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1999 INTEGRATED SITE ENVIRONMENTAL REPORT

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

MAY 2000

U.S. DEPARTMENT OF ENERGY

51350-RP-0010
REV. 0
FINAL

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List of Acronyms

ALARA	as low as reasonably achievable
AMS	air monitoring station
ARARs	applicable or relevant and appropriate requirements
BTV	benchmark toxicity value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Agreement
FRL	final remediation level
gpm	gallons per minute
ICRP	International Commission on Radiological Protection
IEMP	Integrated Environmental Monitoring Plan
mrem	millirem
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
OEPA	Ohio Environmental Protection Agency
OSDF	on-site disposal facility
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendment and Reauthorization Act
TLD	thermoluminescent dosimeter
TSCA	Toxic Substance Control Act

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Units (Abbreviations) and Conversion Table 3003

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	10^{12}	pCi
pCi/L	10^{-6}	microcuries per liter (μCi/L)	μCi/L	10^{6}	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
rem	0.01	Sievert	Sv	100	rem
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

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The Fernald Environmental Management Project's (FEMP) 1999 Integrated Site Environmental Report is prepared in accordance with U.S. Department of Energy (DOE) Order 5400.1, General Environmental Protection Program, and the FEMP's Integrated Environmental Monitoring Plan (IEMP), Revision 1 (DOE 1999b). This annual report provides FEMP stakeholders with the results from the FEMP's environmental monitoring program for 1999 and provides a summary of DOE's progress toward final remediation of the FEMP. In addition, this report provides a summary of the FEMP's compliance with the various environmental regulations, compliance agreements, and DOE policies which govern FEMP activities. All information presented in this Executive Summary is discussed more fully within the body of this summary report and the supporting appendices.

During 1999 the FEMP continued to make significant progress toward final cleanup goals established for the site. A wide range of environmental remediation activities continued during the year including:

- Decontamination and dismantlement of former production buildings and support facilities (Operable Unit 3)
- Excavation and shipment of 89,627 tons (81,310 metric tons) of contaminated waste pit material and soil to the off-site disposal facility Envirocare of Utah, Inc. (Operable Unit 1)
- Large-scale excavation of contaminated soil (Operable Unit 5) and materials from the waste units (Operable Unit 2)
- Placement of approximately 230,000 cubic yards (175,900 cubic meters) of contaminated soil and debris in the on-site disposal facility (Operable Unit 2)
- Extraction of 1,700 million gallons (6,434 million liters) of contaminated groundwater from the Great Miami Aquifer (Operable Unit 5)
- Treatment of approximately 1,200 million gallons (4,500 million liters) of contaminated groundwater (Operable Unit 5).

In addition to these activities, construction of waste processing buildings was completed and material drying operations were initiated (Operable Unit 1). The FEMP submitted the draft proposed plan for remedy selection for Silos 1 and 2 wastes to the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA) and awarded a contract to perform advanced waste retrieval (Operable Unit 4). The remedy for the Silo 3 Project was approved by EPA and OEPA and a contract was awarded for the design, construction, and operation of the Silo 3 stabilization/solidification facility (Operable Unit 4).

The following sections highlight the results of environmental monitoring activities conducted during 1999.

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Liquid Pathway Highlights

Groundwater Pathway

The groundwater pathway is routinely monitored at the FEMP to:

- Determine capture and restoration of the total uranium plume, capture and restoration of non-uranium final remediation level (FRL) constituents, and 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 1999 active restoration of the Great Miami Aquifer continued within each of the groundwater restoration modules:

- South Field (Phase I) Extraction Module – continued pumping from nine extraction wells. Two new extraction wells were installed as a result of a newly defined area of uranium contamination in the South Field area. Pumping is scheduled to begin in early 2000.
- South Plume Module/South Plume Optimization Module – continued pumping from six extraction wells
- Re-Injection Demonstration Module – continued injecting water into the aquifer via five re-injection wells.

In addition, approximately 140 monitoring wells were sampled at various frequencies to determine water quality. Water elevations were measured quarterly in up to 184 monitoring wells. The following highlights describe the key findings from the 1999 groundwater data:

- A total of 1,700 million gallons (6,434 million liters) of groundwater were pumped from the Great Miami Aquifer and 433 million gallons (1,639 million liters) of water were re-injected into the aquifer. As a result of these restoration activities, 698 pounds (318 kilograms) of uranium were removed from the aquifer.
- The results of 1999 groundwater capture analysis and monitoring for total uranium and non-uranium constituents indicate that the design of the enhanced groundwater remedy for the aquifer restoration system is appropriate for capture of the plume. However, as identified above, two new extraction wells were installed as a result of a newly defined area of uranium contamination in the South Field area and will begin pumping in early 2000. The installation of these additional extraction wells during 1999 was not required to maintain capture of the plume; however, they were necessary to support the accelerated aquifer remediation schedule.
- Pumping of the South Plume/South Plume Optimization Module continued to meet the objective of preventing the further southward migration of the southern total uranium plume beyond the extraction wells.

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- The one-year re-injection demonstration, designed to determine the feasibility of large-scale groundwater re-injection to accelerate the remediation of the uranium plume, was completed in 1999. The preliminary evaluation indicated that the testing results are favorable regarding the viability of re-injection at the FEMP, that a reliable source of injection water can be maintained, and that an acceptable injection rate can be sustained without negative effects on the plume or aquifer. A report discussing the results of the demonstration is scheduled for release in June of 2000.

Leak detection monitoring at Cells 1, 2 and 3 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.

Surface Water and Treated Effluent Pathway

Surface water and treated effluent are monitored to determine the effects of FEMP 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, which was approved by the agencies during the 1999 review of the IEMP.

In 1999, 15 surface water and treated effluent locations were sampled at various frequencies and 16 sediment locations were monitored. The following highlights describe the key findings from the 1999 surface water and treated effluent along with sediment data:

- The estimated total pounds of uranium released through the surface water and treated effluent pathway (approximately 419 pounds [190 kg]) decreased 20 percent from the 1998 estimate of 521 pounds (237 kg). This decrease is due, in part, to a reduction in precipitation during 1999 and a revision to the loading term factor used for uncontrolled runoff estimates, which was approved by EPA and OEPA.

- No surface water or treated effluent analytical results from samples collected in 1999 exceeded the FRL for total uranium, the site's primary contaminant. FRL exceedances were limited to two constituents (manganese and chromium), while no benchmark toxicity value exceedances occurred. These occasional, sporadic exceedances are expected to occur until site remediation is complete.

- Permitted discharges were in compliance with the current National Pollutant Discharge Elimination System (NPDES) Permit requirements 99.5 percent of the time. Exceedances of the total suspended solids limit accounted for the permit excursions observed in 1999. No additional exceedances occurred after April 1999 due to operation improvements at the new sewage treatment plant.

The 1999 sediment results were within the range of historical concentrations. In addition, there were no FRL exceedances for sediment in 1999.

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Air Pathway Highlights

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

Radiological Air Particulate Monitoring

- Data collected from the network of 16 fenceline and two background air monitoring stations showed that the annual average radionuclide concentrations were all less than one percent of DOE derived concentration guidelines contained in DOE Order 5400.5, Radiation Protection of the Public and the Environment.

- The maximum effective dose at the fenceline from 1999 airborne emissions (excluding radon) was estimated to be 0.29 millirem (mrem) per year and occurred at AMS-3 along the eastern fenceline of the site. This represents 2.9 percent of the annual National Emission Standards for Hazardous Air Pollutants Subpart H standard of 10 mrem.

Radon Monitoring

In 1999 the continuous radon monitoring network was expanded to provide more frequent data on ambient radon levels and to compensate for the elimination of alpha track-etch cups.

- The annual average radon concentration recorded at the FEMP fenceline ranged from 0.3 picoCuries per liter (pCi/L) to 0.8 pCi/L (inclusive of background concentrations). Fenceline results were well below the DOE standard of 3 pCi/L above background concentrations. Annual average background concentrations measured in 1999 ranged between 0.2 pCi/L and 0.3 pCi/L.

- Radon concentrations in the vicinity of Silos 1 and 2 (part of Operable Unit 4) continued to exhibit an increasing trend in 1999, as did the radon concentrations within the silo head space. This was due to the protective layer of bentonite clay (placed over the silo material in 1991 to lower head space radon concentrations) continuing to "dry out" and lose effectiveness during 1999. As a short-term solution, DOE decided to repair known leaks, then re-seal the dome with a spray-on coating and/or impermeable membrane in order to reduce radon emissions. Re-sealing activities were initiated in late May 1999, and were completed on June 4, 1999. The fourth quarter 1999 combined average radon concentration for the monitors around the silos was approximately 70 percent lower than the fourth quarter 1998 average, suggesting the re-sealing activities contributed to a substantial reduction in radon concentrations at the K-65 Silo area.

Direct Radiation Monitoring

Measurements of direct radiation indicate that levels increase with proximity to Silos 1 and 2. The increasing direct radiation measurements correlate with the increasing radon concentrations and associated decay products in the head spaces of these silos. These levels remain approximately 61 percent lower than radiation levels measured in 1991 prior to the addition of the bentonite layer to Silos 1 and 2. Direct radiation measurements at the western fenceline of the FEMP nearest to the silos decreased slightly from 1998.

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Estimated Dose for 1999

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In 1999 the maximally exposed individual living nearest the FEMP in a west-southwest direction could have hypothetically received a maximum dose of approximately 8.4 mrem. This estimate represents the maximum incremental dose above background attributable to the FEMP. This dose is exclusive of the dose received from radon. The contributions to this all-pathway dose were 0.09 mrem from air inhalation dose and 8.3 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.

Natural Resources

Natural resources encompass the rich diversity of plant and animal life and their supporting habitats found in and around the FEMP. During 1999 the following activities associated with natural resource monitoring and restoration occurred.

- A survey was conducted in 1999 for the federally endangered Indiana brown bat along the northern reach of Paddys Run in advance of ecological restoration activities in a northwestern sector of the FEMP (soil remediation Area 8, Phase II). Of the 35 bats captured, one was an adult female Indiana brown bat, the first confirmed occurrence at the FEMP.

- A survey was conducted for the Sloan's crayfish, a threatened species in the State of Ohio, in the northern reach of Paddys Run in June 1999. Researchers identified 117 Sloan's crayfish. Many of the crayfish identified were juveniles, which suggests successful breeding among the Paddys Run population. Monitoring was also conducted to evaluate the impacts to Sloan's crayfish habitat in the northern reach of Paddys Run from FEMP remediation activities. This impact evaluation is based on periodic visual inspections of sediment loading in Paddys Run. Although increased sediment loading was observed on two occasions from the FEMP's northern drainage ditch, there was no impact because of their relatively short duration. At this point, while it appears the source may be the railyard sediment basin, no obvious cause can be determined for the increased sediment loading. Field observations of the railyard drainage ditches and adjoining on-site disposal facility drainage areas have been inconclusive. This has been discussed with the OEPA early in 2000. DOE will continue to monitor the northern drainage ditch following rain events to ascertain the cause of these isolated occurrences.

- Wetland mitigation efforts continued in a certified clean area in the northeastern portion of the FEMP (Area 1, Phase I). This area was converted into a 12-acre ecosystem consisting of wetland basins and streams with over 3,000 shrub and tree plantings.

- Four ecological restoration projects were undertaken to enhance natural resources at the FEMP during 1999 as part of the Operable Unit 4 dispute resolution agreement. Three of these (Re-vegetation Research Plots Project, Prairie Planting Project, and American Chestnut Research Project) can be viewed from the Fernald Ecological Restoration Park, which was developed on the western side of the site as a wildlife viewing area for the public. The Invasive Plant Control Research Project was conducted in the northern portion of the site to evaluate control techniques for the invasive amur honeysuckle.

In addition, the FEMP has a number of archeological and historical sites representative of the cultural resources of the area. To protect these valuable resources, the FEMP conducts cultural resource surveys prior to soil excavation activities in designated areas of the FEMP. During 1999 there were three unexpected cultural resource discoveries (i.e., historical pottery, chert blade, and whitetail deer remains).

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1.0 The Fernald Environmental Management Project

Abbreviated Timeline

1951 Construction of the Feed Materials Production Center began.
1952 Uranium production began.
1986 EPA and DOE signed the FFCA 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 reopened.)
1997 Environmental remediation activities continued at the FEMP, including construction of Cell 1 of the on-site disposal facility with the first waste placement beginning in December. Remedy for Silos 1 and 2 was separated from the remedy for Silo 3.
1998 Decontamination of nuclear buildings and facilities (Safe Shutdown) neared completion, operation of several aquifer restoration modules was implemented on or ahead of schedules, excavated soil volumes exceeded expectations, and cell construction at the on-site disposal facility continued.
1999 Excavation of the waste pits was initiated and 89,627 tons (81,310 metric tons) of waste was transported to Envirocare of Utah, Inc. Safe Shutdown was completed ahead of schedule and 20 site structures were dismantled. Over 2 billion gallons (7 billion liters) of water were processed and 280,000 cubic yards (210,000 cubic meters) of contaminated soil were excavated. The remedy for Silo 3 was selected.

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 and approximately 400,000 to 1,000,000 pounds (180,000 to 450,000 kg) of uranium were released to the environment. These releases resulted in contamination of soil, surface water, sediment, and groundwater on and around the site.

CERCLA Remedial Process

In broad terms, the remedial response process for remediating sites under CERCLA consists of the following three 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. There is a five-year review process which ensures that the remedy at a site is protective of human health and the environment through evaluating the implementation and performance of the selected remedy.

In 1991 the mission of the site officially changed from uranium production to environmental remediation and site restoration under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. The site was renamed the Fernald Environmental Management Project (FEMP) to reflect the changing 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 Ohio Environmental Protection Agency (OEPA).

In the 1980s programmatic 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 and report the levels of contaminants associated with uranium production operations to the regulatory agencies and the FEMP stakeholders.

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However, with the conclusion of the FEMP's uranium production mission and completion of the CERCLA remedy selection process (for all operable units except Operable Unit 4), focus is now being directed to the safe and efficient implementation of CERCLA remediation activities and facility decontamination and dismantlement operations. In recognition of this shift in emphasis toward remedy implementation, the environmental monitoring program was revised during 1997 to align with the remediation activities planned for the Fernald site.

The site's environmental monitoring program is described in the Integrated Environmental Monitoring Plan (IEMP), Revision 1 (DOE 1999b). The IEMP is updated every two years, at a minimum, to keep pace with the site's monitoring needs as remediation progresses. The current IEMP, Revision 1, describes sampling activities for 1999 and 2000. The 1999 Integrated 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 This summary report (Chapters 1 through 7) documents the results of environmental monitoring activities at the FEMP in 1999. It includes a discussion of remediation activities and summaries of environmental data from groundwater, surface water and treated effluent, sediment, air, and natural resources.

Appendices The appendices provide the 1999 environmental monitoring data for the various media, primarily in 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. This detailed information is summarized in the Summary Report for a broad audience and distribution of the appendices is generally limited to the regulatory agencies. However, a complete copy of the appendices is available for review at the Public Environmental Information Center 10845 Hamilton-Cleves highway, Harrison, OH 45030.

The remainder of this chapter provides:

- A brief overview of the FEMP's 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 FEMP
- A description of the physical, ecological, and human characteristics of the area.

1.1 The Path to Site Restoration

In 1986 the FEMP 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 FEMP was organized into five operable units in 1991. The operable units were defined based on their location and/or the potential for similar technologies to be used for environmental remediation. The initial remedy selection process ended in 1996 with approval of the final records of decision for the operable units. The Record of Decision for Silos 1 and 2 of Operable Unit 4 will be amended when the treatment methods for the silos material have been evaluated.

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A remedy for Silo 3 has already been approved by the regulatory agencies. Following approval of the initial records of decision, work began on the design and implementation of the operable unit remedies. While the operable unit management approach was successful for completing the characterization and remedy-selection process, it was not the most effective organizational structure for completing remedial design and implementing the remedial actions. In order to align sitewide responsibilities and regulatory obligations across the operable units and to efficiently execute remedial design and remedial action, the FEMP established integrated project organizations in 1996. Realignment into project organizations reflected the actual work processes and operations necessary to complete remediation while maintaining 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.

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 FEMP, 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 biota, or 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 FEMP are insignificant routes of exposure to off-site receptors. Therefore, the IEMP focuses on the primary exposure pathways.

Refer to Chapter 6 for information pertaining to 1999 dose calculations from all pathways.

1.2 Environmental Monitoring Program

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 addresses 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 areal 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 via these exposure pathways, and monitoring the pathways to measure the site's continuing impact on the environment as remediation progresses. The characterization data used to develop the final remedy was also used to focus and develop the environmental monitoring program recorded in the IEMP. The key elements of the IEMP are described below:

- 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), biota (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.

- The plan establishes an integrated data evaluation and decision-making process for each environmental medium. Through this process, environmental conditions at the site 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 remediation project organization(s) so that corrective actions can be taken before conditions become unacceptable.

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TABLE 1-1

FEMP OPERABLE UNIT REMEDIES AND ASSOCIATED PROJECT 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 Excavation of materials with constituents of concern above FRLs, waste processing and treatment by thermal drying (as necessary), off-site disposal at a permitted facility, and FEMP remediation	<u>Waste Pits Remedial Action Project</u> is responsible for rail upgrade, excavation of Operable Unit 1 waste units, waste processing and drying, loading, rail transport, and off-site disposal of contaminated soil and debris that exceed the waste acceptance criteria for the on-site disposal facility. (Note: Some of the activities associated with this project are being performed by International Technology Corporation.) <u>Soil and Disposal Facility Project</u> is responsible for directing excavation and certification of contaminated soil beneath the waste pits, as well as at- and below-grade remediation facilities, including the railroad. <u>Aquifer Restoration and Wastewater Project</u> 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 headworks of the advanced wastewater treatment facility for treatment. <u>Demolition Projects</u> is responsible for decontamination and dismantling of Operable Unit 1 remediation facilities not specifically the responsibility of International Technology Corporation.
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 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, off-site disposal of a small fraction of excavated material that exceeds the waste acceptance criteria for the on-site disposal facility and lead-contaminated soil from the South Field firing range, and FEMP remediation	<u>Soil and Disposal Facility Project</u> is responsible for excavating and disposing of waste from all Operable Unit 2 subunits and certifying the footprints. This project also is responsible for the ongoing design, construction, 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. <u>Waste Acceptance Operations</u> 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. <u>Aquifer Restoration and Wastewater Project</u> is responsible for treating contaminated runoff and perched water collected during excavation of Operable Unit 2 subunit wastes; responsible for treating leachate from the on-site disposal facility. Each project is responsible for transporting remediation wastewater to the headworks of the advanced wastewater treatment facility for treatment. This project is also responsible for monitoring leachate within the facility and perched groundwater in the till below the facility.
3	Former production area, *associated facilities*, and equipment (includes all above- and below-grade improvements) including, but not limited to: - All structures, equipment, utilities, effluent lines, and K-65 transfer line - Wastewater treatment facilities - Fire training facilities - Coal pile - Scrap metals piles - Drums, tanks, solid waste, waste product, feedstocks, and thorium	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, concreted 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	<u>Demolition Projects</u> is responsible for decontamination and dismantling of all above-grade portions of buildings and facilities at the FEMP. <u>Soil and Disposal Facility Project</u> 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. <u>Waste Acceptance Operations</u> 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. <u>Aquifer Restoration and Wastewater Project</u> 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. <u>Waste Generator Services</u> is responsible for characterizing, storing, treating, transporting, and disposing of solid waste, low level radioactive waste, hazardous/mixed waste, and nuclear materials in inventory or generated on site.

TABLE 1-1
(Continued)

Operable Unit	Description	Remedy Overview*	Project Organization/Responsibilities
4	- Silos 1 and 2 (containing K-65 esidues) - 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 Silos 1 and 2 will submit Record of Decision Amendment to EPA: December 2000 Silo 3 Explanation of Significant Differences Approved: March 1998 Removal of Silo 3 materials and Silos 1 and 2 residues and decant sump tank sludges with on-site stabilization of materials and residues and sludges followed by off-site disposal; demolition and decontamination, to the extent possible, of silos and remediation facilities; excavation of contaminated soil 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	Silo 3 Project is responsible for Silo 3 content removal, treatment, and transport off site. Silos 1 and 2 Project is responsible for transfer of Silos 1 and 2 residues content to temporary transfer tanks, treatment, and transport off site. Infrastructure and support systems such as roads and utilities will be completed to support the final remediation of the silos. Soil and Disposal Facility 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). 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. Aquifer Restoration and Wastewater Project is responsible for treating decontamination and other wastewaters during decontamination and demolition activities; each project is responsible for capturing and transporting remediation wastewater to the headwaters of the advanced wastewater treatment facility for treatment. Demolition Projects is responsible for decontamination and dismantling of all Operable Unit 4 remediation facilities and associated above ground pipings.
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 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. Site restoration, institutional controls, and post-remediation maintenance	Aquifer Restoration and Wastewater Project is responsible for designing, installing, and operating the extraction/re-injection systems for Great Miami Aquifer groundwater restoration. This group 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 of contaminated groundwater, storm water, and remediation wastewaters at the FEMP. This organization is also responsible for operation, maintenance, and monitoring of the on-site disposal facility leachate collection system and leak detection system. Soil and Disposal Facility 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. This project is also responsible for design, installation, 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 Operations is responsible for reviewing Soils and Disposal Facility Project planning documents. This organization is 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. Demolition Projects is responsible for decontamination and dismantling of all Operable Unit 5 remediation facilities.

[a]Source of information is each operable unit's record of decisions and remedial design documents.

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- Recognizing that the dominant types 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. Under the living document concept, the IEMP will be 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 under a system consisting of quarterly status reports and a comprehensive annual report.

1.3 Characteristics of the Site and Surrounding Area

The natural setting of the 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 of the site rely heavily on the physical environment. Land in the area is used primarily for livestock and crop farming and gravel pit excavation operations. A private water utility is also located approximately 1.25 miles (2.01 kilometers [km]) upstream of the site's effluent discharge to the Great Miami River.

As shown in Figure 1-1, downtown Cincinnati is approximately 18 miles (29 km) southeast of the FEMP. The cities of Fairfield and Hamilton are 6 and 8 miles (10 and 13 km) to the 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.

There is an estimated population of 14,600 within 5 miles (8 km) of the FEMP and an estimated 2.74 million within 50 miles (80 km). Figure 1-2 shows an estimate of population distribution in the surrounding areas.

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 FEMP while Paddys Run, an intermittent stream, flows from north to south along the FEMP's western boundary. In general, the FEMP lies on a terrace that slopes gently between vegetated bedrock outcroppings to the north, southeast, and southwest.

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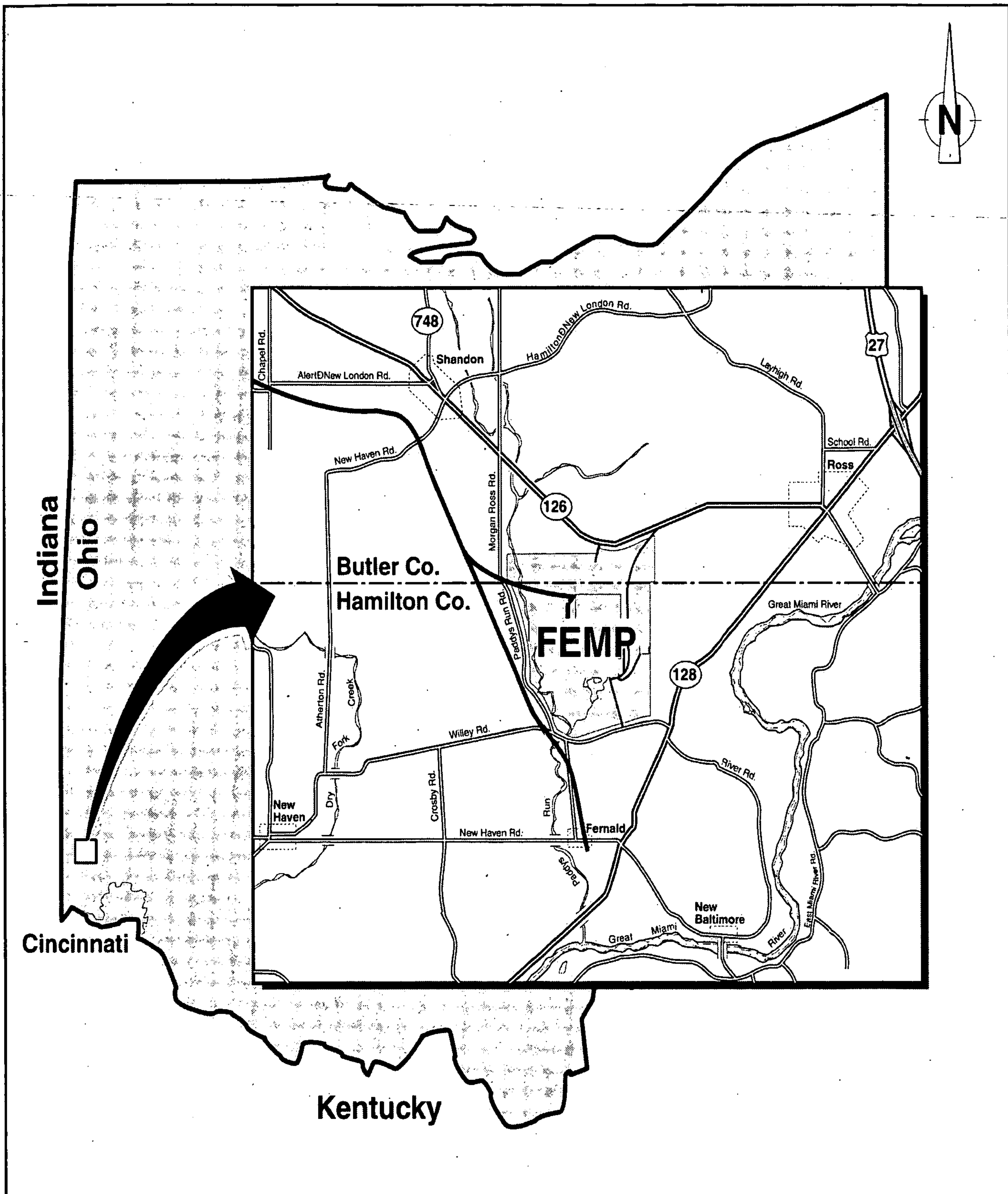

The FEMP covers about 1,050 acres (425 hectares).

Figure 1-1. FEMP and Vicinity

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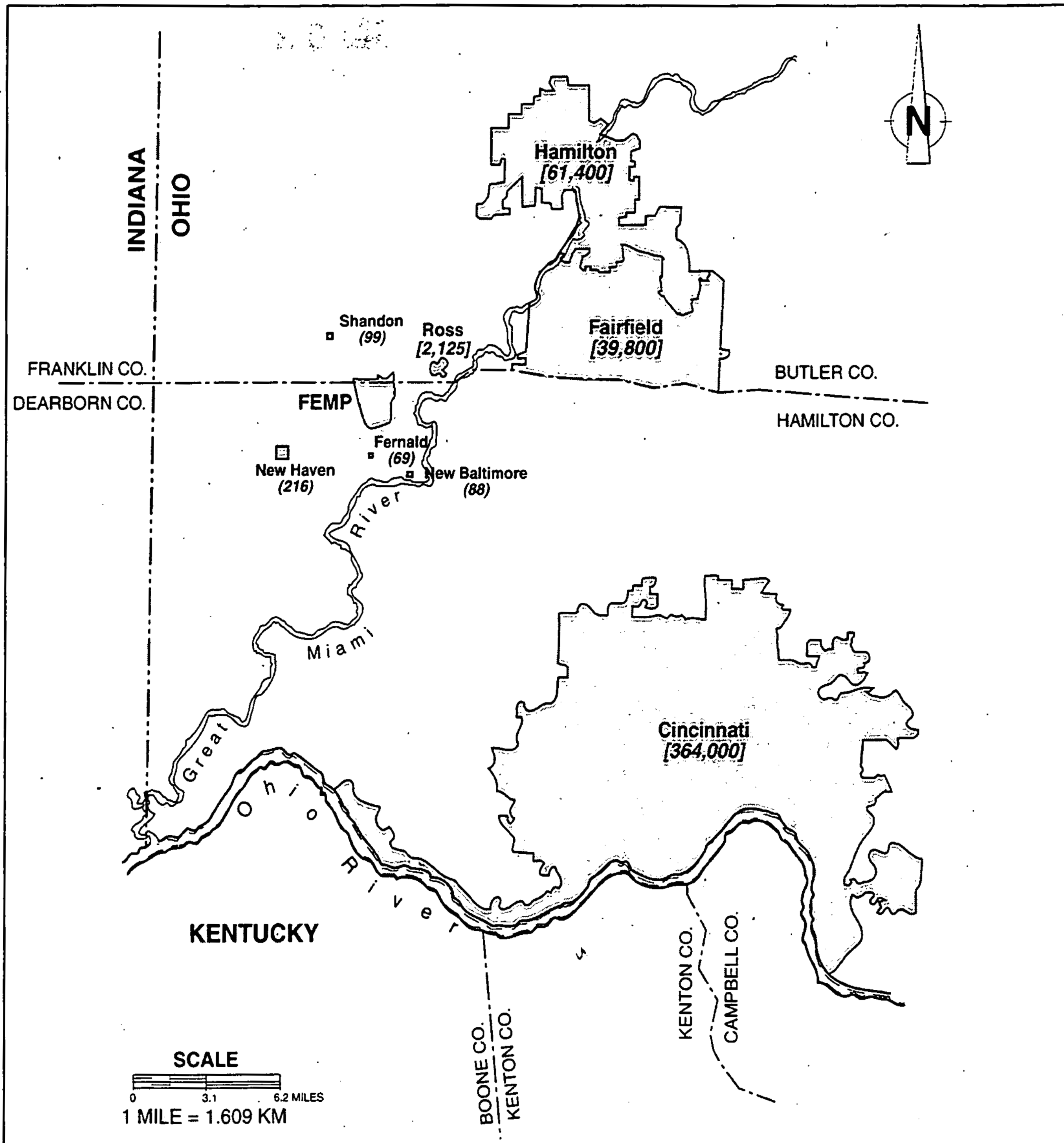

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☐ Population in parentheses estimated in 1989 and population in brackets estimated from 1990 U.S. Census Figures.

Figure 1-2. Major Communities in Southwestern Ohio

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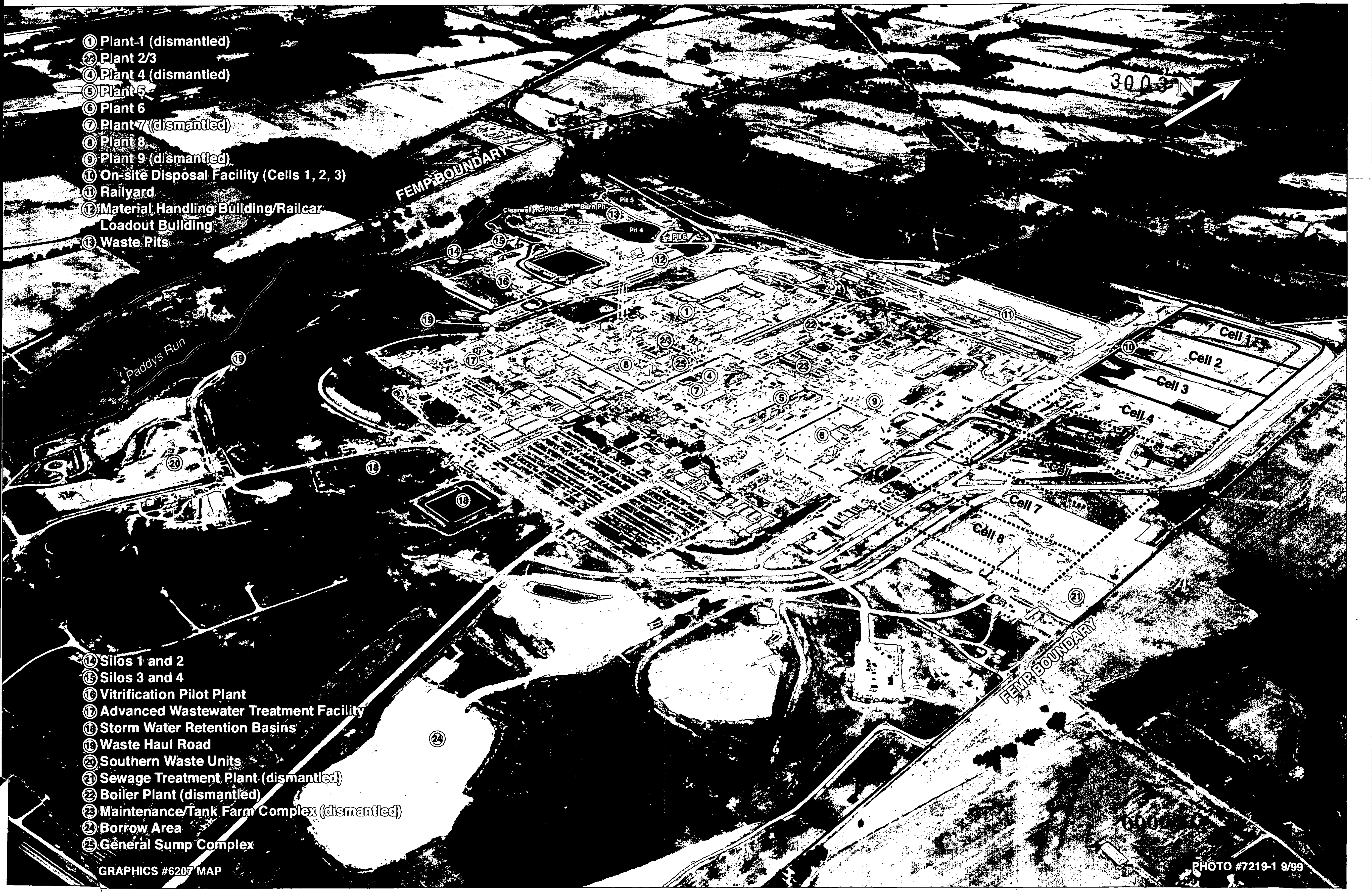
1 Plant 1 (dismantled)
2/3 Plant 2/3
4 Plant 4 (dismantled)
5 Plant 5
6 Plant 6
7 Plant 7 (dismantled)
8 Plant 8
9 Plant 9 (dismantled)
10 On-site Disposal Facility (Cells 1, 2, 3)
11 Railyard
12 Material Handling Building/Railcar Loadout Building
13 Waste Pits
14 Silos 1 and 2
15 Silos 3 and 4
16 Vitrification Pilot Plant
17 Advanced Wastewater Treatment Facility
18 Storm Water Retention Basins
19 Waste Haul Road
20 Southern Waste Units
21 Sewage Treatment Plant (dismantled)
22 Boiler Plant (dismantled)
23 Maintenance/Tank Farm Complex (dismantled)
24 Borrow Area
25 General Sump Complex
3003 N
FEMP BOUNDARY
Paddys Run
Clearwell
Pit 3
Burn Pit
Pit 5
Pit 1
Pit 2
Pit 4
Pit 6
Cell 1
Cell 2
Cell 3
Cell 4
Cell 7
Cell 8
FEMP BOUNDARY
GRAPHICS #6207 MAP
PHOTO #7219-1 9/99

3003

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 (3 to 5 km) wide buried valley. This valley, known as the New Haven Trough, makes up part of the Great Miami Aquifer. The impermeable shale and limestone bedrock that 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 where the glacial overburden has been eroded away, 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 the FEMP's 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 FEMP 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, FEMP surface runoff from the former production area, 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 FEMP, runs in a southerly direction and flows into the Ohio River about 24 miles (39 km) downstream of the FEMP. The segment of the river between the FEMP and the Ohio River is not used as a source of public drinking water.

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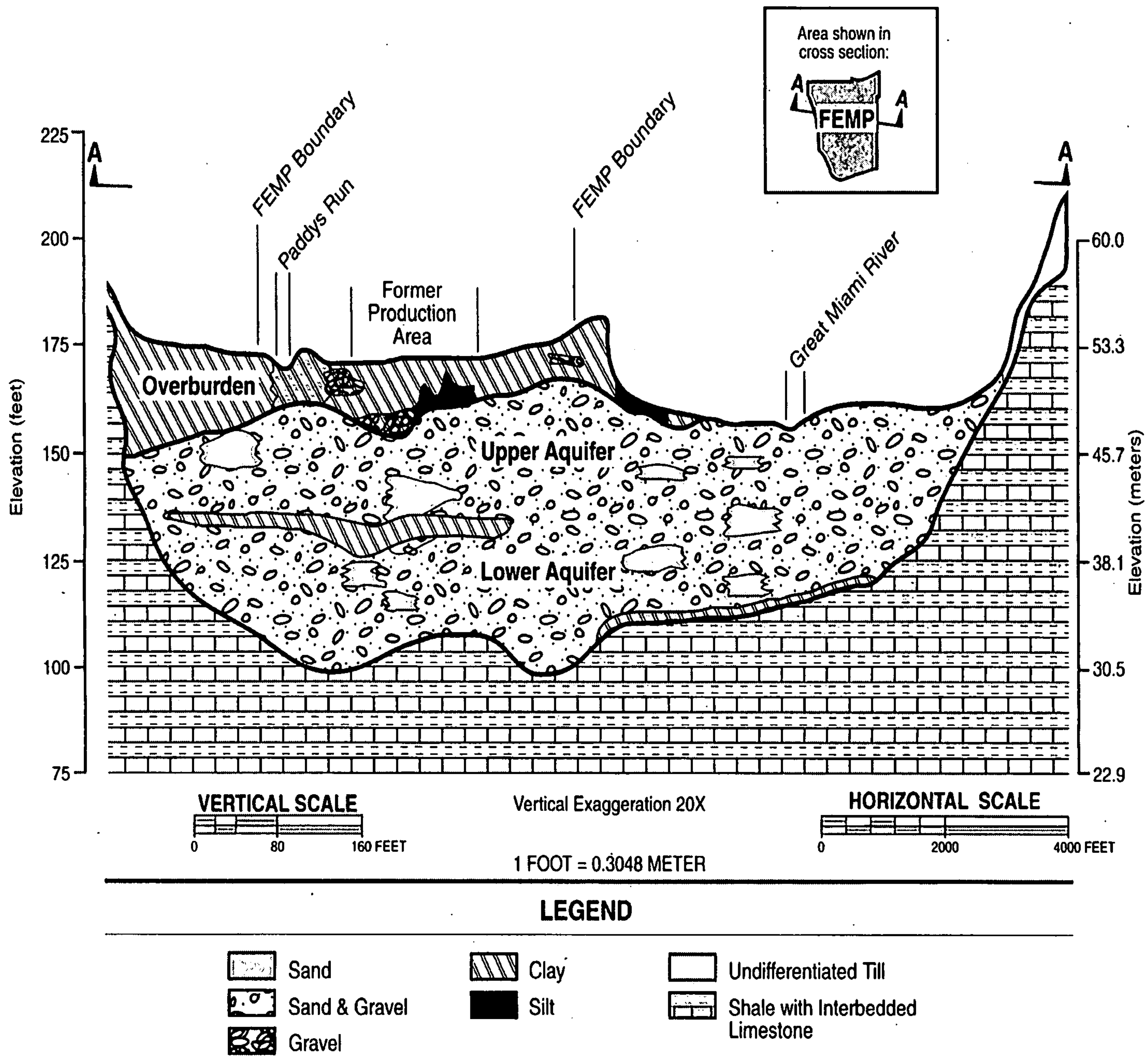

Figure 1-4. Cross-Section of the New Haven Trough, Looking North

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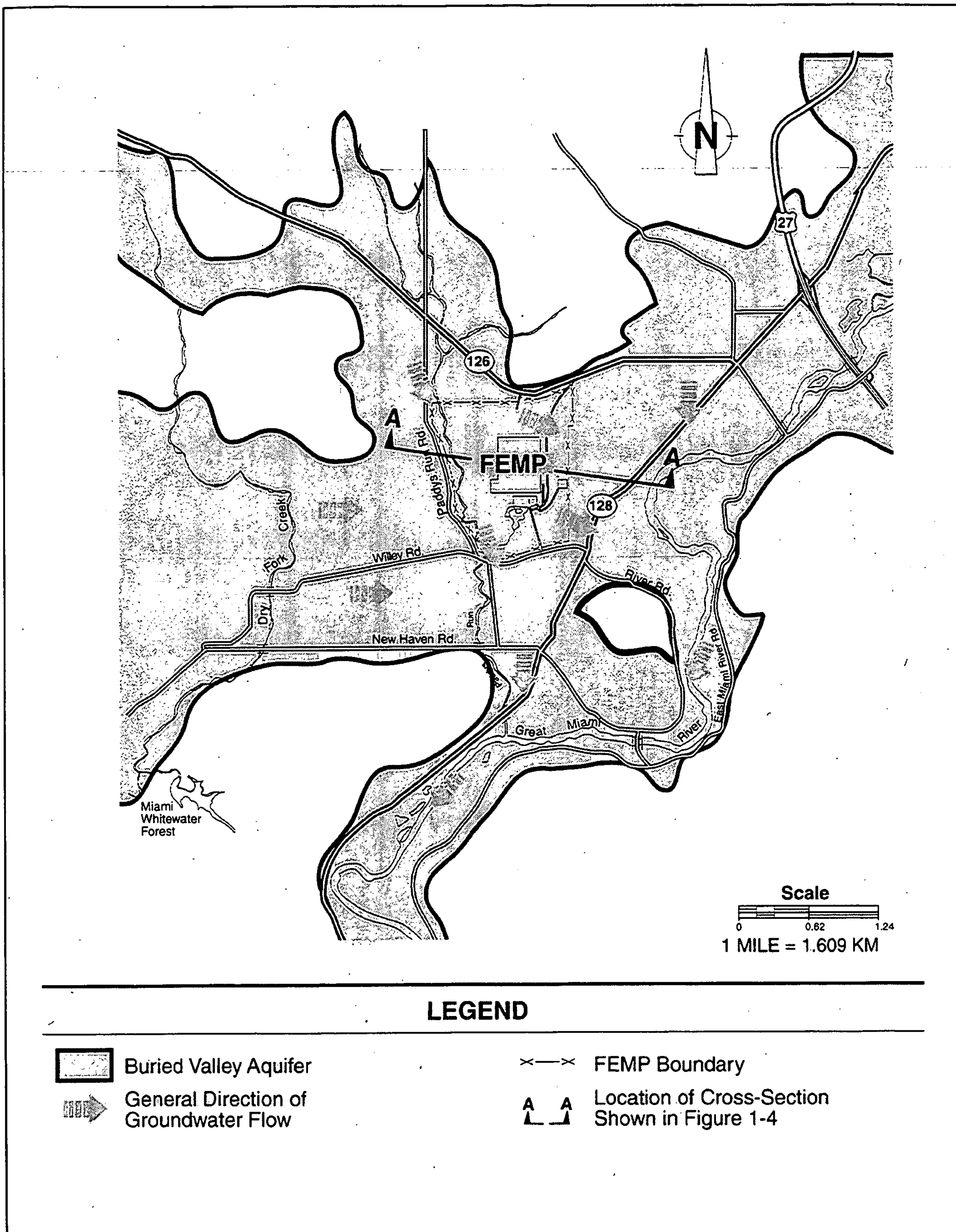

Figure 1-5. Regional Groundwater Flow in the Great Miami Aquifer

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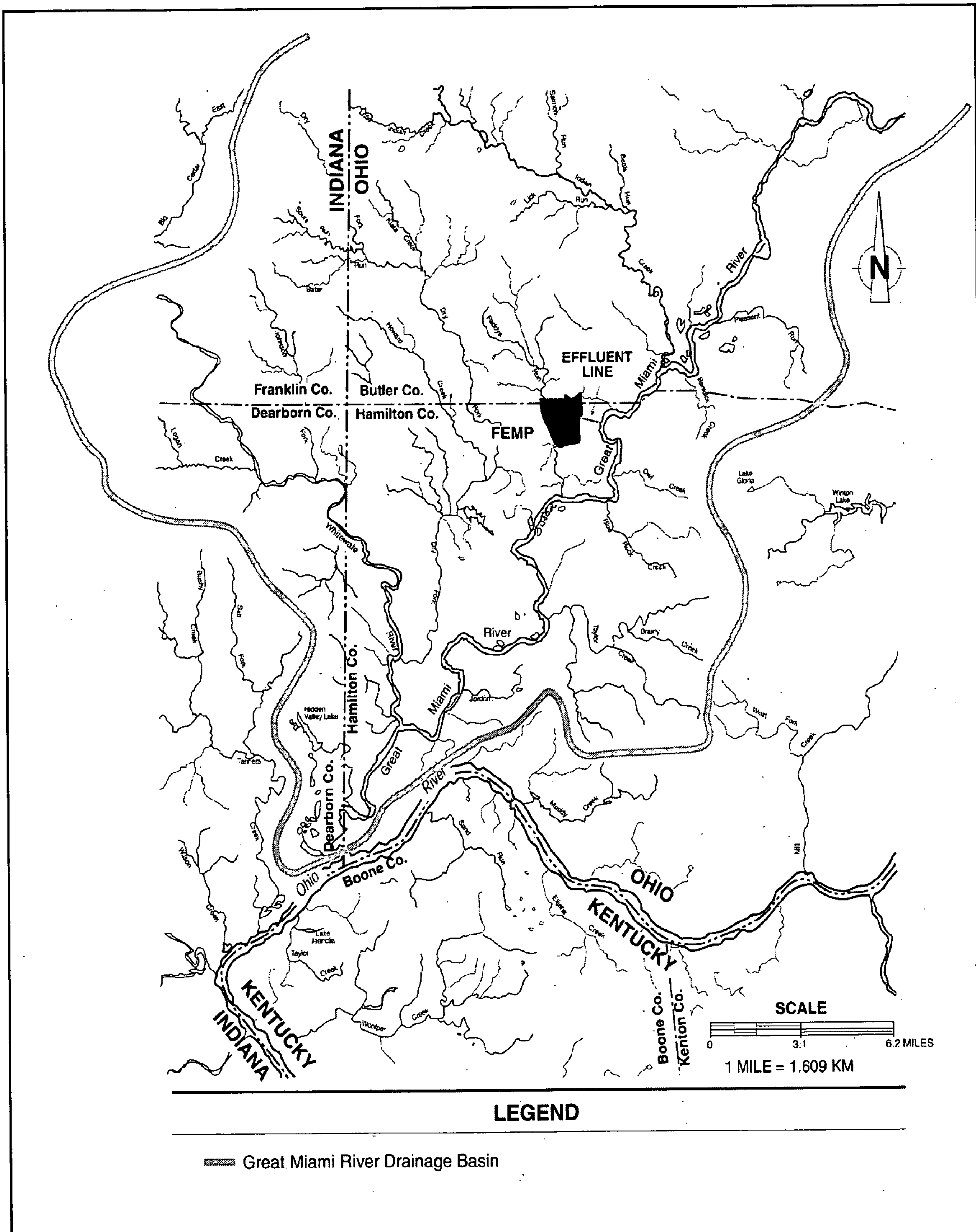

Figure 1-6. Great Miami River Drainage Basin

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The average flow rate for the Great Miami River in 1999 was 2,398 cubic feet per second (ft^3/sec) (67.91 cubic meters per second [m^3/sec]), measured daily approximately 10 river miles (16 river km) upstream of the FEMP's effluent discharge.

