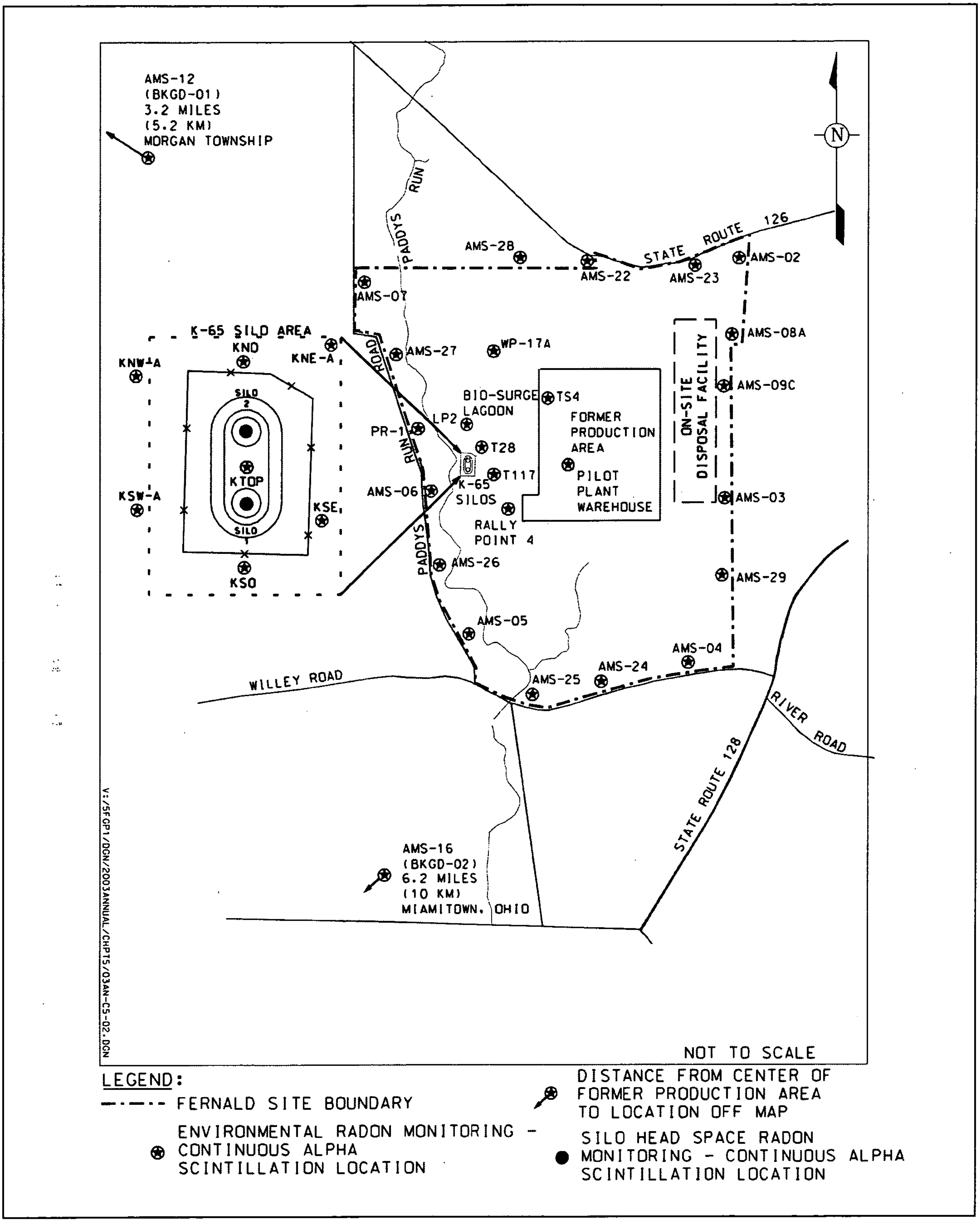

Figure 5-4. Radon Monitoring Locations

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In general, monitoring locations were selected near radon-emitting sources, at the property fenceline, and at background locations. The FFA identifies additional environmental radon monitoring locations, as well as continuous measurement of radon concentrations in the headspace of the K-65 Silos. DOE guidance and EPA air monitor siting criteria were considered when selecting monitoring locations.

5.4.1 Continuous Radon Monitors

Continuous radon monitors use scintillation cells to continuously monitor environmental radon concentrations based on an hourly average. Radon gas in ambient air diffuses into the scintillation cell through a foam barrier without the aid of a pump (this technique is called passive sampling). Inside the cell, radon decays into more radioactive material (progeny products), which gives off alpha particles. The alpha particles interact with the scintillation material inside the cell, producing light pulses. The light pulses are amplified and counted. The number of light pulses counted is proportional to the radon concentration inside the cell.

Continuous monitors reveal important information regarding the dynamics of radon concentrations at different times during the day and at various locations on and off site. These monitors allow for timely review of radon concentrations, which may indicate concentrations are significantly changing from day to day and week to week. However, the use of these monitors is restricted by certain conditions. For example, potential monitoring sites are limited by the availability of electricity.

Table 5-2 provides monthly average radon concentration data from the continuous radon monitors for 2003. The data are used to track radon concentrations throughout the year to ensure the DOE limits are not exceeded. In addition to the summary data presented here, Appendix C, Attachment C.2, of this report provides graphical displays of monthly average radon concentrations from continuous radon monitors during 2003 and 2002.

Results from the fenceline monitoring locations indicate radon levels for 2003 were within historical ranges and well below the DOE limit of 3 pCi/L above background. The annual average radon concentrations at the fenceline ranged from 0.2 to 0.6 pCi/L. The annual average radon concentration at the background monitoring location was 0.3 pCi/L. A review of site fenceline data suggests that during 2003, Waste Pits Project operations did not significantly impact the radon concentrations at the site fenceline (refer to Table 5-2).

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TABLE 5-2
CONTINUOUS ENVIRONMENTAL RADON MONITORING MONTHLY AVERAGE CONCENTRATIONS[a]

Location[b]	2003 Summary Results[c] (Instrument Background Corrected) (pCi/L)			2002 Summary Results[c] (Instrument Background Corrected) (pCi/L)		
	Min.	Max.	Avg.	Min.	Max.	Avg.
Fenceline						
AMS-02	0.1	0.6	0.3	0.0	0.8	0.4
AMS-03	0.1	0.5	0.3	0.2	0.8	0.4
AMS-04	0.2	0.6	0.4	0.1	0.7	0.3
AMS-05	0.2	0.9	0.4	0.1	0.9	0.4
AMS-06	0.3	0.8	0.5	0.1	0.8	0.4
AMS-07	0.3	0.9	0.6	0.2	1.2	0.5
AMS-08A	0.2	0.4	0.3	0.1	0.7	0.3
AMS-09C	0.2	0.5	0.4	0.0	0.7	0.3
AMS-22	0.1	0.4	0.2	0.1	0.6	0.2
AMS-23	0.2	0.4	0.3	0.0	0.4	0.2
AMS-24	0.3	0.7	0.5	0.1	1.1	0.4
AMS-25	0.2	0.6	0.3	0.1	0.8	0.3
AMS-26	0.2	0.6	0.4	0.1	0.7	0.3
AMS-27	0.2	0.8	0.5	0.1	1.0	0.4
AMS-28	0.3	0.9	0.5	0.1	0.8	0.4
AMS-29	0.2	0.5	0.4	0.1	0.5	0.3
Background						
AMS-12	0.2	0.4	0.3	0.1	0.5	0.2
On Site						
KNE-B	0.4	2.9	1.1	1.4	5.6	3.7
KNO	0.4	3.1	1.0	1.1	2.7	1.7
KNW-A	0.4	1.4	0.7	0.5	2.0	1.1
KSE	0.3	4.0	1.0	1.1	3.6	2.4
KSO	0.3	0.8	0.6	0.2	1.2	0.6
KSW-A	0.4	1.5	0.9	0.7	1.7	1.0
KTOP	0.4	12	3.3	2.8	8.8	4.7
LP2	0.4	0.9	0.7	0.4	1.4	0.8
Pilot Plant Warehouse	0.2	0.8	0.4	0.1	0.7	0.4
PR-1	0.3	0.8	0.5	0.1	1.2	0.5
Rally Point 4	0.3	0.7	0.5	0.2	0.8	0.4
Surge Lagoon	0.2	0.8	0.5	0.4	1.3	0.8
T117A	0.2	0.5	0.4	0.2	1.0	0.4
T28	0.2	0.9	0.6	0.4	1.0	0.6
TS4[d]	0.1	0.4	0.2	0.1	1.1	0.6
WP-17A	0.1	0.8	0.4	0.1	1.1	0.5

[a]Monthly average radon concentrations are calculated from the daily average concentrations.
[b]Refer to Figure 5-4 for sample locations.
[c]Instrument background changes as monitors are replaced.
[d]TS4 was removed from service in July 2003.

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In accordance with the FFA, radon concentrations within the headspace of K-65 Silos 1 and 2 are continuously monitored to assess the effectiveness of control measures in reducing radon emissions. From 1993 to 2002, there was a gradual upward trend in silo headspace radon concentrations. The increases in the headspace concentration were attributable to degradation of the 1991 application of bentonite clay to the surface of the K-65 Silo residues. In December 2002 the headspace radon concentrations were temporarily lowered through the initial short-term test of the RCS. The headspace concentrations remained consistent through the end of April 2003. At that time, the RCS began operating on a fairly continual basis. Due to the operation of the RCS, radon headspace concentrations indicated a sharp drop, which lasted through 2003. Appendix C, Attachment C.2, of this report provides a graphical display of monthly average radon concentrations from continuous radon monitors for 2002 and 2003.

During 2003 there were no exceedance events related to the 100-pCi/L DOE limit measured on site, as compared with 10 recorded in 2002. The decrease in the exceedance events is attributable to the operation of the K-65 Silos RCS.

Long-term comparisons are performed on average radon concentrations recorded at the K-65 Silos exclusion fence locations. Historical alpha track-etch and continuous alpha scintillation detector data were used for this comparison (refer to Figure 5-5). The average concentrations adjacent to the K-65 Silos remain below the levels observed prior to the addition of bentonite to the K-65 Silos in 1991.

Long-term comparisons are also performed on average radon concentrations at western property fenceline locations and background locations as a basis for comparison to the 3-pCi/L annual average limit. In 2003 a marginal difference in radon concentrations was observed between background and western property fenceline monitoring locations (refer to Figure 5-6). The on-property monitoring locations also recorded radon levels well below the applicable DOE annual average limit of 30 pCi/L.