1.3.5 Meteorological Conditions

Meteorological data gathered at the FEMP are primarily used to evaluate 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 existing weather conditions. Wind speed and direction, precipitation, and atmospheric stability play a role in predicting how pollutants are distributed in the environment. Weather data, particularly wind speed and direction, and precipitation play an important role in developing the monitoring program design and in interpreting environmental data.

Figures 1-7 and 1-8 illustrate the average wind speed and general direction for 1999 measured at the 33-foot (10-meter) and 197-foot (60-meter) levels, respectively, using the wind rose format. The prevailing winds were from the west through south-southwest approximately 30 to 40 percent of the time at both the 33- and 197-foot (10- and 60-meter) level. Tables in Appendix C, Attachment 4, of this report present meteorological data for 1999, including wind direction and average speed.

In 1999, 34.39 inches (87.35 centimeters [cm]) of precipitation was measured at the FEMP. This is below the average annual precipitation of 41.20 inches (104.6 cm) for 1949 through 1998. Figure 1-9 shows 1999 total precipitation for the area in relation to the annual precipitation amounts recorded from 1989 through 1999. (Precipitation totals through 1992 were taken from the measurements made at the Greater Cincinnati/Northern Kentucky International Airport because of a computer software problem at the FEMP meteorological tower. This problem was corrected, and the 1993 through 1999 totals were obtained from measurements made at the FEMP.) In addition, Figure 1-10 shows 1999 precipitation by month at the FEMP compared to the Cincinnati area average precipitation by month from 1949 through 1998, based on data collected at the Greater Cincinnati/Northern Kentucky International Airport.

1.3.6 Natural Resources

Natural resources have important aesthetic, ecological, economic, educational, historical, recreational, and scientific value to the United States. Their management will be an ongoing process throughout federal ownership of 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. A detailed discussion of the site's diverse ecological habitats and cultural resources is provided in Chapter 7.

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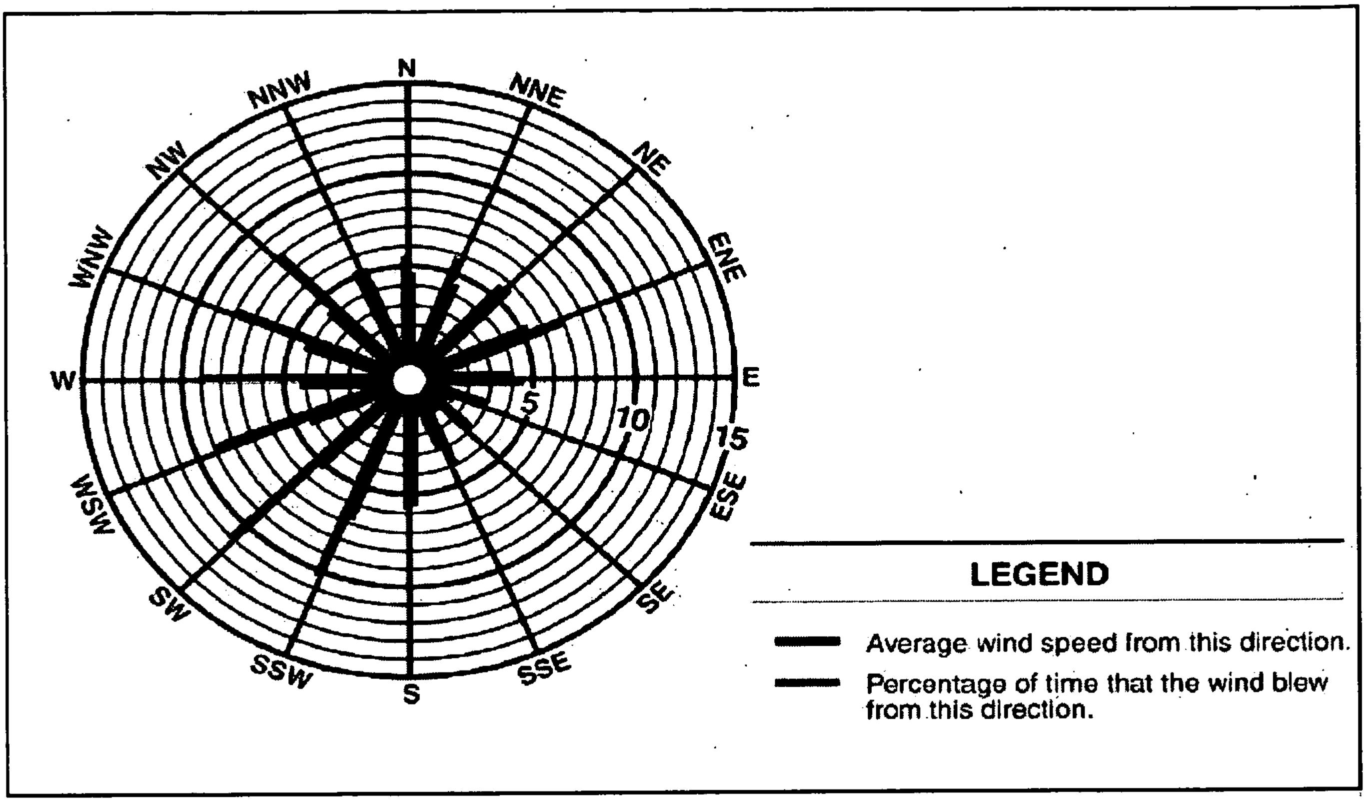

Figure 1-7. 1999 Wind Rose Data, 33 Foot (10 Meter) Height

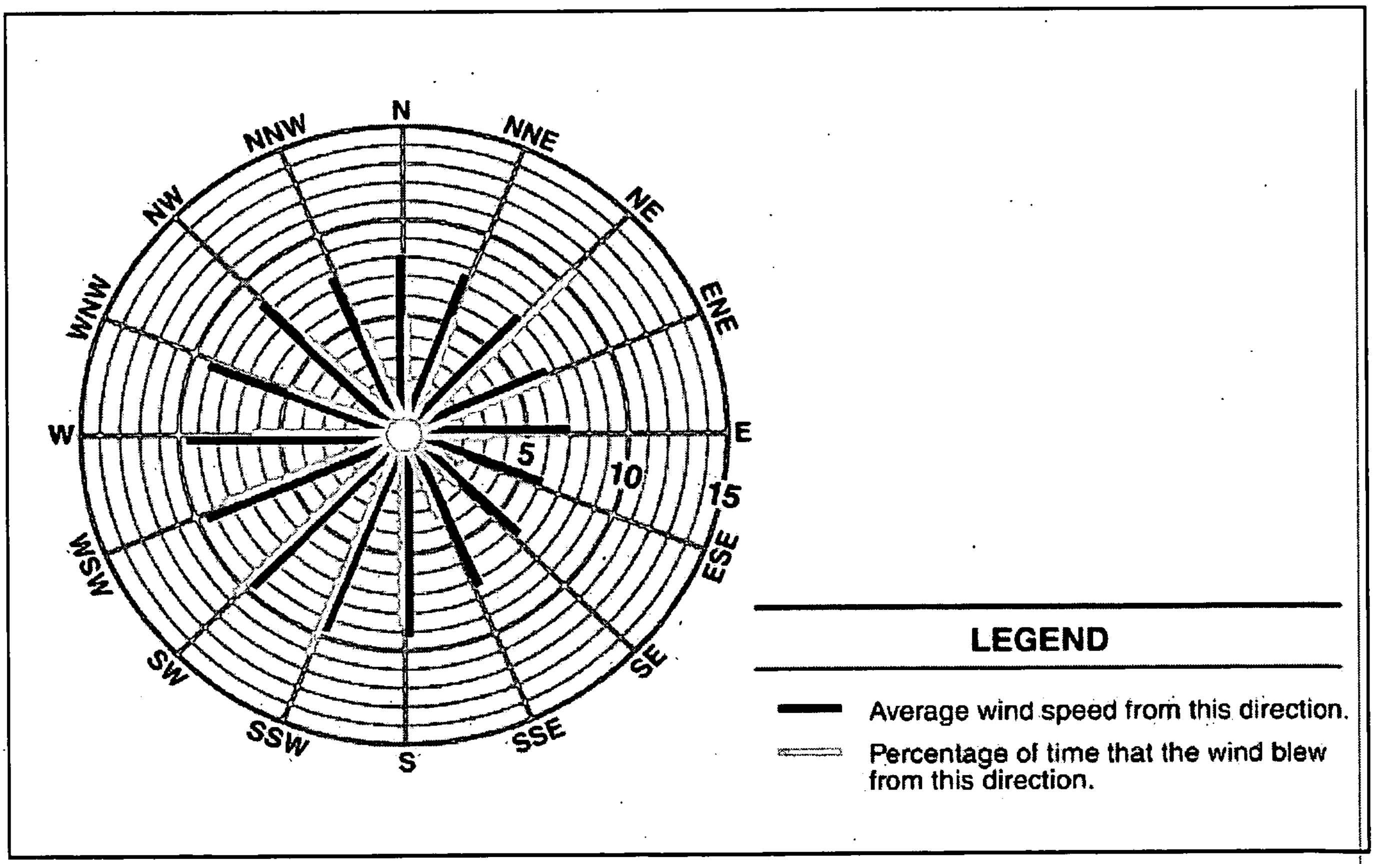

Figure 1-8. 1999 Wind Rose Data, 197 Foot (60 Meter) Height

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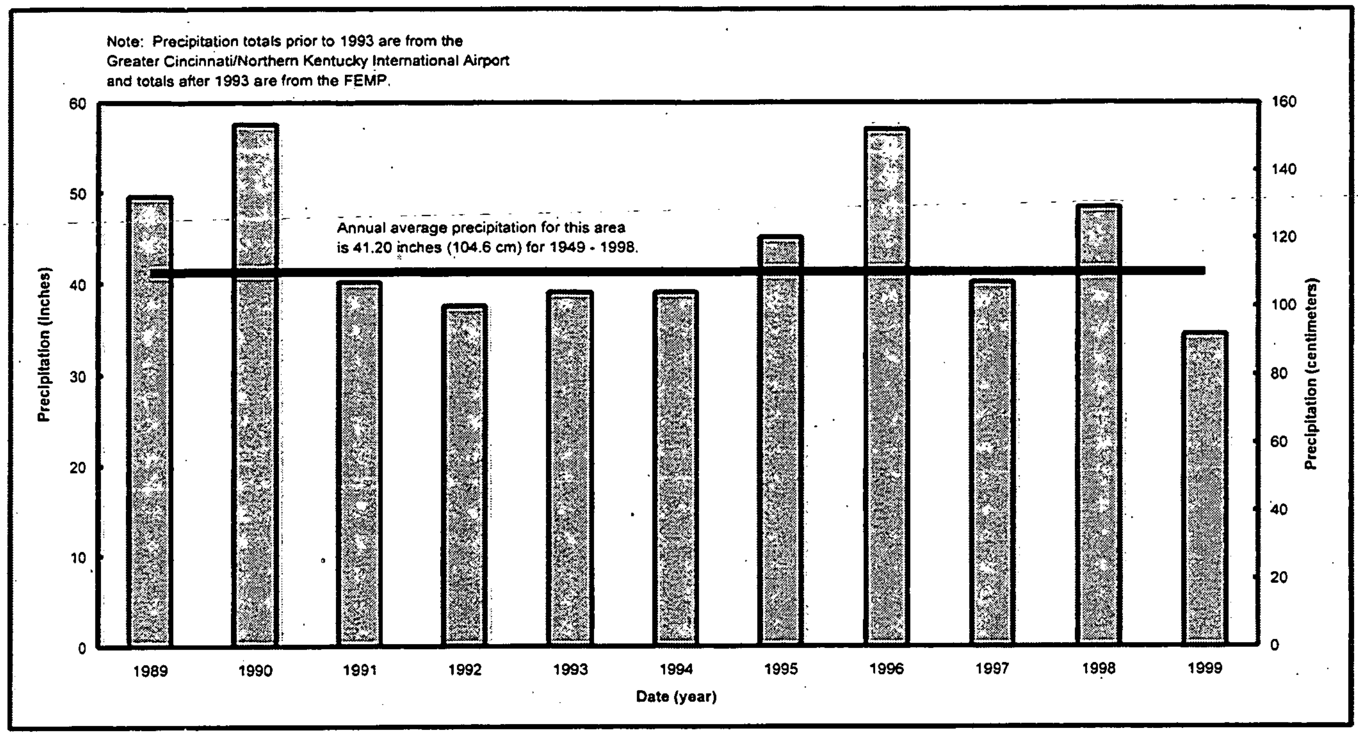

Figure 1-9. Annual FEMP Precipitation Data, 1989 - 1999

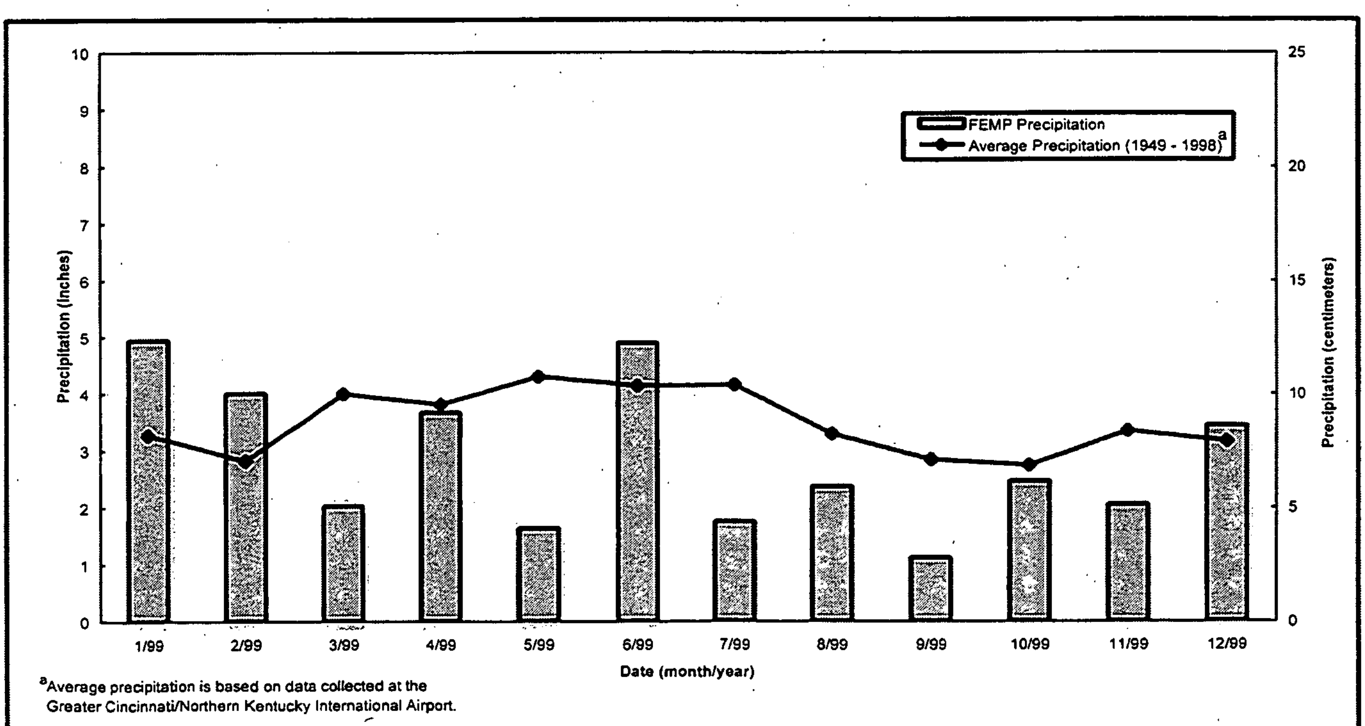

Figure 1-10. 1999 FEMP Monthly Precipitation Data

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2.0 Remediation Status and Compliance Summary

This chapter provides a summary of CERCLA remediation activities in 1999 by project and summarizes compliance activities with other applicable environmental laws, regulations, and legal agreements. CERCLA is the primary driver for environmental remediation of the FEMP.

The EPA and OEPA enforce the laws, regulations, and legal agreements governing work at the FEMP. The EPA develops, promulgates, and enforces environmental protection regulations and technology-based standards. EPA regional offices and state agencies enforce these regulations and standards. Region V of the EPA has regulatory oversight of the CERCLA process at the FEMP, 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 and EPA Region V and/or OEPA identify FEMP 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. The FEMP has completed the first two phases, site characterization and remedy selection. Specifically, the regulatory agencies have approved remedy selection documents for all operable units; however, the remedy for Silos 1 and 2 of Operable Unit 4 is still being re-evaluated. The FEMP is currently involved in the remedial design and implementation phase of CERCLA remediation. Remediation activities, documents, and schedules are identified in each operable unit's remedial design and remedial action work plan. The final phase of CERCLA remediation includes certification and site closure. There is a five-year review which ensures that the remedy at a site is protective of human health and the environment through evaluating the implementation and performance of the selected remedy. The initial five-year review is scheduled for submission in the first quarter of 2001. The Soil and Disposal Facility Project certified several more areas during 1999, as described later in this chapter under the Soil and Disposal Facility Project section.

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 FEMP. All cleanup related CERCLA documentation is available to the public at the Public Environmental Information Center located near the FEMP. The administrative record is located at EPA's Region V office in Chicago, Illinois. In 1999 many documents that describe specific remediation activities were issued and approved. Table 2-1 lists the major documents issued during 1999 and their status. The progress made by the projects toward CERCLA cleanup is summarized in the following sections.

000031

TABLE 2-1

MAJOR FEMP DOCUMENTS FOR 1999

Project	Documents	Status	Date
Waste Pits Remedial Action Project	Operable Unit 1 First Loadout Remedial Action Work Plan	Approved by Regulatory Agencies	January
	Non-Typical Waste Management Plan for Waste Pits Remedial Action Project	Approved by Regulatory Agencies	November
	Waste Pits Remedial Action Project Remedial Action Package	Approved by Regulatory Agencies	December
Soil and Disposal Facility Project	Implementation Plan for Area 2, Phase III Part 2	Submitted to Regulatory Agencies	November
	Area 2, Phase III Part 1 Certification Report	Approved by Regulatory Agencies	December
	Certification Report for Area 8, Phase II and the Area 6 Triangular Area Draft	Approved by Regulatory Agencies	September
	Certification Report for Area 1, Phase II Sector 2B	Approved by Regulatory Agencies	June
Natural Resources	Wetland Mitigation Plan	Approved by Regulatory Agencies	July
	Area 8, Phase II Natural Resource Restoration Design Plan	Submitted to Regulatory Agencies	December
	The Research Grant Projects Annual Report	Approved by Regulatory Agencies	November
Demolition Projects	Operable Unit 3 Completion Report for Decontamination of HWMU No. 50 – UNH Tanks, Hot Raffinate Building and HWMU No. 28 – Trane Incinerator	Approved by Regulatory Agencies	August
	Operable Unit 3 Completion Report Thorium/ Plant 9 Complex Decontamination and Dismantlement Project	Approved by Regulatory Agencies	April
	Operable Unit 3 Miscellaneous Small Structures D&D Project Task Order #432 Completion Report	Approved by OEPA	December
	Project Completion Report for Boiler Plant/Water Plant Complex	Approved by Regulatory Agencies	February
	Operable Unit 3 Project Close-Out Report for Removal Action 12 – Safe Shutdown	Approved by Regulatory Agencies	May
	Project Completion Report for Recycling Supplemental Environmental Projects	Approved by Regulatory Agencies	April
	Silos 1 and 2 Draft Feasibility Study/Proposed Plan	Submitted to Regulatory Agencies	December
Silos Project	Silos 1 and 2 Proof-of-Principle Testing Reports	Submitted to Regulatory Agencies	Various
Aquifer Restoration and Wastewater Project	Monthly Re-Injection Operation Reports	Submitted to Regulatory Agencies	Monthly
	Operations and Maintenance Master Plan	Approved by Regulatory Agencies	December
Environmental Monitoring	Quarterly Integrated Environmental Monitoring Status Reports	Submitted to Regulatory Agencies	Quarterly
	1998 Annual Integrated Site Environmental Report	Submitted to Regulatory Agencies	June
	Integrated Environmental Monitoring Plan, Revision 1	Approved by Regulatory Agencies	April

000032

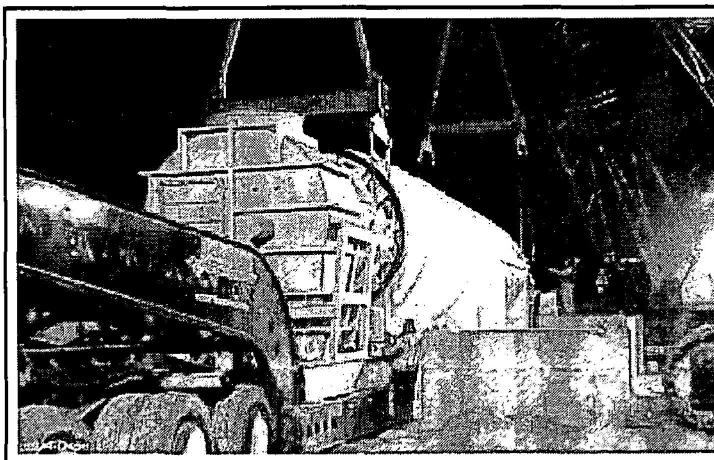
Cleanup levels for the FEMP for surface water, sediment, and groundwater were established in the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996). These final remediation levels (FRLs) were established for constituents of concern, or those constituents at the FEMP determined, through risk assessment, to present risk to human health and/or the environment. Table 2-2 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.

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). 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 to be evaluated in the surface water pathway. BTVs for surface water are discussed in Chapter 4 of this report.

2.1.1 Waste Pits Remedial Action Project

The Waste Pits Remedial Action Project 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 that exceed the waste acceptance criteria (physical, chemical, and radiological standards) for the on-site disposal facility is part of this scope of work. The project is also responsible for collecting wastewater and storm water associated with the Waste Pits Remedial Action Project activities and, as needed, pretreating and transporting 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 emissions controls for dryer operations.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International Technology Corporation, the subcontractor for the Waste Pits Remedial Action Project, completed construction of the Material Handling Building/Railcar Loadout Building early in 1999, providing facilities to support the pre-treatment (e.g., crushing, sorting, and shredding materials) and loadout of railcars. The first railcars were loaded in February of 1999, with contaminated stockpile materials. The first trainload of material was shipped in April to 000033

TABLE 2-2

FINAL REMEDIATION LEVELS FOR GROUNDWATER, SURFACE WATER, AND SEDIMENT

	FRL[a,b]		
Constituent	**Groundwater**	**Surface Water**	**Sediment**
General Chemistry	**(mg/L)**	**(mg/L)**	**(mg/kg)**
Cyanide	NA	0.012	NA
Fluoride	4[c]	2.0	NA
Nitrate[d]	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[d]	0.022	0.010	3,000
Cobalt	0.17	NA	36,000
Copper	1.3	0.012	NA
Lead	0.015[c]	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[e]	20	530	210

000034

TABLE 2-2 (Continued)

Constituent	FRL[a,b] 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]NA = not applicable because no FRL was required for this constituent in this particular environmental media.
[c]The groundwater FRLs for fluoride and lead were changed from 0.89 mg/L and 0.002 mg/L, respectively, due to the Restoration Area Verification Program and documented in the Operable Unit 5 Record of Decision by change pages.
[d]Because of holding time considerations, nitrate/nitrite is analyzed for nitrate and total chromium is analyzed for hexavalent chromium. This is acceptable because total chromium and nitrate/nitrite provide a more conservative result.
[e]Uranium consists of several isotopes. The common isotopes of uranium include uranium-234, uranium-235, uranium-236, and uranium-238. This report interchangeably uses the terms uranium and total uranium. Either of these terms is defined as the sum of the various isotopic components.

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Envirocare of Utah, Inc. Sixteen trainloads of material were shipped from the FEMP throughout 1999, totaling 89,627 tons (81,310 metric tons) of material shipped in 834 cars. Table 2-3 shows the total volumes shipped for 1999.

Construction of the remaining on-site facilities for this project was completed in September 1999. These remaining facilities provided International Technology Corporation with the ability to pre-treat the project wastewater/storm water, as necessary, prior to transfer to the advanced wastewater treatment facility. In addition, these facilities provided the capability to dry the waste material, as necessary, to meet the waste acceptance criteria for disposal at Envirocare of Utah, Inc., and to treat off-gas generated through this drying process.

TABLE 2-3

WASTE PITS REMEDIAL ACTION PROJECT
RAIL SHIPMENTS TO ENVIROCARE DURING 1999

Month	Train	Cars	Tons of Waste
April	1	54	5,813
May	2	50	5,386
	3	52	5,600
June	4	47	5,068
July	5	53	5,700
	6	52	5,603
August	7	50	5,392
September	8	50	5,280
	9	50	5,390
October	10	60	6,416
	11	53	5,696
November	12	50	5,381
	13	50	5,347
	14	60	6,463
December	15	50	5,386
	16	53	5,706
Total	16	834	89,627

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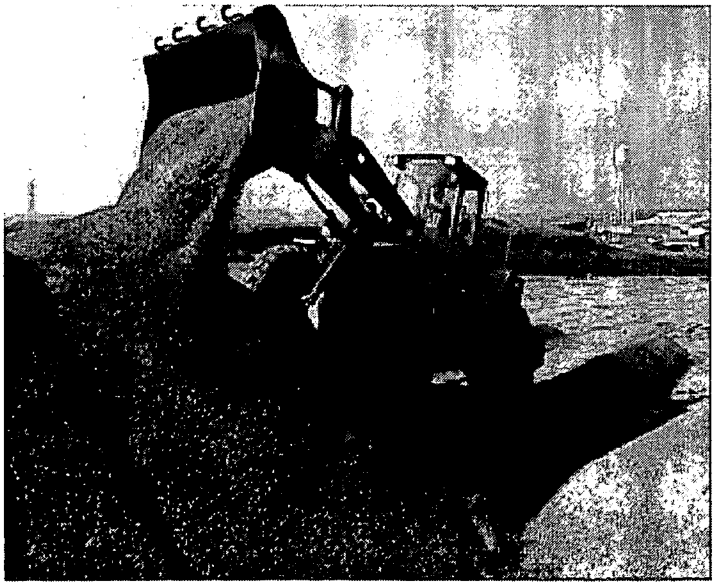
2.1.2 Soil and Disposal Facility Project

In 1998 the Soils Characterization and Excavation Project was responsible for safe remediation of contaminated soil and at- and below-grade debris, and the On-Site Disposal Facility Project was responsible for the construction of the eight-cell engineered disposal facility. The Soil Characterization and Excavation Project and the On-site Disposal Facility Project were combined in 1999 to form the Soil and Disposal Facility Project. These projects were combined so that soil excavation and on-site disposal facility construction could be more effectively integrated. The Soil and Disposal Facility Project will continue to be responsible for both excavation and cell construction. However, the Aquifer Restoration and Wastewater Project manages the operation, maintenance, and monitoring of the on-site disposal facility's leachate collection system and leak detection system.

For purposes of excavation, the FEMP has been divided into 10 remediation areas. Figure 2-1 depicts Remediation Areas 1 through 9. Area 10 consists of potentially contaminated corridors that will not be addressed until the end of remediation, such as haul routes and access roads, and it is not shown on Figure 2-1.

Prior to remediation, pre-design characterization sampling is performed to define the extent of excavation and identify the materials that meet the waste acceptance criteria for the on-site disposal facility. When the design is complete for each area and the contaminated soil and debris have been excavated, additional sampling is performed to demonstrate that the residual levels of the constituents of concern for that area are below the site's FRLs. Occasionally, characterization information is delayed or immediate placement in the on-site disposal facility is not possible. In these cases, materials are sometimes placed in numbered stockpiles and are monitored and tracked until further action is possible. After the analytical results are reviewed to confirm that constituents of concern are below the site's FRLs, the area is certified as meeting the soil restoration goal, and natural resource restoration can begin.



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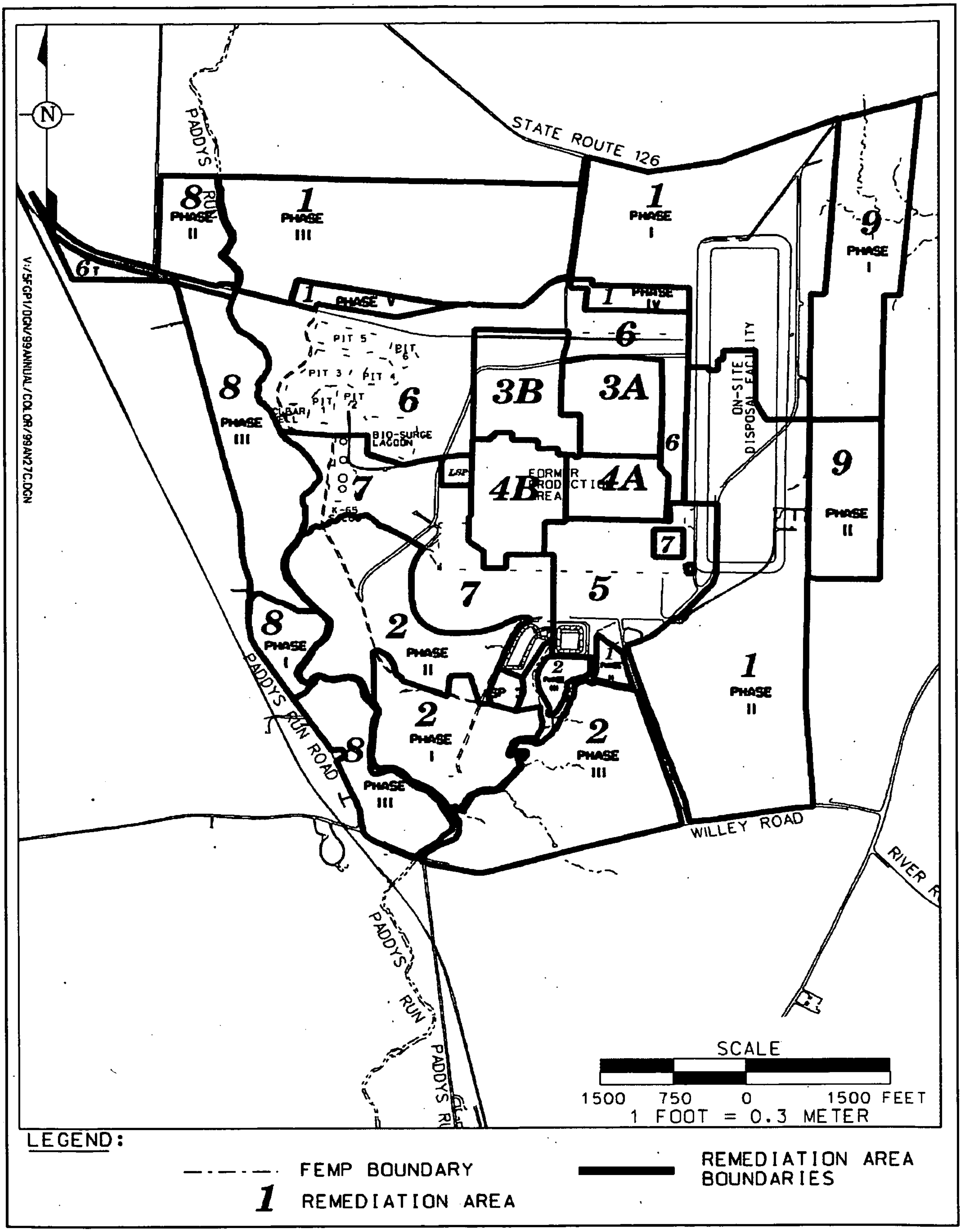

Figure 2-1. Sitewide Remediation Areas

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The Soil and Disposal Facility Project continued soil and debris excavation and placement in 1999. Excavation activities took place in the following remediation areas in 1999:

- Area 1, Phase II (former sewage treatment plant, trap range, additional area and facilities in the southeast corner of the FEMP): Site preparation activities for remediation, such as installation of erosion controls, were completed, including sedimentation basin construction. Subcontracts for the Trap Range Stabilization Project and former sewage treatment plant were negotiated. The treatability study for lead stabilization for the trap range was completed, and OEPA concurrence on the report was received in May. Excavation of former sewage treatment plant soil and foundations began in May, and was completed in September. Field activities for the Trap Range Stabilization Project began in July, and were completed in August. An approximate total of 84,000 cubic yards (yd^3) (64,000 cubic meters [m^3]) of soil and at- and below-grade debris was removed from Area 1, Phase II. Materials meeting the on-site radiological waste acceptance criteria were ultimately placed in the on-site disposal facility, and materials failing these criteria were placed in Stockpile 7. Clay to be used as on-site disposal facility liner material was also prepared in the borrow area.

- Area 2, Phase I (southern waste units, southwest corner of the FEMP): Excavation of the stockpiles, the South Field, and the active flyash pile continued during 1999. Excavation and real-time radiological monitoring of the inactive flyash pile continued into 1999. Additionally, the subcontractor for the Area 1, Phase II trap range stabilization work stabilized the characteristically hazardous soil for lead in the firing range in the South Field. A total of 140,000 yd^3 (107,000 m^3) of soil, including lead stabilized soil, was removed from Area 2, Phase I. Materials meeting the on-site waste acceptance criteria were ultimately placed in the on-site disposal facility, and materials failing these criteria were placed in Stockpile 7.

- Areas 3, 4, 5 (former production area): The release of the Advanced Conceptual Design marked the beginning of excavation design activities in the former production area. Three-dimensional modeling capabilities were developed to investigate soil contamination and support the characterization and design activities. Over 150 borings were placed in Areas 3A and 4A to obtain characterization data needed to support the excavation design. Design work continued throughout 1999, and the 60 percent (Title II) design was submitted in December.

- Area 6 (waste pits area): Characterization sampling was performed in the waste pit area (Operable Unit 1) to support the Waste Pits Remedial Action Project.

- Area 7 (Silos Project area and advanced wastewater treatment facility vicinity): Soil characterization sampling was performed in the silos area (Operable Unit 4) to support the Silos Project's infrastructure development.

- Area 8 (along the western margin of the FEMP): Area 8, Phase II was certified and the certification report was approved by the regulatory agencies. Pre-certification sampling was completed for the southern part of Area 8, Phase III. To date, no excavation is necessary in this area because no contamination was found.

- Area 9 (off-property adjacent to the eastern boundary of the FEMP): Surveying and pre-certification real-time radiologial scanning started in 1999. Planning was also initiated for pre-certification soil sampling.

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Figure 1-3 shows the site from an aerial perspective and shows the progress made at the on-site disposal facility during 1999. Waste placement into Cells 1 and 2 continued throughout 1999. Construction of Cell 3 took place in 1999 and waste placement began in November. Approximately 230,000 yd^3 (175,900 m^3) of contaminated soil and debris have been placed in the on-site disposal facility during 1999. Cell 3 activities included screening and stockpiling of approximately 80,000 tons (73,000 metric tons) of clay from the borrow area for use in liner construction.

Activities associated with natural resources closely parallel the activities of the Soil and Disposal Facility Project. Specific 1999 natural resource activities are discussed in Chapter 7 of this report. Leak detection monitoring activities associated with the on-site disposal facility are discussed in Chapter 3 of this report.

2.1.3 Demolition Projects

The Demolition Projects organization, formerly the Facilities Closure and Demolition Project, is responsible for decontamination and dismantling of the above-grade portion of buildings and facilities associated with production operations and remedial action facilities. This includes decontamination of facilities, isolation of utilities, demolition of buildings, equipment, and other facilities, and removing uranium and other material from former processing equipment and shipping material and equipment off site. The scope includes the collection and proper management of associated decontamination wastewater. Decontamination and dismantling of facilities is performed by the Facilities Shutdown group and the Decontamination and Dismantlement group.

Facilities Shutdown decontamination and closure activities during 1999 included the following facilities:


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- Plant 6 (complete)
- Packaging of tank farm hold up material (complete)
- Maintenance Building (Building 12; complete)
- Pipe bridges (complete)
- Burn Pad (complete)
- Building 63
- General Sump Complex.

Decontamination and Dismantlement group activities performed in 1999 include the following:

- Field activities for decontamination and dismantling of the Boiler Plant/Water Plant Complex were completed. The closeout report was submitted and approved by the regulatory agencies in February.

- Thorium/Plant 9 Complex decontamination and dismantlement was completed. The subcontractor completed field work in February, including structural steel size reduction, decontamination, and demobilization. The project closeout report was submitted to the regulatory agencies and approved in April.