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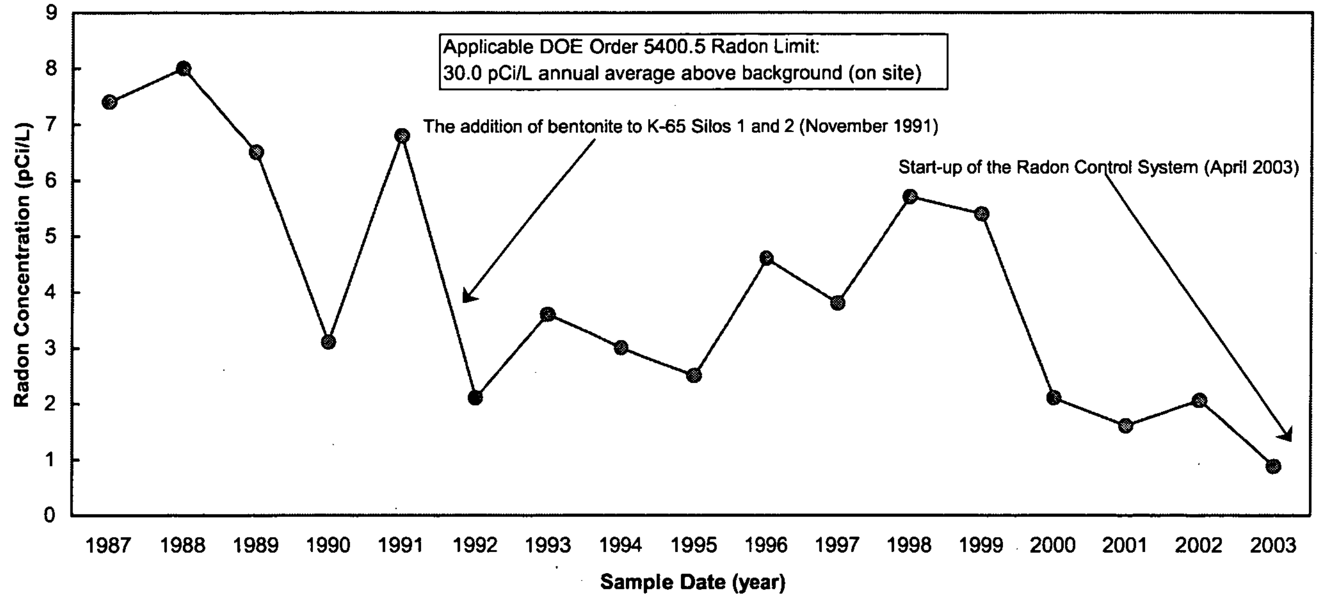
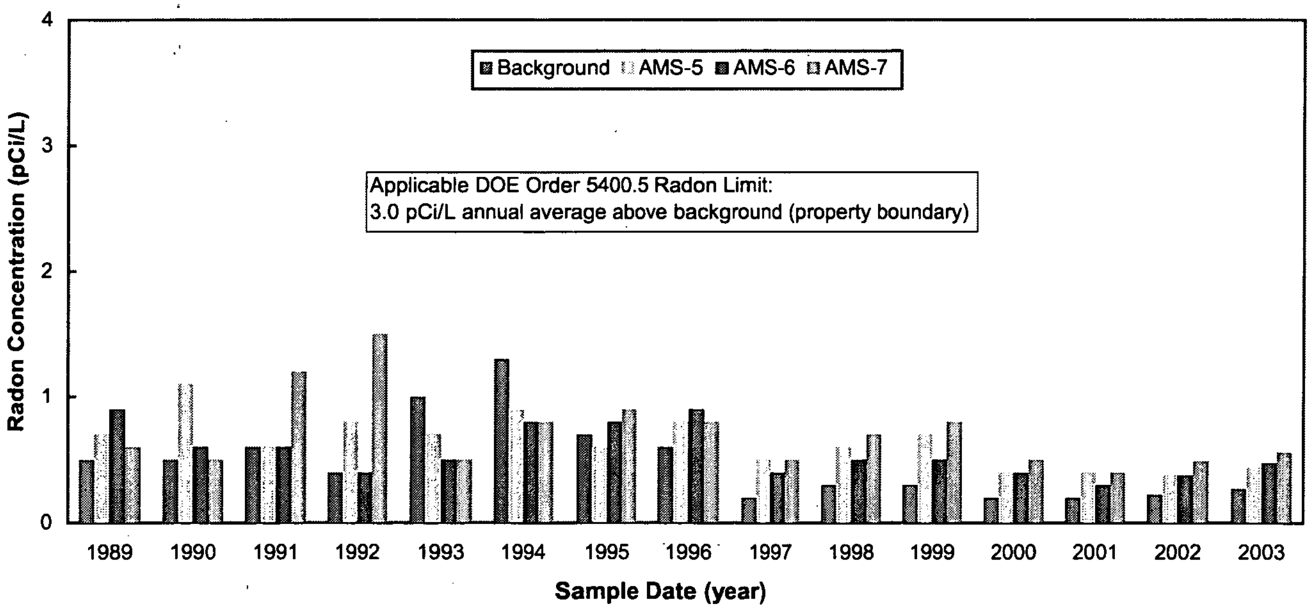


Note: The data from 1987 through 1996 are based on the alpha track-etch detectors and averaging locations corresponding to continuous radon monitors. The data from 1997 through 2003 are based on the average radon concentration from continuous radon monitors at the K-65 exclusion fence. The 2003 average includes KNO and KSO data.

Figure 5-5. Annual Average Radon Concentrations at K-65 Silos Exclusion Fence, 1987-2003



Note: The data from 1989 through 1996 are based on the alpha track-etch detectors and the data from 1997 through 2003 are based on the continuous radon monitors.

Figure 5-6. Annual Average Radon Concentrations at Selected Radon Locations, 1989-2003

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5.5 Monitoring for Direct Radiation

Direct radiation (e.g., X-rays, gamma rays, energetic beta particles, and neutrons) originates from sources such as cosmic radiation, naturally occurring radionuclides in soil, as well as radioactive materials at the Fernald site. The largest source of direct radiation is the material stored in K-65 Silos 1 and 2. Gamma rays and X-rays are the dominant types of radiation emitted from the silos. Energetic beta particles, alpha particles, and neutrons are not a significant component of direct radiation at the Fernald site because uranium, thorium, and their decay products do not emit these types of radiation at levels that create a public exposure concern.

Direct radiation levels at and around the Fernald site were continuously measured at 37 locations with thermoluminescent dosimeters (TLDs) during 2003. TLDs absorb and store the energy of direct radiation within the thermoluminescent material. By heating the thermoluminescent material under controlled conditions in a laboratory, the stored energy is released as light, measured, and correlated to the amount of direct radiation. Figure 5-7 identifies the TLD monitoring locations. These monitoring locations were selected based on the need to monitor the K-65 Silos, the fenceline, and background locations. Table 5-3 provides summary level information pertaining to direct radiation measurements for 2003 and 2002.

TABLE 5-3
DIRECT RADIATION (THERMOLUMINESCENT DOSIMETER) MEASUREMENT SUMMARY

	Direct Radiation (mrem)	
TLD Location	**Summary of 2003 Results**	**Summary of 2002 Results**
Fenceline (21 locations)		
Minimum	64	71
Maximum	76	97
On Site (11 locations)		
Minimum (Health and Safety Bldg.)	56	56
Maximum (K-65 Silo area)	445	1,220
Background (5 locations)		
Minimum	61	70
Maximum	71	83

All monitoring results from TLDs for 2003 were within historical or expected ranges. From 1993 to 2001, there was a gradual upward trend in direct radiation measurements in the immediate area of the K-65 Silos, which stabilized in 2002 (refer to Figure 5-8). During 2003 there was a significant decrease in the direct radiation levels. This was attributed to a reduction of the radon concentrations and associated decay products within the K-65 Silos' headspace. This reduction was accomplished through operations of the Silos Project RCS.

The increasing trend in direct radiation levels at the site's western fenceline (1998 through 2001) also stabilized in 2002. During 2003 there was a significant decrease, particularly at TLD location 6, which is located closest to the K-65 Silos (refer to Figure 5-9). These changes at the fenceline are also attributable to the reduction of radon concentrations and associated decay products within the K-65 Silos' headspace by the operation of the RCS.

Chapter 6 provides more information on the dose associated with the direct radiation results. Detailed results of direct radiation measurements for 2003 and 2002 are provided in Appendix C, Attachment C.3, of this report.

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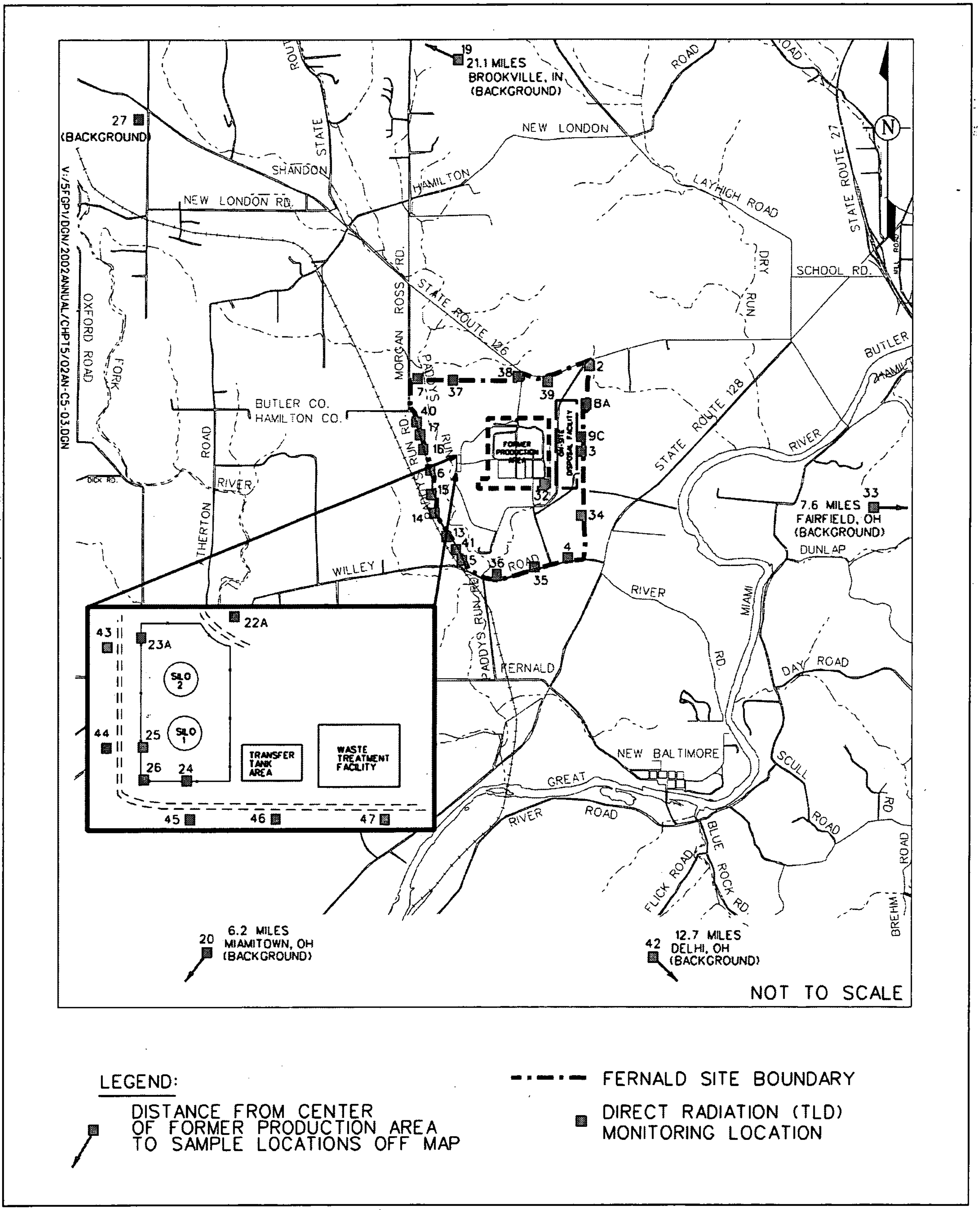

Figure 5-7. Direct Radiation (TLD) Monitoring Locations

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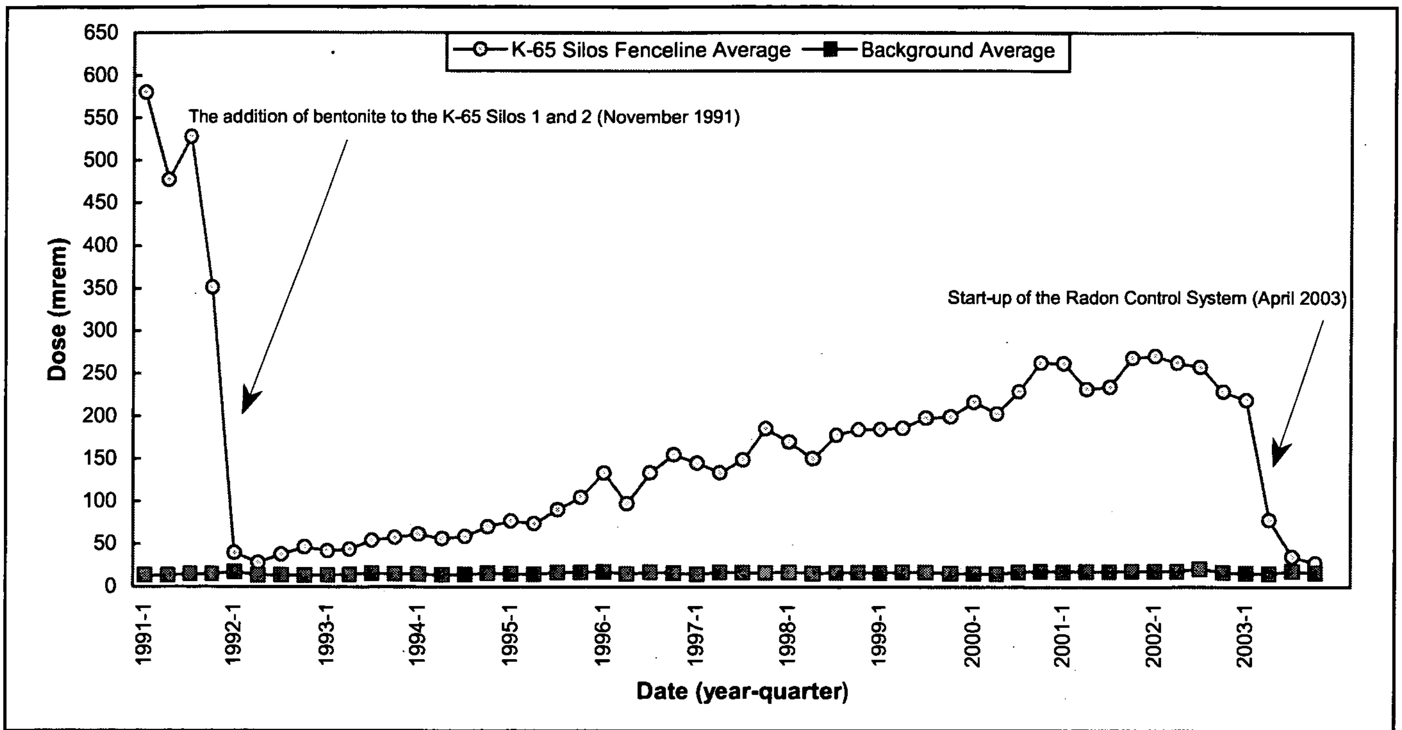

Figure 5-8. Direct Radiation (TLD) Measurements at K-65 Silos Boundary, 1991-2003 (K-65 Silos Fenceline Average vs. Background Average)

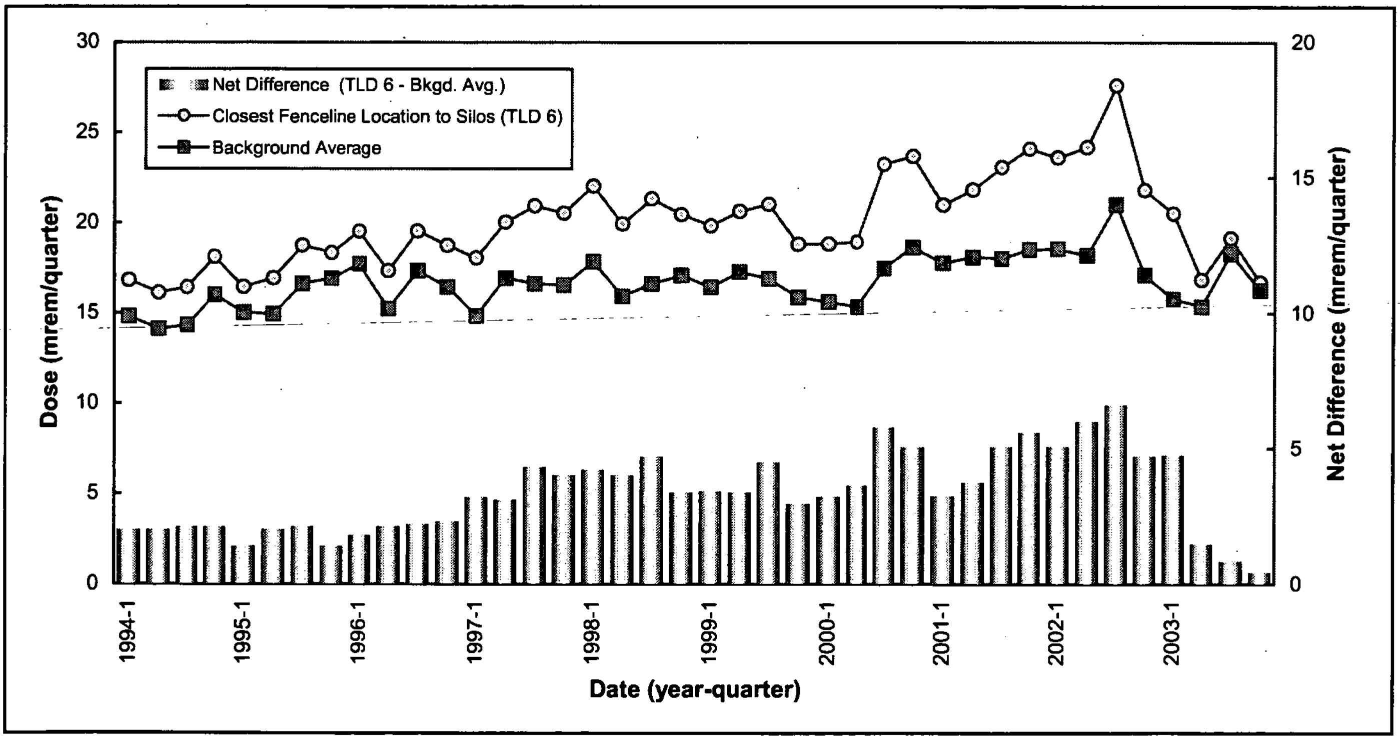

Figure 5-9. Direct Radiation (TLD) Measurements, 1994-2003 (Location 6 vs. Background Average)

000113

5.6 Stack Monitoring for Radionuclide Emissions

During 2003 there were four stacks (or vents) that were monitored for radionuclide emissions as part of the requirements under the NESHAP Subpart H. The locations of the four stacks are show in Figure 5-10. Stack sampling systems typically consist of a continuously operating pump that draws a representative volume of air from the stack through a filter or, in the case of radon monitoring, through a detector. Periodically, the filter is exchanged and analyzed for radiological contaminants that have the potential to be released during remediation activities or processes.

The Building 71 stack filters were analyzed for total particulates, total uranium, and isotopes of uranium and thorium. Results for 2003 were very low and comparable to 2002 results. The results confirm that emissions from the waste processing operations conducted in Building 71 were not a significant source of airborne emissions to the environment. With the Building 71 waste processing operations completed at the end of the second quarter 2003, the Building 71 stack was removed from service on July 1, 2003.

The Waste Pits Project dryer stack particulate filters were analyzed for isotopes of uranium, thorium, and radium. The results confirmed that Waste Pits Project stack particulate emissions are very low and are not the primary source of thorium-230 concentrations at the site fenceline. The stack also contains a continuous radon monitor (for radon-220 and radon-222). The maximum hourly release rate of radon (radon-220 and radon-222) during 2003 was 6,081 microCuries per hour (μCi/hr), which is below the estimated maximum hourly release rate of 13,000 μCi/hr (DOE 1998b) for radon-222. Note there were no exceedances in 2003 of the 13,000 μCi/hr value. The total annual release of radon through the stack was estimated to be 7,680,000 microCuries (μCi). No significant changes in source operations associated with the Waste Pits Project dryer stack were noted during 2003.

In 2003 the Waste Pits Project pugmill ventilation stack (PVS) particulate filters were analyzed for isotopes of uranium, thorium, and radium. The results confirmed that Waste Pits Project PVS particulate emissions are very low and are not the primary source of thorium-230 concentrations at the site fenceline. No significant changes in source operations associated with the Waste Pits Project PVS were noted during 2003.

In 2003 the Silos Project RCS stack particulate filters were analyzed for total particulates, isotopes of uranium, thorium, radium, and polonium, in addition to radon monitoring. The results confirm that the Silos RCS stack particulate and radon emissions are very low. The maximum instantaneous measurement of radon being released from the stack was 203 μCi, and the total annual release of radon through the stack was estimated to be 3,380,000 μCi.

000114

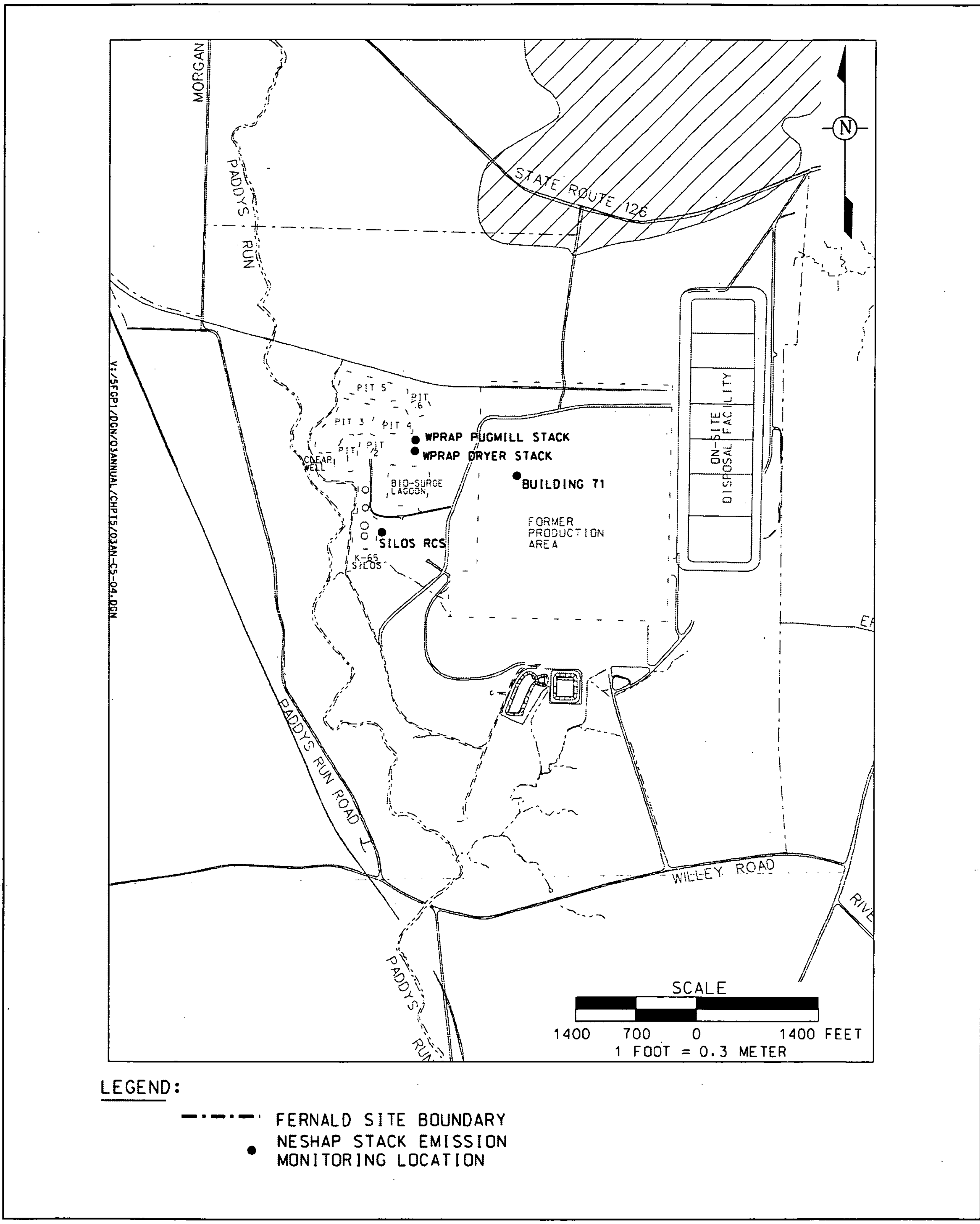

Figure 5-10. NESHAP Stack Emission Monitoring Locations

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Table 5-4 presents the 2003 stack results for total particulates, radionuclides, and radon measurements. Typically, post-production era (i.e., 1990 and later) monitoring data have shown stack emissions of radionuclides to be very low or not detectable. The use of high-efficiency particulate air (HEPA) filtration systems in many remediation activities and processes effectively controls stack emissions and limits the release of airborne contaminants. In summary, the 2003 stack emissions are consistent with the low stack emission data for the post-production period.