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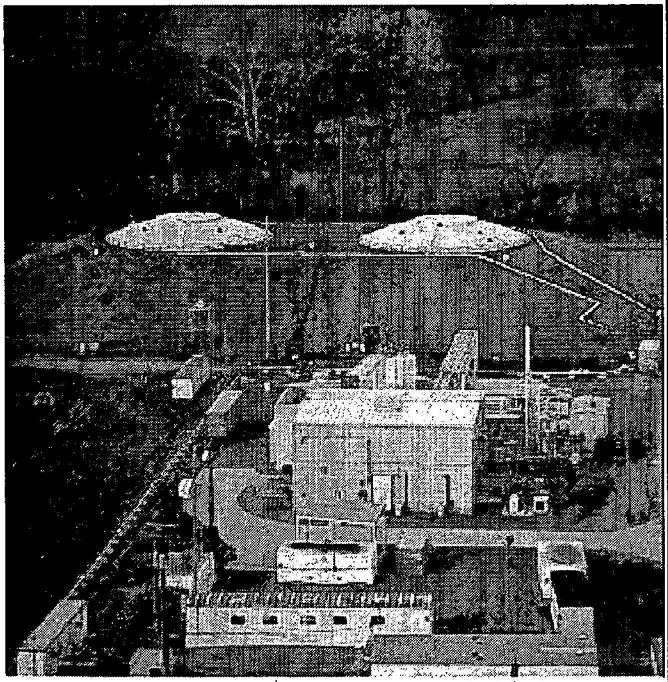
- The Maintenance Building (Building 12)/Tank Farm Complex and Water Storage Tank Project continued throughout 1999. Construction of the new water tank near the advanced wastewater treatment facility began in January and continued throughout 1999. This project included underground utilities installation and water storage tank construction. Decontamination and demolition of the Tank Farm, pipe bridge components, and Building 12A, B, and C were completed.

- Plant 5 Complex: Buildings 5B, 5C, 5E, and 5G were dismantled in 1999. Gross washdown of Building 5E was completed in September. Interior asbestos siding (transite) was removed from Building 5A.

- Recycling of metals through supplemental environmental projects were completed. Shipments of used railroad track to Alaron Corporation for recycling began in January and were completed in February. Copper windings were shipped to DOE-Oak Ridge for recycling. In all, 96 tons of copper, 357 tons of steel rail, 177 tons of metal pallets, and 10 tons of steel containers were recycled, and 110 tons of steel rail was released for unrestricted reuse. The metal reused or recycled through this project totalled 750 tons.

- The Miscellaneous Small Structures project continued in 1999 with the dismantlement of structures 2G, 39B, 63, and 10D.

Demolition Project dismantled a total of 20 structures in 1999, bringing the total number of structures demolished at the FEMP to 78.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2.1.4 Silos Projects

The Silos Project is located on the western edge of the site and 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 low-level radium-bearing residues dating back to the 1950s. Silo 3 contains cold metal oxides, and Silo 4 has never been used. Silos Project remediation activites include the retrieval, stabilization, and off-site disposal of the residues stores in the silos, as well as decontamination and dismantlement of the silo structures and associated facilities. The remedy for Silos 1 and 2 is currently being re-evaluated. The new remedy for Silo 3 was recorded in an Explanation of Significant Differences, which was approved in 1999.

The Silos Project is also responsible for the infrastructure construction and improvements necessary for silos remediation. Infrastructure development during 1999 included road construction, relocation of utilities and materials, and trailer upgrades.

During 1997 the decision was reached among DOE, EPA, and OEPA to separate the remediation of Silo 3 material from 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 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.

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2.1.4.1 Silos 1 and 2 Remediation

Silos 1 and 2 remediation activities during 1999 continued to focus upon re-evaluating, in accordance with CERCLA, technology alternatives for treatment of Silos 1 and 2 material.

"Proof-of-principle" testing was conducted on the following four treatment processes to provide technical and cost data to support evaluation treatment alternatives:

- Vitrification - joule-heated
- Vitrification - non-joule-heated
- Chemical Stabilization - cement based
- Chemical Stabilization - non-cement based.

Four companies with expertise in the commercial-scale application of these technologies were awarded contracts to conduct the testing. The results of this testing were used to support preparation of a revised feasibility study for Silos 1 and 2. The revised feasibility study documents the detailed analysis of alternatives against criteria specified by CERCLA.

Public workshops and comparative analysis briefings were conducted in 1999 to provide the public with the opportunity for input throughout analysis of the alternatives. Based upon the analysis documented in the feasibility study, DOE prepared a draft proposed plan recommending chemical stabilization and off-site disposal at the Nevada Test Site as the preferred remedy for treatment of Silos 1 and 2. The Silos 1 and 2 Draft Feasibility Study/Proposed Plan (FS/PP) (DOE 1999g) was submitted to EPA and OEPA for review and approval in December. After EPA and OEPA approve the proposed plan, it will be issued for formal public comment. After all public comments have been addressed, an amendment to the Operable Unit 4 record of decision will be prepared documenting the final remedy selection decision for Silos 1 and 2.

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 head space, issues with 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 a radon control system to provide control of radon emissions during 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. A contract for implementation of the Silos 1 and 2 Accelerated Waste Retrieval Project was awarded to Foster Wheeler Environmental Corporation in 1999. Initial design activities took place during the remainder of the year.

2.1.4.2 Silo 3 Project

A contract for the Silo 3 stabilization/solidification facility was awarded to Rocky Mountain Remediation Services in December 1998. The remedial design deliverables schedule was submitted to the regulatory agencies in April of 1999 for approval and conceptual design activities were initiated in May. Contractor submittals were reviewed and comments were provided on the Silo 3 Project preliminary design. Concurrence was requested from the regulators to submit the Silo 3 Site Preparation Package for approval in advance of the remainder of the remedial design package. This strategy would allow subcontractor mobilization for excavation and site preparation several months prior to the dates currently scheduled.

2.1.4.3 Supplemental Environmental Projects

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

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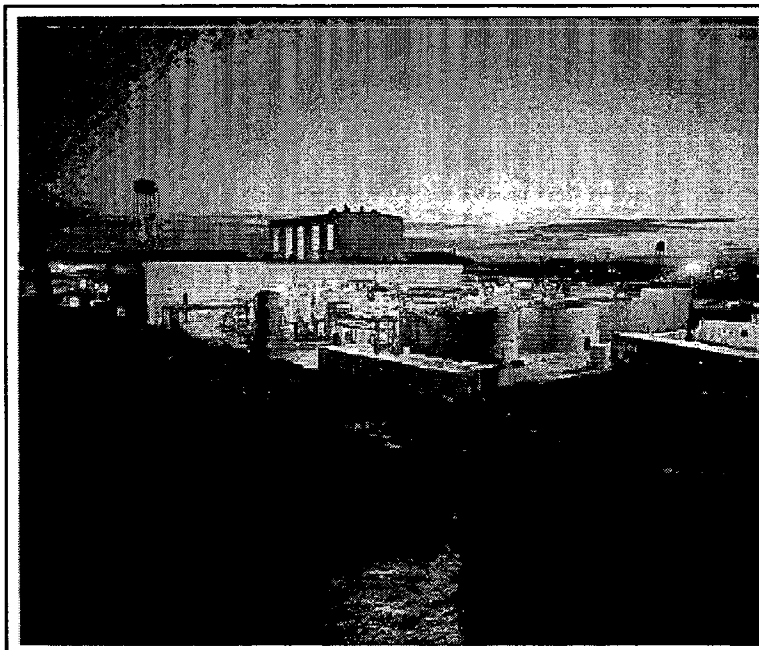
- Establishment of a conservation area near the FEMP
- Research grants for ecological restoration
- Creation of a wild bird/wildflower habitat area
- Railroad track recycling
- Structural steel debris recycling.

The supplemental environmental projects are being performed under the scopes of other projects. Progress on the recycling projects is reported in the Demolition Projects section of this chapter, and progress on the Natural Resources activities is reported in Chapter 7.

2.1.5 Aquifer Restoration and Wastewater Project

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



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In 1999 the Aquifer Restoration and Wastewater Project continued to operate the South Plume Module (including the South Plume Optimization Module), the South Field (Phase I) Extraction Module, and the Re-Injection Demonstration Module. Two new extraction wells were added in the South Field (Phase I) Extraction Module. Four new monitoring wells were also installed, two in the South Field area and two in the South Plume area. Direct push sampling activities were conducted with a Geoprobe® in the South Field, the waste storage area, and the Plant 6 area. The South Field activities support the groundwater remedy performance monitoring, while the waste storage area and Plant 6 area activities support the design of the planned aquifer restoration modules for those areas.

In 1999 a net total of 1,267 million gallons (4,795 million liters) of groundwater were extracted from the Great Miami Aquifer, 698 pounds (318 kg) of uranium were removed from the aquifer, and 433 million gallons (1,639 million liters) of water were re-injected into the aquifer. Refer to Chapter 3 for more details on groundwater monitoring.

Phases 1 and 2 of the advanced wastewater treatment facility and the interim advanced wastewater treatment facility provide final treatment of FEMP contaminated storm water and wastewater. The advanced wastewater treatment facility Phase 3 and the South Plume interim treatment facility are dedicated to treatment of contaminated groundwater associated with FEMP groundwater remediation. In 1999 the following improvements to the site's wastewater storage and treatment infrastructure were made:

- Ozone injection systems were added to both the Storm Water Retention Basin and the Bio-Surge Lagoon to control algae growth.

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- The laboratory facility at the advanced wastewater treatment facility was expanded to better serve the site's water analysis needs.

- Sludge removal systems were added to both the Storm Water Retention Basin and the Bio-Surge Lagoon.

- New piping, pumps and controls were added to the Bio-Surge Lagoon to reroute the flow from the abandoned biodenitrification facility directly to the advanced wastewater treatment facility.

- The drainage area surrounding the Storm Water Retention Basin was improved to maintain the integrity of the basin.

- The Distributed Control System, which is the computer system used to control automated operations at the advanced wastewater treatment facility, was upgraded to comply with Y2K computer requirements and to enhance system operation.

2.2 Summary of Compliance with Other Requirements

CERCLA requires compliance with other laws and regulations as part of remediation of the FEMP. 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 FEMP complied with these requirements in 1999.

The regulations discussed in this section have been identified as ARARs within the FEMP's records of decision. The FEMP 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 regulates treatment, storage, and disposal of hazardous waste and the hazardous part of mixed waste, which is radioactive waste mixed with hazardous waste. Hazardous and mixed waste now generated at the site result from such activities as CERCLA remedial actions, construction, and maintenance activities. The FEMP also has an inventory of mixed waste generated from former production. These wastes are regulated under RCRA and Ohio hazardous waste management regulations; thus, the site must comply with legal requirements for managing these 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 its 1993 Stipulated Amendment entered into between the State of Ohio and DOE, as well as a series of Director's Final Findings and Orders issued by OEPA.

The FEMP completed several administrative activities related to mixed waste storage and treatment during 1999, including:

- Submittal of the 1998 RCRA Annual Report (DOE 1999a), which described hazardous waste activities for 1998

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- Revisions to several sections of the RCRA Part A and B permit application
- Submittal of the Fiscal Year 1999 Annual Update to the Site Treatment Plan (DOE 1999f) 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 the Mixed Waste Treatment subsection.

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. This document is being revised to coincide with the groundwater monitoring strategy identified in the IEMP. This is discussed in Chapter 3 and is called Property Boundary Monitoring.

2.2.1.2 RCRA Closures

The Stipulated Amendment to Consent Decree required that the FEMP 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 FEMP hazardous waste management units. In 1999 the FEMP completed the remediation of four hazardous waste management units under the integrated RCRA/CERCLA process: the Trane incinerator, Plant 9 Warehouse, KC-2 Warehouse, and uranyl nitrate hexahydrate tanks in the Hot Raffinate Building. Excavation activities were completed at a fifth unit, the sludge drying beds located at the former sewage treatment plant. Plans were developed and approved by EPA and OEPA for the decontamination and dismantlement of one additional unit, the Plant 6 Warehouse.

2.2.1.3 Thorium Management

A thorium management strategy and schedule to complete RCRA determinations of thorium materials and to improve the storage of thorium materials at the FEMP 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, in which the FEMP removed 3,400 containers of thorium material and shipped 10,875 drum-equivalents, or 80,480 ft^3 (2,278.9 m^3), of thorium material to the Nevada Test Site for disposal, was completed in 1997. The characterization documentation and formal RCRA waste determinations for the remaining estimated 8,500 containers of thorium legacy waste continued in 1999. The following activities are planned for the future:

- Low-level radioactive, non-RCRA thorium legacy waste will be prepared and shipped to the Nevada Test Site for disposal. The low-level waste shipping activities will begin in 2000.

- The thorium legacy waste determined to be hazardous under RCRA will be treated to meet land disposal restrictions and, upon analytical confirmation, will be prepared and shipped to the Nevada Test Site for disposal.

- Non-RCRA thorium waste that contains free liquids and hydrogen-generating waste will require treatment to meet Nevada Test Site acceptance criteria and will then be shipped to the Nevada Test Site for disposal.

The treatment activities for thorium legacy waste and non-RCRA thorium waste will not begin until 2003 and are being evaluated for possible inclusion in the Silo 3 Stabilization Project.

2.2.1.4 Mixed Waste Treatment

The FEMP 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 EPA or OEPA approves an extension.

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 mixed wastes at the FEMP are stored in consolidation tanks until they are shipped to the incinerator at Oak Ridge, Tennessee. The consolidation tanks at the FEMP hold approximately 20,000 gallons of material, which constitutes a "batch". Batches may contain oils, solvents or a combination of the two.

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

In 1999 the following mixed wastes were shipped to the K-25 Toxic Substances Control Act Incinerator in Oak Ridge, Tennessee:

- 34,761 gallons (131,570 liters) of liquid mixed waste from batches 7 and 8
- 142,400 pounds (64,650 kg) of liquid mixed waste bulked into batch 9.

2.2.2 Clean Water Act

Under the Clean Water Act, the FEMP is governed by National Pollutant Discharge Elimination System (NPDES) regulations that require the control of discharges of nonradioactive 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 FEMP submits monthly reports on NPDES activities to OEPA.

NPDES Permit 1IO00004*ED became effective on November 1, 1995 and expired on March 31, 1998. On September 22, 1997, the FEMP submitted a permit renewal application. An addendum to the permit renewal application, providing information on Operable Unit 1 pit excavation and dryer operation activities, was submitted to OEPA on August 31, 1998.

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Pursuant to Ohio Administrative Code 3745-33-04(c)(1), submittal of the renewal application allowed the FEMP to continue operating under the terms of the expired permit until approval of the new permit application is received from OEPA. Therefore, all 1999 NPDES compliance activities, including sampling and reporting, were conducted under Permit 1IO00004*ED.

OEPA issued the draft NPDES Permit, Permit No. 1IO00004*FD for public notice, and its associated fact sheet on November 5, 1999. The FEMP submitted comments on the draft permit on December 10, 1999. No comments were received from the public. The new permit was issued by the agencies on January 28, 2000, and became effective on March 1, 2000. NPDES reporting for 2000 will reflect compliance with the requirements in the expired permit until March 1, 2000, and the new permit after March 1.

Chapter 4 discusses the surface water and treated effluent results in detail.

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 emissions (with the exception of radon) from the facility in a single year. For 1999 the FEMP was in compliance with the NESHAP dose limit, as determined by ambient air monitoring at the FEMP fenceline boundary.

This regulation also imposes stack monitoring requirements for point source emission sources (stacks). Because the FEMP is a former uranium processing plant, uranium is the radioactive particulate of most concern in monitoring airborne emissions. The FEMP estimated that airborne uranium emissions from all monitored point sources for 1999 were 0.0000329 pounds (0.0000143 kg). Specific point sources are discussed in Chapter 5.

EPA regulates the FEMP's radionuclide emission sources through the NESHAP. OEPA has authority to enforce the State of Ohio's air standards including particulate, chemical, and toxic emission sources. In 1999 the FEMP complied with all emissions standards.

Several remediation activities, including decontamination and dismantling, soil excavation, and on-site disposal facility waste placement, and construction, 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. The SARA Title III, Section 312, Emergency and Hazardous Chemical Inventory Report (DOE 1999e) for 1999 was submitted to OEPA and other local emergency planning/response organizations in February 2000. The report lists the amount and location of hazardous chemicals/substances stored or used in amounts greater than the minimum reporting threshold during any one given 24-hour period.

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The SARA Title III, Section 313, Toxic Chemical Release Inventory Report must be submitted to OEPA and EPA before July 1, 2000. This report, called a Form R, is required if the FEMP meets certain criteria and an applicable threshold for any SARA 313 chemical is reached. 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. In 1999 no chemicals met the SARA 313 manufactured, processed, or otherwise used reporting threshold requirements; thus, no Form R is required.

Any off-site release meeting or exceeding a reportable quantity as defined by SARA Title III, Section 304, requires immediate notifications to local emergency planning committees and the state emergency response commission. Depending on the respective requirements, notifications are made to the National Response Center and to the appropriate federal, state, and local regulatory entities. All releases occurring at the FEMP are evaluated and documented to ensure that proper notifications are made in accordance with SARA. In addition to SARA, releases are also evaluated for notification 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 1999 none of the releases that occurred at the FEMP met the criteria that required reporting to regulatory or other off-site agencies.

2.2.5 Other Environmental Regulations

The FEMP is also required to comply with other environmental laws and regulations besides those described above. Table 2-4 summarizes compliance with each of these requirements for 1999.

2.2.6 Other Permits

Permits are the means by which some environmental laws are implemented. The FEMP has permits for controlled releases to surface water and air. The FEMP's permit for discharging water under the NPDES regulations is discussed in the Clean Water Act section of this chapter. The active Permits to Install remaining for the FEMP wastewater treatment system include those for the Storm Water Retention Basin and Bio-Surge Lagoon.

The FEMP has 10 current air Permits to Operate and 8 associated Permits to Install. These permits cover boilers, diesel storage tanks, clothes dryers, the respirator washing facility, maintenance shop facilities, a laboratory hood system, and a gasoline dispensing facility.

EPA and OEPA approve other air emission sources and wastewater systems under CERCLA remedial design packages or CERCLA-allowed permit information summaries.

2.2.7 Site-Specific Regulatory Agreements

2.2.7.1 Federal Facility Compliance Agreement

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

- Maintain a continuous sample collection program for radiological constituents at the FEMP's treated effluent discharge points and report the results quarterly 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 which became effective May 1, 1996. This agreement requires sampling at the Parshall Flume (PF 4001) and the Storm Water Retention Basin spillway for radiological constituents.

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TABLE 2-4

COMPLIANCE WITH OTHER ENVIRONMENTAL REGULATIONS

Regulation and Purpose	Background Compliance Issues	1999 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 FEMP'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 were shipped to TSCA-approved commercial disposal facilities for incineration on an "as-needed basis". Radiologically contaminated PCB liquids were bulked for later shipment to the TSCA permitted DOE incinerator in Oak Ridge, TN. Most radiologically contaminated PCB solids currently had no treatment or disposal options and remain in storage on site.
Ohio Solid Waste Act		
Regulates infectious waste	The FEMP 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 FEMP'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		
Regulate 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 FEMP to be in full compliance with the requirements mandated by Federal Insecticide, Fungicide, and Rodenticide Act.	All pesticide applications at the FEMP 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 in 1998. It was prepared under DOE's guidelines for implementation of NEPA, 10 Code of Federal Regulations 1021. It also addresses previous DOE commitments to consult with the public prior to any decisions on land use.	DOE issued a Finding of No Significant Impact documenting their final decision in June 1999. The Finding of No Significant Impact functions as the decision document in the NEPA environmental assessment process, and was made available for public comment for 15 days prior to finalization.

TABLE 2-4
(Continued)

Regulation and Purpose	Background Compliance Issues	1999 Compliance Activities
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 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 – species found in riparian areas along Paddys Run.	Followup surveys were completed for the federally endangered Indiana brown bat and the state-threatened Sloan's crayfish. For the first time, an Indiana brown bat was found in the northern reach of Paddys Run in 1999. The Sloan's crayfish survey identified population levels consistent with previous surveys.
Floodplains/ Wetlands Review Requirements		
DOE regulations require a floodplain/wetland assessment for DOE construction and improvement projects.	A wetlands delineation of the FEMP, 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 FEMP property. Updated delineations are conducted approximately every five years.	No assessments were performed in 1999.
National Historic Preservation Act		
Mandates protection of historic and prehistoric cultural resources	The FEMP is within an area rich in historic and prehistoric cultural resources. These cultural resources include 136 prehistoric sites within 1.24 miles (2 km) of the FEMP and 40 historic sites.	Activities were conducted to avoid and address impacts to cultural resources (refer to Chapter 7).
Native American Gravss Protection and Repatriation Act		
Requires the identification and preservation of cultural resources on federal lands, and consultation with Native American Tribes on removal and management of inadvertently discovered Native American cultural items	Historical remains and artifacts were discovered during a 1994 construction project. The Native American remains which included an adolescent boy and his dog were discovered on private property during installation of pipelines for the Public Water Supply project. Partial remains of approximately 20 more people and numerous artifacts were also found.	No Native American remains were discovered or interred in 1999. Cultural resources were identified as a result of surveys performed.
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 U.S. Department of the Interior, U.S. Fish and Wildlife Service, OEPA, 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.	The Trustees and stakeholders continued to discuss the scope of Natural Resource Restoration activities at the FEMP, and the integration of public use and long-term stewardship at the FEMP.

- Maintain a sampling program for daily flow and total uranium at the South Plume extraction wells and report the results quarterly to 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.

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

The Federal Facility Agreement (FFA) between DOE and EPA, signed on November 19, 1991, ensures that DOE takes all necessary actions to control and abate radon-222 emissions at the FEMP, 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 allowed the FEMP 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 emit radon in excess of 20 $pCi/m^2/sec$. The results of the FEMP Radon Monitoring Program for 1999 are discussed in greater detail in Chapter 5.

2.3 As Low As Reasonably Achievable

The ALARA process ensures the selection of the optimum physical design features and administrative controls, which will eliminate, control, or mitigate radiological exposure of general employees, the public, and the environment with respect to what is reasonably achievable.

2.4 Split/Co-Located Sampling Program

In 1999 DOE and OEPA cooperated in a program in which samples of groundwater, surface water, and sediment, were "split" and sent to different analytical laboratories, or "co-located," meaning samples were collected from the same location but at different times. The FEMP has participated in this program with the state since 1987. This program allows for an independent comparison of data to ascertain laboratory analysis and field quality assurance. The results are provided in Table 2-5.

To obtain split samples, technicians alternately add a portion of the sample being collected to two individual sample containers. This collection method helps ensure that both samples are as identical as possible. Split samples are then submitted to two independent laboratories for analysis.

The data from the split/co-located sampling program shows reasonable agreement between DOE and OEPA results for groundwater (except April sample at location 12 [2060]), surface water (except radium-228 results), and sediment samples. The exceptions will continue to be monitored. It is likely that laboratory variability, actual sampling date differences, and sampling methodology differences are the cause of the variability in the results. The slight differences in DOE and OEPA sample results presented for 1999 do not impact the FEMP's compliance with federal or state regulations. The detailed results for the 1999 split/co-located samples are presented in Appendix E of this report.

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TABLE 2-5

1999 FEMP DOE-OEPA SPLIT/CO-LOCATED SAMPLING COMPARISON

Media	Sample Location	Sample Date	Constituent	DOE Result	OEPA Result	FRL
Groundwater[a]				(µg/L)	(µg/L)	(µg/L)
	12	Not Sampled	Not Applicable	-	-	20
	12	April	Total Uranium	46	79	20
	12	July	Total Uranium	106	120	20
	12	October	Total Uranium	99	120	20
	13	January	Total Uranium	38	33	20
	13	April	Total Uranium	31	30	20
	13	July	Total Uranium	30	32	20
	13	October	Total Uranium	27	33	20
	14	January	Total Uranium	3.2	3.0	20
	14	April	Total Uranium	3.4	3.1	20
	14	July	Total Uranium	2.8	2.9	20
	14	October	Total Uranium	2.8	3.3	20
Surface Water[b,c]				(pCi/L)	(pCi/L)	(pCi/L)
	SWR-01	First Quarter	Radium-226	0.211	0.20	38
	SWR-01	First Quarter	Radium-228	5.884	1.2	47
	SWR-01	First Quarter	Total Uranium (µg/L)	1.835	1.9	530
	SWR-01	Second Quarter	Radium-226	0.621	0.17	38
	SWR-01	Second Quarter	Radium-228	0.257	1.3	47
	SWR-01	Second Quarter	Total Uranium (µg/L)	1.297	1.7	530
	SWR-01	Third Quarter	Radium-226	0.446	0.35	38
	SWR-01	Third Quarter	Radium-228	0.189	1.6	47
	SWR-01	Third Quarter	Total Uranium (µg/L)	1.012	1.7	530
	SWR-01	Fourth Quarter	Radium-226	0.474	0.69	38
	SWR-01	Fourth Quarter	Radium-228	0.175	1.8	47
	SWR-01	Fourth Quarter	Total Uranium (µg/L)	1.97	1.3	530
Sediment[d,e]				(pCi/g)	(pCi/g)	(pCi/g)
	P1	August/June	Radium-226	0.494	0.68	2.9

[a]Locations are split.
[b]Locations are co-located.
[c]DOE samples were collected quarterly while OEPA samples were collected bi-monthly; the highest OEPA result for a quarter is being reported.
[d]Locations are co-located.
[e]The DOE sample was collected in August while OEPA sample was collected in June.

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3.0 Groundwater Pathway

Results in Brief: 1999 Groundwater Pathway

Enhanced Groundwater Remedy - During 1999 active restoration of the Great Miami Aquifer continued at the following four groundwater restoration modules:

- South Plume Module - Operational on August 27, 1993
- South Field (Phase I) Extraction Module - Operational on July 13, 1998
- South Plume Optimization Module - Operational on August 9, 1998
- Re-Injection Demonstration Module - Operational on September 2, 1998.

Since 1993

- 5,637 million gallons (21,336 million liters) of water have been pumped from the Great Miami Aquifer.
- 560 million gallons (2,120 million liters) of water have been re-injected into the Great Miami Aquifer.
- 1,509 pounds (685 kg) of uranium have been removed from the Great Miami Aquifer.

During 1999

- 1,700 million gallons (6,434 million liters) of water were pumped from the Great Miami Aquifer.
- 433 million gallons (1,639 million liters) of water were re-injected into the Great Miami Aquifer.
- 698 pounds (318 kg) of uranium were removed from the Great Miami Aquifer.

In 1999 two new extraction wells (32446 and 32447) were installed as part of the South Field (Phase I) Extraction Module in response to the newly defined area of uranium contamination found in the aquifer beneath the southeastern portion of the South Field area. It is anticipated that these new wells will begin pumping during the first quarter of 2000.

Groundwater Monitoring Results - The results of 1999 groundwater capture analysis and monitoring for total uranium and non-uranium constituents indicate that the design of the enhanced groundwater remedy for the aquifer restoration system is appropriate.

On-Site Disposal Facility Monitoring - Leak detection monitoring continued during 1999 indicated that the liner systems for Cells 1, 2, and 3 are performing within the specifications outlined in the approved on-site disposal facility design documents.

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

- Significant achievements realized by the Aquifer Restoration and Wastewater Project in 1999
- Groundwater monitoring activities and results for 1999.

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 FEMP. The FEMP will continue to monitor the groundwater pathway throughout remediation to ensure the protection of this primary exposure pathway.

Groundwater Modeling at the FEMP

The FEMP uses computer models 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, then 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, then 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, then modifications are made to the model to improve its predictive capabilities.

3.1 Summary of the Nature and Extent of Groundwater Contamination

The nature and extent of groundwater contamination from operations at the FEMP has 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. As documented in that report, the primary groundwater contaminant at the FEMP is uranium. Approximately 220 acres (89 hectares) of the Great Miami Aquifer are contaminated above the groundwater FRL for total uranium.

Contamination of the groundwater resulted from infiltration through the bed of Paddys Run and the Storm Sewer Outfall Ditch where the glacial overburden is eroded, and the sand and gravel of the aquifer are in direct contact with uranium-contaminated surface water from the FEMP. To a lesser degree, groundwater contamination also resulted where 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

After the nature and extent of groundwater contamination were defined, 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. The remedy consisted 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 gpm (15,000 L/min) would remediate the aquifer within 27 years. The recommended groundwater remedy was presented to EPA, OEPA, and FEMP stakeholders in the Proposed Plan for Operable Unit 5 (DOE 1995b).

Once the preferred groundwater remedy was identified and approved in the Operable Unit 5 Proposed Plan, the Operable Unit 5 Record of Decision was presented to FEMP stakeholders and subsequently approved by EPA and OEPA in January 1996. The Operable Unit 5 Record of Decision established FRLs for all constituents of concern and formalized the agreement to implement the selected remedy. The Operable Unit 5 Record of Decision committed to ongoing evaluation of innovative remediation technologies so that remedy performance could be improved as such technologies become available. As a result of this commitment, an enhanced groundwater remedy was presented in the Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) (DOE 1997a).

Re-Injection at the FEMP

Re-injection is an enhancement to the groundwater remedy. Groundwater pumped from the aquifer is treated to remove contaminants and then re-injected back into the aquifer at strategic locations. The re-injected groundwater increases the speed at which contaminants move through the aquifer and are pulled by extraction wells, thereby decreasing the overall remediation time.

The enhanced groundwater remedy includes a test of large-scale groundwater re-injection wells. The one-year test was completed in September 1999 and a report discussing the results of the demonstration is scheduled for release in June of 2000. If groundwater re-injection proves to be viable, then it will increase the rate at which contaminants are flushed through the sand and gravel of the aquifer and into the extraction wells. The enhanced groundwater remedy also included additional extraction wells in on-property areas of aquifer contamination, which are not accessible until after contaminated surface soils are remediated. Groundwater modeling studies conducted in support of the enhanced groundwater remedy suggest that, with the early installation of additional extraction wells and re-injection technology, the remedy could potentially be reduced to 10 years. EPA and OEPA approved the enhanced groundwater remedy. Figure 3-1 identifies current and future extraction and re-injection well locations for the enhanced groundwater remedy.

While the remedial investigation and feasibility study process was in progress and a groundwater remedy was being selected, off-property contaminated groundwater was being pumped in 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 total uranium plume in this area from moving any further to the south. Figure 3-2 shows the South Plume Module Extraction Wells 3924, 3925, 3926, and 3927. These extraction wells have successfully stopped further southern migration of the total uranium plume beyond the wells and have contributed to significantly reducing total uranium concentrations in the off-property portion of the plume.

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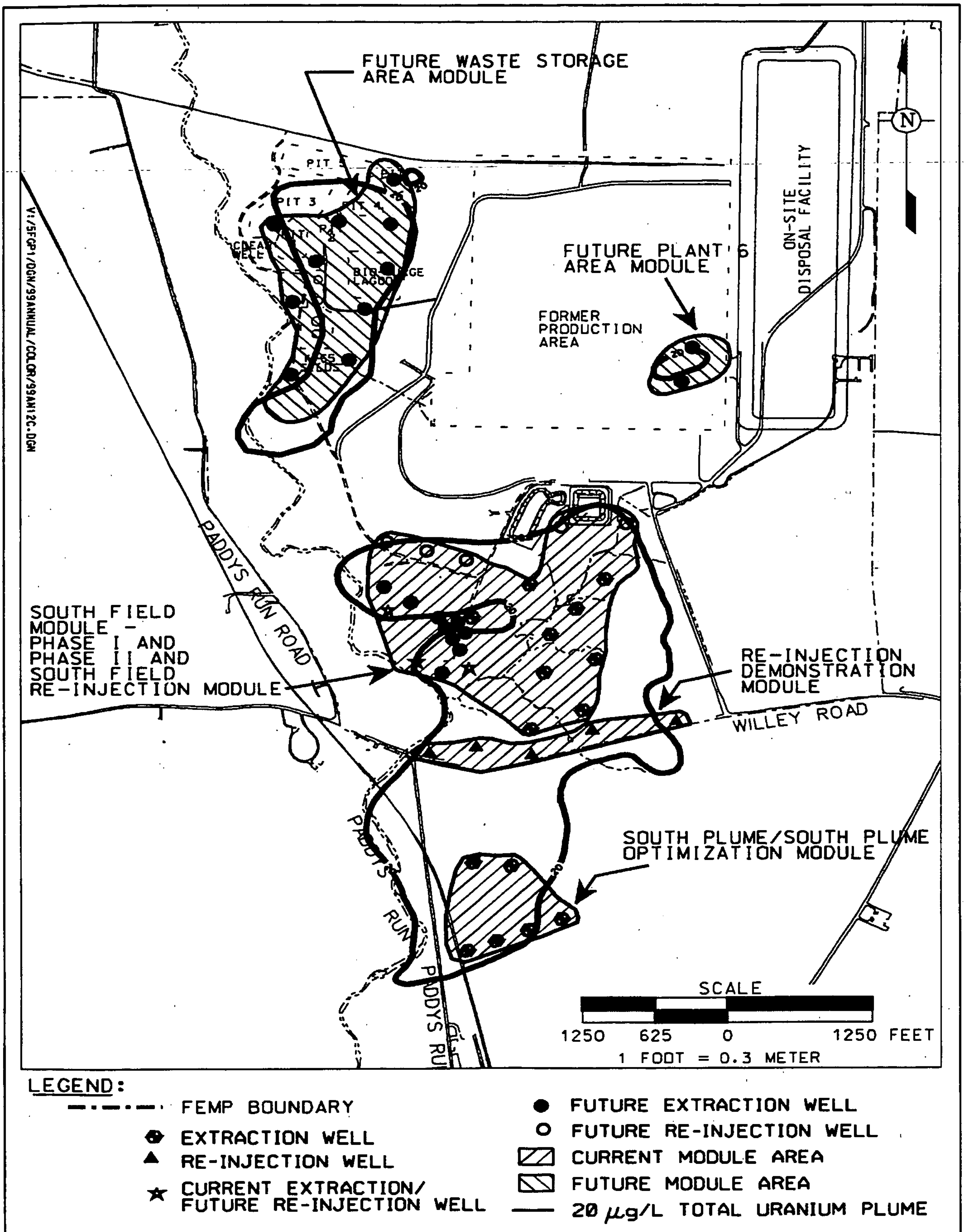

Figure 3-1. Current and Future Extraction and Re-Injection Wells for the Enhanced Groundwater Remedy

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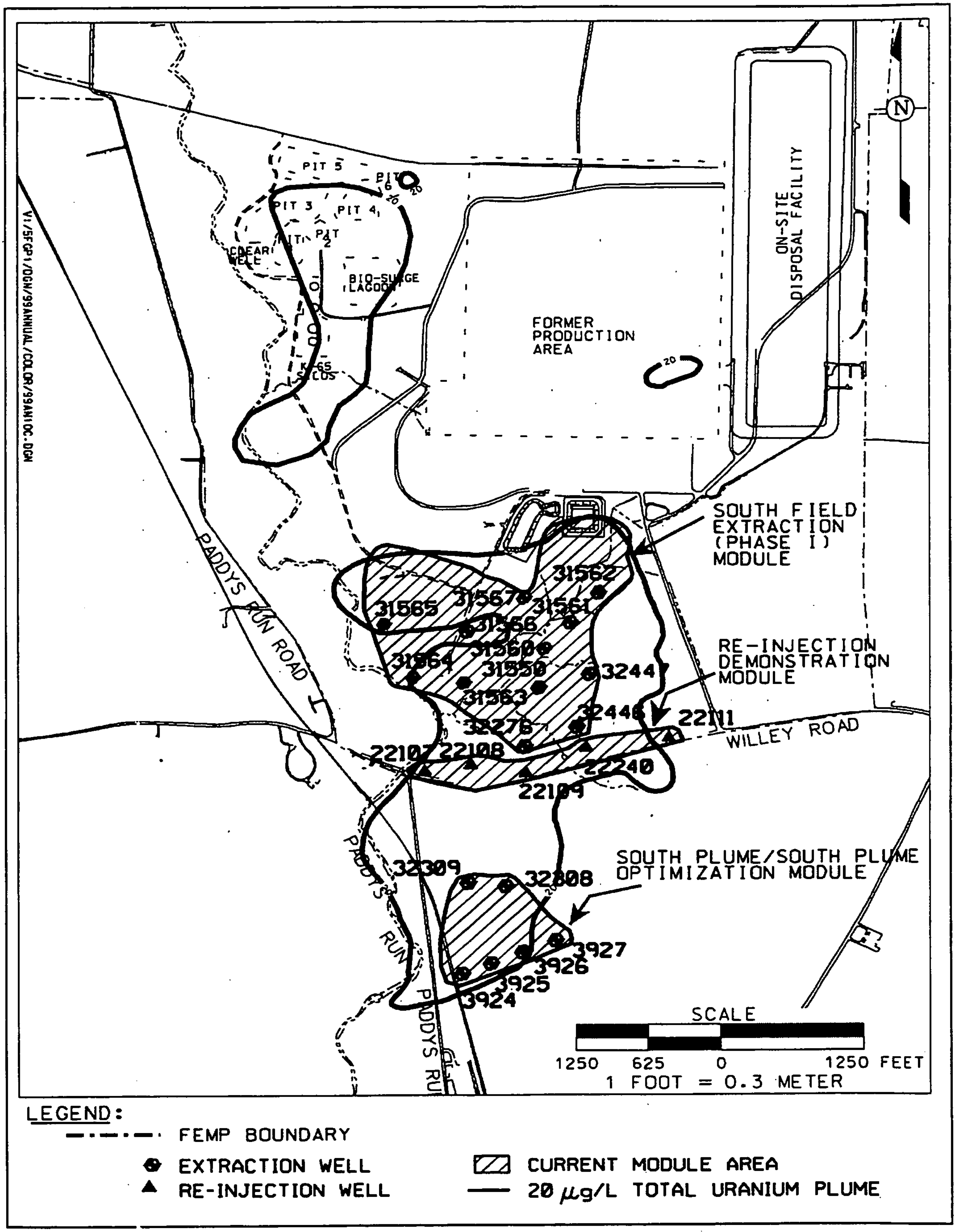

Figure 3-2. Current Extraction and Re-Injection Wells for the Enhanced Groundwater Remedy

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During 1998 significant portions of the enhanced groundwater remedy were completed. By the end of June 1998, construction was complete on the pipeline distribution network and associated electronic controls for three groundwater restoration modules: South Plume Optimization Module, South Field (Phase I) Extraction Module, and Re-Injection Demonstration Module. By September 1998, all three modules were on line and, along with the South Plume Module, which has been in operation since August 1993, were pumping 3,500 gpm (13,000 L/min) from the aquifer and re-injecting 1,000 gpm (3,800 L/min).

During 1999 active remediation of the Great Miami Aquifer continued at the following groundwater restoration modules: South Plume/South Plume Optimization Module, South Field (Phase I) Extraction Module, and Re-injection Demonstration Module. As a result of groundwater remedy performance monitoring, two additional extraction wells (32446 and 32447) and the associated infrastructure were installed in 1999 as part of the South Field (Phase I) Extraction Module. The location of these wells was based on refined total uranium plume interpretations in the South Field area and groundwater modeling results. The refined plume interpretations were possible due to the use of direct push (Geoprobe® profile sampling as a supplement to the existing monitoring well network. The installation of these additional extraction wells during 1999 was necessary to support the accelerated aquifer remediation schedule. It is anticipated that these new wells will begin pumping during the first quarter of 2000. Figure 3-2 depicts the current extraction and re-injection well locations. The operational information associated with these modules is presented in subsequent sections.

3.3 Groundwater Monitoring Highlights for 1999

Reporting under the IEMP combines all FEMP groundwater monitoring activities into a single reporting mechanism and ensures that groundwater monitoring efficiently supports the enhanced groundwater remedy. For this report, groundwater monitoring results are discussed in terms of restoration and compliance monitoring.

The key elements of the FEMP groundwater monitoring program design are described below:

Groundwater elevation measurements are collected from aquifer monitoring wells at the FEMP. Elevations are plotted on maps and then contoured. The elevation contour maps are used by FEMP scientists to study the direction and rate of groundwater flow in the aquifer. A key use of these maps is to estimate the area that is being "captured" by pumping of the FEMP's groundwater extraction wells. Definition of this capture zone is important in ensuring that the uranium plumes targeted for clean up are being remediated.

- **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 as identified in Table 2-2. Monitoring is conducted to ascertain groundwater quality and groundwater flow direction. Figure 3-3 shows a typical groundwater monitoring well at the FEMP and Figure 3-4 identifies the relative placement depths of groundwater monitoring wells at the FEMP. As part of the comprehensive IEMP groundwater monitoring program, approximately 140 wells were monitored for water quality in 1999. Figure 3-5 identifies the location of the current IEMP water quality monitoring wells, extraction wells, and re-injection wells. In addition to water quality monitoring, 184 wells were monitored quarterly for groundwater elevations. Figure 3-6 depicts the IEMP routine water-level (groundwater elevation) monitoring wells. It should also be noted that four new monitoring wells were installed during 1999, two in the South Field area and two in the South Plume area.