TABLE 5-4
2003 NESHAP STACK EMISSIONS

Radionuclide (Unit)	WPP Dryer Stack[a, b]	WPP PVS Stack[a, b]	Silos RCS Stack[a, b]	Building 71 Stack[a, b]
Total Uranium (lbs/yr)	NS	NS	NS	8.8E-06
Uranium-238 (lbs/yr)	3.1E-05	1.2E-03	3.1E-05	2.8E-05
Uranium-235/236 (lbs/yr)	2.0E-07	3.4E-06	5.7E-07	6.3E-07
Uranium-234 (lbs/yr)	1.1E-09	3.1E-08	2.1E-09	1.6E-09
Thorium-232 (lbs/yr)	4.1E-06	2.6E-04	6.1E-05	2.2E-05
Thorium-230 (lbs/yr)	4.9E-10	4.4E-08	3.6E-09	3.6E-10
Thorium-228 (lbs/yr)	1.1E-15	4.4E-14	8.2E-15	9.1E-16
Thorium-227 (lbs/yr)	NS	NS	ND	NS
Radium-226 (lbs/yr)	4.6E-13	3.2E-11	ND	NS
Polonium-210 (lbs/yr)	NS	NS	6.3E-15	NS
Total Particulates (lbs/yr)	NS	NS	1.5E-01	0.0E+00
Total Radon (mCi/yr)	7,680	NS	3,380	NS

[a]Includes probe rinse results.
[b]NS = not sampled
ND = not detectable

5.7 Monitoring for Non-Radiological Pollutants

The FCP continued to operate the Waste Pits Project gas-fired dryers during 2003. The estimated emissions from the dryer operations were based on emission factors from the AP-42 technical reference document (Compilation of Air Pollution Emission Factors, Vol. 1; Stationary Point and Area Sources, 5th edition, January 1995 [EPA 1995]). The sulfur dioxide emissions were estimated to be 206 pounds (94 kg). Nitrogen oxide emissions for 2003 were estimated to be 17,192 pounds (7,805 kg). Carbon monoxide emissions were estimated to be 28,882 pounds (13,112 kg). The estimate for particulate as PM10 (particles with an aerodynamic diameter less than or equal to a nominal 10 micron) was 2,613 pounds (1,186 kg). Non-methane total organic compound emissions for 2003 were estimated to be 2,991 pounds (1,358 kg). There are no regulatory limits associated with non-radiological pollutants from the dryers; however, the dryers are required to employ the best available technology to limit emissions. In order to meet the best available technology requirement, burners designed to lower emissions of nitrogen oxides are used in the dryers.

OEPA requires an estimate of emissions from the boiler plant as part of the FCP's effort to demonstrate compliance with the Clean Air Act. The boilers at the site are dual fired by natural gas and diesel fuel. Non-radiological pollutants from boiler operations include particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, and non-methane total organic compounds. Opacity is a measure of how much light is blocked by particulate matter present in stack emissions. Excursions occur when regulatory limits for opacity are exceeded. There were no opacity excursions at the boilers for 2003. There have been no excursions since the site converted from coal-fired boilers to natural gas/diesel-fired boilers in 1997. By mid-2003 the services of the natural gas/diesel-fired boilers were no longer needed; therefore, the natural gas/diesel-fired boilers were permanently shut down on May 1, 2003.

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In order to estimate sulfur dioxide emissions, scientists determine the sulfur and heat content of the fuel. Using this information and the total amount of fuel burned, the amount of sulfur dioxide emissions can be calculated. For 2003 sulfur dioxide emissions from all boilers were calculated at 28.6 pounds (13 kg). This was well below the allowable limit of 79 tons (72 metric tons) per year calculated from information in permits issued by OEPA.

The nitrogen oxide emissions were estimated using data obtained from stack emission test results. Nitrogen oxide emissions for all boilers for 2003 were estimated at 2,976 pounds (1,351 kg). Carbon monoxide emissions, based on emission factors from AP-42 for all boilers in 2003, were estimated at 2,674 pounds (1,214 kg). To date, OEPA has not set nitrogen oxide or carbon monoxide limits for the Fernald site. Particulate matter emissions, based on emission factors from AP-42 for all boilers in 2003, were estimated at 246 pounds (112 kg). This was below the allowable limit of 6.3 tons (5.7 metric tons) per year calculated from information in the permits issued by OEPA. Non-methane total organic compounds, based on emission factors from AP-42 for all boilers in 2003, were estimated at 276 pounds (125 kg). Table 5-5 provides a comprehensive list of 2003 emissions from the Waste Pits Project dryers and boiler plant.

TABLE 5-5
CHEMICAL EMISSIONS FROM WASTE PITS PROJECT DRYERS AND BOILER PLANT

Chemical Name	Emissions from WPP Dryers (lb/kg)	Emissions from Boiler Plant (lb/kg)	Sources of Emissions	Basis of Estimate
Particulates	2,613/1,186	246/112	Fossil Fuel Combustion	AP-42 Emission Factors[a]
Sulfur Dioxide	206/94	28.6/13	Fossil Fuel Combustion	AP-42 Emission Factors[a] or sulfur content of fuel
Nitrogen Oxide	17,192/7,805	2,976/1,351	Fossil Fuel Combustion	Stack Emission Test Results for natural gas or AP-42 Emission Factors[a] for diesel fuel
Carbon Monoxide	28,882/13,112	2,674/1,214	Fossil Fuel Combustion	AP-42 Emission Factors[a]
Non-Methane Total Organic Compounds	2,991/1,358	276/125	Fossil Fuel Combustion	AP-42 Emission Factors[a]

[a]Compilation of Air Pollution Emission Factors, Vol. 1; Stationary Point and Area Sources, 5th edition, January 1995 (EPA 1995); Section 1.3, Fuel Oil Combustion, Final Section, Supplement E, September 1998; and Section 1.4, Natural Gas Combustion, Final Section, Supplement D, July 1998.

5.8 Biota (Produce) Sampling

As mentioned in Chapter 1, the Fernald site is surrounded by farmland. Locally grown sweet corn and tomatoes are two of the major crops sold from roadside stands within 3 miles (4.8 km) of the FCP. Local residents also grow apples, beets, feed corn, cucumbers, lettuce, peppers, potatoes, soybeans, and squash.

Under the IEMP, produce is sampled once every three years to ensure that airborne emissions from the remediation of the site are not adversely affecting produce grown near the FCP. In 2003 produce and grain samples from 15 locations were collected and then analyzed for uranium and thorium-230. Figure 5-11 depicts produce monitoring locations. Historically, produce samples have been analyzed for uranium only because it has been the major contributor to dose from airborne emissions at the FCP. With the start of the Waste Pits Project in late 1999, thorium-230 has become the major contributor to dose via the air inhalation pathway. Therefore, thorium-230 analysis of produce samples was initiated in 2000. Table 5-6 presents the summary results of the produce sampling program.

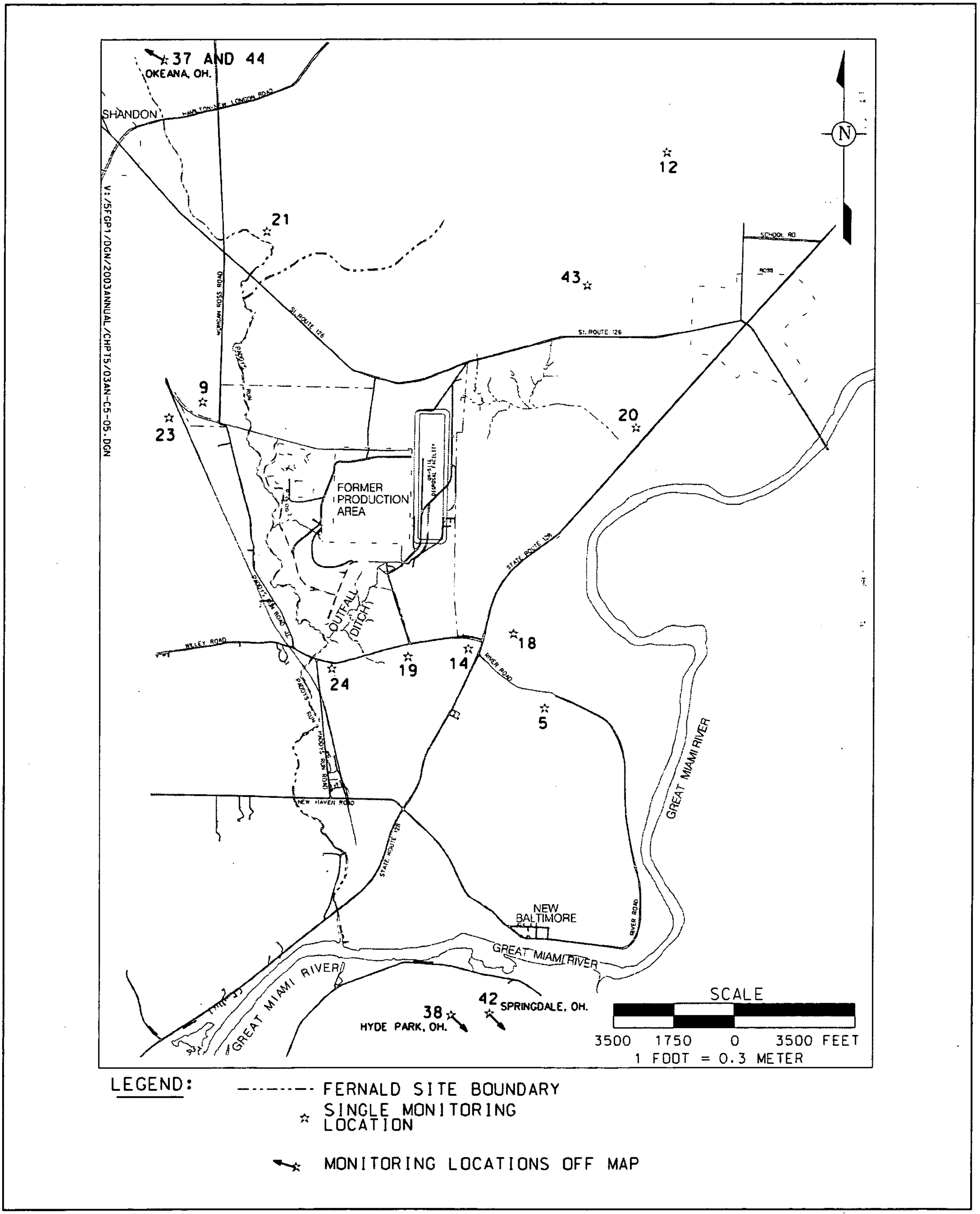

Figure 5-11. Produce Monitoring Locations

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As indicated in Table 5-6, the total uranium results for 2003 remained within the range of historical background concentrations of produce samples collected from 1990 through 2000. In addition, as indicated in Table C.4-1 of Appendix C, Attachment 4, concentrations of uranium were less than detectable in 21 of the 28 samples analyzed. Therefore, the uranium data suggest there is no substantial impact from past or current FCP emissions on locally grown produce.

As mentioned above, thorium-230 analysis was only performed on locally grown produce in 2000. With a limited amount of historical thorium data for produce, comparisons to background would be inconclusive. Another mechanism for evaluating the impact of thorium-230 emissions on locally grown produce is a comparison of the effective dose equivalent (dose) from consuming locally grown produce to the applicable dose limits. The applicable and relevant standard is in DOE Order 5400.5: 100 millirem per year, all-pathways dose limit to members of the public. The dose from consuming locally grown produce for 2003 is calculated to be less than one percent of the standard (0.003% of the DOE standard). Therefore, the thorium data also suggest there is no substantial impact from past or current FCP emissions on locally grown produce. (Refer to Chapter 6 and Appendix C, Attachment C.4, of this report for further discussion of doses.)

Detailed results of produce sampling for 2003 are provided in Appendix C, Attachment C.4, of this report. Note that with the Waste Pits Project advancing toward completion, the anticipated accelerated remediation of the FCP, and both uranium and thorium results indicating no substantial impact on locally grown produce, it is likely that produce sampling, currently on a three-year frequency, will not be conducted in the future. Future revisions of the IEMP will address the need for this monitoring and discontinuation will be based on OEPA and EPA approval.

TABLE 5-6

2003 BIOTA (PRODUCE) SUMMARY RESULTS

Produce[a]	Number of Samples	Minimum[b]	Maximum (All Concentrations in pCi/g [dry weight])	Background[b]	1990-2000 Historical Background Range Minimum[b] (pCi/g, dry weight)	Maximum[b] (pCi/g, dry weight)
			Total Uranium			
Corn	8	ND	0.084	ND	ND	0.2
Soybeans	6	ND	0.07	ND	ND	1.2
Cucumbers	7	0.06	0.11	ND	ND	0.021
Tomatoes	7	ND	0.091	0.05	ND	0.61
			Thorium-230			
Corn	8	0.04	0.36	0.13	NA	NA
Soybeans	6	0.14	0.24	0.25	NA	NA
Cucumbers	7	0.22	0.38	0.29	ND	ND
Tomatoes	7	0.37	0.48	0.37	ND	ND

[a]Refer to Figure 5-11 for sample locations.
[b]ND = not detectable
NA = not applicable

000119

Chapter 6
Radiation Dose

6.0 Radiation Dose

Results in Brief: 2003 Estimated Doses

Airborne Emissions — The estimated maximum effective dose equivalent at the site fenceline from 2003 airborne emissions (excluding radon) was calculated to be 0.82 mrem (8.2E-03 mSv), which is 8.2 percent of the EPA NESHAP 10-mrem annual dose limit.

Direct Radiation — The estimated 2003 effective dose equivalent at an off-site receptor location near the western fenceline of the site was 6.7 mrem (6.7E-02 mSv).