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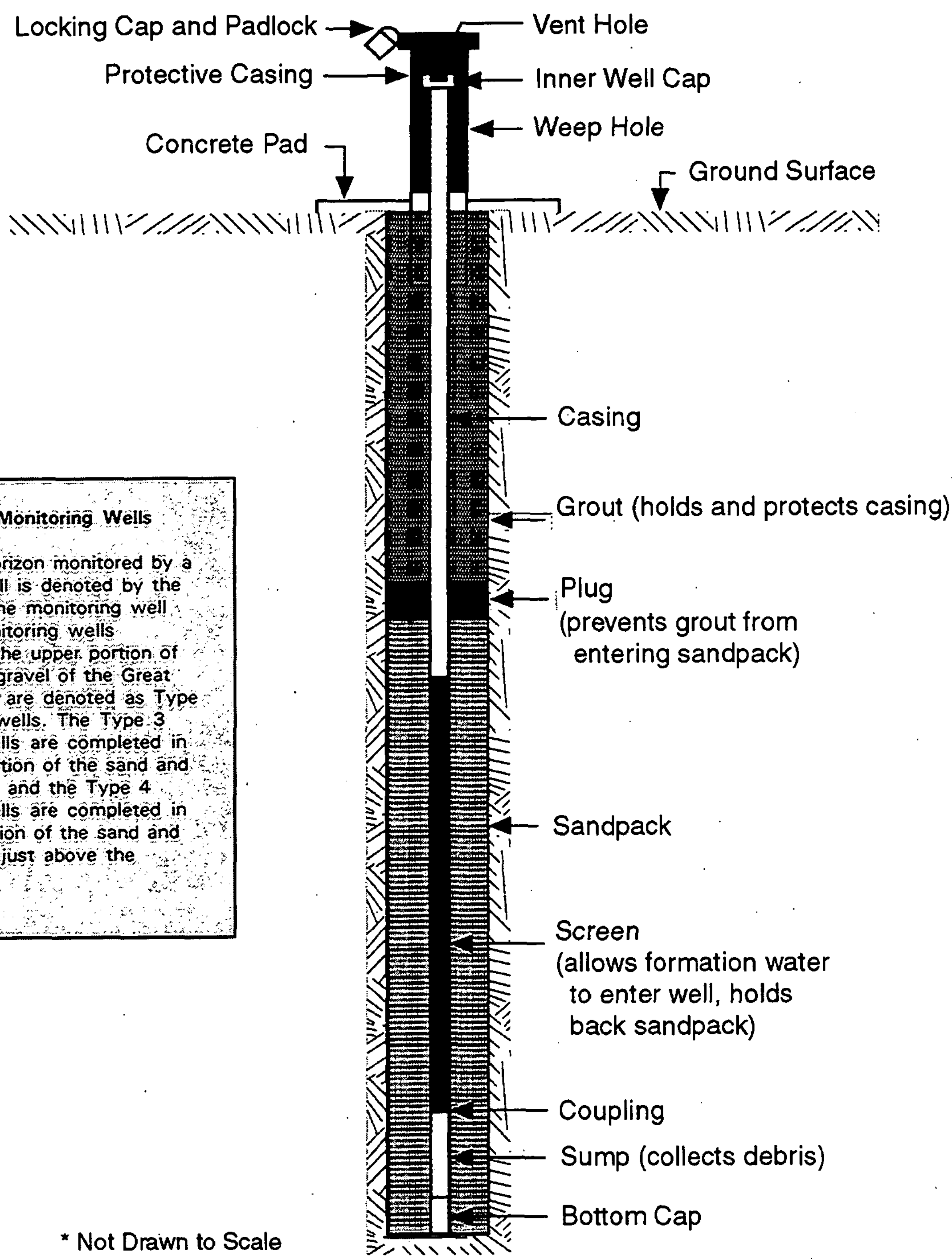

Groundwater Monitoring Wells

The aquifer horizon monitored by a monitoring 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, and the Type 4 monitoring wells are completed in the lower portion of the sand and gravel aquifer just above the bedrock.

Figure 3-3. Monitoring Well Diagram

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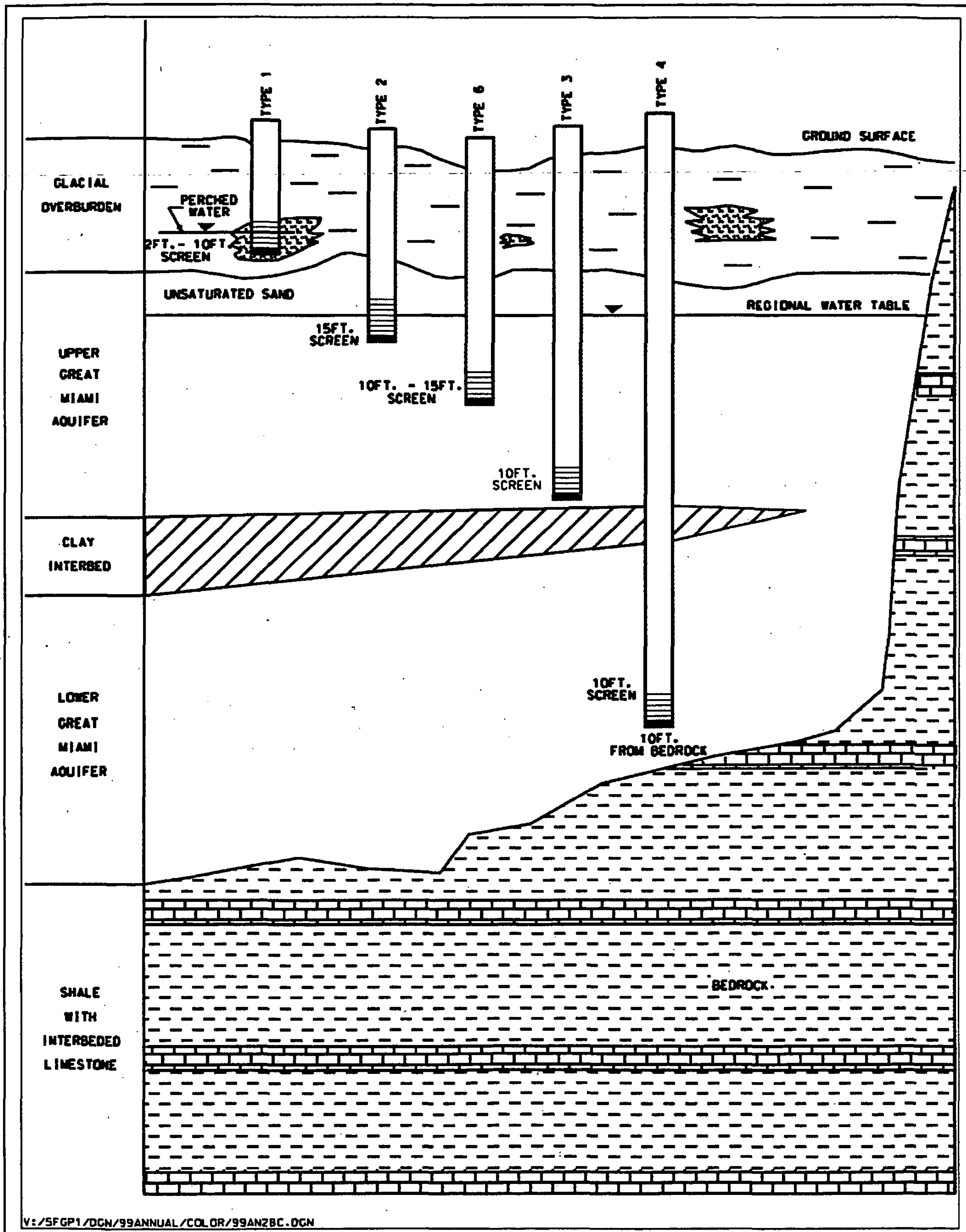

Figure 3-4. Monitoring Well Depths and Screen Locations

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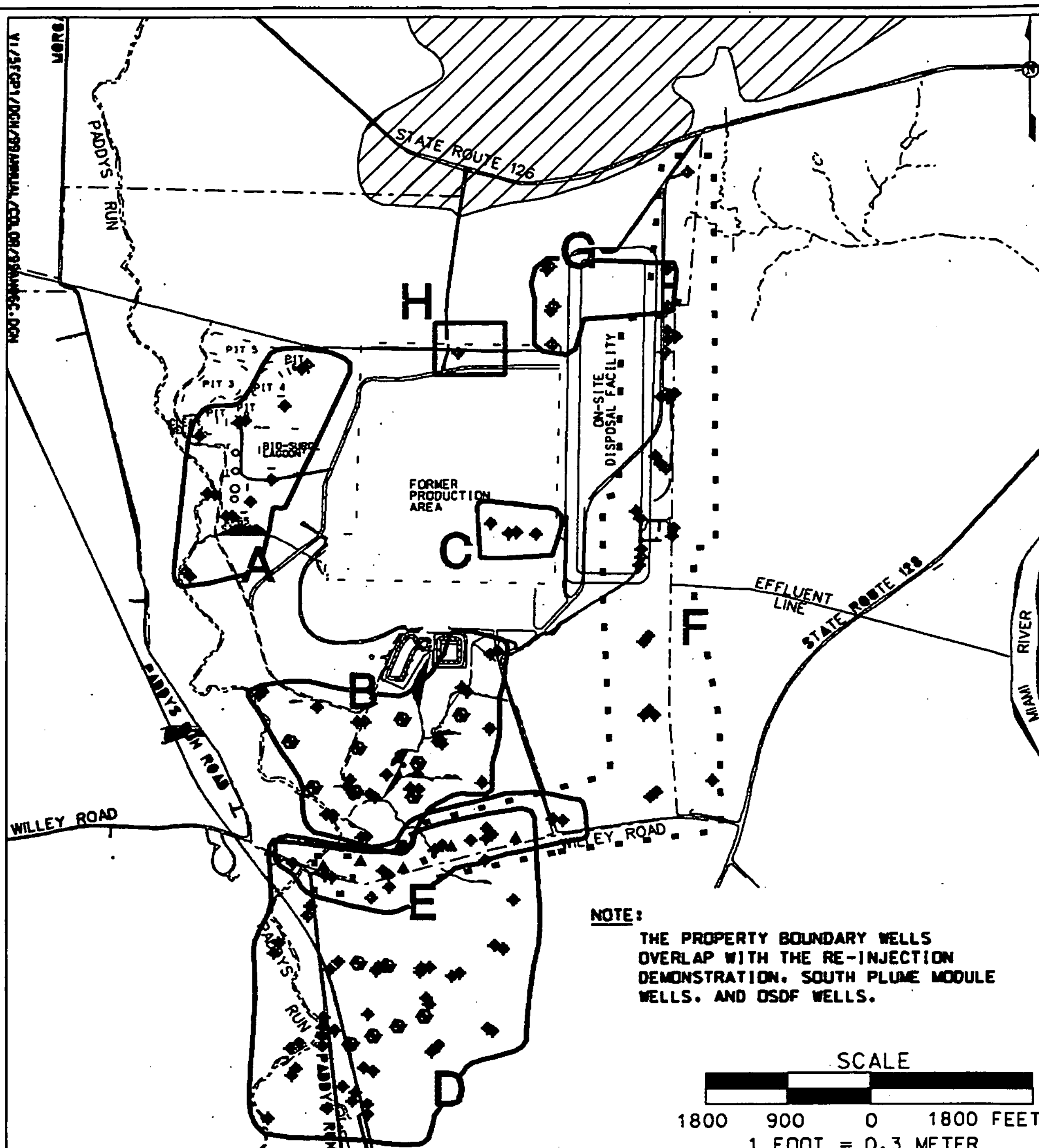

LEGEND:
A - WASTE STORAGE AREA
B - SOUTH FIELD EXTRACTION AREA
C - PLANT 6 AREA
D - SOUTH PLUME AREA
E - RE-INJECTION DEMONSTRATION AREA
F - PROPERTY BOUNDARY WELLS
G - OSDF MONITORING WELLS
H - KC-2 WAREHOUSE WELL
—·—·— FEMP BOUNDARY
◆ MONITORING WELL
⊕ EXTRACTION WELL
▲ RE-INJECTION WELL

Figure 3-5. IEMP Water Quality Monitoring Wells

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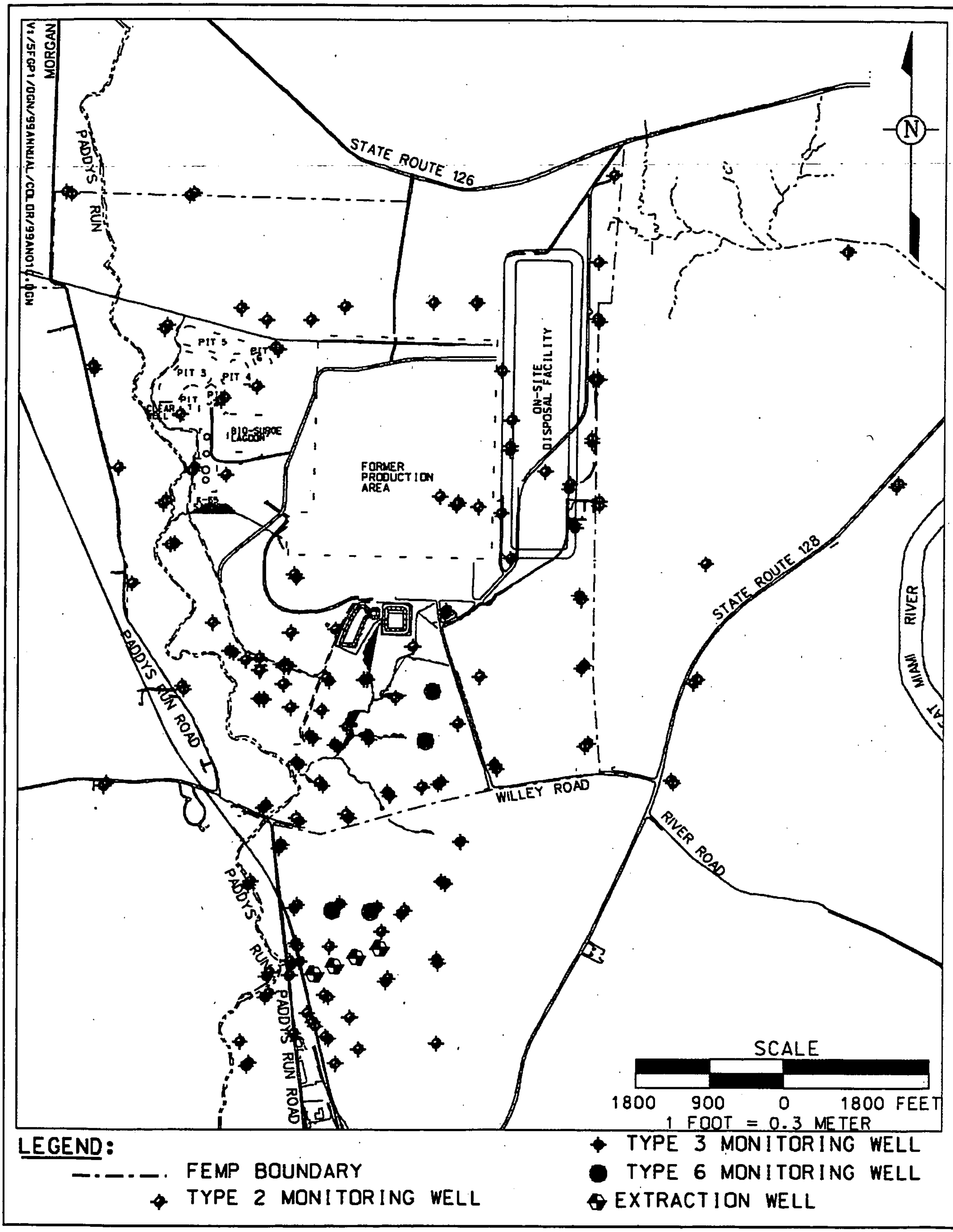

Figure 3-6. IEMP Groundwater Elevation Monitoring Wells

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

- **Reporting** - Groundwater reporting requirements are combined into IEMP quarterly status reports and annual integrated 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 following subsections:

- Operational Summary
  - South Plume/South Plume Optimization Module
  - South Field (Phase I) Extraction Module
  - Re-Injection Demonstration Module
- Monitoring Results for Total Uranium
- Monitoring Results for Non-Uranium Constituents.

More detailed information on the above can be found in Appendix A of this report. Each subsection below identifies the specific Attachment of Appendix A where the detailed information can be found.

3.3.1.1 Operational Summary

Figure 3-2 shows the extraction and re-injection well locations associated with the current restoration modules. Table 3-1 summarizes the pounds of uranium removed and the amount of groundwater pumped by the three restoration modules active during 1999. Figure 3-7 identifies the yearly and cumulative pounds of uranium removed from the Great Miami Aquifer from 1993 through 1999. Since 1993:

- 5,637 million gallons (21,336 million liters) of water have been pumped from the Great Miami Aquifer.

- 560 million gallons (2,120 million liters) of treated water have been re-injected into the Great Miami Aquifer.

- 1,509 pounds (685 kg) of uranium have been removed from the Great Miami Aquifer.

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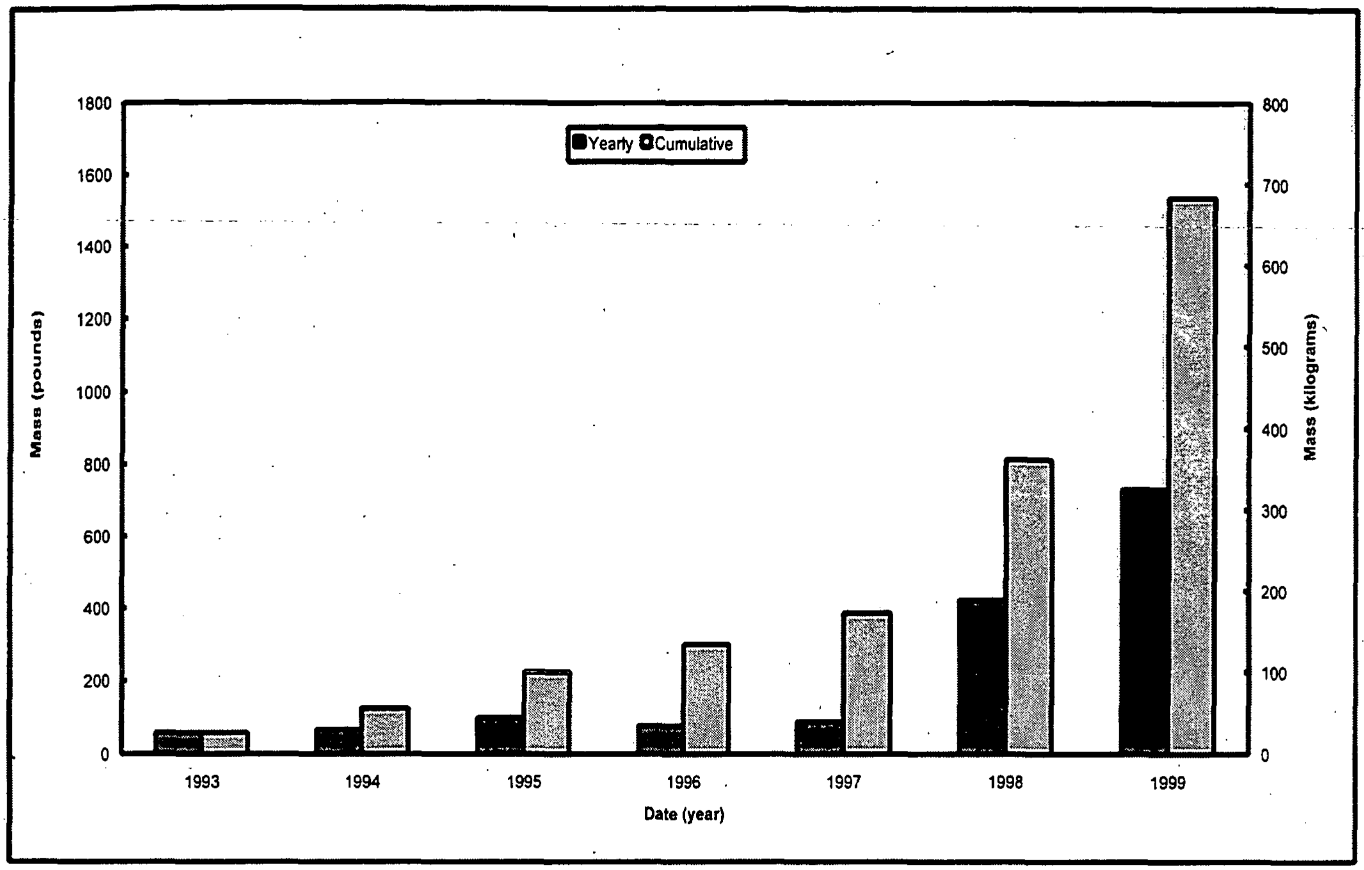

Figure 3-7. Pounds of Uranium Removed from the Great Miami Aquifer 1993 - 1999

TABLE 3-1

1999 GROUNDWATER RESTORATION MODULE STATUS

			Target Pumping Rate		Gallons Pumped/ Re-Injected		Uranium Removed/ Re-Injected in 1999	
Module	Restoration Wells	Operational Status	Gpm	Lpm	M gal.	M Liters	lbs	kg
South Plume/ South Plume Optimization Module	3924 3925 3926 3927	Operating since August 1993	1,500	5,700	947	3,584	259	118
	32308 32309	Operating since August 1998	500	1,900				
South Field (Phase I) Extraction Module	31550 31560 31561 31562 31563 31564 31566 31567 32276	Operating since July 1998	1,500	5,700	753	2,850	464	211
Re-Injection Demonstration Module	22107 22108 22109 22111 22240	Operating since September 1998	1,000	3,800	433	1,639	25	11
Aquifer Restoration System Totals								
(pumped)					1,700	6,434	723	329
(re-injected)					433	1,639	25	11
(net)					1,267	4,795	698	318

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The following subsections provide information on the individual modules. Appendix A, Attachment 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.

3.3.1.2 South Plume/South Plume Optimization Module

Operational Summary

As previously identified, the South Plume Module has been operational since 1993. Extraction Wells 3924, 3925, 3926, and 3927, which comprise the South Plume Module, continued to pump during 1999. The two extraction wells of the South Plume Optimization Module (Extraction Wells 32308 and 32309) began operating on August 9, 1998.

The South Plume/South Plume Optimization Module is evaluated quarterly to ensure that it continues to meet the primary objectives of preventing the further southward movement of the plume without adversely affecting the Paddys Run Road Site plume and actively remediate the off-property portion of the plume. The evaluation is 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 the capture zone. (Refer to Figure 3-8 for the capture zones associated with the South Plume/South Plume Optimization Module.) Based on analysis of the data in 1999, the module continues to meet its primary objectives in that the:

- Southward movement of the total uranium plume beyond the extraction wells has not been detected
- Active remediation of the central portion of the off-property total uranium plume continues
- Paddys Run Road Site plume, located south of the extraction wells, is not being adversely affected by the pumping.

The Paddys Run Road Site plume is a result of separate industrial activities along Paddys Run Road that are not associated with the FEMP.

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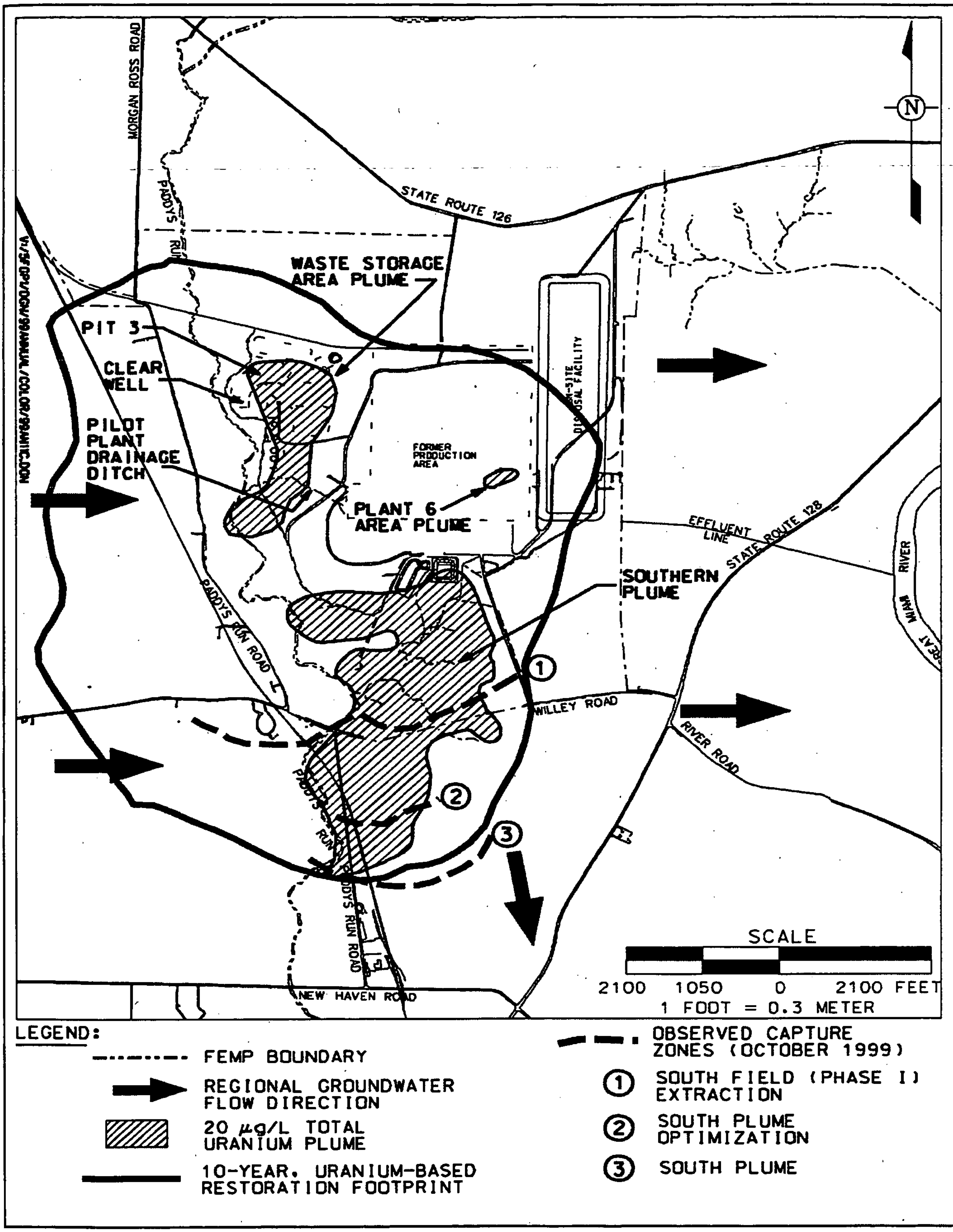

Figure 3-8. Total Uranium Plume in the Aquifer with Concentrations Greater than 20 µg/L at the End of 1999

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3.3.1.3 South Field (Phase I) Extraction Module Operational Summary

The 10 extraction wells of the South Field (Phase I) Extraction Module (Extraction Wells 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276) began operating on July 13, 1998. After evaluating the total uranium concentrations from Extraction Well 31566 in 1998 and finding the concentrations averaging much less than the 20 micrograms per liter (µg/L) total uranium FRL, DOE decided to discontinue operation of this well. The well pump was shut off on August 7, 1998. To compensate for the decreased total system flow with Extraction Well 31566 turned off, pumping rates were increased at Extraction Wells 31562 and 32276. EPA and OEPA were informed of these changes through weekly site status conference calls.

The South Field (Phase I) Extraction Module is evaluated quarterly to ensure that it continues to meet the primary objective of remediating the groundwater contamination in the South Field area. The evaluation is 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 the capture zone. (Refer to Figure 3-8 for the capture zone associated with the South Field [Phase I] Extraction Module.) As a result of groundwater remedy performance monitoring, two additional extraction wells (32446 and 32447) were installed in 1999 as part of the South Field (Phase I) Extraction Module. The locations of these wells were based on refined total uranium plume interpretations in the South Field area and groundwater modeling results. The refined plume interpretations were possible due to the use of direct push profile sampling collected with a Geoprobe®, as a supplement to the existing monitoring well network. The installation of these additional extraction wells during 1999 was not required to maintain capture of the plume; however, they were necessary to support the accelerated aquifer remediation schedule. It is anticipated that these new wells will begin pumping during the first quarter of 2000. Refer to Figure 3-2 for the location of these new extraction wells.

3.3.1.4 Re-Injection Demonstration Module Operational Summary

A one-year re-injection demonstration was completed to determine whether large-scale re-injection operations are feasible at the FEMP. The one-year test was completed in September 1999 and a report discussing the results of the demonstration is scheduled for release in June of 2000. At the end of 1999, the preliminary evaluation indicated that the testing results are favorable regarding the viability of re-injection at the FEMP, that a reliable source of injection water can be maintained, and that an acceptable injection rate can be sustained without negative effects on the plume or aquifer.

The five re-injection wells of the Re-Injection Demonstration Module (Re-Injection Wells 22107, 22108, 22109, 22111, and 22240) began operating on September 2, 1998. Sampling specified in the Re-Injection Demonstration Test Plan (DOE 1998a) was initiated during the second quarter of 1998 and continued in 1999.

As part of the Re-Injection Demonstration, total uranium samples were collected at various depths in the aquifer using a Geoprobe®. These data were used to supplement the total uranium plume map discussed in the next section and used to assess the effects of active pumping and re-injection on the plume. A more detailed discussion of these Geoprobe® sample results will be provided in the Re-Injection Demonstration Report to be submitted in June of 2000.

Geoprobe®

The Geoprobe® is a hydraulically powered, direct push machine that is currently used at the FEMP 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 its mounted on and percussive force to push into the ground without drilling (or cutting) to displace soil in the tool's path. DOE uses this technique to collect data on the progress of aquifer restoration and will use it to determine the optimal location and depth of any additional monitoring wells which may be installed in the future.

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3.3.1.5 Monitoring Results for Total Uranium

Total uranium is the primary FRL constituent because it is the most prevalent site contaminant and has impacted the largest area of the aquifer.

The 10-year, uranium-based restoration footprint

The 10-year, uranium-based restoration footprint shows the anticipated total areal extent of the Great Miami Aquifer which is to be influenced by the aquifer restoration activities over the 10-year duration of the remediation as presented in aquifer restoration remedial design documents. The extent is determined from groundwater modeling results which show the composite groundwater capture zone derived from the capture zones for each extraction well.

Figure 3-8 shows general groundwater flow directions and the interpretation of the total uranium plume in the aquifer, as updated with data collected through 1999. The shaded areas represent the maximum size of the total uranium plume that is above the 20 μg/L groundwater FRL for total uranium. The fourth quarter 1999 observed capture zones for the South Field (Phase I) Extraction, South Plume, and South Plume Optimization Modules are also identified on Figure 3-8. 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 3-8 also depicts that the total uranium concentrations greater than the FRL are within the 10-year, uranium-based restoration footprint.

The interpreted 20 μg/L total uranium plume boundary in the area of the South Field has changed in shape somewhat from 1998. The plume shape and concentration contours have been modified to better reflect the Geoprobe® data in the eastern, on-property area of the southern plume (refer to Figure 3-9). These data were collected as part of remedy performance monitoring and resulted in the installation of two additional extraction wells in the South Field area (Extraction Wells 32446 and 32447 on Figure 3-9).

North and east of the former inactive flyash pile area (Figure 3-9), two monitoring wells showed substantial changes in total uranium concentrations:

- Monitoring Well 2046, located north of the former inactive flyash pile, decreased from 165 μg/L during the fourth quarter of 1998 to about 57 μg/L during the fourth quarter of 1999.
- Monitoring Well 2385, located east of the former inactive flyash pile, increased from 242 μg/L during the fourth quarter of 1998 to nearly 600 μg/L during the fourth quarter of 1999.

These substantial changes indicate the extraction wells to the east of this area are, as designed, accelerating the plume movement toward them from the area beneath the former inactive flyash pile.

In other areas of the southern total uranium plume, based on evaluation of total uranium concentration versus time plots, many monitoring wells are showing downward trends and a few wells are showing steady or increasing trends in uranium concentration. These trends are a result of contamination movement in response to the remedial pumping and re-injection. Areas where concentrations are holding steady or increasing may indicate a need to modify extraction well pumping rates. Pumping rate modifications will be made and evaluated as necessary over the life of the groundwater remedy in an effort to optimize the extraction system.

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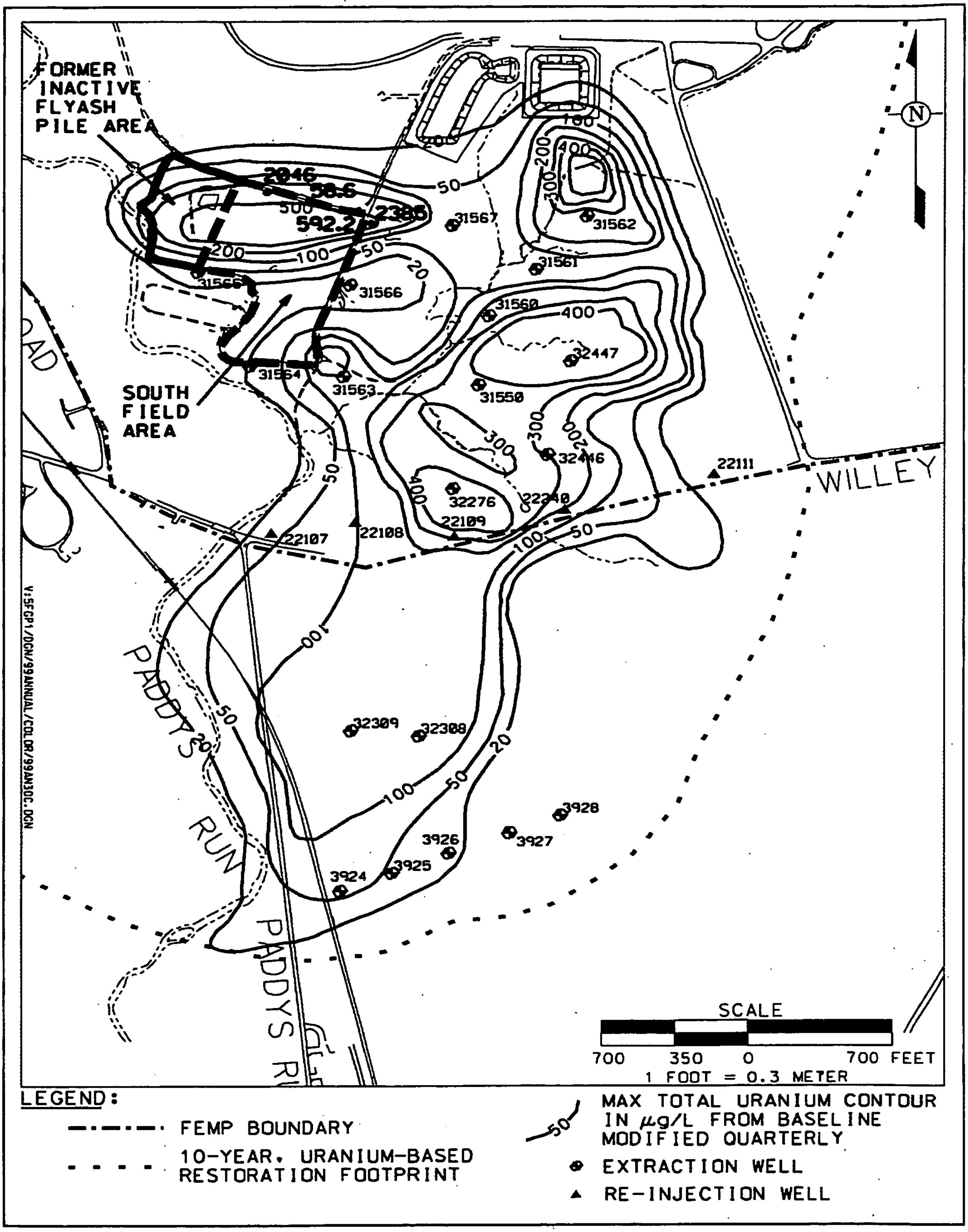

Figure 3-9. Detailed Southern Total Uranium Plume in the Aquifer at the End of 1999

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Groundwater was sampled from the existing monitoring well network in the waste storage area and in the Plant 6 area during 1999 to track water quality conditions. Based on the monitoring well sampling, the interpreted total uranium plumes in the Plant 6 area and waste storage area do not appear to have significantly changed since sampling in 1997.

Early in 2000, additional characterization efforts utilizing 30 direct-push sampling locations were conducted in the waste pit and Plant 6 areas to support the engineering design of the aquifer restoration modules planned for these areas. The information was not collected as part of the 1999 IEMP monitoring program; however, the significance of the new data warrants its mention in this report.

Although additional characterization of the Plant 6 area detected no new findings, there were some changes to the plume configuration in the waste storage area. Prior to this characterization effort, uranium contamination in the waste storage area was interpreted as a single large uranium plume (refer to Figure 3-8). As a result of the recent data, this interpretation has been refined to depict three individual plumes. One plume is a relatively narrow east-west trending plume that parallels and extends east of the Pilot Plant Drainage Ditch, with uranium concentrations up to 566 μg/L. The second plume is in the vicinity of the silos and the Bio-Surge Lagoon, with uranium concentrations up to 31 μg/L. This plume has not been fully defined due to the inability to sample beneath these areas. The third and final plume is east of Waste Pit 3 and the clearwell area with uranium concentrations up to 30 μg/L. Additional discussion and illustrations of the results of this characterization effort will be presented in the Engineering Design of the Great Miami Aquifer Remedy for the waste storage and Plant 6 areas and summarized in forthcoming IEMP quarterly status reports.

Appendix A, Attachment 2, of this report provides individual monitoring well total uranium results and quarterly total uranium plume maps. Appendix A, Attachment 3, of this report provides capture zone evaluations based on groundwater flow directions from groundwater elevation data. It includes quarterly groundwater elevation maps and graphical displays of groundwater elevation data.

3.3.1.6 Monitoring Results for Non-Uranium Constituents

Although the enhanced groundwater remedy is primarily targeting remediation of the uranium plume, other FRL constituents (Table 3-2) contained within the uranium plume are also being addressed. The FEMP monitors these other constituents to determine where they exceed the FRL.

Table 3-2 summarizes the results of monitoring for non-uranium FRL constituents, and Figure 3-10 identifies the locations of the wells that had FRL exceedances. Included in the table for each FRL constituent are the number of wells with 1999 FRL exceedances, the number of wells with FRL exceedances outside the 10-year, uranium-based restoration footprint, and the range of 1999 data above the FRL from wells inside or outside the 10-year, uranium-based restoration footprint.

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TABLE 3-2

NON-URANIUM CONSTITUENTS WITH 1999 RESULTS ABOVE FINAL REMEDIATION LEVELS

Constituent	Number of Wells Exceeding the FRL	Number of Wells Exceeding the FRL Outside the 10-Year, Uranium-Based Restoration Footprint	Groundwater FRL	Range of 1999 Data Inside the 10-Year, Uranium-Based Restoration Footprint above the FRL	Range of 1999 Data Outside the 10-Year, Uranium-Based Restoration Footprint above the FRL[a]
General			(mg/L)	(mg/L)	(mg/L)
Nitrate/Nitrite	3	0	11[b]	13.6 to 36.8	NA
Inorganics					
Boron	2	0	0.33	0.331 to 1.16	NA
Lead	2	0	0.015	0.0184 to 0.0227	NA
Manganese	9	1[c]	0.900	0.936 to 5.23	0.963
Molybdenum	1	0	0.10	0.44	NA
Nickel	5	1[c]	0.10	0.101 to 0.972	0.13
Zinc	11	7[c]	0.021	0.0218 to 0.367	0.0226 to 1.11
Volatile Organics			(µg/L)	(µg/L)	(µg/L)
Carbon disulfide	3	1	5.5	9 to 14	6
Trichloroethene	2	0	5.0	20.7 to 80	NA
Radionuclides			(pCi/L)	(pCi/L)	(pCi/L)
Technetium-99	3	0	94	166.342 to 1352.266	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.
[c]Additional 2000 data are needed from Monitoring Wells 22198, 2426, and 3426 before a determination of persistence can be made.

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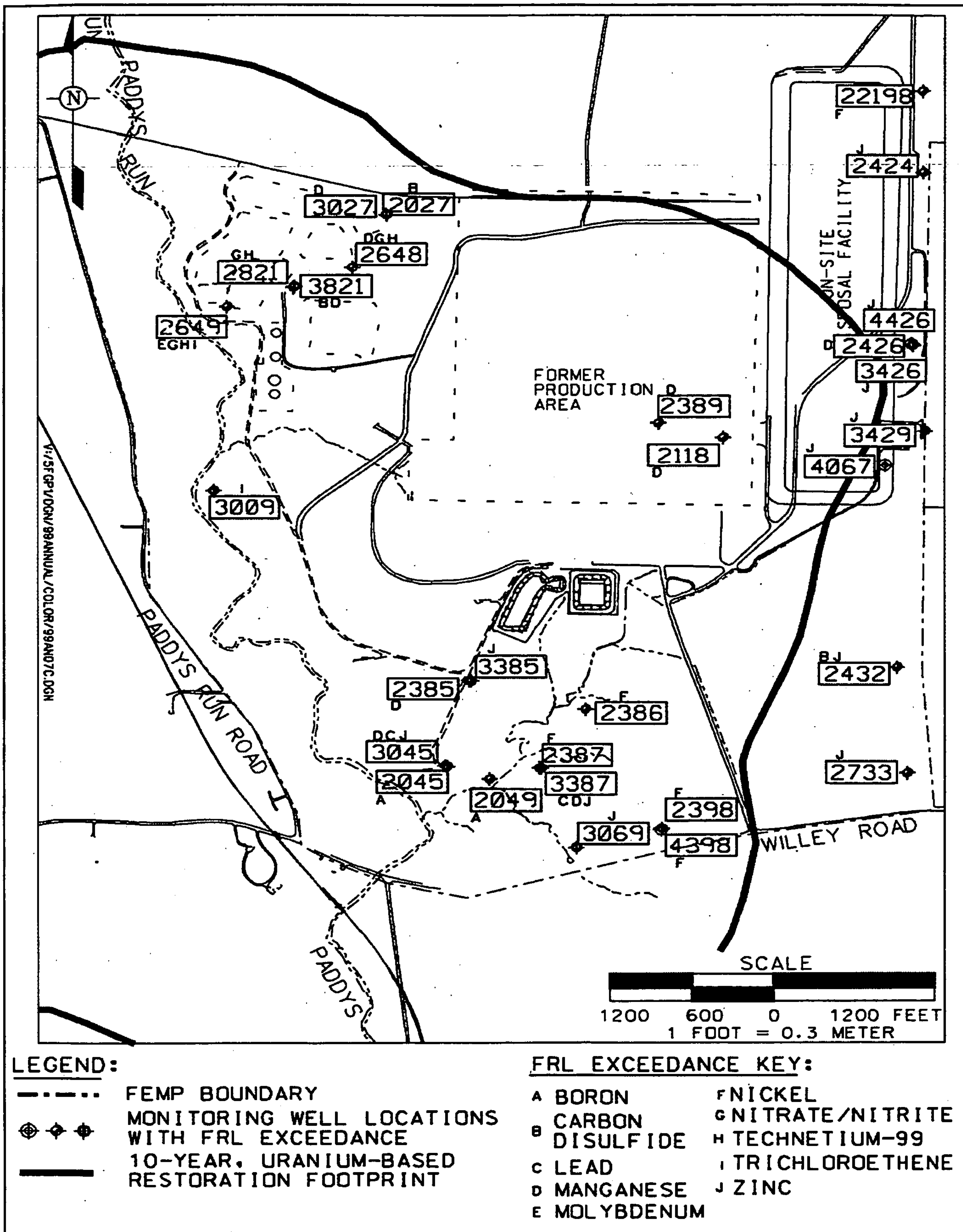

Figure 3-10. Non-Uranium Constituents with 1999 Results Above Final Remediation Levels

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During 1999 non-uranium FRL exceedances were observed at 29 monitoring well locations as shown in Figure 3-10. A total of 10 non-uranium FRL constituents exceeded FRLs in 1999. All these exceedances were within the 10-year, uranium-based restoration footprint and are expected to be addressed by the enhanced groundwater remedy, except exceedances for carbon disulfide, manganese, nickel, and zinc at various monitoring well locations along the eastern property boundary (refer to Figure 3-10). No plumes for the above FRL constituents at the locations outside the 10-year, uranium-based restoration footprint were identified in the extensive groundwater characterization efforts evaluated as part of the Operable Unit 5 Remedial Investigation Report.

The constituents with FRL exceedances at the well locations outside the 10-year, uranium-based restoration footprint were further evaluated to see if they were random events or if they were persistent according to criteria discussed in Appendix A, Attachment 4, of this report. Only one 1999 FRL exceedance was classified as persistent; zinc in Monitoring Well 4067. The cause for this exceedance is not understood at this time and the data indicate a decreasing trend, with the most recent quarterly data indicating an estimated concentration slightly above the FRL. Also, as footnoted in Table 3-2, some FRL exceedances require additional data to be collected in 2000 before a determination of persistence can be made.

Appendix A, Attachment 4, of this report provides detailed information of non-uranium FRL exceedances, the persistence of these exceedances, and where it is necessary to collect additional samples to determine persistence.

3.3.2 Other Monitoring Commitments

Three other groundwater monitoring activities are included in the IEMP:

- Private Well Monitoring
- Property Boundary Monitoring
- KC-2 Warehouse Well 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 below provides additional details on the three compliance-monitoring activities.

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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 total uranium plume migration. One of these private wells is where off-property groundwater contamination was initially detected in 1981. Other private wells ceased to be monitored in 1997 because a DOE-sponsored public water supply became available to FEMP 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 total uranium plume map shown in Figure 3-8.

Property Boundary Monitoring is comprised of 33 monitoring wells, located downgradient of the FEMP, along the eastern and southern portions of the property boundary. These wells are monitored quarterly for 27 of the most mobile FRL constituents in order to determine if contaminant excursions at the property boundary are occurring during the remediation process. Data from these wells were integrated with other IEMP data for 1999 and were incorporated into the total uranium plume map shown in Figure 3-8. Non-uranium data from these wells were included above in the section on monitoring results for non-uranium constituents.

The KC-2 Warehouse well monitoring has also been included as part of the IEMP. Monitoring of this well (Well 67) is conducted on an annual basis as a result of the presence of what appeared to be contaminated sediment at the bottom of the well. This well is scheduled to be plugged and abandoned in 2000. Sampling results from this well in 1999 revealed lower concentrations of hazardous substance list metals than the previous year's sampling results. All results were below their respective groundwater FRLs. The monitoring results for this well and additional detail on the sampling events are presented in Appendix A, Attachment 5, of this report.

3.4 On-Site Disposal Facility Monitoring

Groundwater monitoring in support of the on-site disposal facility continued in 1999. 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 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.

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Groundwater monitoring for the cells of the on-site disposal facility is conducted in the till (perched water) and in the Great Miami Aquifer. 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, 2, and 3, along with sample information and range of total uranium concentrations. During 1999 Monitoring Well 22205 was installed downgradient of Cell 4 in the Great Miami Aquifer and sampling of this well is scheduled to be initiated in the summer of 2000. It will not be necessary to install an upgradient Great Miami Aquifer monitoring well for Cell 4 as existing Monitoring Well 2421 will be used. Figure 3-11 identifies the on-site disposal facility footprint and monitoring well locations.

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	22201	Great Miami Aquifer	March 31, 1997	23	ND - 5.196
(December 1997)	22198	Great Miami Aquifer	March 31, 1997	32	0.557 - 3.814
	12338	Till	October 30, 1997	26	ND - 19
	12338C	Leachate Collection System	February 17, 1998	8	ND - 119
	12338D	Leak Detection System	February 18, 1998	7	1.5 - 20.17
Cell 2	22200	Great Miami Aquifer	June 30, 1997	18	ND - 1.11
(November 1998)	22199	Great Miami Aquifer	June 25, 1997	18	0.259 -12.1
	12339	Till	June 29, 1998	25	ND - 3.607
	12339C	Leachate Collection System	November 23, 1998	5	4.51 - 22.7
	12339D	Leak Detection System	December 14, 1998	5	12 - 71[b]
Cell 3	22203	Great Miami Aquifer	August 24, 1998	16	ND - 0.907
(November 1999)	22204	Great Miami Aquifer	August 24, 1998	16	ND - 2.995
	12340	Till	July 28, 1998	19	ND - 9.14

[a]ND = not detectable

[b]Data not considered reliable due to malfunction in the leachate pipeline and the resultant mixing of individual flows.

Placement of contaminated soil and debris in Cell 1 continued during 1999. As of December 1999, Cell 1 was approximately 80 percent full. Groundwater sampling was initiated for Cell 1 in 1997 in an effort to establish a baseline for the monitoring wells prior to waste placement in December 1997. During 1998 a draft technical memorandum was issued to discuss the baseline results. The regulatory agencies issued comments on this technical memorandum identifying that it would be necessary to extend sampling in order to better establish baseline conditions. Accordingly, a strategy to extend the baseline sampling period for the horizontal till wells associated with Cells 1, 2, and 3 was approved by the regulatory agencies in 1999. Sampling of groundwater, the leachate collection system, and the leak detection system also continued in 1999. Based on 1999 monitoring data associated with Cell 1, the liner system for Cell 1 is performing within the specifications outlined in the approved cell design.

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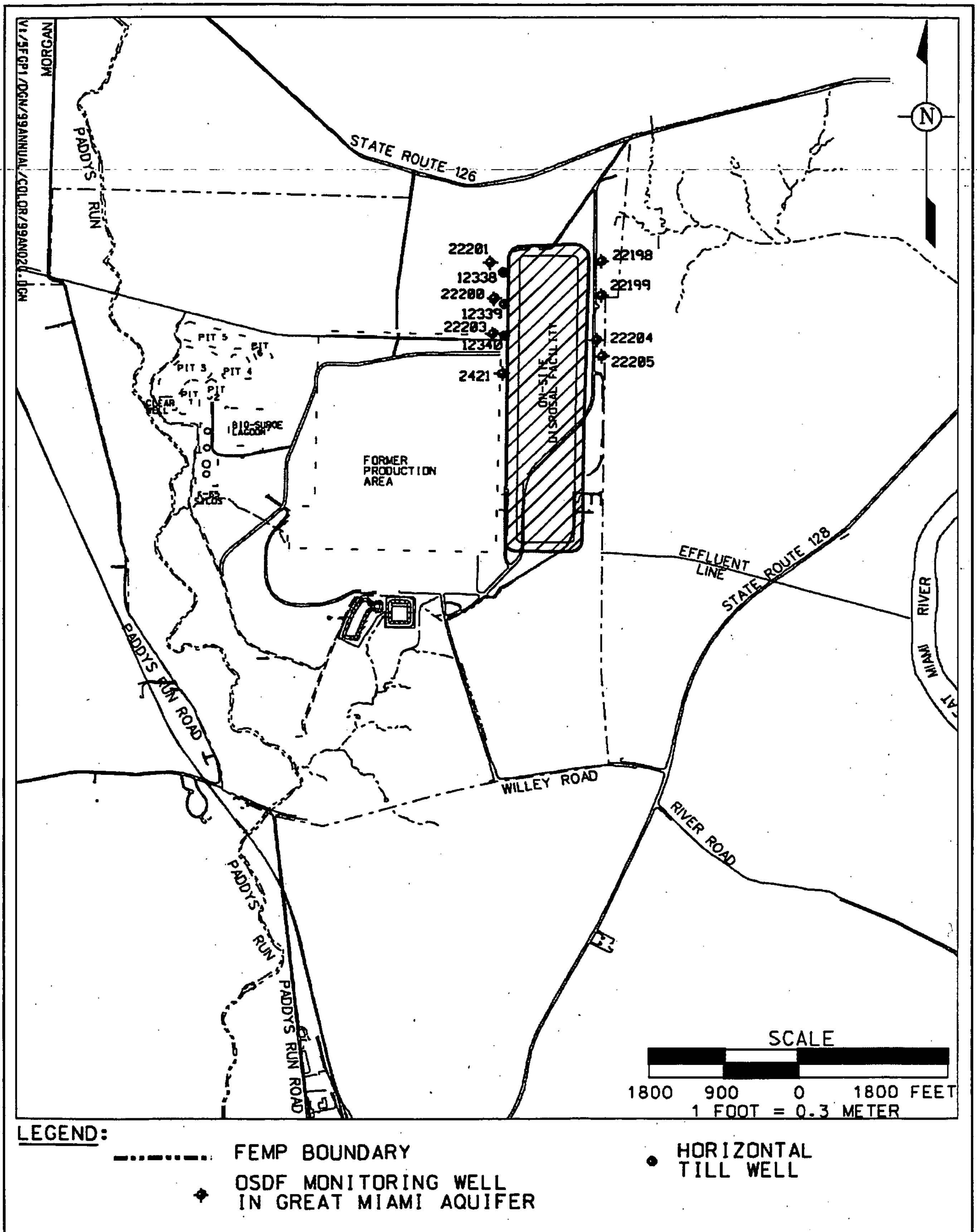

Figure 3-11. On-Site Disposal Facility Footprint and Monitoring Well Locations

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Soil and debris placement also continued in Cell 2 during 1999. As of December 1999, Cell 2 was approximately 40 percent full. Groundwater sampling was also initiated in 1997 for Cell 2 and continued in 1999. Waste placement was initiated in November 1998, and then leachate collection and leak detection system monitoring began. According to 1999 monitoring data associated with Cell 2, the liner system for Cell 2 is performing within the specifications outlined in the approved cell design.

Groundwater sampling was initiated in 1998 for Cell 3. Soil and debris placement began in the fourth quarter of 1999. As of December 1999, Cell 3 was approximately 10 percent full. According to 1999 monitoring data associated with Cell 3, the liner system for Cell 3 is performing within the specifications outlined in the approved cell design.

In all the samples collected from the horizontal till wells and Great Miami Aquifer wells, none of the constituents analyzed for this program exceeded the groundwater FRLs. For additional information on the groundwater sampling results for the on-site disposal facility, refer to Appendix A, Attachment 6, of this report.

3.5 Guide to Aquifer Restoration and Wastewater Project Documents

Numerous studies and reports have been issued by the FEMP during the CERCLA process to document the progress of the aquifer restoration. Table 3-4 is a reference for the reader to consult when seeking additional information about any phase of the site CERCLA process related to groundwater which has been completed to date. The times during which the major accomplishments under the CERCLA process were performed are shown on the left. The middle column identifies the major CERCLA process, which was in progress at the time. The last column indicates the documents where significant findings, results, and recommendations can be located. These documents are available for public viewing in the FEMP Public Environmental Information Center.

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TABLE 3-4

CHRONOLOGICAL SUMMARY OF AQUIFER RESTORATION ACTIVITIES

Date	Activity	Reporting Document[a]
1988 - 1995	Determine the Scope of the Problem and Select a Solution	
	Determine the nature and extent of groundwater contamination and investigate the risk posed to human health and/or the environment	**Remedial Investigation Report for Operable Unit 5** (1995)
	Evaluate various remediation technologies; consider efficiency, land use scenarios, and cost	**Feasibility Study Report for Operable Unit 5** (1995)
	Establish remediation goals for site contaminants in environmental media; commit to a selected cleanup remedy	**Record of Decision for Remedial Actions at Operable Unit 5** (1996)
1996 - 1997	Design and Construct a System to Cleanup the Aquifer	
	Define how and when needed construction drawings, specifications, plans, and procurement documents will be prepared	**Remedial Design Work Plan for Remedial Actions at Operable Unit 5** (1996)
	Develop a strategy and schedule for completing restoration of the aquifer	**Remedial Action Work Plan for Aquifer Restoration at Operable Unit 5** (1997)
	Design the aquifer restoration system (e.g., number of wells, pumping rates, well locations, etc.)	**Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)** (1997)
	Develop a plan to monitor progress of the clean up	Chapter 3 of the **Integrated Environmental Monitoring Plan** (1997)
	Develop operational strategy for the aquifer system	**Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project** (1997)
1993 - 1998	Start-Up the Systems to Cleanup the Aquifer	
	South Plume Module activity began as a removal action in 1993 integrated into remediation.	**South Plume Removal Action Design Monitoring Evaluation Program Plan** (1993)
		Design Monitoring Evaluation Program Plan System Evaluation Report (various dates through September 1997)
	South Field (Phase 1) and South Plume Optimization Modules, which began operation in 1998	**Start-Up Monitoring Plan for the South Field Extraction and South Plume Optimization Modules** (1998)
	Re-Injection Demonstration Module, which began operation in 1998	**Re-Injection Demonstration Test Plan** (1997)
1997 - 1999	Monitoring of the Systems to Cleanup the Aquifer	**IEMP** quarterly status reports (beginning with December 1997 and ending with December 1999)
	Complete Re-Injection Demonstration	**Monthly Re-Injection Report** (September 1999) and **Integrated Environmental Monitoring Status Report for Third Quarter 1999** (December 1999)
	Revised operational strategy for the aquifer system	**Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Project** (December 1999)
	Begin pre-design characterization of uranium plumes in the waste storage area and Plant 6 area	**Integrated Environmental Monitoring Status Report for Fourth Quarter 1999** (March 2000)

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4.0 Surface Water and Treated Effluent Pathway

Results in Brief: 1999 Treated Effluent and Surface Water Pathway

Surveillance Monitoring - No surface water or treated effluent analytical results, from samples collected in 1999, exceeded the surface water FRL for total uranium, the primary site contaminant. FRL exceedances were limited to two constituents (manganese and chromium) while no BTV exceedances occurred. *Occasional, sporadic FRL and BTV exceedances are to be expected until site remediation is complete.*

NPDES - Permitted discharges were in compliance with the current NPDES permit requirements 99.5 percent of the time. All of the noncompliances were experienced at the new sewage treatment plant (STP 4601) where total suspended solids exceeded the permit limits 11 times in treated effluent.

Uranium Discharges - In 1999, 233 pounds (106 kg) of uranium were discharged in treated effluent to the Great Miami River. Approximately 186 pounds (84.4 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 419 pounds [190 kg]) decreased 20 percent from the 1998 estimate.

Sediment - The 1999 sediment results are within the range of historical concentrations. In addition, there were no FRL exceedances for any sediment result in 1999.

This chapter presents the 1999 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 FEMP by two primary mechanisms: treated effluent that is monitored as it is discharged to the Great Miami River, and through uncontrolled runoff entering the site's drainages from areas of the site containing 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.

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

- **Controlled runoff** is contaminated storm water that is collected, treated and eventually discharged to the Great Miami River as treated effluent.
- **Uncontrolled runoff** is storm water that is not collected by the site 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 FEMP's wastewater treatment facilities and discharged to the Great Miami River.
- **Surface water** is water that flows within natural drainage features.

4.1 Summary of Surface Water and Treated Effluent Pathway

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 FEMP wastewater operations. Under normal operation this combined flow is comprised of:

- Storm water runoff collected from the former production area, waste pit area and the southern waste unit excavation area
- Treated and untreated groundwater from the South Plume/South Plume Optimization and South Field (Phase I) Extraction Modules
- Remediation wastewater such as on-site disposal facility leachate, decontamination rinse water generated during building decontamination and dismantling activities, and wastewater generated from the operation of the Waste Pit Remedial Action Project dryer facility
- Treated sanitary wastewater from the new sewage treatment plant.

During periods of heavy, sequential rainfall events, untreated storm water (which exceeds the capacity of FEMP treatment systems) is bypassed directly to the Great Miami River.

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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 shows monthly precipitation totals for 1999. 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, Storm Sewer Outfall Ditch) and the northeast drainage. The arrows on this figure indicate the general flow direction of uncontrolled runoff that is determined from the topography. Uncontrolled runoff from the FEMP 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 1999 that affected (or had the potential to affect) the surface water pathway included:

- 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
- Excavation activities associated with the southern waste units (Area 2, Phase I)
- Excavation activities in the former sewage treatment plant area (Area 1, Phase II)
- Construction and operation activities associated with the Waste Pits Remedial Action Project including dryer operation, pit excavation and waste material handling, and railcar loading and shipping
- Construction activities associated with two additional groundwater extraction wells supporting the South Field Extraction Module
- Construction activities associated with the roads and electrical upgrades portion of the Silos Infrastructure Project.

To minimize the effects of remediation on the environment, engineered and administrative controls are used at the FEMP 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 also sometimes lined with riprap and/or synthetic liners to control erosion. In areas where remediation activities may expose contaminated materials (e.g., the southern waste units), contaminated runoff is collected in lined basins and routed for treatment at one of the FEMP's wastewater treatment facilities. Administrative controls include limiting the duration of open excavations, as well as, routinely inspecting each of the engineered controls used.

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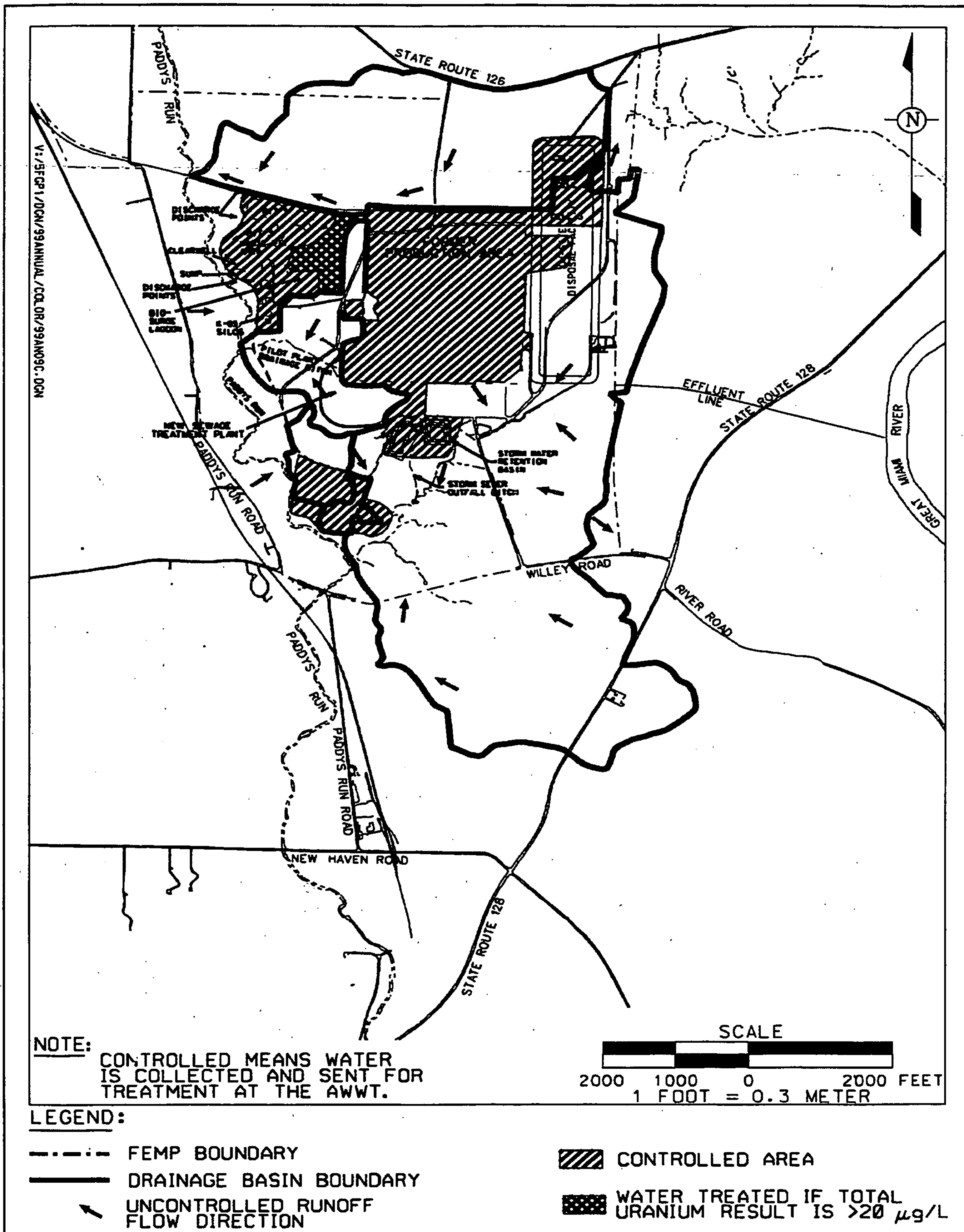

Figure 4-1. Controlled Surface Water Areas and Uncontrolled Runoff Flow Directions

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Each remediation project is responsible for constructing and maintaining the engineered control structures required under their 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 fence repairs, reseeding of eroded areas) were performed in 1999 as a result of these inspections.

Engineered controls installed during 1997 and 1998 continued to be used and maintained in 1999. No new storm water controls were installed during 1999.

4.3 Surface Water, Treated Effluent, and Sediment Highlights for 1999

Surface water, treated effluent, and sediment are sampled to determine the effect of the FEMP'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 in the major site drainages (i.e., Paddys Run and Storm Sewer Outfall Ditch) and in the Great Miami River for radiological constituents.

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

- **Sampling** - Sample locations, frequency, and constituents were selected to address the requirements of the NPDES Permit, FFCA, and Operable Unit 5 Record of Decision, and to provide a comprehensive assessment of surface water quality at 15 key locations (refer to Figures 4-2 and 4-3). Surface water is monitored for up to 55 FRL constituents (refer to Table 2-2) 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 to surface water due to FEMP 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 reporting requirements are combined into IEMP quarterly status reports and annual integrated site environmental reports. Monthly discharge monitoring reports required by the NPDES Permit are submitted to OEPA.

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

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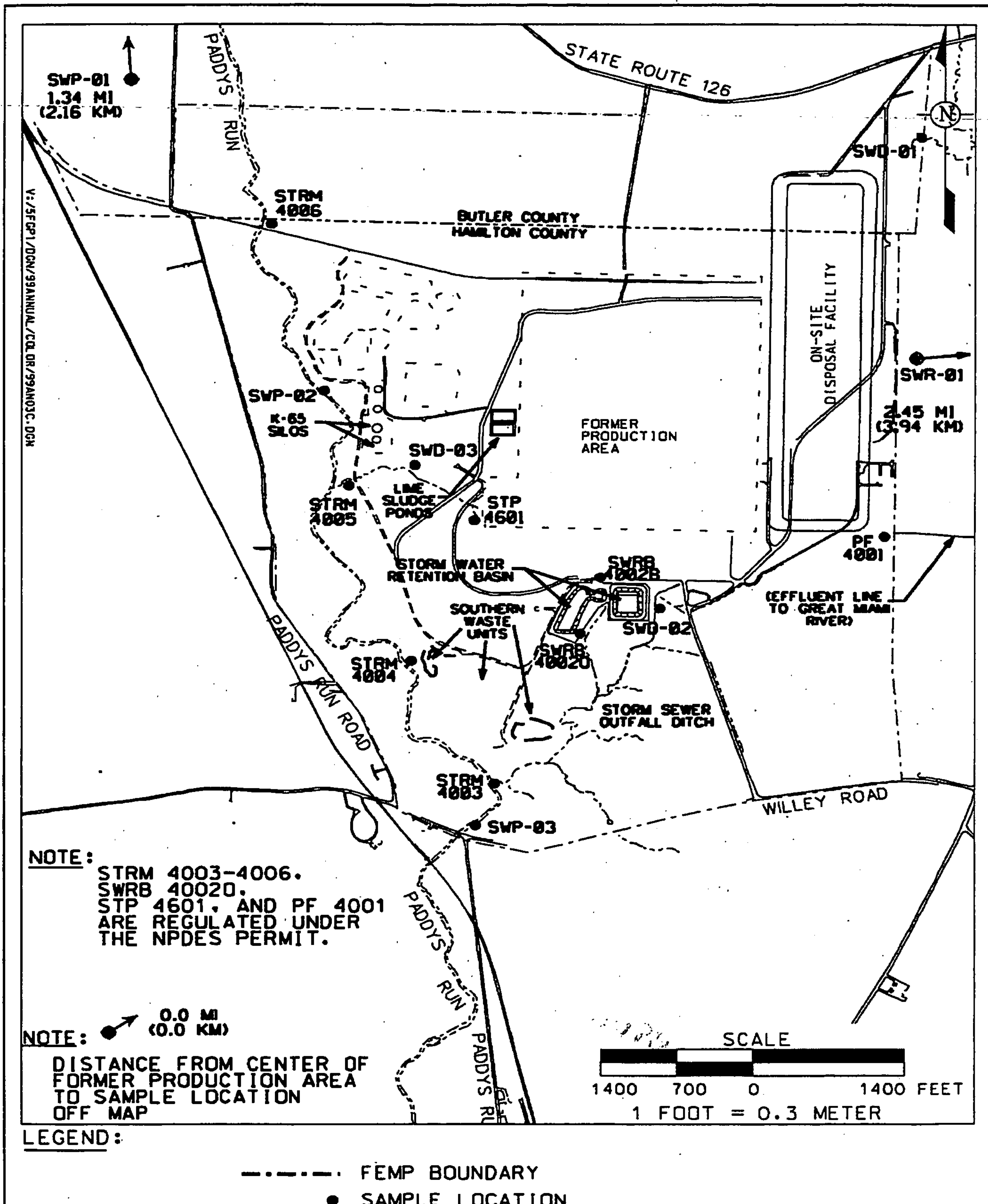

Figure 4-2. IEMP Surface Water and Treated Effluent Sample Locations

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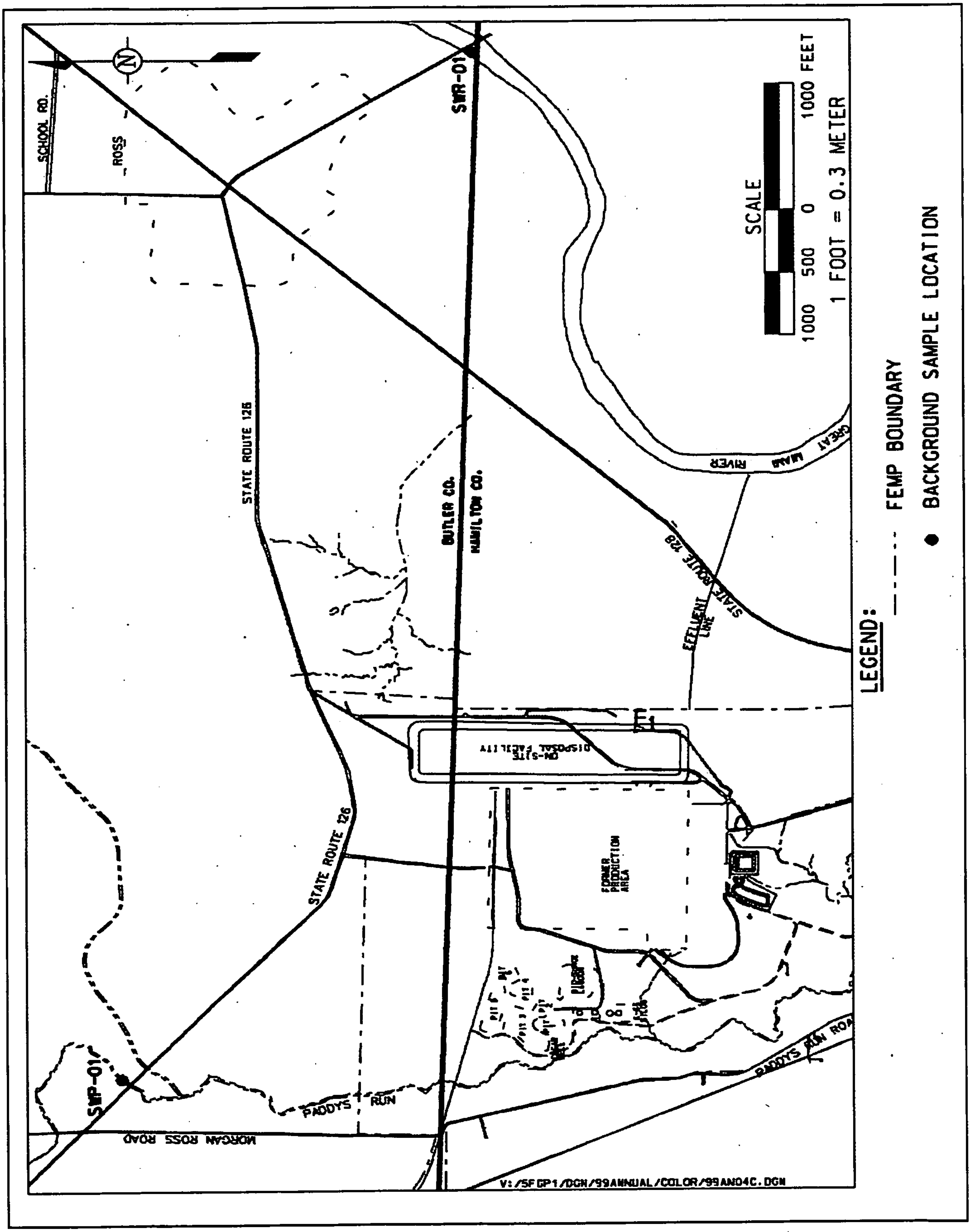

Figure 4-3. IEMP Background Surface Water Sample Locations

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Data from samples collected under the IEMP are used to fulfill both compliance monitoring and surveillance monitoring functions. 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 and the FFCA. 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. 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 surface background sample locations.

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 water mixes with effluent water in the Great Miami River.

4.3.1 Surveillance Monitoring

Data resulting from 1999 sampling efforts were evaluated to provide surveillance monitoring of remediation activities. This evaluation showed that during 1999, 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. There were no BTV exceedances at any monitored location. Table 4-1 summarizes these exceedances and Figure 4-4 identifies the locations of the exceedances.

TABLE 4-1

CONSTITUENTS WITH 1999 RESULTS ABOVE FRLs

Constituent	Number of Locations Exceeding FRL	Surface Water FRL	Range of 1999 Data above FRL
Inorganics		(mg/L)	(mg/L)
Chromium[a]	1	0.010	0.0131
Manganese	1	1.5	1.71

[a]FRL based on hexavalent chromium, from Operable Unit 5 Record of Decision, Table 9-5; however, the sampling results are for total chromium.

One of the exceedances in 1999 was for manganese that occurred at the Paddys Run background location SWP-01. Background monitoring locations are located upstream and outside the influence of FEMP discharges. The background data are used to distinguish impacts from FEMP activities against upstream water quality conditions. Therefore, concentrations at the background locations (both in Paddys Run [SWP-01] and in the Great Miami River [SWR-01]) are not attributable to the FEMP.

The other exceedance, which may be attributable to FEMP activities, was in December for chromium at SWP-03, the downstream property boundary location in Paddys Run. The result was 0.0131 milligrams per liter (mg/L), slightly above the FRL of 0.01 mg/L. The FRL is based on hexavalent chromium; however, the sampling result is for total chromium. Hexavalent chromium is some fraction of total chromium, but because hexavalent chromium samples can only be held in the laboratory for a short time before analysis, the analysis is performed for total chromium.

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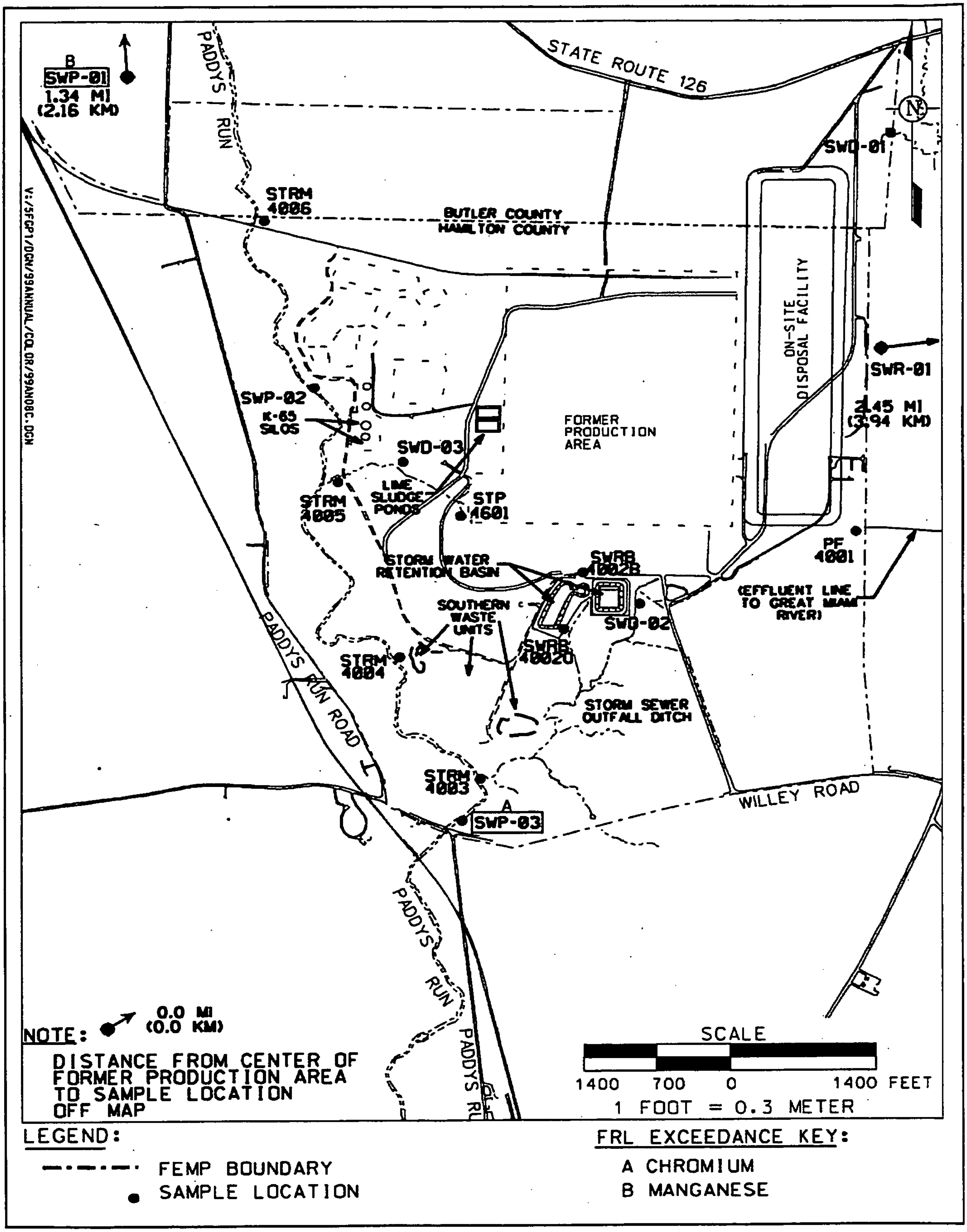

Figure 4-4: Constituents with 1999 Results Above Final Remediation Levels

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Even with the FEMP's implementation of storm water and sediment controls, sporadic FRL and BTV exceedances can be expected to occur until final remediation of contaminated source areas (soils and sediments) are complete. The FRL and BTV exceedances will continue to be evaluated for persistence through the IEMP sampling program, and increasing trends will be identified 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 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 property boundary (Willey Road) 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 it represents points beyond which direct exposure to the public is possible.

The exceedance for total chromium identified above at location SWP-03 occurred on December 14, 1999. A review of the chromium results for other monitored points draining to Paddys Run indicate a detected range from 0.0023 to 0.0035 mg/L during 1999. Results from samples taken at SWP-03 during December 1999 indicate a detected range from 0.0029 to 0.0035 mg/L. Given the data available and the field activities that occurred in 1999, no specific circumstance can be discerned that would explain the chromium exceedance nor can the validity of the chromium exceedance be discerned due to the lack of site specific chromium speciation data. Therefore, this exceedance is considered an isolated event and does not indicate any significant impacts to the environment or operational problems with the FEMP's storm water and sediment control systems.

The maximum total uranium concentration at SWP-03 during 1999 was 3.21 μg/L which was well 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 1999. This figure illustrates the decrease of the total uranium concentration in Paddys Run from 1986 following completion of the Storm Water Retention Basin; the basin collects contaminated storm water from the former production area.

There were no FRL or BTV exceedances at the Parshall Flume during 1999. The 1999 maximum daily total uranium concentration at the Parshall Flume prior to discharge through the effluent line to the Great Miami River was 65.8 μg/L. After the water from the Parshall Flume mixed with the water in the Great Miami River the concentration would have been approximately 2 μg/L. Both concentrations, those from the Parshall Flume and after mixing with the Great Miami River, were well below the surface water total uranium FRL. Contaminant concentrations observed at the Parshall Flume in 1999 are further discussed in the compliance monitoring section.

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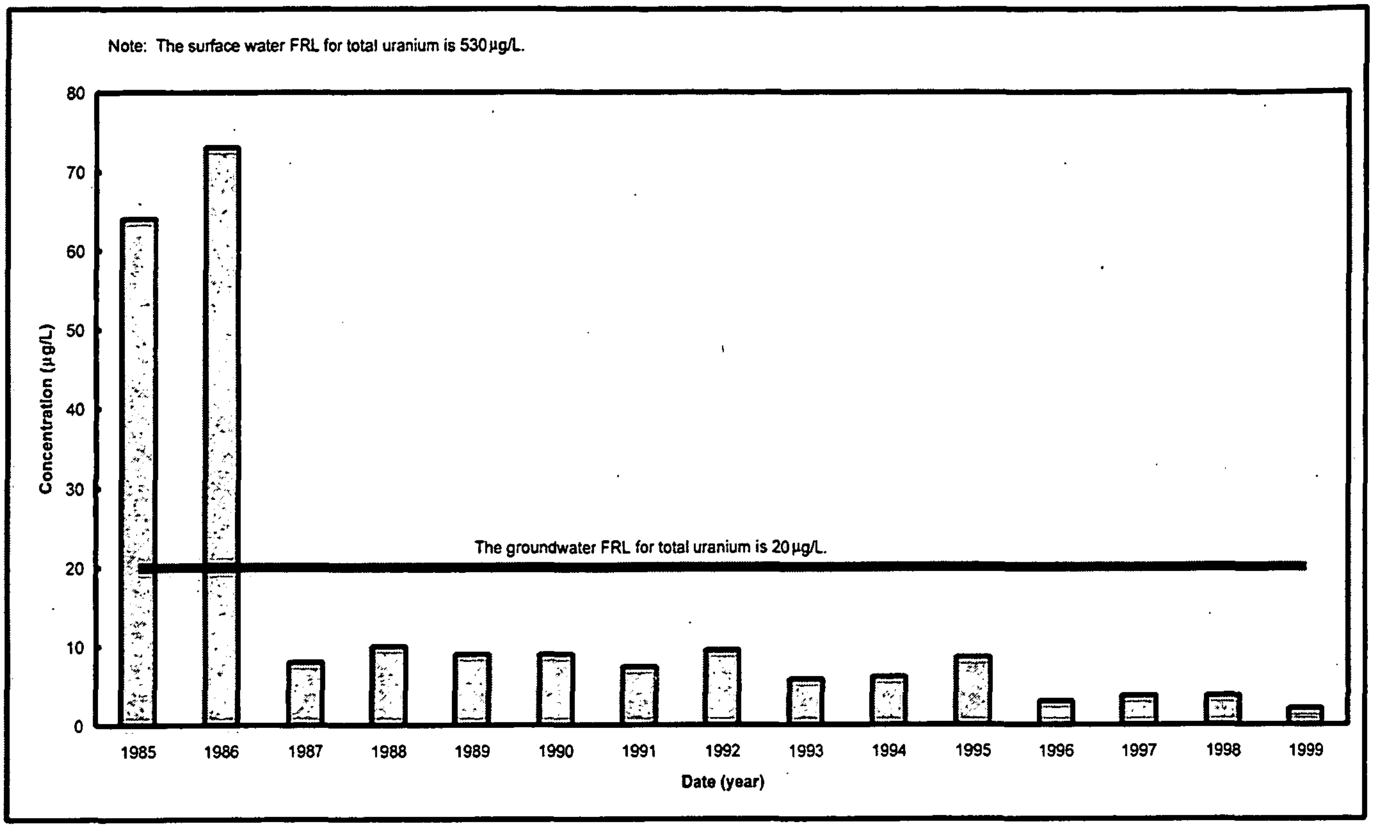

Figure 4-5. Annual Average Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03) Sample Location, 1985 - 1999

Evaluation of surface water data is also performed to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer. To provide this assessment, three sample locations were selected to evaluate contaminant concentrations in surface water just upstreatm of or within those primary areas where site drainages have eroded through the protective glacial overburden. These sample locations are SWP-02, SWD-02, and the Storm Water Retention Basin overflow (SWRB 4002O). In areas where there is no overburden, a direct pathway exists for contaminants to reach the aquifer. This contaminant pathway to the aquifer was and is being considered in the design and refinement of the enhanced groundwater remedy. To account for this, groundwater extraction wells are placed downgradient of the areas where direct infiltration occurs to mitigate any potential cross-media impacts during surface remediation.

During 1999, two surface water samples at location SWD-02 exceeded the total uranium groundwater FRL. No other constituents monitored at these locations exceeded groundwater FRLs. Table 4-2 summarizes the total uranium cross-media exceedances.

TABLE 4-2

EVALUATION OF 1999 TOTAL URANIUM GROUNDWATER FRL EXCEEDANCES FOR CROSS-MEDIA IMPACTS

Location	Number of Exceedances	Number of Samples	Maximum Total Uranium Result[a] (µg/L)
SWD-02	2	11	38.04

[a]The groundwater FRL for total uranium is 20 µg/L.

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Based on the exceedances in Table 4-2, it is not likely that there were any significant cross-media impacts to the Great Miami Aquifer. Both surface water and groundwater data from monitoring wells will continue to be collected at these sensitive areas under the IEMP to address the cross-media concern. Additional details concerning the cross-media impacts are provided in Appendix B, Attachment 1, of this report.