Biota (Produce) — The dose for consuming locally grown produce was calculated to 0.003 mrem (3.0E-05 mSv).

Dose to the Maximally Exposed Individual — The dose to the maximally exposed individual for 2003 was estimated to be 7.33 mrem (7.3E-02 mSv) at an off-site receptor location near the western fenceline of the site. This is 7.3 percent of the 100-mrem (1-mSv) DOE limit.

This chapter provides estimated doses to the public from the air, biota (produce), and direct radiation pathways for 2003 as a result of remedial actions taken at the Fernald site. EPA NESHAP regulations require the FCP to demonstrate that the site's radionuclide airborne emissions are low enough to ensure that no one in the public receives an effective dose of 10 millirem (mrem) (0.1 milliSievert [mSv]) or more in any one year. Moreover, to determine whether the Fernald site is within the DOE effective dose limit of 100 mrem (1 mSv) per year from all exposure pathways (excluding radon), estimates of dose due to direct radiation and produce are combined with airborne emissions to estimate the total dose to the maximally exposed individual. This estimate reflects the incremental dose above background that is attributable to the site.

The DOE limits for radon and its decay products in air are provided in terms of concentrations rather than dose limits and are addressed independently of the all-pathway dose limit. A concentration-based limit is used because dose calculations associated with radon and its decay products are highly sensitive to input parameters which are difficult to confirm with environmental measurements. Nevertheless, dose estimates for radon have been included in response to stakeholders' interest in radon exposures. A number of different radon dose calculations are presented to demonstrate the variation of radon doses based on each method of calculation. The radon dose estimates in this chapter can also be compared with radon dose estimates presented in previous annual site environmental reports and other radon dose studies, such as the study that resulted from the Fernald Dosimetry Reconstruction Project (RAC 1996).

This chapter also provides an assessment of dose to aquatic organisms that may be affected by the site's effluent to nearby streams and rivers. An assessment of dose to biota (i.e., aquatic and terrestrial organisms) is one of the requirements of DOE Order 5400.5 (DOE 1990b). By limiting the dose to aquatic organisms, DOE Order 5400.5 seeks to limit the severity and likelihood of off-site environmental impacts attributable to the cleanup and restoration efforts at the Fernald site. The dose assessment to biota is performed through the use of a computer model which estimates dose based on concentrations of radionuclides measured in effluent discharged to the Great Miami River.

6.1 Estimated Dose from Airborne Emissions

The estimated dose from 2003 airborne emissions was calculated from annual average radionuclide concentrations measured at the 17 IEMP air particulate monitoring locations (one background and 16 fenceline locations [refer to Figure 5-1 in Chapter 5 for the location of the air particulate monitoring locations]). The annual average background concentration was subtracted from the fenceline concentrations in order to account for the natural occurrence of airborne radionuclides. Dose estimates were determined by converting the net annual average radionuclide concentrations measured at each fenceline monitoring location to doses using values listed in 40 Code of Federal Regulations 61 (NESHAP) Subpart H, Appendix E, Table 2.

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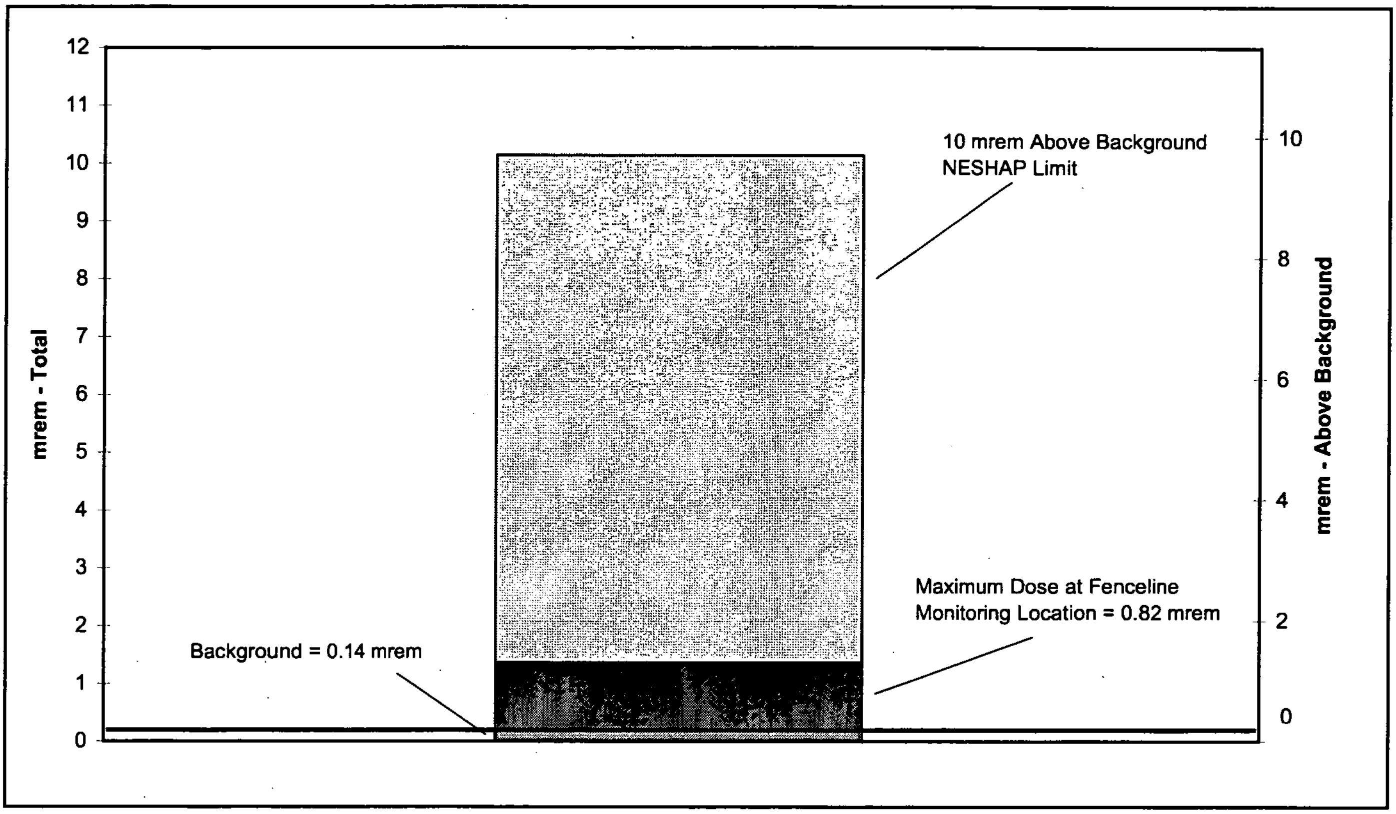

Figure 6-1. Comparison of 2003 Air Pathway Doses and Allowable Limits

The maximum effective dose at the fenceline from 2003 airborne emissions was estimated to be 0.82 mrem (8.2E-03 mSv) per year and occurred at AMS-9C along the eastern fenceline of the site. The dose estimate is based on the conservative assumption that a person remains outdoors at the AMS-9C location for 100 percent of the time during the year. Recognizing that the nearest residence is located approximately 2,500 feet (762 meters) downwind from AMS-9C (east-southeast from the site), the actual dose received by this receptor would be substantially lower than 0.82 mrem (8.2E-03 mSv) per year.

The maximum fenceline dose of 0.82 mrem (8.2E-03 mSv) in 2003 is consistent with the maximum fenceline dose of 0.8 mrem (8.0E-03 mSv) in 2002. The equivalence between the 2002 and 2003 doses is particularly noteworthy given the Waste Pits Project accelerated waste processing activities in 2003. The operation of the PVS, which was designed to capture particulate emissions from waste material processed by the dryers, is credited with limiting Waste Pits Project emissions during accelerated waste processing activities while maintaining the 2003 maximum dose to approximately 0.8 mrem, well below the NESHAP limit.

Figure 6-1 provides a comparison between the air pathway doses at the background and maximum fenceline locations with the annual NESHAP limit of 10 mrem (0.1 mSv). The background and maximum fenceline doses shown in Figure 6-1 are primarily attributable to the airborne concentration of uranium, thorium, and radium, and exclude contributions from radon (dose from radon is excluded from the annual NESHAP limit of 10 mrem [0.1 mSv]). The maximum air pathway dose of 0.82 mrem (8.2E-03 mSv) above background (which is in addition to the air pathway background dose of 0.14 mrem [1.4E-03 mSv]) is 8.2 percent of the annual NESHAP limit. The estimated dose for each radionuclide from airborne emissions measured at each fenceline air monitor is provided in Appendix D of this report.

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The collective effective dose from 2003 airborne emissions (not including radon) to the population within 50 miles (80 km) of the Fernald site was estimated to be 3.84 person-rem (3.84E-02 person-Sievert [person-Sv]) for a population of 2.7 million. The collective effective population dose for all pathways (air, direct radiation, and consumption of local produce) was estimated to be 3.99 person-rem (3.99E-02 person-Sv). The collective effective dose provides an aggregate measure of the impact of airborne emissions from the Fernald site to the population in the area. For comparison, the same group of people received an estimated collective effective dose of 300,000 person-rem (3,000 person-Sv) from background radiation, excluding radon.

6.2 Direct Radiation Dose

Direct radiation dose is the result of gamma and X-ray radiation emitted from radionuclides stored on site. The largest source of direct radiation at the site is the waste stored in the K-65 Silos. As the waste in the silos undergoes radioactive decay, gamma rays and X-rays are emitted. Direct radiation from the decay of radon progeny in the silos' headspace contributes a major fraction of the direct radiation from the K-65 Silos.

As discussed in Chapter 5, there was a significant decrease in the radiation levels during 2003, particularly at TLD location 6, which is located closest to the K-65 Silos (refer to Figure 5-9). These changes at the fenceline are also attributable to the reduction of radon concentrations and associated decay products within the K-65 Silos' headspace by the operation of the Silos Project RCS.

The direct radiation dose for 2003 at the fenceline was estimated using the highest dose from the fenceline monitoring locations and subtracting the background dose. This method provides a conservative estimate of direct radiation dose and measures the impact of radiation levels near the silos and the fenceline due to radon and its associated decay products in the silo headspace (refer to Chapter 5). From the data in Table 5-3, the maximum fenceline measurement was 76 mrem (7.6E-01 mSv) per year and occurred at TLD location 16. The average background dose from the five background TLD locations was 65.6 mrem (6.56E-01 mSv). The difference in these values (10.4 mrem [1.04E-01 mSv]) is the estimated fenceline direct radiation dose for a hypothetical individual who stands at the fenceline, specifically TLD location 16, for the entire year.

In accordance with DOE Order 5400.5, which requires that realistic exposure conditions be used for conducting dose evaluations, an estimate of direct radiation dose was calculated for the residence nearest the K-65 Silos. This dose was estimated by using the net fenceline TLD measurement at TLD location 16 and accounting for the distance between the fenceline TLD location and the residence (approximately 326 feet [99 meters]), which would lower the direct radiation dose to approximately 6.7 mrem (6.7E-02 mSv). This estimate remains extremely conservative in that it assumes a resident at this location is present 24 hours per day for a full year and does not account for shielding provided by the structure of the house.

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6.3 Estimated Dose from Consumption of Locally Grown Produce

There is a potential for low levels of radioactive particulate emissions to be deposited onto soil surrounding the FCP and possibly absorbed by produce, thereby delivering a secondary pathway dose. This secondary pathway dose is estimated using the conservative assumption that a large fraction of a person's diet of vegetables comes from gardens and farms in the FCP area. This modeled diet assumes an annual consumption of 100 pounds (45 kg) of grains (corn and soybeans), and 100 pounds (45 kg) of other vegetables (tomatoes and cucumbers). To represent the foods in the diet, samples of corn, soybeans, tomatoes, and cucumbers from local gardens and farms were collected and analyzed in 2003 for uranium and thorium-230.

Historically, produce sampling at the FCP consisted of uranium analysis. During the 2000 sampling year, isotopes of thorium and radium-226 were included in the analyses. Thorium analysis was included because thorium-230 became the major contributor to dose from airborne emissions during the last four years. Radium analysis was included as a response to a study conducted by the Agency for Toxic Substance and Disease Registry (ATSDR 2000), which suggested that radium may be a potential contributor to dose based on the ATSDR's review of historical environmental data. Of the samples analyzed in 2000, only total uranium and thorium-230 analyses yielded detectable results. Therefore, the 2003 produce samples were analyzed for total uranium and thorium-230 per the IEMP.