It should be noted that in early 2000, pre-design groundwater characterization activities in the waste storage and Plant 6 areas confirmed that an area in the Pilot Plant Drianage Ditch adjacent to Paddys Run should be considered as a primary source of infiltration, and therefore a cross-media impact to the underlying aquifer (identified in Chapter 3). Therefore, STRM 4005 (the IEMP and NPDES monitoring point immediately upstream of this point of confluence) and SWD-03 will also be evaluated and discussed in future IEMP reports with respect to cross-media impacts to the groundwater pathway.

4.3.2 Compliance Monitoring

4.3.2.1 FFCA and Operable Unit 5 Record of Decision Compliance

The FEMP is required to monitor treated effluent discharges at the Parshall Flume for total uranium mass discharges and total uranium concentrations. These requirements are 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 does not exceed 600 pounds (272 kg) per year. The Operable Unit 5 Record of Decision also requires that the monthly average total uranium concentration in the effluent must be at or below 20 μg/L. This 20 μg/L concentration limit became effective January 1, 1998.

The Operable Unit 5 Record of Decision remedy allows the FEMP 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. It should be noted that an overflow condition has the potential to generate the potential cross-media impacts described above. To comply with the 20 μg/L limit during these types of bypasses, the FEMP is allowed to deduct the concentration of uranium from the monthly average total uranium at the Parshall Flume calculation 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 to ensure the 600 pound (272 kg) per year discharge limit is not exceeded.

In addition to "significant precipitation" related bypasses, the FEMP is also allowed to bypass water from the Storm Water Retention Basin during certain scheduled wastewater treatment plant maintenance activities. The total uranium concentration in the discharge related to maintenance activities may be deducted from the monthly average calculation demonstrating compliance with the 20 μg/L concentration limit. However, the mass of total uranium discharged during these maintenance bypasses is still considered in the discharge mass to ensure compliance with the 600 pound (272 kg) discharge limit. These maintenance bypasses must be pre-approved by the regulatory agencies.

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During 1999 there were no bypasses as a result of excessive precipitation while only one bypass event for maintenance was required. Table 4-3 shows a summary of the Storm Water Retention Basin treatment bypass events during 1999. Figure 4-6 shows that the cumulative mass of total uranium discharged to the Great Miami River during 1999 was 233 pounds (106 kg) which is well below the 600 pound (272 kg) annual limit.

TABLE 4-3

1999 TREATMENT BYPASS EVENTS

Event	Duration (hours)	Number of Bypass Days[a]	Cumulative Number of Bypass Days	Total Uranium Discharged (pounds)	Total Water Discharged (millions of gallons)
Treatment Plant Maintenance Bypass				(to Great Miami River)	(to Great Miami River)
March 15 through March 17	72	3	3	3.29	13.8

[a]Days are counted according to the definition provided in the Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Project (DOE 1999c).

Figure 4-7 depicts that the 20 μg/L concentration limit was met every month during 1999 with the exception of January. The average concentration for January was 26.1 μg/L. The January exceedance was partially due to frozen leaking valves allowing contaminated process fluids to enter the effluent line. The leaking valves were identified on January 6, 1999, and the situation controlled by January 11, 1999. However, the total uranium concentrations at the Parshall Flume during this time (January 6 through 11) were well above normal. Additionally, the total uranium concentrations in the new sewage treatment plant effluent were well above normal during January. Once discovered, the sewage treatment plant effluent was temporarily redirected during a portion of January to the advanced wastewater treatment facility Phase II. In addition, some extraction and re-injection wells were shut down during a portion of January to mitigate the higher total uranium concentrations occurring at the Parshall Flume.

Appendix B, Attachment 1, of this report provides more detail on the bypass days deleted from the monthly average calculation to determine compliance with the 20 μg/L limit.

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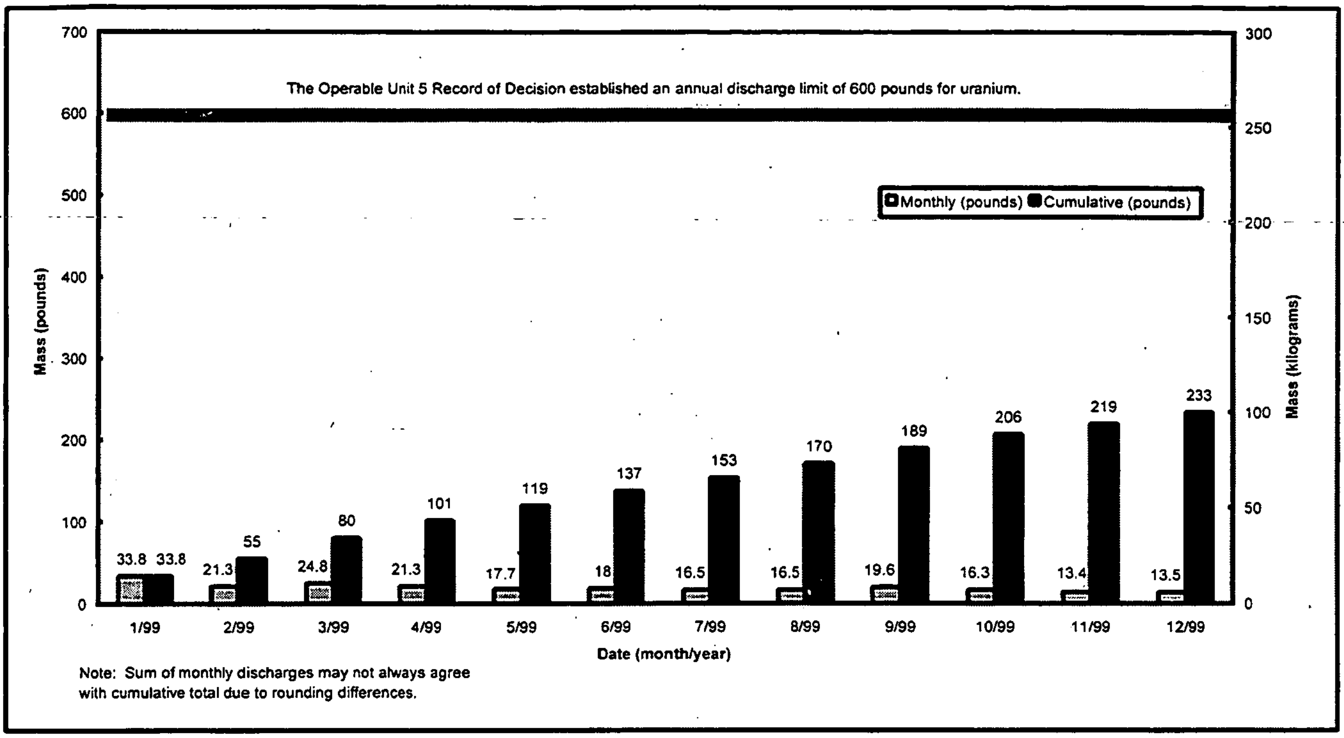

Figure 4-6. Pounds of Uranium Discharged to the Great Miami River from the Parshall Flume (PF 4001) in 1999

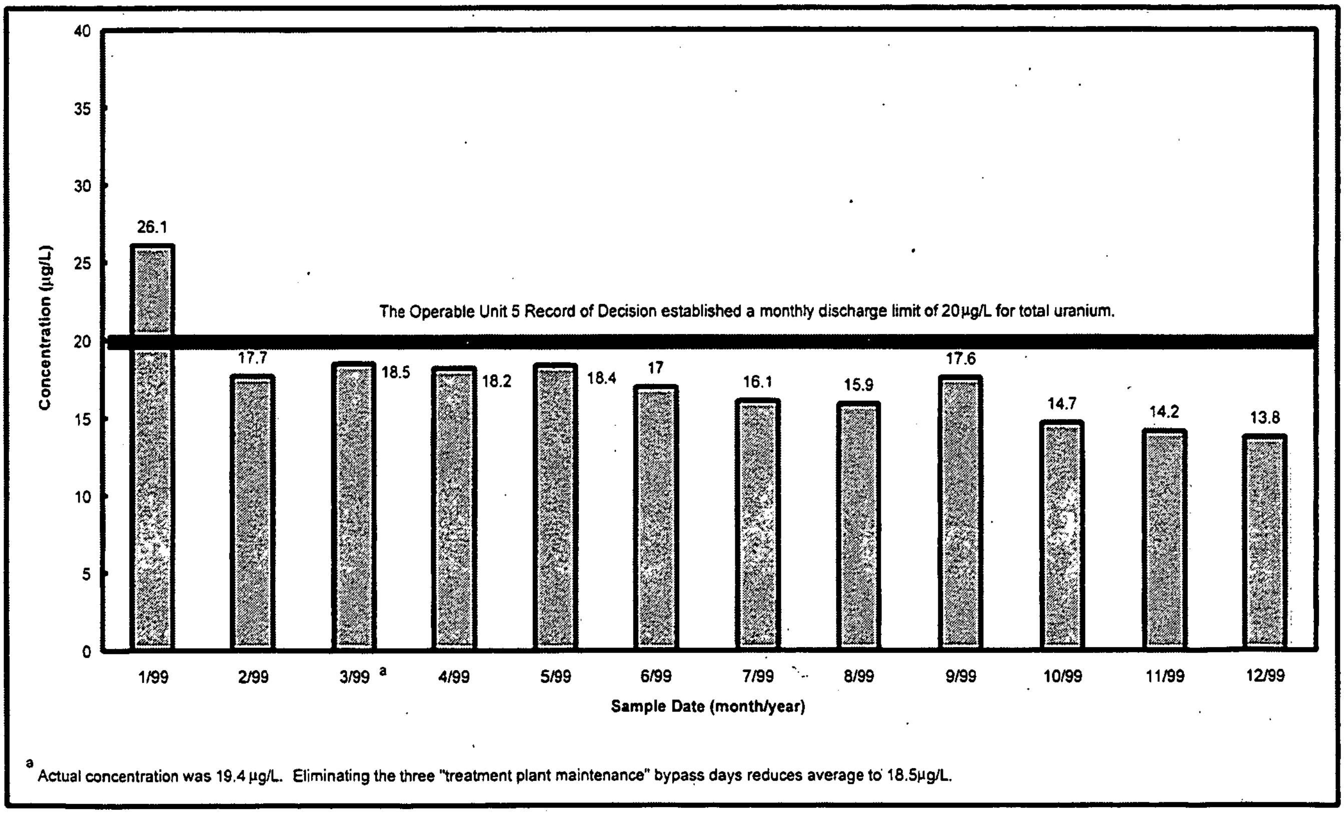

Figure 4-7. 1999 Monthly Average Total Uranium Concentration in Water Discharged from the Parshall Flume (PF 4001) to the Great Miami River

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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 FEMP, is regulated under the state-administrated NPDES program. The current permit became effective November 1, 1995, and expired on March 31, 1998. A NPDES Permit Renewal Application was submitted to OEPA in September 1997, and was amended by addendum in August 1998. The addendum provided information related to the Waste Pits Remedial Action Project. The new NPDES Permit was drafted and the public notice issued on November 12, 1999. Negotiations with OEPA on the draft permit continued through the end of 1999. (The permit was issued January 28, 2000 and became effective March 1, 2000.) Pursuant to Ohio Administrative Code 3745-33-04(c)(1), submittal of the renewal application allows the FEMP to continue operating under the terms of the expired permit until approval of the new permit application is received from OEPA. The permit specifies discharge and sample requirements, as well as discharge limits, for several chemical constituents. Figure 4-2 identifies NPDES sample locations.

Wastewater and uncontrolled runoff discharges from the FEMP were in compliance with the current permit requirements 99.5 percent of the time during 1999. Of all sample results associated with NPDES monitoring, seven sample results at only one location, the new sewage treatment plant (STP 4601), were not within the discharge limits specified by the permit. A total of 11 noncompliances were reported to OEPA pursuant to the terms of the NPDES Permit; the seven noncompliances related to daily maximum exceedances and four noncompliances for monthly average exceedances for total suspended solids. No impact on compliance at the Parshall Flume was experienced as a result of these noncompliances at the sewage treatment plant. Due to the improvements made in operating and controlling the sewage treatment plant, noncompliances were not experienced after April 1999.

4.3.3 Uranium Discharges in Surface Water and Treated Effluent

As identified in Figure 4-6, 233 pounds (106 kg) of uranium in treated effluent were discharged to the Great Miami River through the Parshall Flume (PF 4001) in 1999. 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 1999.

Previous estimates of uncontrolled runoff have been calculated using a loading term of 6.25 pounds (2.84 kg) of uranium discharged to Paddys Run for every inch (2.54 cm) of rainfall. This term was based on site conditions and analytical data collected during the late 1980s and early 1990s. The loading term was revised during 1999 to 2.6 (1.2 kg) pounds of uranium discharged per inch (2.54 cm) of rainfall based on current drainage patterns and recent analytical data. The new loading term reflects the decreasing uranium concentrations measured at points discharging to Paddys Run. In addition, it reflects that there have been significant improvements in the capture of contaminated storm water by the Pilot Plant Drainage Sump, southern waste unit surface water control system, and excavation and placement of contaminated soils into the on-site disposal facility. The new loading term was approved by EPA and OEPA and was used for reporting the fourth quarter 1999 data. During 1999, 34.39 inches (87.35 cm) of precipitation fell at the FEMP; therefore, it is estimated that approximately 186 pounds (84.4 kg) of uranium entered the environment through uncontrolled runoff. It should also be noted that there were no overflows at the Storm Water Retention Basin during 1999; therefore, no additional pounds of uranium were contributed by this source.

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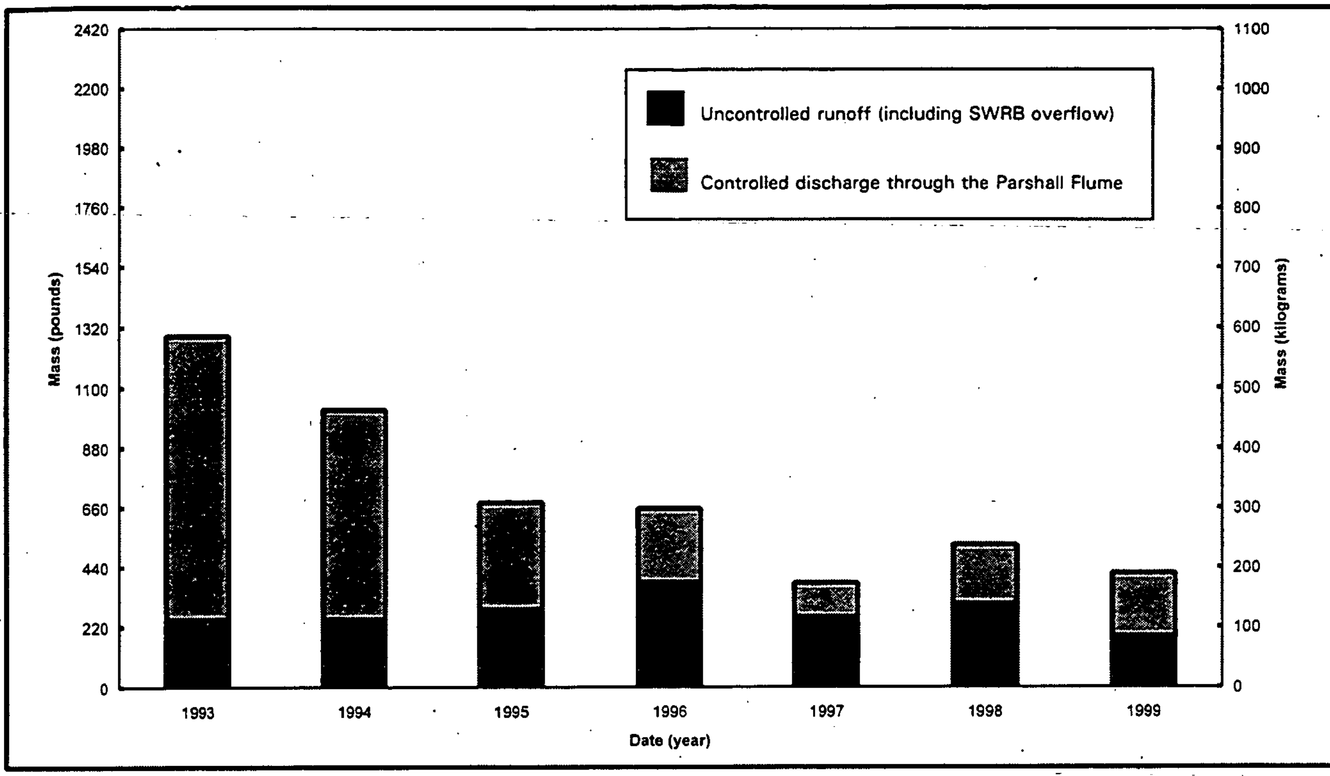

Figure 4-8. Uranium Discharged from the FEMP Via the Surface Water Pathway, 1993 - 1999

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 419 pounds (190 kg). These estimated total pounds of uranium released decreased 20 percent from the 1998 estimate.

The following summarizes the differences in uranium discharges comparing 1999 with 1998:

- The amount of uranium discharged to the Great Miami River in treated effluent was 216 pounds (98.1 kg) in 1998 and 233 pounds (106 kg) in 1999. This increase is considered insignificant and was expected due to the additional groundwater volume pumped.

- The amount of uranium in uncontrolled runoff estimated in 1999 was 186 pounds (84.4 kg) which was a 39 percent decrease from the amount estimated in 1998 (303 pounds [138 kg]). This substantial decrease is attributed to a reduction in rainfall (34.39 inches [87.35 cm] in 1999 compared to 48.43 inches [123.0 cm] in 1998), no Storm Water Retention Basin overflows in 1999, and the revision of the loading term factor used in calculating the estimate.

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 August at 16 locations along Paddys Run, the Storm Sewer Outfall Ditch, and the Great Miami River (refer to Figure 4-9). Samples collected at each location were analyzed for total uranium. However, samples collected from the Storm Sewer Outfall Ditch, Paddys Run north and south of the outfall ditch, and from the Paddys Run background location were also analyzed for radium-226, radium-228, and isotopic thorium. Per the IEMP, Revision 1, the monitoring program was revised to eliminate four of the 20 monitoring locations based on a nine-year trend of sediment data that are near or equivalent to background concentrations for the contaminants.

Figure 4-9 illustrates specific sample locations that are summarized below:

- **Storm Sewer Outfall Ditch**: five samples collected along the Storm Sewer Outfall Ditch from Paddys Run to immediately south of the Storm Water Retention Basin (D1 through D5)

- **Paddys Run**: five samples collected north of the confluence with the Storm Sewer Outfall Ditch (PN1 through PN5), three samples collected south of the confluence (PS1 through PS3), and one background sample collected 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).

Analytical results of samples collected from the Storm Sewer Outfall Ditch, Paddys Run, and the Great Miami River from 1999 are presented in Table 4-4 and were below the FRL for total uranium, isotopic thorium, radium-226, and radium-228. On average, there was a slight increase in all constituents at the Paddys Run North and Storm Sewer Outfall Ditch locations while average total uranium concentrations increased at all of the monitored locations. However, all results are within the range of historical background levels.

Monitoring of sediment will continue under the IEMP to determine the effectiveness of the engineered controls designed to reduce erosion from the FEMP and sedimentation of Paddys Run and its tributaries. Appendix B, Attachment 2, of this report contains additional details of the sediment monitoring results.

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TABLE 4-4

SUMMARY STATISTICS FOR SEDIMENT MONITORING PROGRAM

			1999 Results - Concentration (dry weight)					
		No. of	Minimum[a,b,c]		Maximum[a,b,c]		Average[a,b,c]	
Radionuclide	Sediment FRL	Samples[a]	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)
Great Miami River, North of the Effluent Line								
Total Uranium	210 mg/kg	1	1.30	(1.92)	NA	NA	NA	NA
Great Miami River, South of the Effluent Line								
Total Uranium	210 mg/kg	1	2.51	(3.72)	NA	NA	NA	NA
Paddys Run Background, North of S.R. 126								
Radium-226	2.9 pCi/g	1	0.494	NA	NA	NA	NA	NA
Radium-228	4.8 pCi/g	1	0.416	NA	NA	NA	NA	NA
Thorium-228	3.2 pCi/g	1	0.426	NA	NA	NA	NA	NA
Thorium-230	18,000 pCi/g	1	0.461	NA	NA	NA	NA	NA
Thorium-232	1.6 pCi/g	1	0.364	NA	NA	NA	NA	NA
Total Uranium	210 mg/kg	1	0.824	(1.22)	NA	NA	NA	NA
Paddys Run, North of the Storm Sewer Outfall Ditch								
Radium-226	2.9 pCi/g	5	0.612	NA	0.889	NA	0.745	NA
Radium-228	4.8 pCi/g	5	0.478	NA	0.655	NA	0.602	NA
Thorium-228	3.2 pCi/g	5	0.295	NA	0.704	NA	0.511	NA
Thorium-230	18,000 pCi/g	5	0.548	NA	1.22	NA	0.842	NA
Thorium-232	1.6 pCi/g	5	0.277	NA	0.604	NA	0.458	NA
Total Uranium	210 mg/kg	5	0.939	(1.39)	2.01	(2.98)	1.98	(2.19)
Storm Sewer Outfall Ditch								
Radium-226	2.9 pCi/g	5	0.538	NA	0.932	NA	0.7548	NA
Radium-228	4.8 pCi/g	5	0.339	NA	0.813	NA	0.614	NA
Thorium-228	3.2 pCi/g	5	0.426	NA	0.773	NA	0.615	NA
Thorium-230	18,000 pCi/g	5	0.595	NA	0.959	NA	0.929	NA
Thorium-232	1.6 pCi/g	5	0.294	NA	0.674	NA	0.479	NA
Total Uranium	210 mg/kg	5	1.51	(2.24)	4.49	(6.65)	2.75	(4.07)
Paddys Run, South of the Storm Sewer Outfall Ditch								
Radium-226	2.9 pCi/g	1	0.645	NA	NA	NA	NA	NA
Radium-228	4.8 pCi/g	1	0.582	NA	NA	NA	NA	NA
Thorium-228	3.2 pCi/g	1	0.347	NA	NA	NA	NA	NA
Thorium-230	18,000 pCi/g	1	0.675	NA	NA	NA	NA	NA
Thorium-232	1.6 pCi/g	1	0.352	NA	NA	NA	NA	NA
Total Uranium	210 mg/kg	1	1.03	(1.53)	1.30	(1.92)	1.21	(1.79)

[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, maximum, and average).
[b]If the number of samples is greater than or equal to three, then the minimum, maximum, and average are reported. If the number of samples is 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

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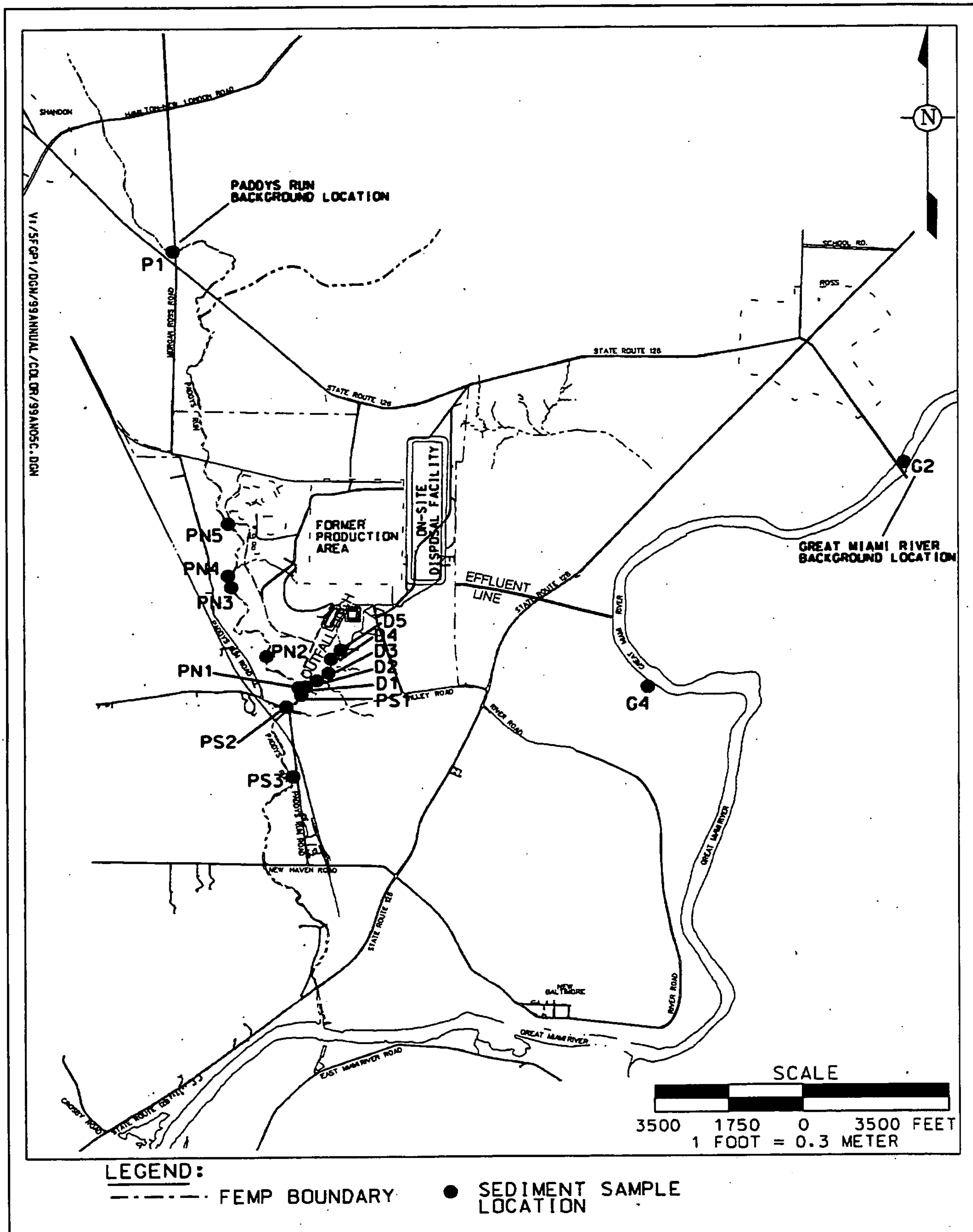

Figure 4-9. 1999 Sediment Sample Locations

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5.0 Air Pathway

This chapter describes the air pathway components used to track and trend airborne emissions from the FEMP. It includes a discussion of radiological air particulates, radon, and direct radiation. In addition, this chapter provides a summary of radiological emissions from stacks and vents, as well as, non-radiological emissions associated with boiler plant operations at the FEMP.

Results in Brief: 1999 Air Pathway

Radiological Air Particulates - Data collected from fenceline air monitoring stations show that average concentrations for each radionuclide monitored were less than one 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 FEMP fenceline and off-property locations. The maximum annual average concentration at the FEMP fenceline measured by continuous radon monitors was 0.5 pCi/L above background.

Direct Radiation - Measurements of direct radiation indicate levels increasing with proximity to the K-65 Silos. However, these levels are still approximately 61 percent lower than the radiation levels measured in 1991 prior to the addition of the bentonite layer within the K-65 Silos. These measurements are consistent with the fact that the K-65 Silos contain radium and its decay products, which contribute to direct radiation levels.

Boiler Plant - There were no opacity excursions reported during 1999.

As discussed in Chapter 1, the public may be exposed to radiation from the FEMP through the air pathway. This pathway includes emissions from specific point sources, such as plant stacks, as well as fugitive dust from soil excavations and other remediation activities. When production operations were suspended in July of 1989, the major point source emissions from the FEMP were eliminated. Since then, the principal sources of airborne emissions have been fugitive dust from environmental remediation activities, the cooling tower mists, and laboratory fume hoods, which contain low levels of uranium.

Air pathway monitoring focuses on airborne pollutants that may be carried from the FEMP as a particulate 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 surface. 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 environment during the remediation process because airborne contaminants can potentially migrate off property quickly and travel long distances. The FEMP'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 FEMP changed from production to remediation, work activities also changed. This change in work scope altered the mechanics of the distribution of 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 (i.e., excavation and hauling of contaminated soil, demolition of production facilities, and general construction activities supporting the remediation process) and the storage of radon generating waste materials.

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The following are examples of emission sources that were active during 1999:

- Excavation of contaminated soil, flyash, and debris from the southern waste units (Operable Unit 2)
- 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 (Operable Unit 2)
- Decontamination and dismantlement of the Thorium/Plant 9 complex and the former sewage treatment plant complex (Operable Unit3)
- Radon and direct radiation emissions from the K-65 Silos (Operable Unit 4)
- Excavation of Waste Pit 3 and Waste Pit 5 and the associated waste processing and rail car load-out operations at the Waste Pit Remedial Action Project (Operable Unit 1).

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

- Administrative Controls - typical administrative controls include: management and control procedures, record keeping, periodic assessments, and establishing speed limits; control zones; and construction zones.
- Engineered Controls - typical engineered controls include: physical barriers; wetting agents; control, collection, and treatment systems; filtration; fixatives; sealants; and dust suppressants. 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.

5.2 Air Highlights for 1999

The FEMP'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:

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- **Sampling** - Sample locations, frequency, and the constituents were selected to address DOE and EPA requirements for assessing radiological emissions from the 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 20 locations, radon measurements at 29 locations, and direct radiation at 32 locations on and off the FEMP 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 IEMP quarterly status reports and annual integrated site environmental reports. The addition of quarterly reporting provides more timely information to the remediation projects, regulatory agencies, and FEMP stakeholders.

5.3 Radiological Air Particulate Sampling Results

Air Particulate Monitoring Research Project

During 1999 the DOE Environmental Measurements Laboratory (DOE-EML) completed the first phase of their research study on air particulate monitoring at the FEMP. The objective of the overall study is to evaluate the dose contributions from the respirable fraction (those particles small enough to pass deep into the lungs when inhaled) of total emissions. During the first phase of the study, the distribution of particle sizes and corresponding uranium concentrations were characterized at the AMS-9C air monitoring station.

The results from the first phase of the study indicate that approximately 70 percent of the airborne uranium emissions consist of particles that are larger than 15 μm. Particles larger than 15 μm are not inhaled deeply into the lungs and therefore would not contribute a large dose in comparison to particles less than 15 μm. The DOE-EML results suggest that the dose calculation methods used at the FEMP, which assume all of the airborne uranium particles are approximately 1 μm in size and fully respirable, may overestimate the dose from airborne emissions by as much as a factor of seven. Additional measurements are needed to better quantify the particle size distribution and dose from uranium and thorium emissions. However, the available data suggests that the actual inhalation dose at the fenceline in 1999 is well below the estimated maximum inhalation dose of 0.29 mrem (refer to Chapter 6).

DOE-EML continues to characterize the uranium and thorium concentrations and the particle size distribution of particulate emissions from the FEMP. In 1999 new samplers were placed at the AMS-9C and background monitoring locations. The next phase of the research project is to focus on improving the detection limit for the sample analysis, correlating airborne particulate concentrations with local meteorological conditions, and evaluating the thorium contribution to inhalation dose. Additional information on this continuing research project will be included in future annual integrated site environmental reports.

As described in the IEMP, the FEMP utilizes a network of 20 high volume air particulate monitoring stations to measure the collective contributions from all fugitive and point source particulate emissions from the site. This monitoring network includes 16 monitoring locations on the FEMP fenceline, two thorium monitoring locations, and two background locations. Figure 5-1 provides the locations of the IEMP air monitoring stations and also provides the locations for two project-specific monitors, STP-1 and STP-2.

The sampling and analysis program for the 16 fenceline and two background locations consists of biweekly total uranium and particulate analyses and a quarterly composite sample targeted at the expected major contributors to dose from the site (i.e., uranium, thorium, and radium). The analytical data from this program are used to assess the effectiveness of the FEMP's 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 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. This dose is reported in the annual NESHAP Subpart H compliance report and is included as Appendix D of this report.

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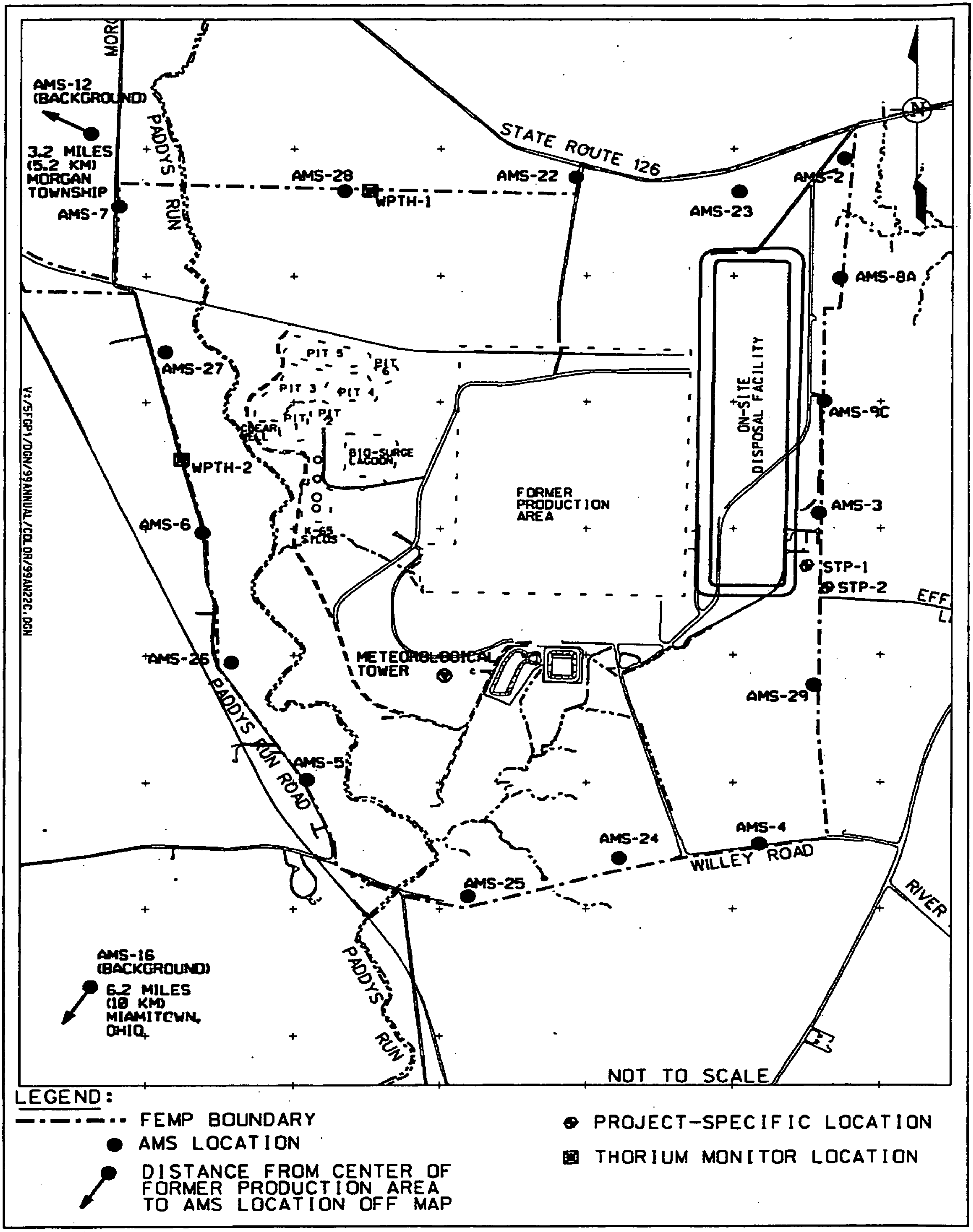

Figure 5-1. Radiological Air Monitoring Locations

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- DOE Order 5400.5, Radiation Protection of the Public and Environment, establishes 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, 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.

Table 5-1 presents the total uranium concentrations for 1999 and 1998. The annual average concentrations of total uranium at all fenceline air monitoring stations were less than one percent of the DOE-derived concentration guide value (0.1 picoCuries per cubic meter [pCi/m^3]). In 1999 total uranium at all air monitoring locations ranged from less than detectable concentrations to a maximum concentration of 1.1E-03 pCi/m^3 at AMS-8A. For comparison, background locations ranged from less than detectable to 4.5E-05 pCi/m^3 at AMS-12.

TABLE 5-1

TOTAL URANIUM AND TOTAL PARTICULATE CONCENTRATIONS IN AIR

Location	1999 Total Uranium (pCi/m^3)	1998 Total Uranium (pCi/m^3)	1999 Total Particulate (μg/m^3)	1998 Total Particulate (μg/m^3)
Fenceline Locations				
Minimum	0.0E+00	0.0E+00	11	6.8
Maximum	1.1E-03	7.6E-04	92	86
Average	5.3E-05	6.3E-05	35	33
Background Locations				
Minimum	0.0E+00	0.0E+00	16	12
Maximum	4.5E-05	1.1E-04	61	84
Average	1.2E-05	1.3E-05	36	36

In addition to the total uranium analyses, total particulate measurements are obtained from each filter every two weeks. Table 5-1 presents the total particulate results for 1999 and 1998. Total particulate concentrations ranged from 11 micrograms per cubic meter (μg/m^3) to a maximum of 92 μg/m^3 at AMS-27. There are no general or site-specific regulatory limits associated with total particulate measurements used in the data evaluation process.

Total particulate data were evaluated with the total uranium results to identify any increasing trends that may be related to remediation activities. During 1999 no increasing trends were identified that indicated the potential for exceeding the NESHAP dose limit or DOE guidelines. However, increases in total uranium concentrations were detected at some air monitoring stations (AMS-3, AMS-8A, and AMS-9C) on the eastern fenceline during the second half of 1999 (refer to Figure 5-2). One notable temporary increase was observed in late July at AMS-8A. This increase was attributed to a short-lived practice of dumping waste material from an access ramp into Cell 2 of the on-site disposal facility. Other temporary increases were due to the construction activity associated with the on-site disposal facility and demolition activity at the former sewage treatment plant complex. While these types of temporary increases can be expected when periods of increased remediation activity coincide with warm dry weather, they will continue to be monitored and the data will be provided to the remediation projects to ensure that emission controls are operating as expected. Appendix C, Attachment 1, of this report provides graphical displays of the 1999 total uranium and total particulate data.

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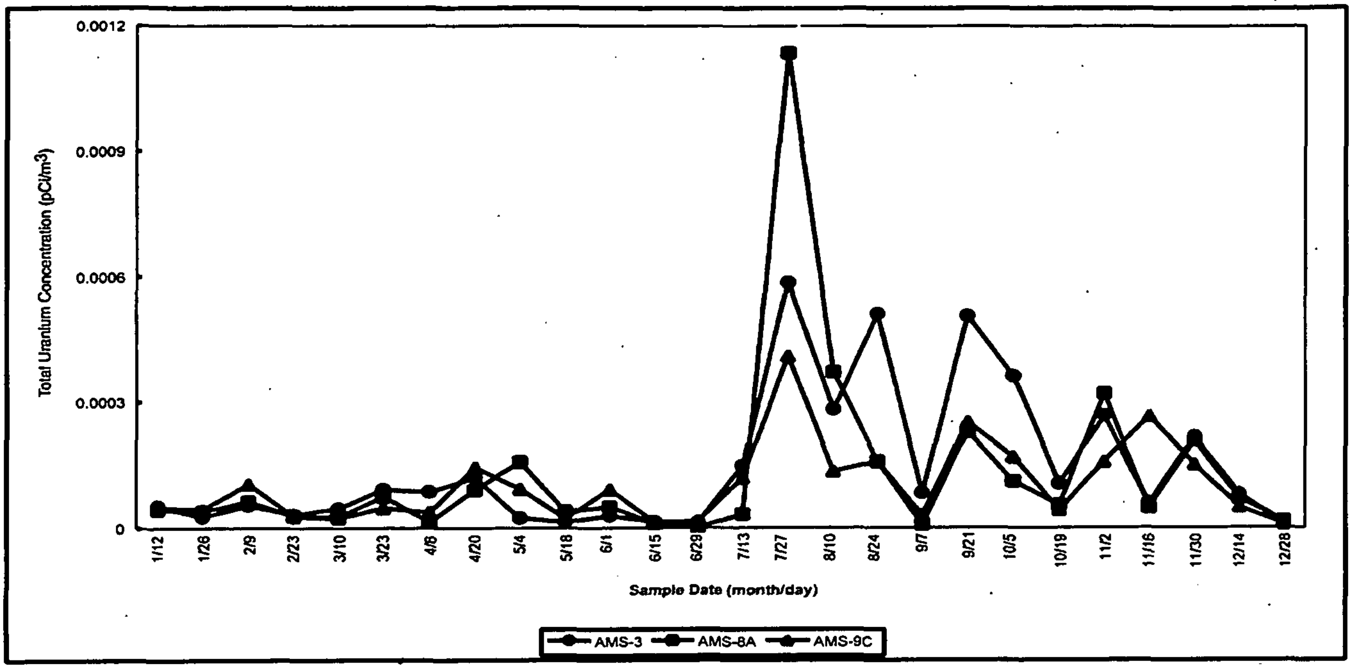

Figure 5-2. 1999 Total Uranium Concentrations in Air (AMS-3, AMS-8A, and AMS-9C)

As discussed earlier, quarterly composite samples were collected at each air monitoring station during 1999. The samples were analyzed for isotopes of radium, thorium, and uranium. The 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 1999. The maximum dose associated with the quarterly composite results for 1999 was 0.29 mrem and occurred at AMS-3. 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 monitoring station, which were 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 one percent of the corresponding DOE-derived concentration guide values. The results from the fenceline monitors show that on average uranium isotopes contributes 45 percent of the dose from 1999 airborne emissions. On average, isotopes of thorium and radium account for 39 percent and 16 percent of the dose, respectively.

In 1999 the percentage of dose from uranium isotopes was lower than in previous years, when uranium typically contributed greater than 62 percent of the dose. The decrease in the percentage of dose from uranium is attributed to continuing remediation of the site, and its effect on the composition of air emissions. As uranium-contaminated buildings are dismantled, and soil contamination areas are excavated, the amount of exposed uranium contaminated debris and soil is gradually decreasing. Concurrent with this gradual decrease in the amount of uranium contamination, fugitive emissions from the excavation of the waste pits are expected to increase the average concentration of thorium-230 at the fenceline. Together, these two remediation activities are expected to change the relative contribution of uranium and thorium-230 to the dose from airborne emissions. Appendix C, Attachment 1, of this report contains graphical displays of the contributors to dose and the annual average isotopic concentrations at each air monitoring station.

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In addition to demonstrating compliance, there are two monitors in the waste pit area (WPTH-1 and WPTH-2) which were installed to address potential increases in airborne thorium concentrations (refer to Figure 5-1). Increases in airborne thorium concentrations (specifically thorium-230) could be caused by fugitive emissions during excavation of the waste pits. During 1999, the thorium-230 concentrations measured at WPTH-1 and WPTH-2 increased in September with the start of waste pit excavation. As expected, slightly elevated levels of thorium-230 were measured at WPTH-1 and WPTH-2 through December 1999 and some of the increased concentrations are attributed to the increase in material handling associated with the start-up of the Waste Pits Remedial Action Project dryers in late December. Increases in thorium-230 concentrations were also observed in the fourth quarter composite samples from other fenceline monitors (AMS-2, AMS-22, and AMS-23) which are downwind of the Waste Pit Remedial Action Project. These types of increases can be expected when large-scale remediation projects such as the excavation of the waste pits begin operations. Although the higher thorium-230 concentrations were measurable at the site fenceline, the annual average thorium-230 concentration at WPTH-1 and WPTH-2 remained below one percent of the DOE-derived concentration guide value for thorium-230. The elevated levels of thorium-230 concentrations at WPTH-1 and WPTH-2 were short-lived. During the first quarter of 2000, thorium-230 concentrations decreased to levels that were comparable to concentrations measured prior to the material handling operations associated with the start-up of the waste pit dryers. During the course of the waste pit excavation, thorium-230 concentrations continue to be monitored and the data provided to the remediation projects to ensure that emission controls are operating as expected.

Airborne concentrations of thorium-228 and thorium-232 measured at WPTH-1 and WPTH-2 were comparable to background concentrations throughout 1999. This fenceline data reflect the fact that, in comparison to thorium-230, the concentrations of thorium-228 and thorium-232 in the waste pit material are relatively low. Waste Pits Remedial Action Project operations are not expected to significantly impact the fenceline concentrations of thorium-228 and thorium-232. Appendix C, Attachment 1, of this report provides graphical displays of the isotopic thorium data from the WPTH-1 and WPTH-2 monitors.

5.3.1 Summary of Project-Specific Air Monitoring

Project-specific radiological air monitoring for the decontamination and dismantlement of the Thorium/Plant 9 Complex continued through February 1999. The monitoring program included five project-specific air monitoring stations located near the project boundary that were monitored weekly for total uranium and total particulate concentrations. This monitoring program was conducted under the Operable Unit 3, Integrated Remedial Action, Thorium/ Plant 9 Complex Implementation Plan for Above-Grade Decontamination and Dismantlement (DOE 1997c) and was implemented to evaluate the effectiveness of project-specific emission controls during the project.

During 1999 the uranium concentrations from the Plant 9 monitors indicated a reduction in average total uranium concentrations from the average concentrations measured in 1998. These reductions reflected the reduced activities in the Thorium/Plant 9 Complex as the dismantlement project neared completion. More detailed environmental data from the Thorium/ Plant 9 Complex dismantlement project is available in the Project Completion Report for Thorium/Plant 9 Complex Decontamination and Dismantlement Project (DOE 1999d).

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Project-specific radiological air monitoring for the dismantlement of the former sewage treatment plant began during late June 1998 and continued throughout 1999. This monitoring program, consisting of biweekly total uranium and total particulate measurements, was conducted under the Sewage Treatment Plant Complex Implementation Plan for Decontamination and Dismantlement (DOE 1998b). Project-specific monitoring was implemented at the former sewage treatment plant complex because it is located immediately adjacent to the eastern fenceline of the FEMP. As such, fugitive emissions resulting from project activities could cross the FEMP property boundary without being monitored by the IEMP fenceline monitoring network. To address this concern, a project-specific air monitor, STP-1, was installed just south of the sewage treatment plant, between AMS-3 and AMS-29 (refer to Figure 5-1). In May 1999 the STP-1 monitor was relocated to the FEMP fenceline and designated as STP-2. The relocation as necessary in order to accommodate the below-grade excavation of the sewage treatment plant complex.

Total uranium concentrations at STP-1 and STP-2 ranged from 5.4E-06 to 3.8E-04 pCi/m³. These uranium concentrations were less than one percent of the DOE-derived concentration guide value for total uranium (0.1 pCi/m³) and less than two percent of the applicable NESHAP Subpart H values. Total particulate concentrations ranged from 19 to 72 µg/m³. Total particulate concentrations at STP-1 and STP-2 were comparable to levels measured at other fenceline monitors.

Increases in total uranium concentrations were detected at the STP-2 location during the second half of 1999 (refer to Figure 5-3). This temporary increase was due to the demolition and excavation activity associated with the former sewage treatment plant complex. The STP-2 project monitor remained in place until all excavation activities were completed. Appendix C, Attachment 1, of this report provides graphical displays of the 1999 total uranium and total particulate data from the STP-1 and STP-2 monitors.

Each remediation project will continue to be assessed to determine if air monitoring will be required to support the evaluation of project-specific emission controls.

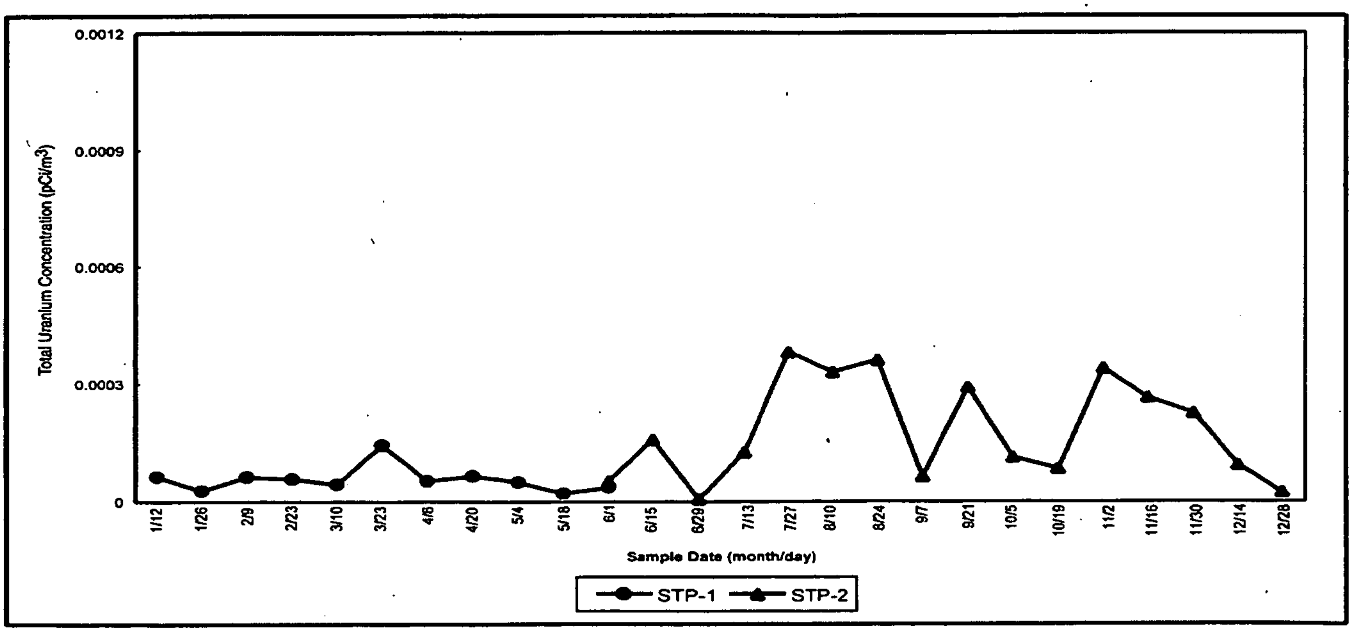

Figure 5-3. 1999 Total Uranium Concentrations in Air (STP-1 and STP-2)

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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 porosity changes that increase the rate at which radon escapes. Summary level meteorological data from 1999 are presented in Appendix C, Attachment 4, and Figures 1-7 through 1-10 of this report.

Environmental radon concentrations are also influenced by atmospheric conditions. During periods of calm winds and temperature inversions (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, when these inversions occur, radon's movement is limited vertically, and concentrations tend to increase near the ground.

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

DOE Order 5400.5, Radiation Protection of the Public and the Environment, 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 above interim storage facilities (such as the FEMP) are defined under DOE Order 5400.5 and must not exceed:

- 100 picoCuries per liter (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.

In 1999 an expanded continuous radon-monitoring network was used for determining compliance with the above limits. The continuous radon-monitoring program was expanded to compensate for the elimination of the alpha track-etch program in 1998. These changes to radon monitoring were approved by the EPA and OEPA and documented in the IEMP, Revision 1. The continuous monitoring network provides for more frequent feedback to remediation projects, regulatory agencies, and FEMP 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 FEMP Public Environmental Information Center.

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In general, monitoring locations were selected near radon emitting sources, at the FEMP property fenceline, and at background locations. The FFA identifies additional environmental radon monitoring locations, as well as, continuous measurement of radon concentrations in the head space of the K-65 Silos (refer to Figure 5-4). DOE guidance and EPA air monitor siting criteria were considered when selecting monitoring locations.

5.4.1 Continuous Alpha Scintillation Detectors

Alpha scintillation detectors use scintillation cells to continuously monitor environmental radon concentrations on an hourly basis. 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 (daughter products), which give 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 1999. The data are used to track radon concentrations through the year to ensure DOE limits are not exceeded. In addition to the summary data presented here, Appendix C, Attachment 2, of this report provides graphical displays of monthly average radon concentrations from continuous radon monitors during 1999 and 1998.

Results from the fenceline monitoring locations indicate radon levels for 1999 were within historical ranges and well below the DOE limit of 3 pCi/L above background. The range of annual average concentrations at the fenceline was 0.3 to 0.8 pCi/L inclusive of background concentrations. The range of annual average background radon concentrations was 0.2 to 0.3 pCi/L.

In accordance with the FFA, radon concentrations within the head space of K-65 Silos 1 and 2 are continuously monitored to supply information regarding remediation activities and to assess the effectiveness of control measures in reducing radon emissions. Over time radon concentrations in the silo head space have been trending upward. Radon monitoring data have also indicated increases in radon levels at the K-65 Silo exclusion fence due to increased emissions from the K-65 Silos. These increases are attributable to degradation of the 1987 application of a foam sealant to the external surface of the silo domes and degradation of the 1991 application of bentonite clay to the surface of the K-65 Silo residues.

As expected, the highest continuous environmental radon monitoring results were recorded at the K-65 exclusion fence resulting from radon emissions from the K-65 Silos. Annual average concentrations around the K-65 exclusion fence ranged from 3.1 to 9.6 pCi/L. Other on-property monitoring locations also recorded radon levels well below the DOE limit of 30 pCi/L annual average.

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TABLE 5-2

CONTINUOUS ENVIRONMENTAL RADON MONITORING MONTHLY AVERAGE CONCENTRATIONS[a]

Location[b]	1999 Summary Results[c] (Instrument Background Corrected) (pCi/L) Min.	Max.	Avg.	1998 Summary Results[c,d] (Instrument Background Corrected) (pCi/L) Min.	Max.	Avg.
Fenceline						
AMS-02	0.2	1.0	0.5	0.2	0.7	0.4
AMS-03	0.1	1.0	0.5	0.6	0.8	0.7
AMS-04	0.1	0.8	0.4	0.1	0.7	0.4
AMS-05	0.2	1.4	0.7	0.2	1.3	0.6
AMS-06	0.2	0.8	0.5	0.2	0.9	0.5
AMS-07	0.3	1.5	0.8	0.2	1.5	0.7
AMS-08A[e]	0.1	0.8	0.4	0.8	NA	NA
AMS-09C	0.2	0.8	0.5	0.2	0.9	0.6
AMS-22	0.1	0.5	0.3	0.2	0.7	0.4
AMS-23	0.1	0.6	0.3	0.4	0.5	0.4
AMS-24[e]	0.2	1.1	0.6	0.7	NA	NA
AMS-25[e]	0.2	0.8	0.5	0.6	NA	NA
AMS-26	0.2	0.8	0.5	0.2	0.8	0.6
AMS-27	0.2	1.1	0.6	0.2	1.1	0.7
AMS-28[e]	0.1	0.8	0.4	0.4	NA	NA
AMS-29[e]	0.1	0.8	0.4	0.7	NA	NA
Background						
AMS-12	0.1	0.5	0.2	0.1	0.6	0.3
AMS-16	0.1	0.5	0.3	0.2	0.6	0.4
On Site						
KNE	1.7	18.3	9.6	2.0	18.2	9.1
KNW	2.1	8.2	3.8	1.0	4.8	2.4
KSE	1.2	9.9	4.9	2.4	16.9	8.3
KSW	1.7	4.8	3.1	1.4	5.2	3.1
KTOP	3.4	15.8	8.4	7.2	24.6	13.0
Pilot Plant Warehouse	0.3	0.8	0.4	0.1	0.9	0.4
Rally Point 4	0.5	1.3	0.8	0.2	1.3	0.7
Surge Lagoon	0.4	1.0	0.7	0.3	1.3	0.7
T28	1.1	3.8	2.2	0.9	2.8	1.8
TS4[f]	0.2	0.9	0.5	NA	NA	NA
WP-17A	0.1	1.1	0.6	0.2	0.9	0.5

[a]Monthly average radon concentrations are calculated from daily average concentrations. Daily average concentrations are calculated by summing all hourly count data, treating the sum as a single daily measurement, and then converting the sum to a (daily average) concentration.
[b]Refer to Figure 5-4 for sample locations
[c]Instrument background changes as monitors are replaced
[d]NA = not applicable
[e]Unit was placed in service in December 1998.
[f]Unit was placed in service in January 1999.

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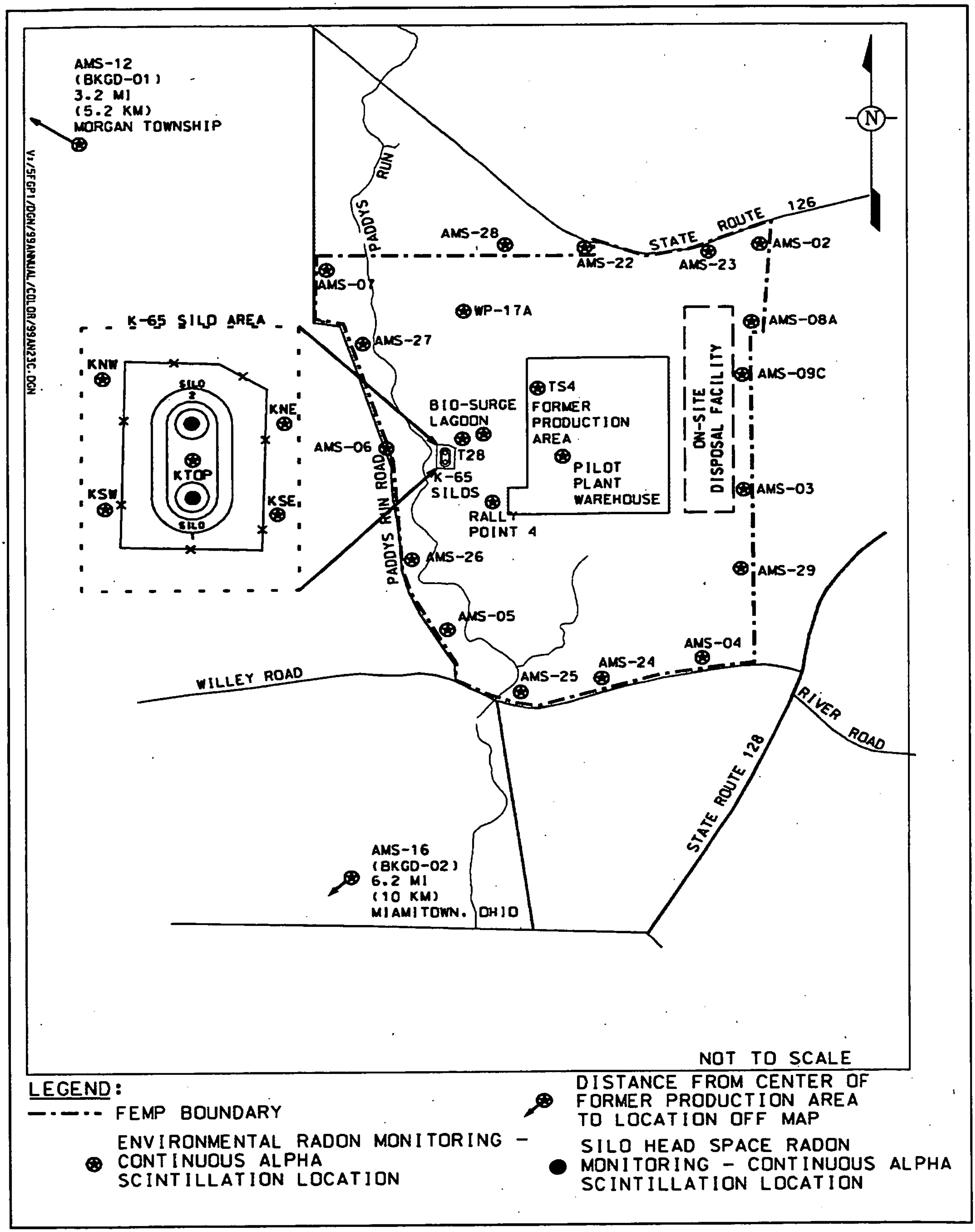

Figure 5-4. Radon Monitoring - Continuous Alpha Scintillation Locations

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Annual comparisons are performed on average radon concentrations recorded at the K-65 Silos exclusion fence locations, historical western fenceline locations, and background locations (historical alpha track-etch and alpha scintillation detector data were used for this comparison). The results indicate a measurable increase at the K-65 Silos exclusion fence over time (Figure 5-5) and a marginal difference between background and western fenceline monitoring locations (Figure 5-6). It is important to note that the increase in average concentrations adjacent to the K-65 Silos are still below the levels observed prior to the addition of bentonite to the K-65 Silos in 1991.

During the fourth quarter of 1998, there was a noticeable increase in the number of exceedances of the DOE Order 5400.5 100 pCi/L radon limit recorded at the K-65 Silo exclusion fenceline. In response to the increasing radon concentrations in the vicinity of the K-65 Silos, DOE conducted detailed inspections of the silo domes using radiological survey instruments to pinpoint leak locations. As expected, leaks were found at the gasketed surfaces of man-way flanges, sounding ports, and other silo penetrations. Radon was also found to be leaking from the covered access ports that were cut into the center protective cap of each silo to allow for the bentonite installation. Over time the port covers have weathered, causing leakage at the seams. As a short-term method to lower silo emissions, DOE attached plastic coated tarps over each silo port cover using an adhesive and silicone-based sealant.

Although the long-term solution for controlling radon emissions from the silos involves a radon control system related to the Accelerated Waste Retrieval Project, DOE evaluated the advantages and disadvantages of three control measures in the interim:

- Reducing head space radon inventory by repairing the bentonite seal or by adding additional material
- Reducing radon emissions by identifying and repairing known leaks, followed by re-sealing the dome with a spray-on coating and/or impermeable membrane
- Reducing radon emissions by maintaining a slight negative pressure in the head space by collecting a small amount of head space gas per silo, removing the radon, then exhausting it to the atmosphere.

Based on keeping work area exposures ALARA, DOE decided on re-sealing the identified areas. Re-sealing activities were initiated in late May 1999, and were completed on June 4, 1999. Following the re-sealing of the silo domes, radon data from the K-65 Silo area have been closely monitored in order to gauge the effectiveness in reducing radon emissions.

A comparison of the 1999 and 1998 fourth quarter average radon concentrations at the KNE and KSE exclusion fence monitors (chosen because of prevailing wind directions) provides some measure of the effectiveness of the re-sealing activities. The fourth quarter 1999 combined average radon concentration for the KNE and KSE monitors was approximately 70 percent lower than the fourth quarter 1998 average, suggesting the re-sealing activities contributed to a substantial reduction in radon concentrations at the K-65 Silo area.

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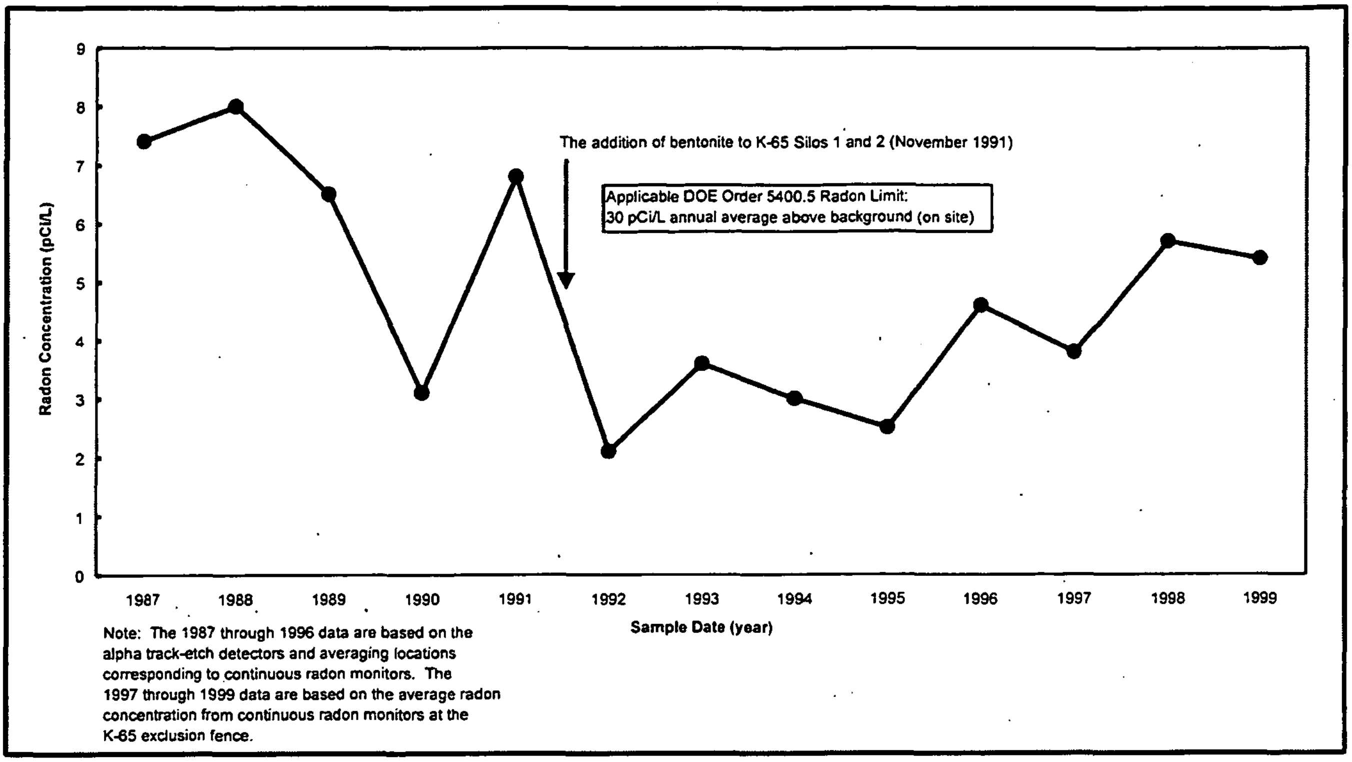

Figure 5-5. Annual Average Radon Concentrations at K-65 Silos Exclusion Fence, 1987 - 1999

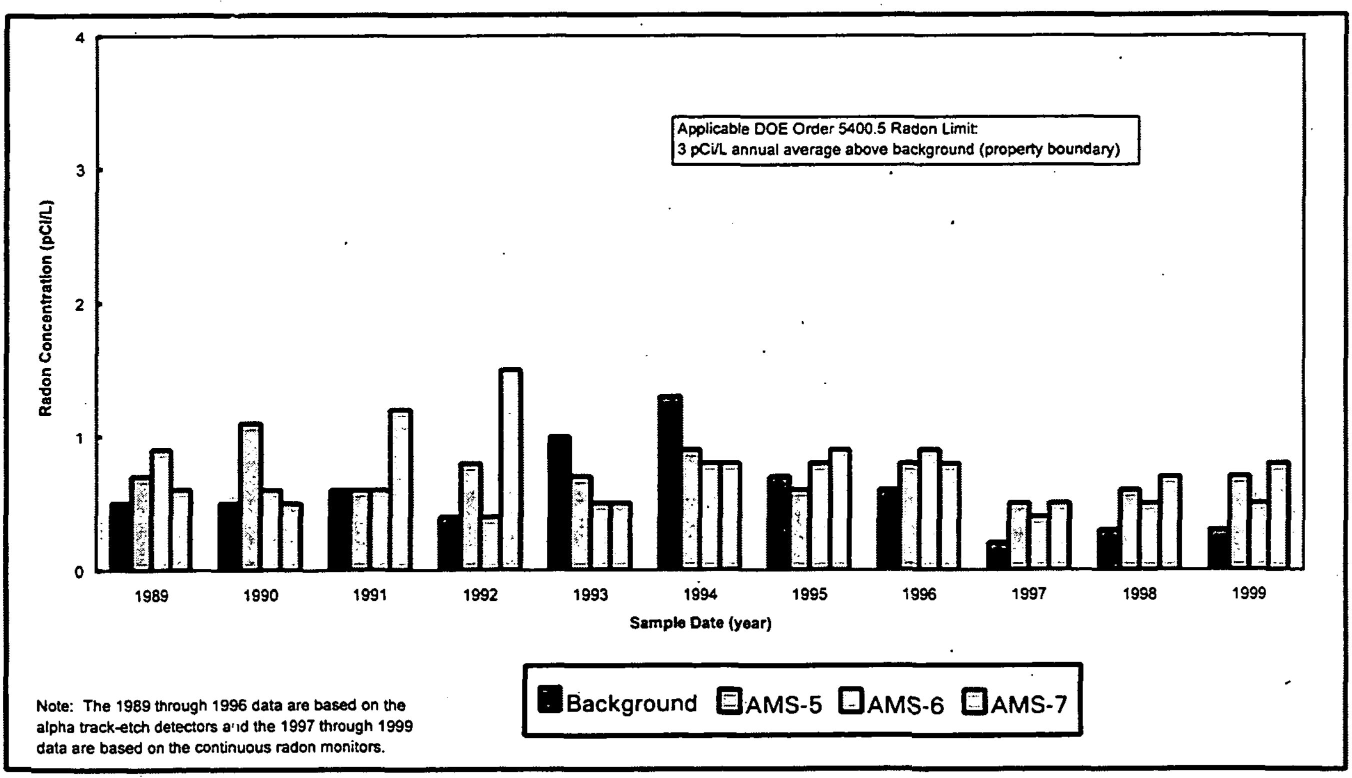

Figure 5-6. Annual Average Radon Concentrations at Selected Radon Locations, 1989 - 1999

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A review of meteorological data provides further support for the effectiveness of the re-sealing activities. The number of strong inversion hours (as defined by a temperature gradient of greater than 1.5 degrees Celsius per 100 meters in elevation) recorded during fourth quarter 1999 was very similar to fourth quarter 1998 (987 hours in 1999 compared to 985 hours in 1998). However, approximately 20 percent more of the strongest "G" class inversion hours (temperature gradient of greater than 4 degrees Celsius per 100 meters in elevation) were recorded for fourth quarter 1999. Given the larger and stronger inversions during the fourth quarter of 1999, radon concentrations at the K-65 exclusion fence monitors should have been greater during fourth quarter 1999 had the re-sealing activity been ineffective.

There were 47 exceedances of the 100 pCi/L DOE limit measured on site during 1999 (refer to Table C.2-1 in Appendix C) compared with 24 in 1998 and five in 1997. As in past years, the exceedances were observed at monitoring locations adjacent to the K-65 Silos and occurred during periods of atmospheric inversions. Of the exceedances recorded during 1999, the first 35 occurred prior to the dome re-sealing activities. The remaining 12 exceedances occurred during the fourth quarter of 1999. Of these, a majority occurred exclusively at the KNW monitor, in contrast to past years when most exceedances occurred at the KNE monitor. A review of activities occurring around the K-65 Silos indicated that the cause of the exceedances at the KNW monitor was related to the pumping of contaminated water from the K-65 decant sump, which collects contaminated water from the K-65 Silos. Because the pumping activities occurred during periods of strong inversions, radon emissions from the sump and the tanker were concentrated at relatively high levels on the western side of the K-65 Silos near the KNW monitor, and contributed to the exceedances. The increased radon concentrations at the KNW monitor were also attributable to relocating the monitor closer to the K-65 Silos, which was necessary due to road construction activities for the Accelerated Waste Retrieval Project.

In order to better monitor radon levels in the K-65 Silos area during the Accelerated Waste Retrieval Project, five radon monitoring locations will be added to the existing IEMP radon network in 2000. Four of the monitors will be located in the immediate vicinity of the silos, the fifth monitor will be located along the western fenceline of the FEMP. The data and specific locations of the additional radon monitors will be reported in future IEMP quarterly status reports and annual integrated site environmental reports.

5.5 Monitoring for Direct Radiation

Direct radiation (i.e., 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 FEMP. The largest source of direct radiation at the FEMP is the material stored in the 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 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 FEMP were continuously measured at 32 locations with thermoluminescent dosimeters (TLDs) during 1999. TLDs absorb and store the energy of direct radiation within the thermoluminescent material. By heating the thermoluminescent material under controlled conditions, 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 FEMP fenceline, and several off-site locations, including background locations.

Table 5-3 provides summary level information pertaining to direct radiation measurements for 1999 and 1998.

000110

TABLE 5-3

DIRECT RADIATION (THERMOLUMINESCENT DOSIMETER) MEASUREMENT SUMMARY

	Direct Radiation (mrem)	
TLD Location	**Summary of 1999 Results**	**Summary of 1998 Results**
Fenceline		
Minimum	63	63
Maximum	81	84
On Site		
Minimum	55	55
Maximum	904	817
Background		
Minimum	62	61
Maximum	77	77

All monitoring results from TLDs for 1999 were within historical ranges. However, there is an increasing trend in direct radiation measurements in the immediate area of the K-65 Silos which will continue to be monitored (refer to Figure 5-8). This trend is attributable to a corresponding increase in radon concentrations and associated decay products within the K-65 Silos head space. The increased direct radiation measurements adjacent to K-65 Silos are still well below the levels observed prior to the addition of bentonite to the K-65 Silos in 1991.

Additionally, an increase in direct radiation levels above background has also been detected at the FEMP western fenceline over the past three years (1997 through 1999), particularly at TLD location 6 which is located closest to the K-65 Silos (refer to Figure 5-9). The relatively small increases in direct radiation levels at the fenceline are difficult to measure consistently due to small variations in the sensitivity and accuracy of the environmental TLDs. These increases at the fenceline are also attributable to the increase in radon concentrations and associated decay products within the K-65 Silos head space. The slight upward trend in background radiation levels shown in Figure 5-9 is attributed to changes in the laboratory processing of the TLDs. These trends will continue to be monitored and presented in IEMP quarterly status reports and annual integrated site environmental reports.

Detailed results of direct radiation measurements for 1999 and 1998 are provided in Appendix C, Attachment 3, of this report.

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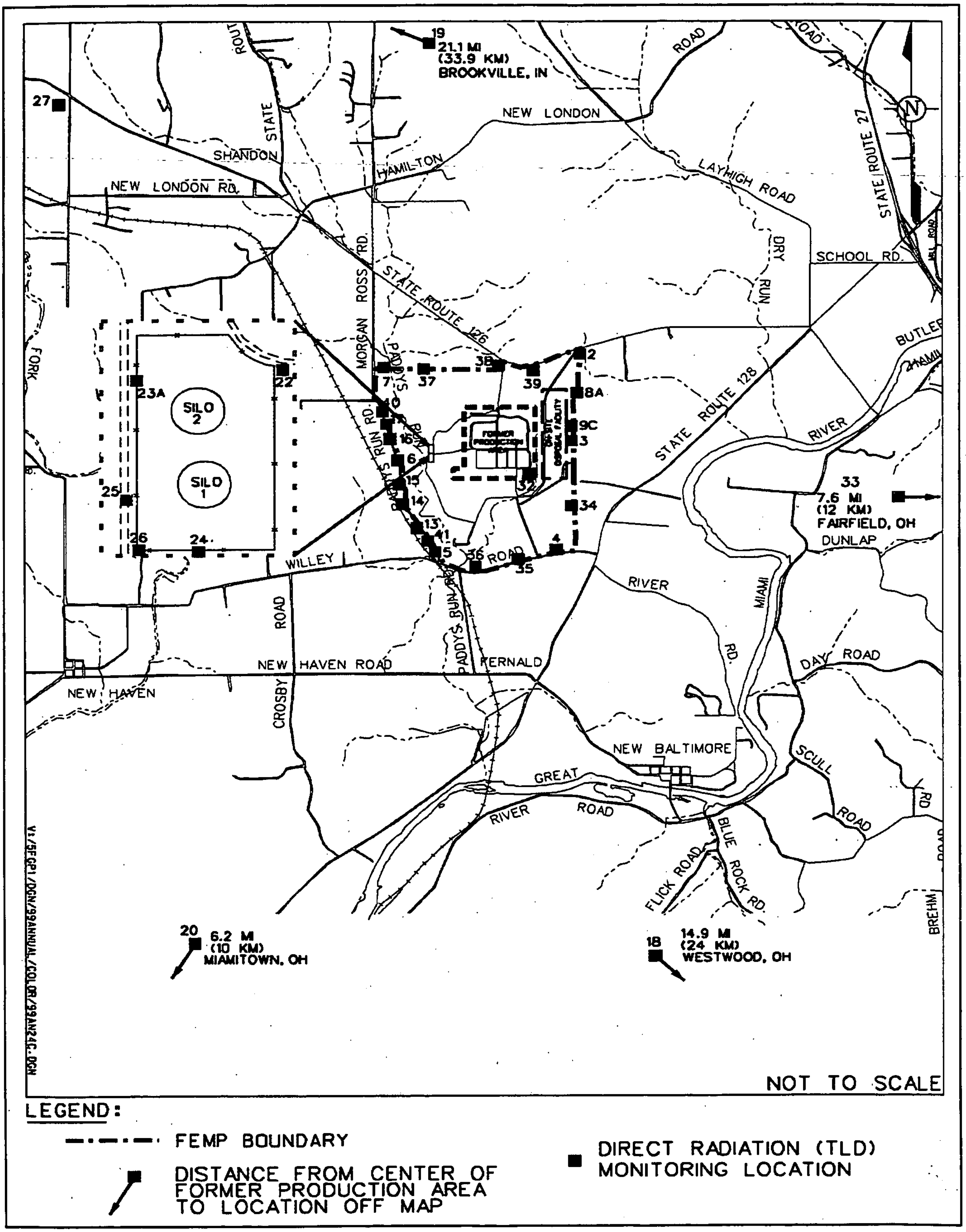

Figure 5-7. Direct Radiation (TLD) Monitoring Locations

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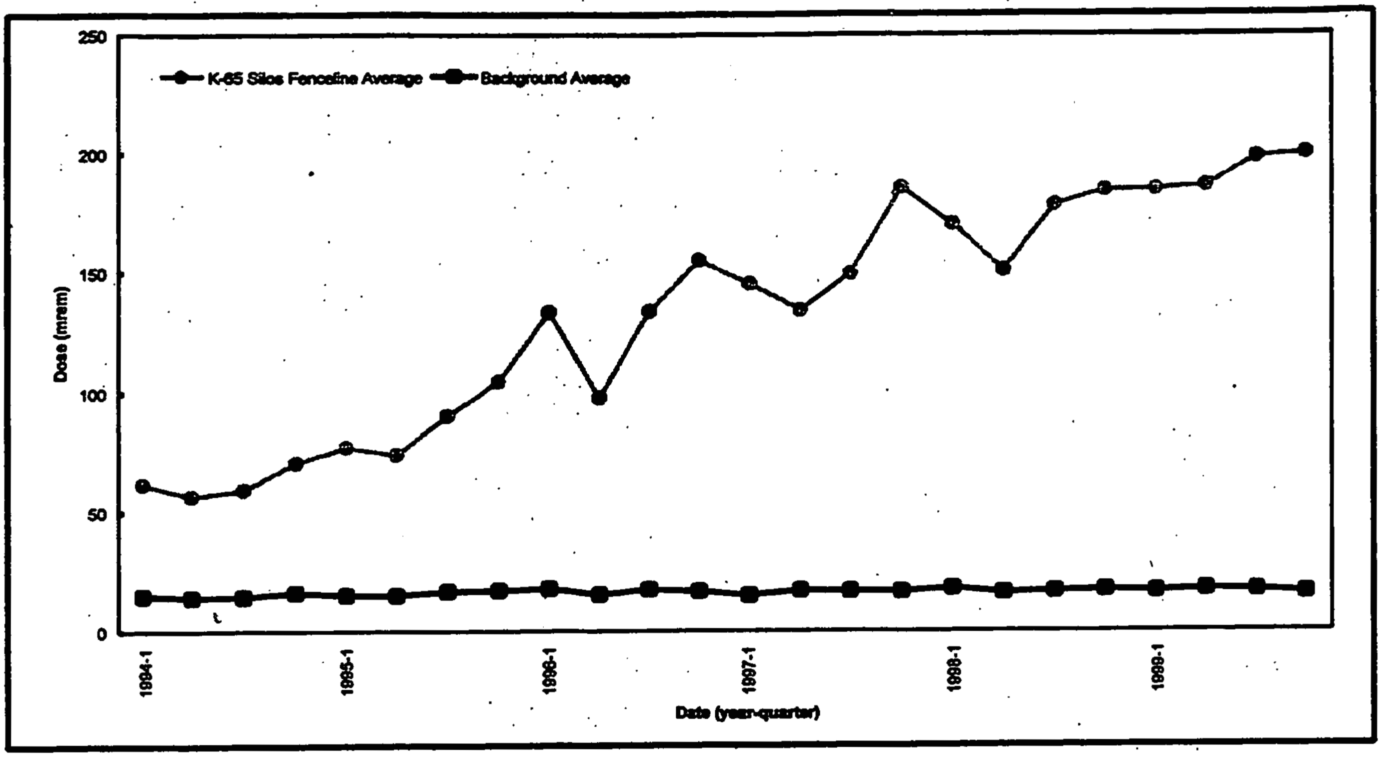

Figure 5-8. Direct Radiation (TLD) Measurements, 1994 - 1999 (K-65 Silos Fenceline Average Versus Background Average)

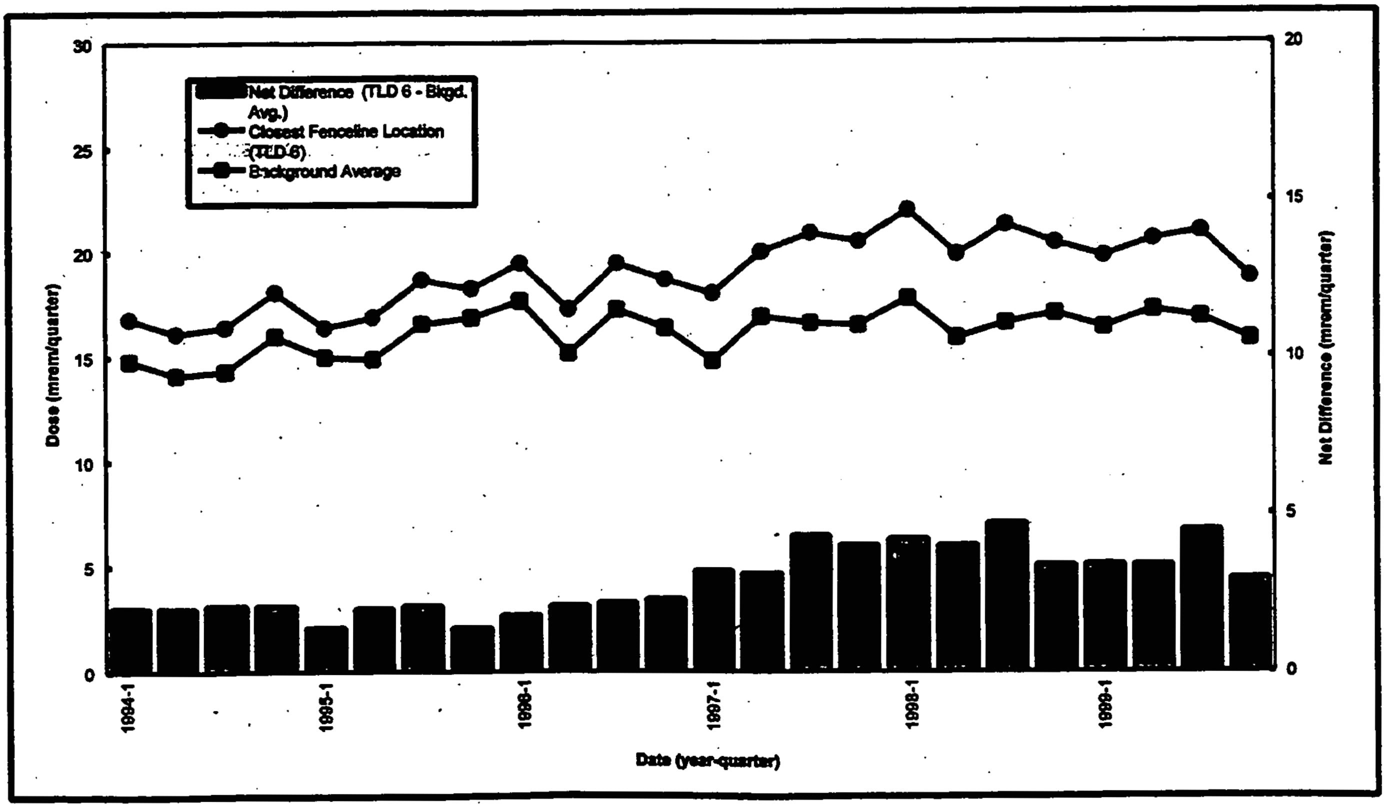

Figure 5-9. Direct Radiation (TLD) Measurements, 1994 - 1999 (Location 6 Versus Background Average)

000113

5.6 Stack Monitoring

With the transition from uranium production to full-scale remediation activities came a significant reduction in the number of stacks and vents (point sources) which require monitoring. Three stack monitors were in operation during 1999: Laundry, Building 71, and Waste Pits Remedial Action Project dryer. No significant changes in source operations associated with either the Laundry or Building 71 stack were noted during 1999.