For 2003 the estimated dose from consuming locally grown produce was calculated to be 0.003 mrem (3.0E-5 mSv). For comparison, the 2000 dose was calculated to be 0.9 mrem (9.0E-03 mSv). As indicated in Chapter 5, produce samples had very low concentrations of thorium-230 (i.e., 0.04 to 0.48 pCi/g) while most uranium concentrations were not detectable. More details on produce samples are provided in Appendix C.4 of this report.

6.4 Total of Doses to Maximally Exposed Individual

The maximally exposed individual is the member of the public who receives the highest estimated effective dose equivalent based on the sum of the individual pathway doses. As shown in Table 6-1, the 2003 dose to the maximally exposed individual is the sum of the estimated doses from direct radiation dose, airborne emissions (excluding radon), and consumption of locally grown produce. The conservative assumptions used throughout the dose calculation process ensure that the dose to the maximally exposed individual is the maximum possible dose any member of the public could receive. The 2003 dose to the maximally exposed individual is estimated to be 7.33 mrem (7.33E-02 mSv).

The contributions to this all-pathway dose are:

- 6.7 mrem (6.7E-02 mSv) from direct radiation to an off-site receptor located near the western fenceline of the site
- 0.63 mrem (6.3E-03 mSv) from air inhalation dose, as measured at AMS-6, to an off-site receptor located near the western fenceline of the site
- 0.003 mrem (3.0E-05 mSv) biota (produce) dose from consuming locally grown produce.

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This estimate represents the incremental dose above background attributable to the Fernald site, exclusive of the dose received from radon. Figure 6-2 provides a comparison between the average background radiation dose at background locations (65.6 mrem [6.56E-01 mSv]) and the all-pathway dose to the maximally exposed individual (7.33 mrem [7.33E-02 mSv]). Figure 6-2 also provides a graphical comparison to the annual DOE all-pathway limit of 100 mrem (1 mSv).

TABLE 6-1
DOSE TO MAXIMALLY EXPOSED INDIVIDUAL

Pathway	Dose Attributable to the Fernald Site	Applicable Limit
Direct radiation	6.7 mrem	100 mrem (total of all pathways)
Airborne emissions at AMS-6 (excluding radon)	0.63 mrem	10 mrem (air pathway)
Consumption of locally grown produce	0.003 mrem	100 mrem (total of all pathways)
Maximally exposed individual	7.33 mrem	100 mrem (total of all pathways)

6.5 Significance of Estimated Radiation Doses for 2003

One method of evaluating the significance of the estimated doses is to compare them with doses received from background radiation. Background radiation yields approximately 100 mrem (1 mSv) per year from natural sources, excluding radon. For example, the dose received each year from cosmic and terrestrial background radiation contributes approximately 26 mrem (2.6E-01 mSv) and 28 mrem (2.8E-01 mSv), respectively. In addition, the background radiation dose will vary in different parts of the country. Living in the Cincinnati area contributes an annual dose of approximately 110 mrem (1.1 mSv), whereas living in the Denver area would contribute approximately 125 mrem (1.25 mSv) from background radiation (U.S. National Academy of Science 1980) (NCRP 1987). Comparing the maximally exposed individual dose to the background dose demonstrates that, even with the conservative estimates, the dose to the nearest resident from the Fernald site is much less than the natural background radiation dose. Although the estimated dose will be received in addition to the background dose, this comparison provides a basis for evaluating the significance of the estimated doses.

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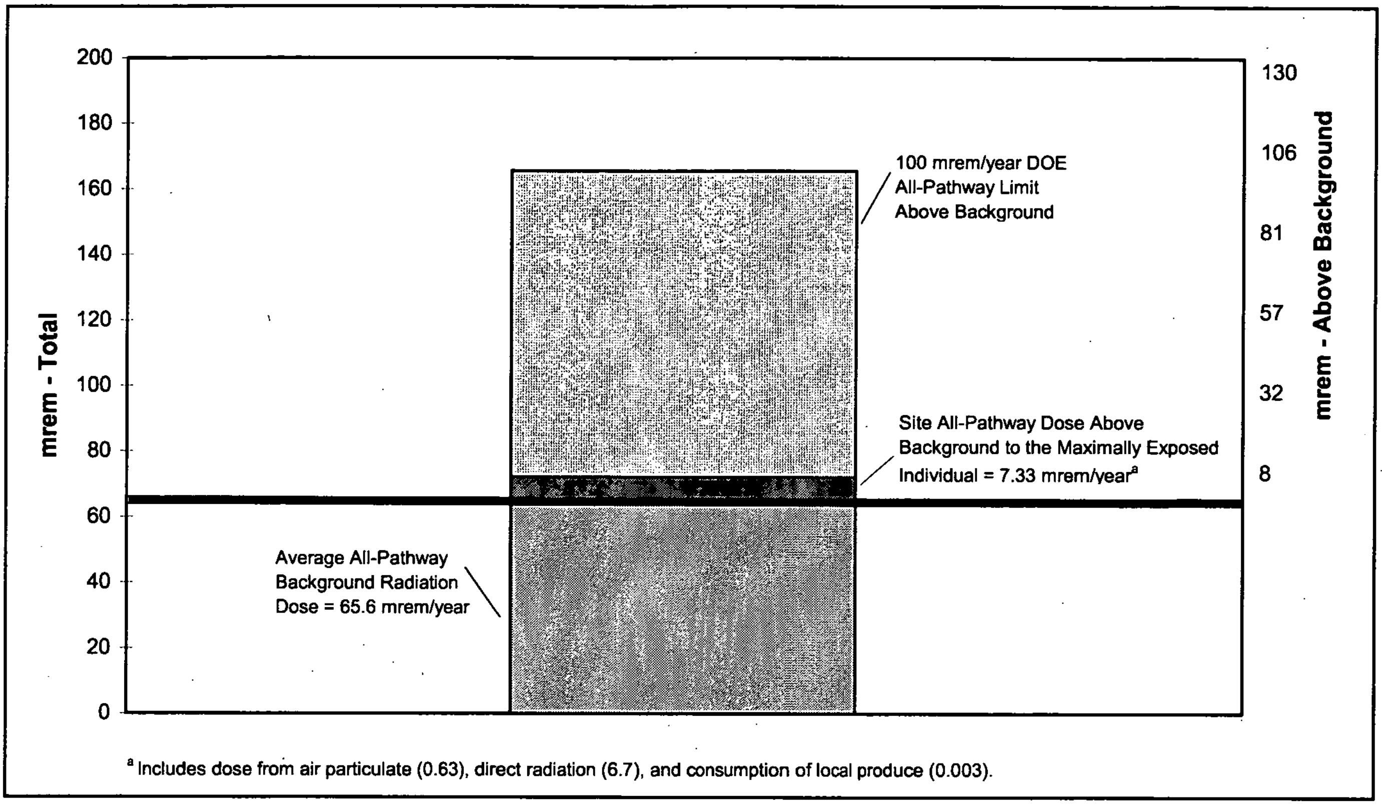

Figure 6-2. Comparison of 2003 All-Pathway Doses and Allowable Limits

Another method of determining the significance of the estimated doses is to compare them with dose limits developed to protect the public. The International Commission on Radiological Protection (ICRP) has recommended that members of the public receive no more than 100 mrem (1 mSv) per year above background. As a result of this recommendation, DOE has incorporated 100 mrem (1 mSv) per year above background as the limit in DOE Order 5400.5. The sum of all estimated doses from site operations for 2003 (7.33 mrem [7.33E-02 mSv]) was significantly below this limit.

6.6 Estimated Dose from Radon

Radon in the air decays to produce more radioactive material, known as daughter products. Airborne daughter products attach to dust particles that may be inhaled and deposited within the lungs. As the daughter products decay, they emit electrostatically charged particles (alpha and beta particles) that may damage sensitive tissues of the lung. For exposures to radon and its daughters, the target organ for the radiation dose is the lung.

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Radon dose estimate methodologies from the ICRP and National Council on Radiation Protection (NCRP) have been revised and updated over the years with the primary effect being a decrease in the estimated health damage (detriment) per unit of radiation exposure. The revisions were based on re-evaluations of studies examining the detrimental health effects (e.g., epidemiological studies) on highly exposed worker populations (e.g., uranium miners). Therefore, radon dose estimates were generated for this report using the following four different calculation methods:

- Working level-month determination
  Historically, radon daughter exposure rates have been measured in the units of working levels, a measure of the activity concentration of the radon daughters in air. A working level is approximately equivalent to a radioactivity concentration of 100 pCi/L of radon in 100 percent equilibrium with its daughters. An individual exposure is then determined by multiplying the working level by the number of 170-hour periods (i.e., a work month) at that level, yielding the exposure unit working level-month. Working level-months of exposure are provided because all dose conversion factors and detriment coefficients used in estimating a dose from radon and its daughters are derived from this fundamental unit.
- NCRP 78 report (NCRP 1984)
  This document, in part, provides equations for converting exposure resulting from inhalation of radon daughter products to an equivalent lung dose. This method considered the whole lung as the target organ for the radiation exposure. A number of dose conversion factors and assumptions are used to equate the lung dose to a whole body radiation dose (i.e., effective dose equivalent). Equations from this report were used in previous annual site environmental reports and are presented here for direct comparison to previous years' estimates.
- ICRP 66 (ICRP 1994a) tissue weighting factor modification to NCRP 78 equation
  ICRP 66 introduced a specific tissue-weighting factor representing the localized radiation exposure to the bronchial epithelium (a specific region of the lung thought to be the source for lung cancer) from inhalation of radon daughter products. Using the NCRP 78 equations, this new weighting factor results in a reduction of the effective dose by a factor of three. Incorporation of factors from this report allows comparison to dose estimates provided in the Fernald Dosimetry Reconstruction Project performed by Radiological Assessments Corporation under contract with the Centers for Disease Control.
- ICRP 65 report (ICRP 1994b)
  This report suggests the use of detriment coefficients for estimating dose from exposure to radon daughter products. These detriment coefficients are based on epidemiological studies of the lung cancer rates among uranium miners. The new coefficients result in a dose conversion factor of approximately 500 mrem per working level-month. This report was released in 1994 and represents a more recent methodology for calculating radon dose.

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Table 6-2 presents the 2003 radon dose estimates, and includes concentration values for fenceline and background locations as well as DOE radon concentration limit values. Estimated working level-month exposures are given for each concentration value, as well as effective dose equivalents using the NCRP 78, ICRP 66, and ICRP 65 methods. Doses were calculated from annual average continuous radon data (assuming the suggested environmental radon daughter product equilibrium concentration of 70 percent). All dose estimates are for a hypothetical maximally exposed reference man of average body size and breathing rate who continuously breathed air at the site's fenceline while engaged in light, physical activity 24 hours a day for the entire year. This exposure scenario is highly conservative, but suggests that in using the ICRP 65 methodology the dose from radon emissions at the fenceline monitor nearest a public receptor is 18 mrem (0.18 mSv) per year above background.

Although there are no regulatory limits for dose from radon and its daughters, the radon concentration limits imposed by DOE Order 5400.5 provide a benchmark for evaluating the estimated doses from radon at the Fernald site boundary. In DOE Order 5400.5, the annual average radon concentration limit at the facility boundary is 3 pCi/L above background. Using the ICRP 65 methodology, a concentration of 3 pCi/L equates to an effective dose equivalent of 547 mrem (5.48 mSv). As presented in Table 6-2, the maximum measured radon concentration and corresponding dose at the Fernald site boundary are well below the limits associated with DOE Order 5400.5.

TABLE 6-2
2003 RADON DOSE ESTIMATE[a]

Location	Radon Concentration (pCi/L)	Exposure in Working Level-Months	NCRP 78 Effective Dose Equivalent Equation (mrem)[b]	(mrem)[c]	ICRP 65 Effective Dose Equivalent (mrem)[d]
Background	0.3	0.108	216	72	55
FCP Fenceline Nearest Receptor (net, above background)	0.1	0.036	72	24	18
Maximum Fenceline (net, above background)	0.3	0.108	216	72	55
DOE Order 5400.5 Limit (net, above background)	3.0	1.08	2,160	720	547

[a]Assuming the suggested environmental radon daughter product equilibrium concentration of 70 percent.
[b]NCRP 78 suggests whole lung tissue weighting factor of 0.12.
[c]NCRP 78 calculation using the ICRP 66 bronchial epithelium weighting factor of 0.04.
[d]Using the dose conversion factor for the maximally exposed reference man.

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6.7 Estimated Dose to Biota

DOE Order 5400.5 requires that populations of aquatic biota be protected at a dose limit of 1 rad/day (10 milliGray per day [mGy/day]). The DOE has issued a technical standard entitled, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (DOE 2002b) and supporting software (RAD-BCG) for use in the evaluating and reporting of compliance with biota dose limits.

In general, the dose and compliance assessment process involves comparing concentrations of contaminants measured in surface water and sediment samples to established Biota Concentration Guides (BCGs) for specific radionuclides. More specifically, the measured contaminant concentration in water and/or sediment is divided by the appropriate BCG value. If the resulting fraction is less than 1.0, compliance with the biota dose limit is assured. The BCGs were set so that real biota exposed to such concentrations would not be expected to exceed the biota dose limit of 1 rad/day (10 mGy/day) during a calendar year. BCGs have been established for a set of radionuclides that are relatively common constituents in past radionuclide releases to the environment from DOE facilities. At facilities such as Fernald, where multiple contaminants (e.g., uranium, radium, and thorium) can be released, a "sum of the fractions" rule applies. Compliance with the biota dose limit is assured if the sum of the fractions from multiple contaminants is less than 1.0.

For 2003 compliance with the dose limit to aquatic biota was determined by using the maximum concentrations of applicable radionuclides found in effluent discharged to the Great Miami River (refer to Chapter 4) as input into the RAD-BCG computer model. The results of the assessment indicate that the sum of the fractions was 0.035, which is well below the compliance threshold value of 1.0.

Detailed data and information on evaluating compliance with the biota dose limits for 2003 and previous years are provided in Appendix C, Attachment C.6, of this report.

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Chapter 7
Natural Resources

7.0 Natural Resources

This chapter provides background information on the natural resources associated with the Fernald site and summarizes the activities in 2003 relating to these resources. Included in this chapter is a discussion of the following:

- Threatened and endangered species
- Impacted habitat areas
- Ecological restoration activities
- Cultural resources.

Much of the 1,050 acres (425 hectares) of the Fernald site property is undeveloped land that provides habitat for a variety of animals and plants. Wetlands, deciduous and riparian (stream side) woodlands, old fields, grasslands, and aquatic habitats are among the site's natural resources. Some of these areas provide habitat for state and federal endangered species. Cultural resources, such as prehistoric archaeological sites, can also be found at the Fernald site. Monitoring of these natural and cultural resources is addressed in the Natural Resource Monitoring Plan, which is included in the IEMP. This document presents an approach for monitoring and reporting the status of several priority natural resources in order to remain in compliance with the pertinent regulations and agreements.

7.1 Threatened and Endangered Species

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

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

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

Spring Coral Root - The state-listed threatened spring coral root (*Corallorhiza wisteriana*) is a white and red orchid that blooms in April and May, and grows in partially shaded areas of forested wetlands and wooded ravines. This plant has not been identified at the Fernald site; however, suitable habitat exists in portions of the northern woodlot.

The Endangered Species Act requires the protection of any federally listed threatened or endangered species, as well as any habitat critical for the species' existence. Several Ohio laws mandate the protection of state-listed endangered species as well. Since 1993 a number of surveys have been conducted to determine the presence of any threatened or endangered species at the Fernald site. As a result of these surveys, the federally endangered Indiana brown bat and the state-threatened Sloan's crayfish have been found at the Fernald site. In addition, suitable habitat exists at the site for the federally endangered running buffalo clover and the state-threatened spring coral root. Neither of these species has been found on the property, but their habitat ranges encompass the site. Figure 7-1 shows the habitats and potential habitats of these species. Based on provisions set forth in the IEMP, any threatened or endangered species habitat will be surveyed prior to any remediation or restoration activities. If threatened or endangered species are present, appropriate avoidance or mitigation efforts will be undertaken. No surveys were conducted in 2003.

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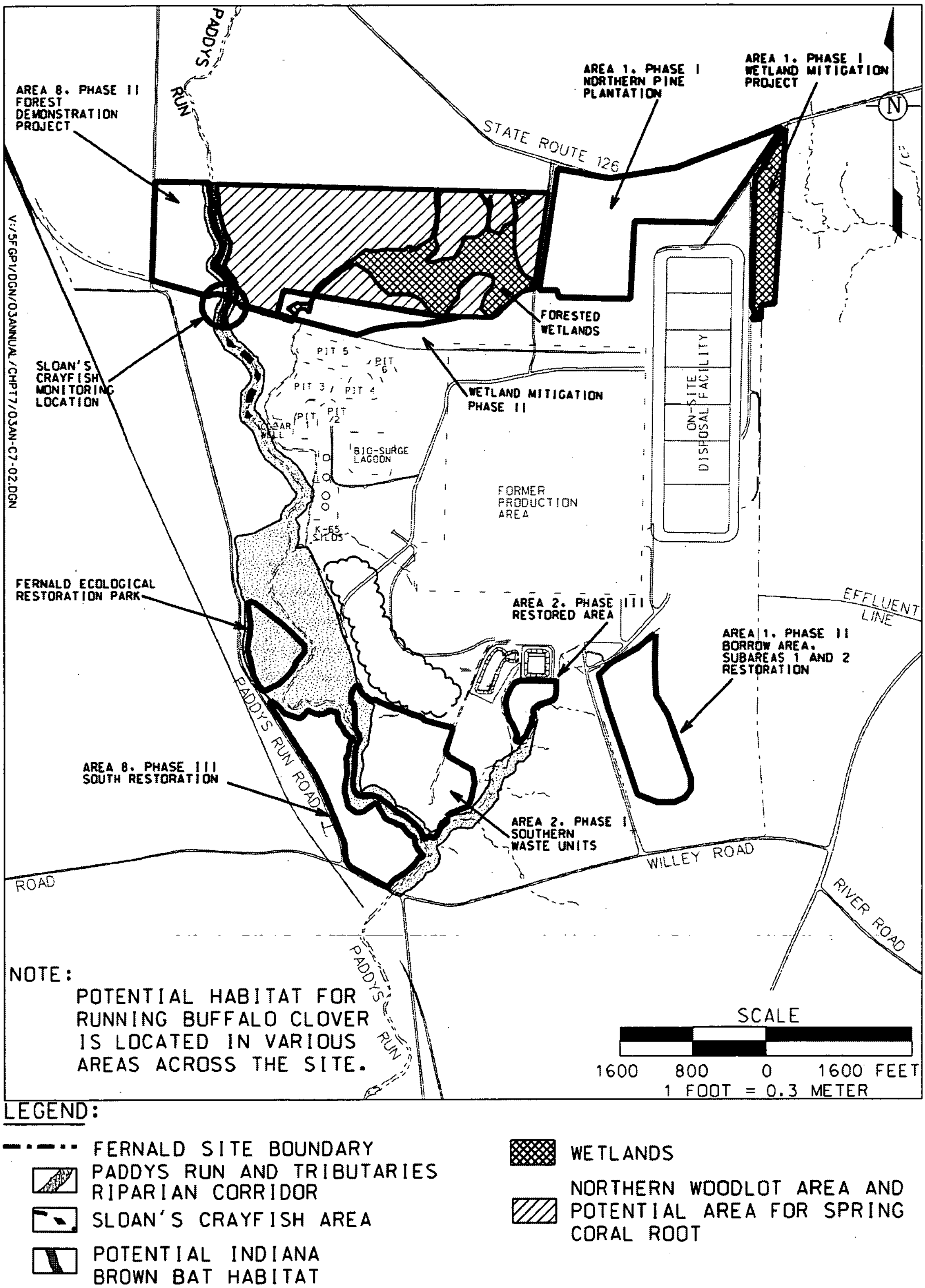

Figure 7-1. Priority Natural Resource Areas

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7.1.1 Sloan's Crayfish Monitoring and Provisions for Protection

A Sloan's crayfish survey was conducted in August 2001 in order to determine if there were any impacts following debris removal near Paddys Run in Area 1, Phase III. The survey results from the 2001 sampling effort demonstrated that the Paddys Run Sloan's crayfish population was not impacted by the debris removal operation. A large number of individuals were observed both downstream and upstream of the project area. Researchers did note a general decline in the ratio between Sloan's crayfish and *Orconectes rusticus*, which is a larger, more aggressive crayfish species that often competes with the Sloan's crayfish. Similar trends are observed statewide, and are attributed to the aggressive nature of *Orconectes rusticus*.

The IEMP originally required that visual field inspections of sediment loading be conducted within one day of a "significant rain event," which is considered to be 0.5 inch (1 cm) or more of rain in one 24-hour period. The purpose of this field-inspection monitoring is to determine if there is an increase of sediment in the northern reaches of Paddys Run due to remediation activities. Sediment loading can adversely impact the Sloan's crayfish by restricting its ability to "breathe" in water. If remediation activities cause sustained (four to five days) increased sediment loading to Sloan's crayfish habitat in Paddys Run, alternatives such as crayfish relocation are considered. Figure 7-1 identifies the Sloan's crayfish monitoring location.

The Sloan's crayfish monitoring program was suspended in 2002 because construction activities in the area decreased and episodes of increased sediment loading were rare. However, the program was resumed briefly in February 2003 due to railyard expansion activities and again in November 2003 when grading activities for the Wetland Mitigation Project (Phase II) commenced. Monitoring has continued since November 2003. No instances of increased sediment loading were observed during 2003 monitoring efforts.

7.2 Impacted Habitat

DOE and the Natural Resource Trustees tentatively agreed that it would not be necessary to quantitatively assess habitat impacted through remediation because DOE will be conducting natural resource restoration on approximately 884 acres (358 hectares) of the site. Therefore, a summary of the year's habitat impacts is presented here.

A small (less than one acre [0.4 hectare]) forested area was disturbed in order to remove contamination in Area 2 (Phase II). Several trees were cleared to accommodate access and excavation. This area was reseeded and stabilized with coir matting after remedial activities were completed. Additionally, several small areas (less than 1 acre [0.4 hectare]) of grasses and pine plantation were cleared in support of extraction well installation activities. Where possible, disturbed areas were reseeded with native grasses and wildflowers.

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7.3 Ecological Restoration Activities

Ecological restoration of the Southern Waste Units was completed, while restoration of the Northern Pine Plantation continued in 2003. Several additional projects were initiated in 2003, including Area 8 (Phase III) South Restoration, Phase II of the Wetland Mitigation Project, and Subareas 1 and 2 of the borrow area restoration. These projects are described in more detail below and are identified on Figure 7-1. Figure 7-1 also shows the location for previous restoration projects implemented at the Fernald site. Ecological restoration monitoring activities for several projects also continued in 2003.

The Area 2 (Phase I) Southern Waste Units Restoration Project encompasses approximately 25 acres (10 hectares) in the southwest portion of the Fernald site property. The area consists of the former active and inactive flyash piles, the South Field, and the Carolina area. The ecological restoration objectives for this project are to expand the riparian corridor along Paddys Run, create several open water and wetland areas, and establish the early stages of forest communities in upland areas. Several of the open water areas provide additional recharge to the Great Miami Aquifer. The project involves extensive soil amendment and seeding, and planting over 4,300 trees and shrubs. Soil amendment is the process of improving compacted, low-nutrient soils that remain following remediation. Organic matter, such as woodchips and compost, is incorporated into the ground with a disk or plow. These amendments improve growing conditions by loosening the soil, retaining moisture in the soil, and adding nutrients to the soil.

The Area 1 (Phase I) Northern Pine Plantation Restoration Project involves the conversion of the planted pine plantation in the northern portion of the Fernald site to the early stages of a deciduous forest with interspersed areas of wetlands and grasslands. The overall restoration objective is to enhance the Northern Pine Plantation by increasing the diversity of vegetation in the area through planting over 4,600 trees and shrubs, and creating new wetland and vernal pool features. Native deciduous trees and shrubs are to be planted between remnant patches of pines. The existing stand of deciduous trees in the northwestern portion of the Northern Pine Plantation is to remain unchanged except for continued efforts to eliminate invasive and aggressive species (e.g., honeysuckle, wild grape, garlic mustard, multiflora rose) during project implementation and monitoring. In 2003 all grading and planting activities were completed. Existing drainage swales and depressions were expanded, creating new wetland features. Vegetative cover of the wetland areas was accelerated by planting grasses, sedges, rushes, and wildflower plugs within the wetland footprints. Additional aquatic vegetation and organisms were transferred in muck that was obtained from existing wetlands. Drainage swales were also planted with dormant willow cuttings. In upland areas, all remaining trees and shrubs were planted and seeding of access paths was completed. Access corridors for deer movement were interspersed throughout the project area, and deer exclusion fencing was installed around plants susceptible to browsing. All cleared areas of the Northern Pine Plantation project area were seeded with native prairie grasses.

In Area 8 (Phase III) South, restoration objectives involve converting former pastures into tallgrass prairies and expanding the forested corridor along Paddys Run. The first phase of this project was initiated in the fall. Approximately 700 trees and shrubs were planted within an 8-acre (3.2-hectare) pasture adjacent to Willey Road. Workers also prepared two pastures for seeding with native grasses and wildflowers. In addition, invasive bush honeysuckle was cleared from existing forested areas. Work will continue in 2004 with additional tree and shrub plantings, and seeding prairie areas.

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The Wetland Mitigation Project (Phase II) involves the restoration of an 8-acre (3.2-hectare) former borrow area north of the waste pits. Three shallow basins will be constructed and planted with a variety of wetland grasses, sedges, rushes, and wildflowers. Water will enter the basins from adjacent wetlands of the Northern Woodlot. Water control structures will be used to regulate the depth of water within each basin. The Wetland Mitigation Project (Phase II) will contribute about 5 acres (2 hectares) toward the site wetland mitigation requirements. In 2003 grading of the basins and spillways was initiated, and the water control structures were installed. Construction activities will continue in 2004, including the completion of berm construction, spillway installation, addition of topsoil, wetland plug planting, and seeding. Clearing of invasive plants in the Northern Woodlot will be conducted to prepare for tree planting and seeding. "Invasive" plants are non-native species that can quickly overtake an area by out-competing native vegetation for available resources. For instance, bush honeysuckle aggressively invades semi-shaded woodlands and forest edges. These shrubs grow so dense that native wildflowers, shrubs, and tree seedlings cannot get enough light to survive. As a result, native plant diversity is severely reduced and secondary succession (the process of natural habitat regeneration) is permanently altered. Field personnel use several methods to clear invasive species, such as mowing, cutting, pulling, and/or spraying with herbicide.

Borrow area restoration involves the creation of wetlands and tallgrass prairies across the southeast portion of the Fernald site. Subareas 1 and 2 of this project were completed in 2003. Activities included the construction of several shallow ponds and swales, and the seeding of wetland vegetation across the project area.

Ecological restoration monitoring has been divided into two phases: the Implementation Phase and the Functional Phase. Implementation Phase monitoring is conducted to ensure that restoration projects are completed as intended in their designs. This effort involves the mortality counts and herbaceous cover estimates that are conducted after a project is completed. 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. Mortality and herbaceous cover thresholds are described in the 2002 Consolidated Monitoring Report for Restored Areas at the Fernald Closure Project (DOE 2003a). Generally, additional planting is needed if vegetation survival drops below 80 percent or herbaceous cover drops below 90 percent. However, each project is evaluated on a case-by-case basis, and consideration is given to factors such as deer browsing impacts.

In 2003 implementation monitoring continued for the Area 1 (Phase I) Wetland Mitigation Project and was initiated for the Southern Waste Units. In the Wetland Mitigation Project, monitoring was limited to photo observations of each wetland basin. Comparison with earlier photos documents that the project is maturing as planned.

Implementation monitoring continued for the Southern Waste Units as vegetation survival and herbaceous cover were evaluated. Overall vegetation survival is approximately 78 percent. Mortality appears to be due primarily to mammal browsing on shrubs. Deer pressure continues to be an issue within restored areas at the Fernald site. However, the results of the monitoring effort are encouraging because new techniques for controlling deer browsing proved very effective. Restoration personnel began fencing selected shrub patches within the Southern Waste Units. The fencing was successful at preventing mammals from browsing on planted shrubs. As a result, the use of fencing around shrub patches will be increased in future restoration projects. 000134

Herbaceous cover surveys demonstrated typical progress for seeded areas that are in their first year of growth. Native grasses and wildflowers were successfully established across the project area. However, these species spend most of their energy growing a deep root system in their first year or two; therefore, much of the seeded vegetation was still small in size.

Functional Phase monitoring at the Fernald site involved the characterization of restored wetland communities. Wetland vegetation in the Area 1 (Phase I) Wetland Mitigation Project, the Area 8 (Phase II) Forest Demonstration Project, and the restored area in Area 2 (Phase III) were compared to baseline and reference sites. Each of these areas showed considerable progress. In general, the diversity and quality of native vegetation present in these restored areas was very near the levels measured in established referenced sites. In 2004 several restored prairie and savanna areas will be evaluated.

*The common arrowhead (*sagittaria latifolia*) thriving in the restored wetlands on site.*

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7.4 Cultural Resources

The Fernald site 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 historic time, resulting in richly diverse cultural resources. In summary, 148 prehistoric and 40 historic sites have been identified within 1.24 miles (2 km) of the Fernald site.

Several laws have been established to protect cultural resources during remedial activities at the Fernald site. The National Historic Preservation Act requires DOE to take into consideration 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 requires that prehistoric human remains and associated artifacts be identified and returned to the appropriate Native American tribe.

To comply with these laws, DOE conducts archeological surveys prior to remediation activities in undeveloped areas of the Fernald. Figure 7-2 shows that the majority of the site has been surveyed. These surveys have resulted in the identification of six sites that may be eligible for listing on the National Register of Historic Places. None of these sites was impacted by remediation activities and no additional surveys were needed in 2003.

DOE also keeps track of unexpected discoveries of cultural resources during remediation activities at the Fernald site. Table 7-1 lists the artifacts that were encountered in 2003. None of the findings was significant, and no impacts to cultural resources occurred.

TABLE 7-1
UNEXPECTED CULTURAL RESOURCE DISCOVERIES FOUND IN 2003

Unexpected Discovery[a]	Time Period	Location of Discovery[b]
Ceramic earthenware	Historic (1770-1880)	Area 2 (Phase II)
Ceramic whiteware	Historic (1820-1900)	Area 2 (Phase II)
Ceramic yellowware	Historic (1830-1900)	Area 2 (Phase II)
Skeletal Remains (animal)	Historic	Area 1 (Phase II)
Metal (iron-steel)	Historic	Area 1 (Phase II)
Projectile point	Prehistoric (Early Archaic 6300-5800 BC)	Area 9 (Phase II)
Projectile point	Prehistoric (Adena 800-300 BC)	Area 9 (Phase II)
Blade	Prehistoric (Fort Ancient Madison Phase 1450-1660 AD)	Area 8 (Phase I)
Projectile Point	Prehistoric (Fort Ancient Schomaker Phase 1250-1450 AD)	Area 9 (Phase II)

[a]No further excavation is warranted.
[b]Identified by soil remediation area. Refer to Figure 2-1.

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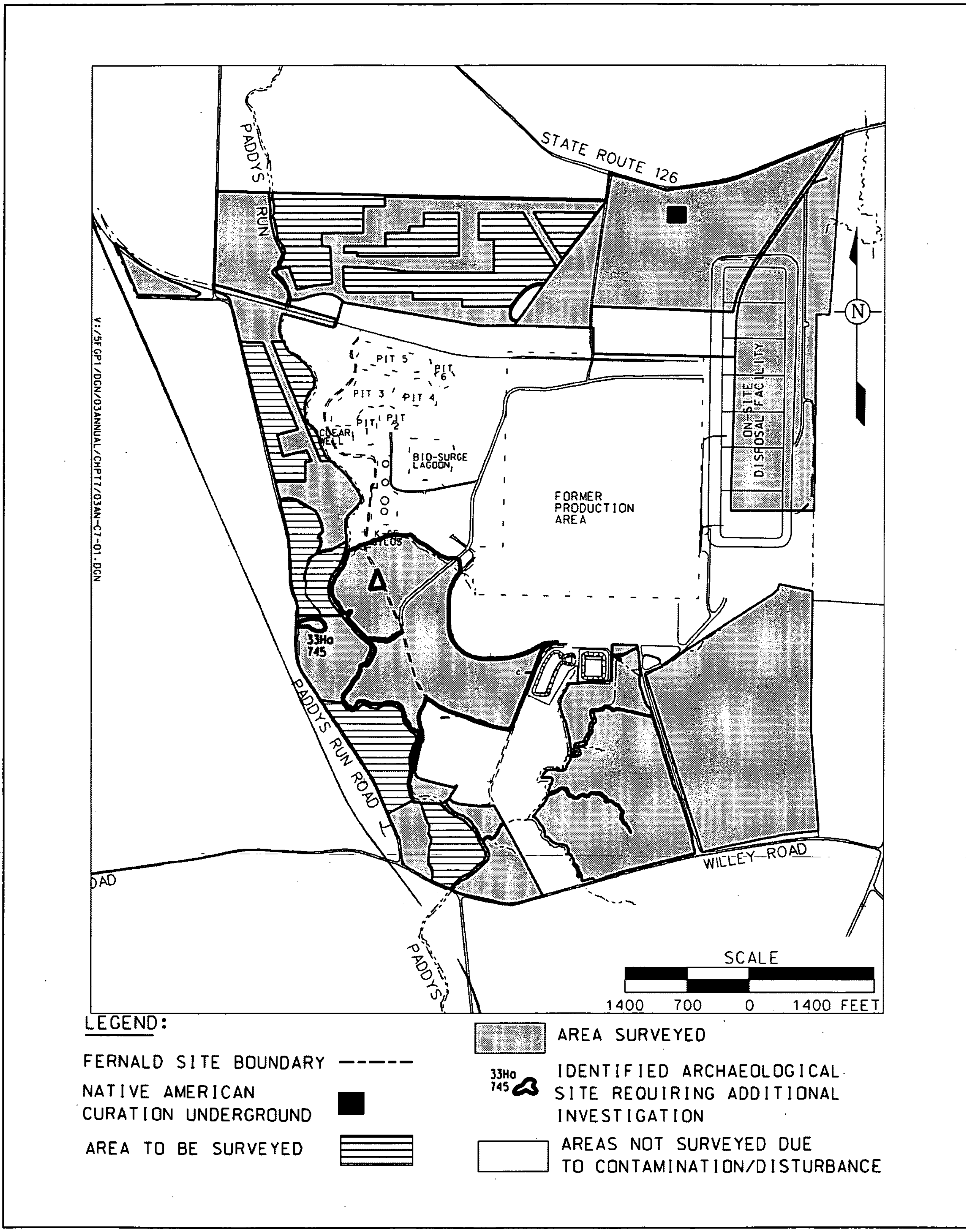

Figure 7-2. Cultural Resource Survey Areas

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Glossary

Glossary

ALARA

An acronym for "as low as reasonably achievable." Used to describe an approach to radiation exposure and emissions control or management, whereby exposures and resulting doses to workers and the public are maintained as far below the specified limits as economic, technical, and practical considerations will permit.

Alpha Particle

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

Aquifer

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

ARARs

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

Background Radiation

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

Beta Particle

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

Bypass Events

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

Capture Zone

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

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Certification — The process by which a soil remediation area is certified as clean. Samples from the area are collected and analyzed, and the contaminant levels compared to the final remedial levels established in the Operable Unit 5 Record of Decision. Not all soil remediation areas at the Fernald site require excavation before certification is done.

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

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

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

Dose — Quantity of radiation absorbed in tissue.

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

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

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

Flyash — The ash remaining after the burning of coal in a boiler plant.

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

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

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

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

Head Works Includes the various flow equalization basins and/or preliminary treatment units which serve as the central collection and distribution points to the wastewater treatment operations in the main facility.

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

Opacity The amount of light that is blocked by particulates present in stack emissions.

Overpacking The act of placing a deteriorating drum inside a new, larger drum to prevent further deterioration or the possible release of contaminants during storage.

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

Radiation The energy released as particles or waves when an atom's nucleus spontaneously loses or gains neutrons and/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, both artificially produced and naturally occurring. Radionuclides are characterized by the number of neutrons and protons in an atom's nucleus and their characteristic decay processes.

Receptors Individuals or organisms that are or could be impacted by contamination.

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

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

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

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

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

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

Surface Water Water that is flowing within natural drainage features.

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

Thermoluminescent Dosimeter A device used to monitor the amount of radiation to which it has been exposed.

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

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

Waste Acceptance Criteria Disposal facilities specify the types and sizes of materials, acceptable levels of constituents, and other criteria for all material that will be disposed in that facility. These are known as waste acceptance criteria. Off-site disposal facilities that will dispose of Fernald waste (such as the Nevada Test Site) have specific waste acceptance criteria. In addition, the on-site disposal facility has waste acceptance criteria that have been approved by the regulatory agencies. The Waste Acceptance Organization is responsible for ensuring that all waste to be placed in the on-site disposal facility meets all these criteria before waste placement.

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