During the initial start-up and operation of the Waste Pits Remedial Action Project dryer in December 1999, there were a series of false alarms at the stack monitor. In response to each alarm, the monitoring system was inspected. The sample filter in the stack monitoring system was replaced, as necessary (e.g., in response to the alarm). The stack filters that were collected were analyzed as a composite sample. The Waste Pits Remedial Action Project dryer stack also contains a continuous radon (i.e., radon-220 and radon-222) monitor. During dryer operations, the maximum daily release of radon (radon-220 and radon-222) from the dryer stack was 3,224 μCi, which is below the estimated maximum hourly release rate of 13,000 μCi/hr (DOE 1998) for radon-222. Table 5-4 summarizes FEMP stack emissions for 1999. Figure 5-10 provides monitored stack locations.

Typically, post production monitoring data have shown stack emissions of uranium and thorium to be very low or not detectable. The 1999 stack emissions are consistent with historical stack emission data.

TABLE 5-4

1999 NESHAP STACK EMISSIONS

Radionuclide (Unit)	Laundry Stack[a,b]	WPRAP Dryer Stack[a,b,c]	Building 71 Stack[a,b]
Uranium, Total (lbs/yr.)	2.6E-05	NA	2.6E-05
Uranium-238 (lbs/yr.)	NA	ND	NA
Uranium-235/236 (lbs/yr.)	NA	ND	NA
Uranium-234 (lbs/yr.)	NA	ND	NA
Thorium-232 (lbs/yr.)	5.8E-04	ND	5.2E-05
Thorium-230 (lbs/yr.)	6.9E-09	ND	1.0E-09
Thorium-228 (lbs/yr.)	NA	ND	NA
Radium-226 (lbs/yr.)	NA	ND	NA
Particulates, Total (lbs/yr.)	6.0E-01	NS	5.8E-01
Radon, Total (μCi)	NS	3865	NS

[a]NA = not applicable because no analysis was performed
[b]NS = not sampled
[c]ND = non-detectable

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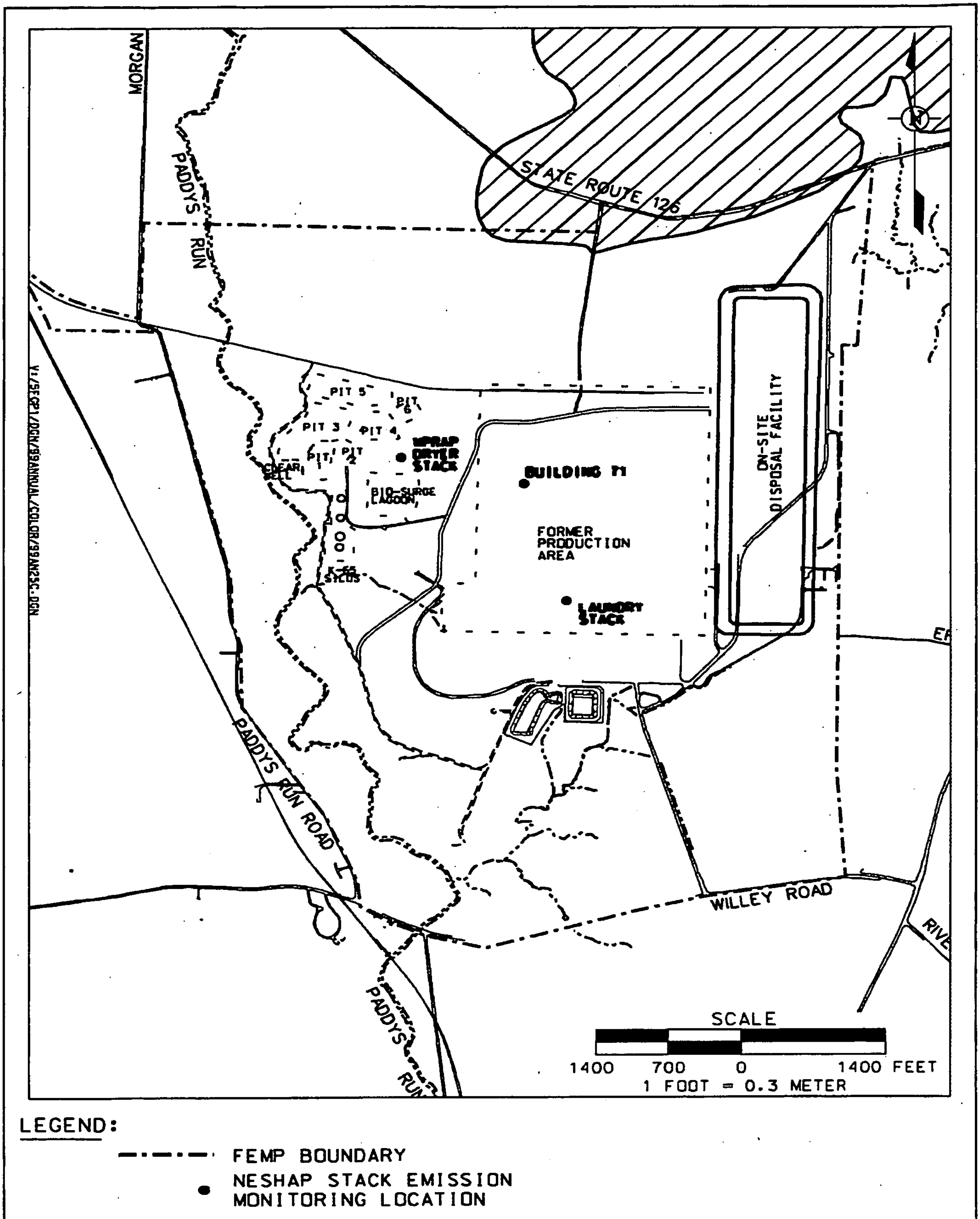

Figure 5-10. NESHAP Stack Emission Monitoring Locations

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5.7 Monitoring for Non-Radiological Pollutants

OEPA requires an estimate of emissions from the boiler plant as part of the FEMP's effort to demonstrate compliance with the Clean Air Act. The FEMP estimated the amount of non-radiological pollutants, including particulate matter, sulfur dioxide, nitrogen oxides, and carbon monoxide, and measured the shade, or density, of particulate emissions from the boilers. Shade, also called opacity, is a measure of how much light is blocked by particulate matter present in stack emissions. There were no excursions in opacity at the boilers for 1999. For comparison, there were no excursions in 1998 or 1997 and 14 excursions in 1996. The reduction in opacity excursions since 1996 is due to the FEMP's conversion from coal-fired boilers to natural gas/diesel-fired boilers.

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 1999 sulfur dioxide emissions from all boilers were calculated to be 97 pounds (44 kg). This was well below the allowable limit of over 79 tons (72 metric tons) per year calculated from information in the permits issued by OEPA.

The nitrogen oxide and carbon monoxide emissions are estimated using data obtained from stack emission test results. Nitrogen oxide emissions for all boilers for 1999 were estimated to be 8,100 pounds (3,700 kg). Carbon monoxide emissions for all boilers in 1999 were estimated to be 9,900 pounds (4,500 kg). To date, OEPA has not set nitrogen oxide or carbon monoxide limits for FEMP industrial processes.

Table 5-5 provides a comprehensive list of 1999 boiler plant emissions.

TABLE 5-5

BOILER PLANT EMISSIONS

Chemical Name	Type of Release	Quantity Released (lb/kg)	Major Release Sources	Basis of Estimate
Particulates	Stack Emissions	2,200/1,000	Fossil Fuels Combustion	AP-42 Emission Factors[a]
Sulfur Dioxide	Stack Emissions	97/44	Fossil Fuels Combustion	AP-42 Emission Factors[a]
Nitrogen Oxide	Stack Emissions	8,100/3,700	Fossil Fuels Combustion	Stack Emission Test Results
Carbon Monoxide	Stack Emissions	9,900/4,500	Fossil Fuels Combustion	AP-42 Emission Factors[a]
Non-Methane Volatile Organic Compounds	Stack Emissions	620/280	Fossil Fuels 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).

000116

6.0 Radiation Dose

Results in Brief: 1999 Estimated Doses

Airborne Emissions - The estimated maximum effective dose at the site fenceline from 1999 airborne emissions (excluding radon) was calculated to be 0.29 mrem. This equals 2.9 percent of the EPA NESHAP 10 mrem annual dose limit.

Direct Radiation - The estimated 1999 effective dose at an off-site receptor location near the western fenceline of the FEMP was approximately 8 mrem.

Dose to the Maximally Exposed Individual - The dose to the maximally exposed individual for 1999 was estimated to be 8.4 mrem at an off-site receptor location near the western fenceline of the FEMP.

This chapter provides estimated doses from the air and direct radiation pathways for 1999. EPA regulations require the FEMP to demonstrate that its radionuclide airborne emissions are low enough to ensure that no one in the public receives an effective dose of 10 mrem or more in any one year. Moreover, to determine whether the FEMP is within the DOE dose limit of 100 mrem per year from all exposure pathways (excluding radon), estimates of dose due to direct radiation are combined with the airborne emissions to estimate the total effective dose to the maximally exposed individual. This estimate reflects the incremental dose above background that is attributable to the FEMP.

The DOE limits for dose from radon and its decay products in air are provided in terms of concentrations 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. Nonetheless, dose estimates for radon have been included in this section in response to FEMP stakeholders' interests in radon exposures. A number of different radon dose calculations are presented in this section to provide readers with a basis for comparison with radon dose estimates presented in previous annual site environmental reports and other radon dose studies (i.e., Fernald Dosimetry Reconstruction Project [RAC 1996]).

6.1 Estimated Dose from Airborne Emissions

The estimated dose from 1999 airborne emissions was calculated from annual average radionuclide concentrations measured at the 18 IEMP air particulate monitoring locations (two background and 16 fenceline locations). Annual average background concentrations were 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 dose using values listed in 40 Code of Federal Regulations 61 (NESHAP) Subpart H, Appendix E, Table 2.

The maximum effective dose at the fenceline from 1999 airborne emissions was estimated to be 0.29 mrem per year and occurred at AMS-3 along the eastern fenceline of the site. The dose estimate is based on the conservative assumption that a person remains outdoors at the AMS-3 location for 100 percent of the time during the year. Recognizing that the nearest residence is located approximately 1,500 feet (450 meters) downwind from AMS-3 (east-southeast from the site), the actual dose received by this receptor would be substantially lower than 0.29 mrem per year.

Figure 6-1 provides a comparison between the air pathway doses at the average background and maximum fenceline locations along with the annual NESHAP limit of 10 mrem. The average background and maximum fenceline doses shown in Figure 6-1 are 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). The maximum air pathway dose of 0.29 mrem (above background) is in addition to the average air pathway background dose of 0.24 mrem and is 2.9 percent of the annual NESHAP limit. The detailed estimated dose from airborne emissions at each fenceline air monitor is provided in Appendix D of this report.

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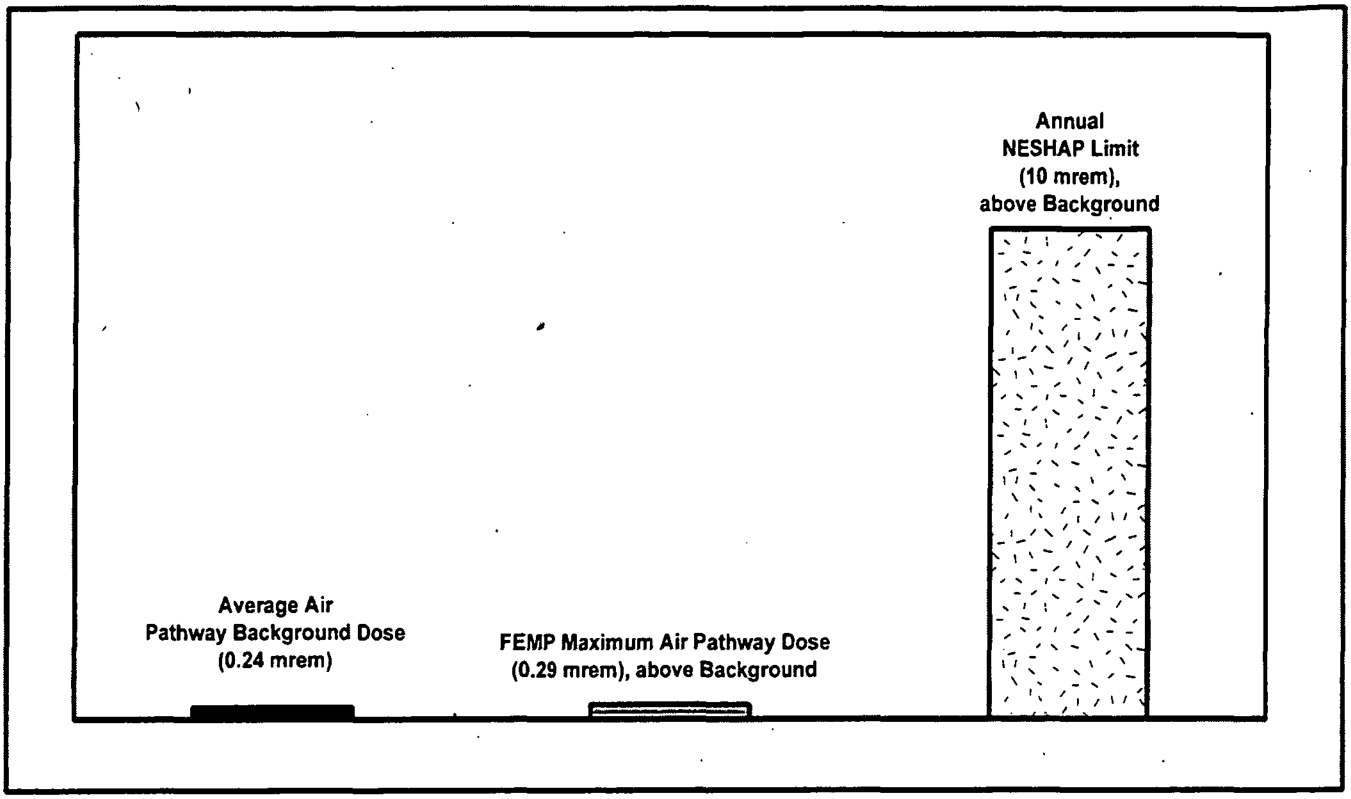

Figure 6-1. Comparison of 1999 Air Pathway Doses and Allowable Limits

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 FEMP 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 silo head space contributes a major fraction of the direct radiation from the K-65 Silos. As the head space radon concentrations have increased, the direct radiation from the silos has also increased. Direct radiation levels at the K-65 Silos and site fenceline are monitored by a network of environmental TLDs. Chapter 5 provides a description of the direct radiation monitoring.

In 1998 the FEMP revised the method for comparing fenceline and background TLD data and estimating direct radiation dose. The revised method provides a more conservative estimate of direct radiation dose and provides a clearer analysis of the impact of increasing radiation levels near the silos and the fenceline due to increasing levels of radon and associated decay products in the silo head space (refer to Chapter 5). In 1999 the direct radiation dose at the fenceline was estimated using the highest dose from the fenceline monitoring locations and subtracting the average dose measured at background TLD locations. From the data in Table 5-3, the maximum fenceline measurement was 81 mrem per year and occurred at TLD locations 6 and 16. The average background dose from TLD locations 18, 19, 20, 27, and 33 was 66 mrem. The difference in these values (15 mrem) is the estimated fenceline direct radiation dose for a hypothetical individual who stands at the fenceline, specifically TLD locations 6 or 16, for the entire year.

000118

In accordance with DOE Order 5400.5, Radiation Protection of the Public and the Environment, which requires that realistic exposure conditions be used for conducting dose evaluations, a more realistic estimate of direct radiation dose was calculated for a residence nearest the K-65 Silos. This dose was estimated by using the fenceline TLD measurement that yielded the maximum dose to the resident TLD (location 15 with 79 mrem) and subtracting the average background dose of 66 mrem. The difference in these values is 13 mrem per year. Accounting for the distance between the fenceline TLD location and the residence (approximately 326 feet [99 meters]) lowers the direct radiation dose to approximately 8 mrem. 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 that no shielding is provided by the structure of the house.

6.3 Total of Doses to Maximally Exposed Individual

The maximally exposed individual is the member of the public who receives the highest estimated effective dose based on the sum of the individual pathway doses. For 1999 the dose to the maximally exposed individual (Table 6-1) is the sum of the estimated doses from airborne emissions (excluding radon) and the estimated direct radiation dose at a location approximately 100 feet (30 meters) west-southwest of the FEMP fenceline at a location near the K-65 Silos. 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 1999 dose to the maximally exposed individual is estimated to be 8.4 mrem. The contributions to this all-pathway dose are:

- 0.09 mrem from air inhalation dose which was measured at AMS-26 on the western fenceline of the FEMP nearest to the off-site receptor location
- 8.3 mrem from direct radiation measured at TLD location 15 on the western fenceline of the FEMP nearest to the off-site receptor location.

This estimate represents the incremental dose above background attributable to the FEMP, exclusive of the dose received from radon. Figure 6-2 provides a comparison between the average all pathway dose at background (66.24 mrem) and the all pathway dose to the maximally exposed individual (8.4 mrem). The all pathway dose is comprised of the doses from direct radiation levels and airborne concentrations of uranium, thorium, and radium. The dose to the maximally exposed individual represents marginal increase in dose above background that is attributable to airborne emissions and direct radiation from the FEMP. Figure 6-2 also provides a comparison to the annual DOE all pathway limit of 100 mrem.

000119

TABLE 6-1

DOSE TO MAXIMALLY EXPOSED INDIVIDUAL

Pathway	Dose Attributable to the FEMP	Applicable Limit (Above Background)
Air		
Airborne emissions at AMS-26 (excluding radon)	0.09 mrem	10 mrem (air pathway)
Direct radiation	8.3 mrem	100 mrem (total of all pathways)
Maximally exposed individual	8.4 mrem	100 mrem (total of all pathways)

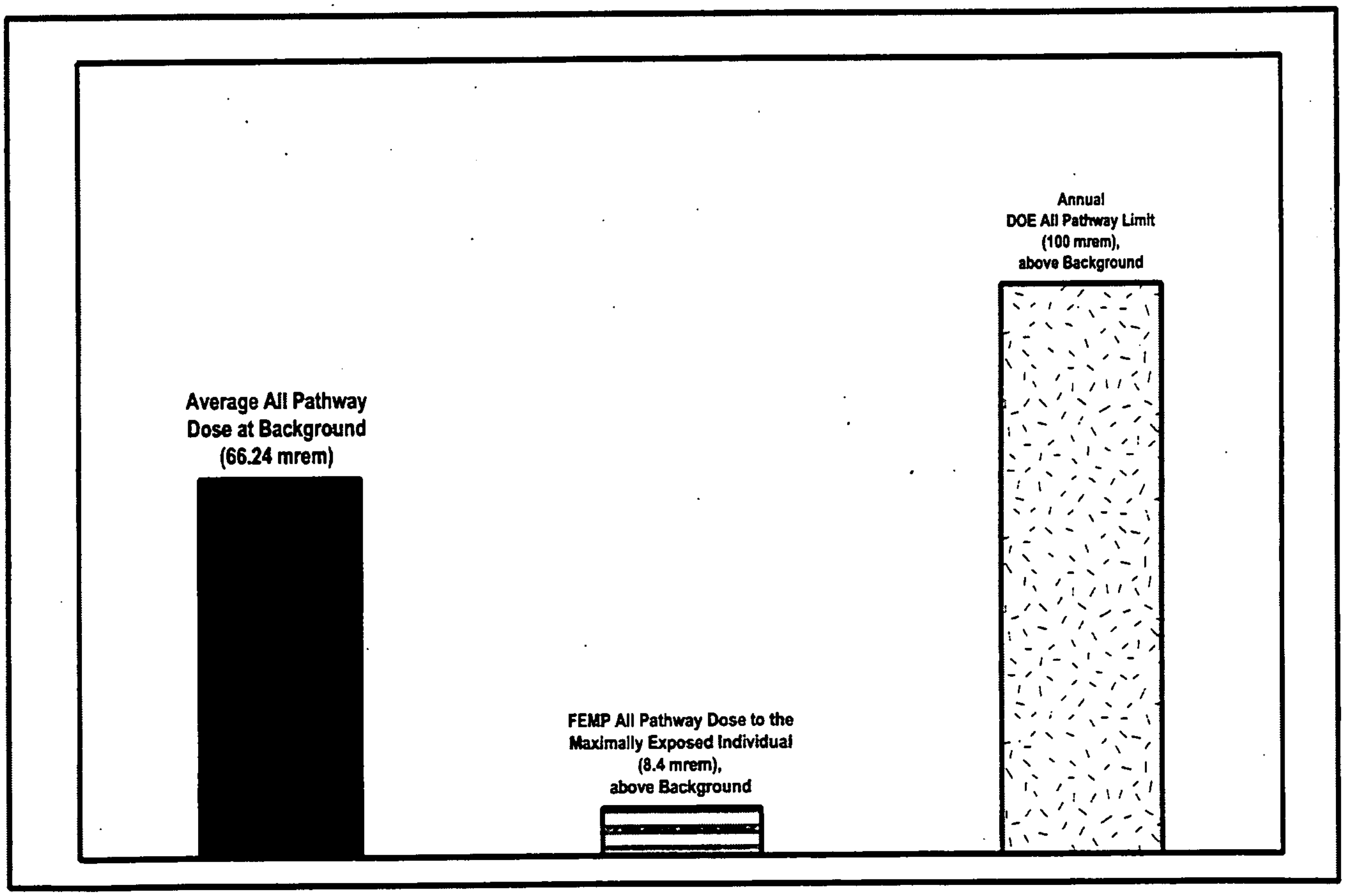

Figure 6-2. Comparison of 1999 All Pathway Doses and Allowable Limits

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6.4 Significance of Estimated Radiation Doses for 1999

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 per year from natural sources, excluding radon. For example, the dose received each year from cosmic and terrestrial background radiation contributes approximately 26 and 28 mrem, 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, whereas living in the Denver area would contribute approximately 125 mrem from background radiation (U.S. National Academy of Science 1980) (National Council on Radiation Protection and Measurements 1987). Comparing the maximally exposed individual dose to the background dose demonstrates that, even with the conservative estimates, the dose from the FEMP is much less than background. 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.

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 per year above background. As a result of this recommendation, DOE has incorporated 100 mrem per year above background as the limit in DOE Order 5400.5. The sum of all estimated doses from FEMP operations for 1999 was significantly below this limit.

6.5 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.

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 (i.e., epidemiological studies) on highly exposed worker populations (i.e., 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.

000121

- NCRP 78 report
  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 utilized to equate the lung dose to a whole body radiation dose (i.e., effective dose equivalent). Equations from this report were utilized in previous annual site environmental reports and are presented here for direct comparison to previous years' estimates.

- ICRP 66 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
  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. ICRP issued this report in 1994 and recommended these conversion coefficients for calculating radon dose.

Table 6-2 presents the 1999 radon dose estimates. The table 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 utilizing 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 FEMP western 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 at the nearest receptor from FEMP radon emissions is 36 mrem per year above background.

Because there are no limits for effective dose equivalent from radon and its daughters, it is important to refer to the concentration limits imposed by DOE Order 5400.5. As previously stated, the annual average radon concentration limit at the facility boundary is 3 pCi/L above background. Measured concentrations for all fenceline-monitoring points are well below this limit.

000122

TABLE 6-2

1999 RADON DOSE ESTIMATE[a]

Location	Radon Concentration (pCi/L)	Exposure in Working Level-Months (WLM)	NCRP 78 Effective Dose Equivalent Equation (mrem)[b]	NCRP 78 Effective Dose Equivalent Equation (mrem)[c]	ICRP 65 Effective Dose Equivalent (mrem)[d]
Average Background	0.3	0.108	216	72	55
FEMP Fenceline Nearest Receptor (net, above background)	0.2	0.072	144	48	36
Maximum Fenceline (net, above background)	0.5	0.180	360	120	91
DOE Order 5400.5 Limit (net, above background)	3	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]Utilizing the dose conversion factor for the maximally-exposed reference man

7.0 Natural Resources

This chapter provides background information on the natural resources associated with the FEMP and summarizes the 1999 activities relating to these resources. Included in this chapter is a discussion of the following:

- Threatened and endangered species
- Cultural resources
- Impacted habitat areas.

Much of the 1,050 acres (425 hectares) of the FEMP 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 FEMP'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 FEMP. These resources are considered in the Natural Resource Monitoring Plan, which is included in the IEMP. The plan presents an approach for monitoring and reporting the status of several priority natural resources to remain in compliance with the pertinent regulations and agreements.

7.1 Threatened and Endangered Species

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, several surveys have been conducted to determine the presence of any threatened or endangered species at the FEMP. As a result of these surveys, the federally endangered Indiana brown bat and the state-threatened Sloan's crayfish have been found at the FEMP. In addition, suitable habitat exists for two other species: the federally endangered running buffalo clover and the state-threatened spring coral root. Neither of these species has been found on property, but their habitat ranges encompass the FEMP. 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.

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 FEMP in the northern reach 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 FEMP 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 FEMP; however, because running buffalo clover is found nearby in the Miami Whitewater Forest, the potential exists for this species to become established at the FEMP. The running buffalo clover prefers habitat with well-drained soil, filtered sunlight, 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 which 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 FEMP; however, suitable habitat exists in portions of the northern woodlot.

000124

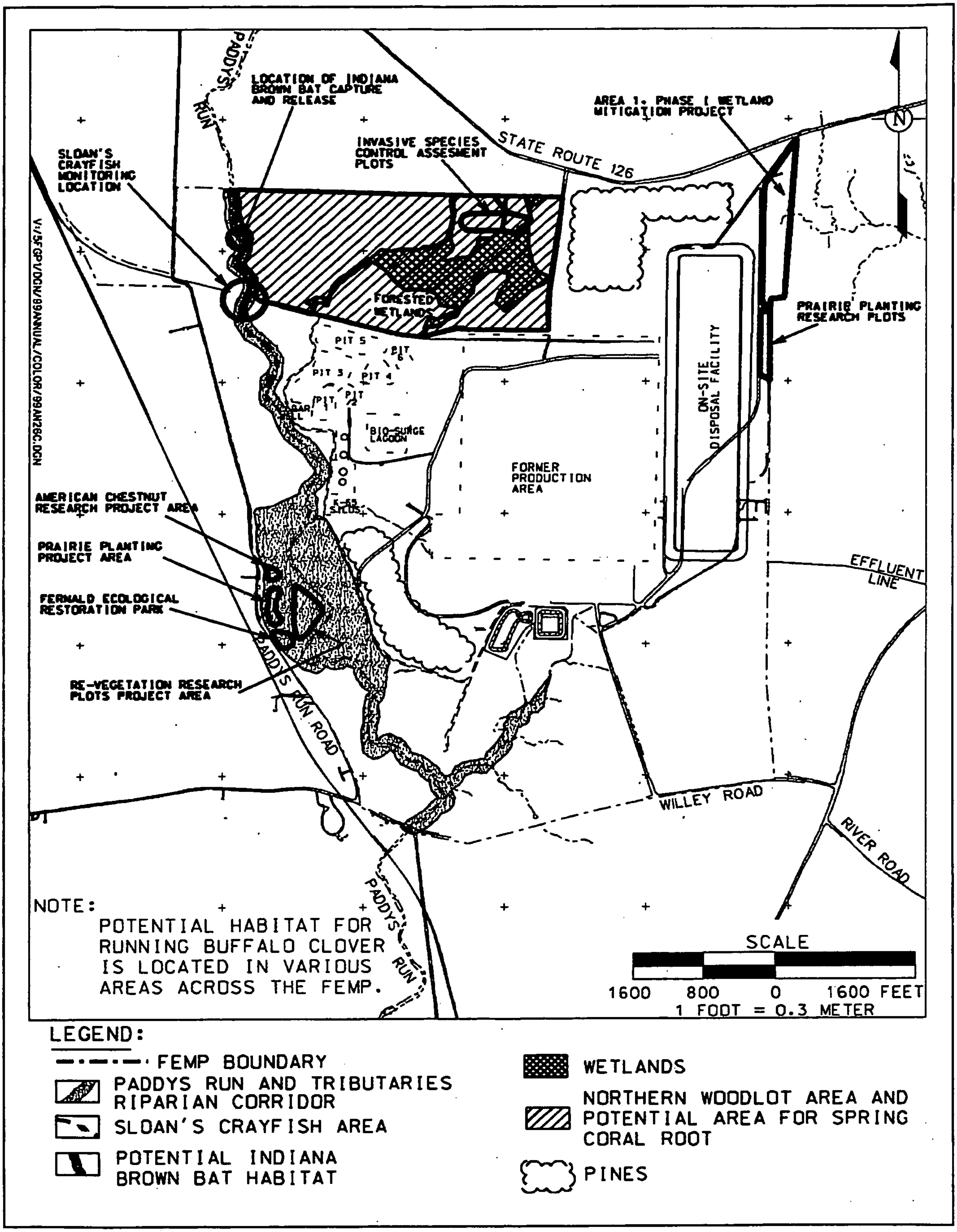

Figure 7-1. Priority Natural Resource Areas

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Several ecological surveys were conducted in 1999. Bat populations along the northern reach of Paddys Run were sampled using mist nets as the means of capture on August 9 and 10, 1999. This effort was conducted in advance of the ecological restoration of Area 8, Phase II, which began in the fall of 1999. Of the 35 bats captured, one was an adult female Indiana brown bat. All of the bats were weighed and released. This represented the first confirmed occurrence of the Indiana brown bat at the FEMP. Until this 1999 survey, the FEMP was considered to have suitable habitat for the Indiana brown bat, but no known population. As a result of this finding, the Area 8, Phase II Natural Resource Restoration Design Plan was revised to eliminate earthwork and tree removal near Paddys Run. Also, the use of exfoliating bark species that are preferred by the Indiana brown bat (such as shagbark hickory) were integrated into the restoration plan.

Pursuant to the IEMP, the state-threatened Sloan's crayfish was surveyed in the northern reach of Paddys Run in June of 1999. Researchers identified 117 Sloan's crayfish. Many of the crayfish identified were juveniles, which suggests successful breeding among the Paddys Run population.

No specific surveys were conducted at the FEMP in 1999 for running buffalo clover or spring coral root because no remediation activities occurred within their respective potential habitat areas. However, in 1999, Ohio University continued their survey efforts in order to identify the plants in the northern woodlot area. Researchers did not find any spring coral root or running buffalo clover in this area.

7.1.1 Sloan's Crayfish Monitoring and Provisions for Protection

As identified above, the 1999 follow-up survey for the Sloan's crayfish found a large, healthy population still residing in Paddys Run.

A significant rain event is considered to be 0.5 inch (1 cm) or more of rain in one storm event.

The IEMP requires that visual field inspections of sediment loading be conducted within 24 hours of a "significant rain event." The purpose of this monitoring was to determine if there was 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, then alternatives such as crayfish relocation are considered. Figure 7-1 identifies the Sloan's crayfish monitoring location.

The 1999 monitoring effort yielded similar findings to previous years. Results of visual field inspections conducted in 1999 indicated that sediment loading from remediation activities has not impacted Sloan's crayfish habitat in Paddys Run. Although increased sediment loading was observed from the northern drainage ditch on two occasions, April and December of 1999, these instances did not result in an impact because of their relatively short duration. At this point, while it appears the source may be the railyard sediment basin, no obvious cause can be determined. Field observations of the railyard drainage ditches and adjoining on-site disposal facility drainage areas have been inconclusive. This was discussed with OEPA early in 2000. Higher sediment loading conditions in Paddys Run on other occasions appeared to be a function of upstream influences unrelated to FEMP activities. DOE will continue to monitor the northern drainge ditch following rain events to ascertain the cause of these isolated occurrences of increased turbidity.

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7.2 Cultural Resources

Factors such as geologic setting, surface water, soil, vegetation, and climate determine the population and cultural growth of an area. The FEMP 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. The periods of occupation include the Paleo-Indian (12000 to 8000 B.C.), Archaic (8000 to 1000 B.C.), Woodland Tradition (1000 B.C. to 1000 A.D.), Mississippian Tradition (1000 to 1660 A.D.), and Historic Times (1660 A.D. to present).

The National Historic Preservation Act requires that DOE take into consideration the effects of its actions on sites that are listed or eligible for listing on the National Register of Historic Places. These sites are termed "historic properties." Native American remains and artifacts such as funerary objects and sacred objects are protected under the Native American Graves Protection and Repatriation Act.

Pursuant to implementing regulations for these laws, DOE worked with the Advisory Council on Historic Preservation and the Ohio Historic Preservation Office to develop two programmatic agreements for the FEMP. These agreements specify all activities required to consider and protect cultural resources at the FEMP. As a result, DOE must survey for and recover historic properties prior to any ground-disturbing activities in non-contaminated or previously undisturbed areas. Once construction activities begin, DOE also has contingency plans in place if unexpected cultural resources are uncovered during construction activities. These incidences are called "unexpected discoveries." For 1999, most remediation activities at the FEMP occurred in areas that were already surveyed or otherwise exempt from cultural resource survey requirements (i.e., previously disturbed areas). However, three unexpected discoveries were encountered during remediation activities in 1999 (refer to Table 7-1).

TABLE 7-1

UNEXPECTED CULTURAL RESOURCE DISCOVERIES FOUND IN 1999

Unexpected Discovery[a]
Historical pottery (1780 AD to 1880 AD)
Chert Blade (Prehistoric affiliation)
Remains, Whitetail Deer (Age – Contemporary)

[a]No further excavation is warranted

During 1999, 16.5 acres (6.68 hectares) were surveyed prior to the initiation of ground-disturbing activities. The survey was conducted in the northwest corner of DOE property (between Paddys Run Road and Paddys Run, north of the railroad tracks, and south of the northern fenceline) in support of the Area 8, Phase II Natural Resource Restoration Project.

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Figure 7-2 depicts the areas that have been surveyed. The 1999 surveys resulted in the discovery of four archaeological sites, three prehistoric and one historic. None of the four sites is eligible for inclusion on the National Register of Historic Places. Under the Archaeological Resources Protection Act, the location of specific archaeological sites is considered sensitive information. Therefore, these locations are not indicated on Figure 7-2.

7.3 Impacted Habitat Areas

DOE and the Natural Resource Trustees tentatively agreed that because DOE will be restoring 884 acres (358 hectares), it will not be necessary to quantitatively assess impacted habitat. This information is provided in the following sections, along with a summary of ecological restoration activities that have occurred during 1999.

Within Area 2, Phase I, approximately 3 acres (1 hectare) of riparian (streamside) shrubs and small trees were removed in the vicinity of Paddys Run and the southern waste units prior to certification and potential remediation. Certain trees were marked for preservation before the understory was removed. Three acres (1 hectare) of shrubs and small trees were also removed from the northern woodlot (Area 1, Phase III). This effort actually resulted in a positive impact, because most of the vegetation cleared consisted of non-native and aggressive amur honeysuckle *(Lonicera maackii)* and multiflora rose *(Rosa multiflora)*. No wetlands were impacted in 1999.

Several ecological restoration activities were undertaken at the FEMP in 1999. These projects consisted of wetland mitigation efforts and four environmental projects conducted under ecological research grants as part of the resolution agreement between DOE, EPA, and OEPA for missed Operable Unit 4 milestones (EPA 1997). The wetland mitigation efforts and the four environmental projects are described in more detail below and identified on Figure 7-1. Figure 7-1 also shows the Fernald Ecological Restoration Park that was constructed during 1998.

Wetland mitigation efforts continued in Area 1, Phase I during 1999 in order to partially fulfill DOE's 16.5 acre (6.68 hectare) mitigation requirement. In this area, a formerly grazed pasture was converted to a 12 acre (4.9 hectare) ecosystem containing eight wetland basins which are connected by gravity flow streams. The wetland portion of this ecosystem covers approximately 7 acres (3 hectares). Vegetative cover (forest, shrubland, prairie, marsh) was established for both wet and dry conditions. This project involves extensive grading and planting of over 3,000 shrubs and trees and 30 species of grasses and wildflowers native to southwest Ohio.

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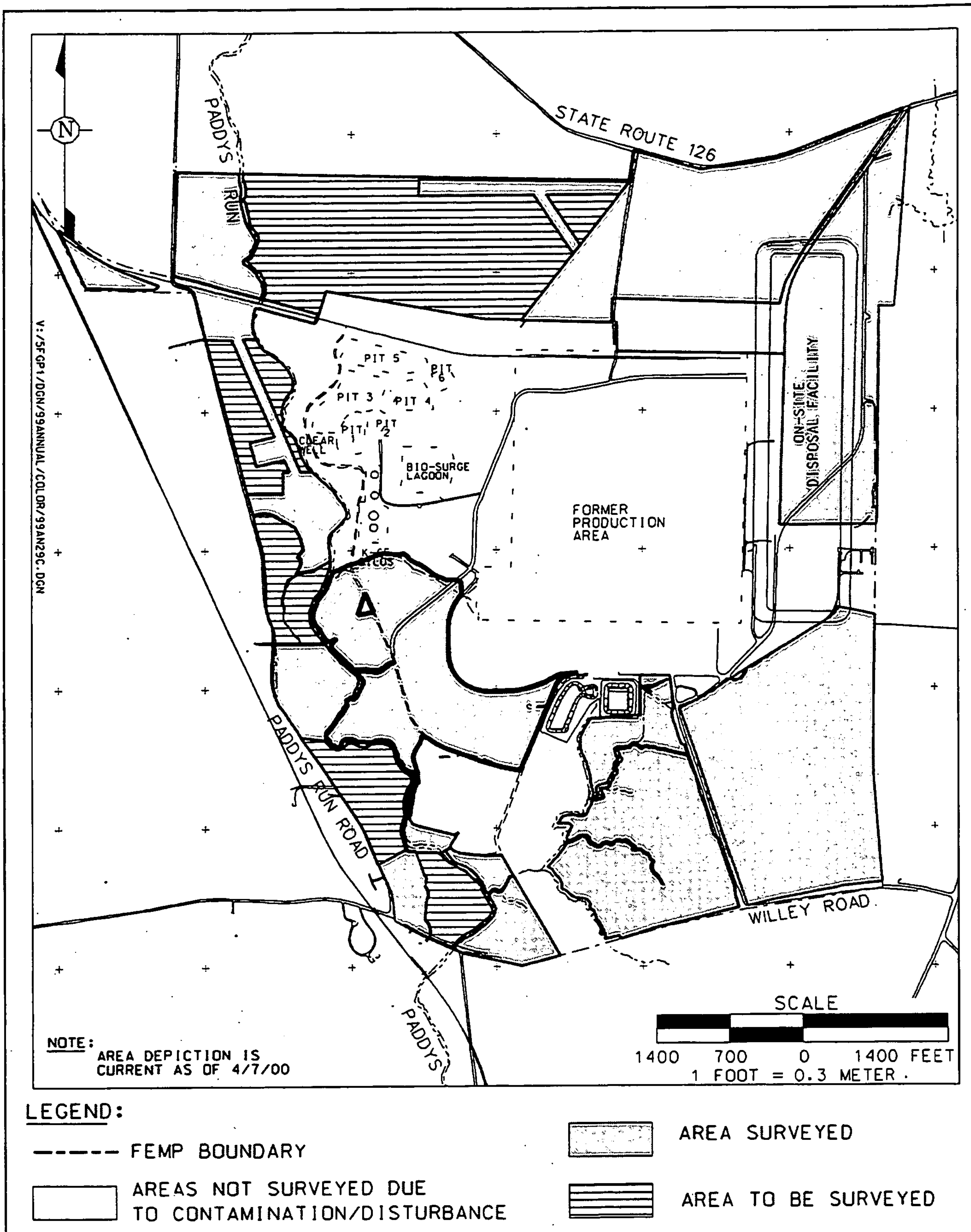

Figure 7-2. Cultural Resource Survey Areas

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The Invasive Plant Control Research Project also continued in Area 1, Phase III during 1999. This project is being conducted under an ecological research grant as part of the Operable Unit 4 dispute resolution agreement. After a plant survey was conducted by Ohio University in Area 1, Phase III, eight plots were established in order to test the effectiveness of several chemical and mechanical control techniques for the invasive amur honeysuckle *(Lonicera maackii)*. To evaluate how planted vegetation would respond to these techniques, tree seedlings were planted throughout every plot. The species planted included black walnut *(Juglans nigra)*, green ash *(Fraxinus pennsylvanica)*, chinquapin oak *(Quercus muehlenbergii)*, black cherry *(Prunus serotina)*, redbud *(Cercis canadensis)*, and flowering dogwood *(Cornus florida)*. These species were selected because they are appropriate to the habitat and are native to southwest Ohio. Half of the seedlings planted were protected with tree tubes to investigate the effects of deer browsing. These plots will be monitored over the next four years (final monitoring to occur in 2002) to evaluate tree seedling growth and survival against each technique, along with the rates of native and invasive plant volunteering within the plots. The final product of this research will be management recommendations for the control of invasive plant species at the FEMP.

The Area 8, Phase I Re-vegetation Research Plots Project continued during 1999 as part of the Operable Unit 4 dispute resolution agreement. This project involved planting 300 saplings and 2,400 seedlings within six 82 by 160 feet (25 by 50 meter) plots in Area 8, Phase I. The research area can be seen from the overlooks at the Fernald Ecological Restoration Park. Two plots were planted with saplings only, two with a combination of saplings and seedlings, and two with seedlings only. Two additional plots were established as a control. Tree species that were planted included chinquapin oak *(Quercus muhlenbergii)*, hackberry *(Celtis occidentalis)*, black walnut *(Juglans nigra)*, green ash *(Fraxinus pennsylvanica)*, and Ohio buckeye *(Aesculus glabra)*. These species were selected based on availability and their appropriateness to the habitat. Because the chinquapin oak seedlings did not arrive in time, they will be planted in spring of 2000. Researchers from Miami University will measure survivability and growth over the next four years to determine the optimal combination of tree sizes and densities for use in future restoration efforts at the FEMP. Tree tubes and repellants will also be used to investigate the effects of deer browsing.

A Prairie Planting Project in an undisturbed area of the FEMP was also required under the Operable Unit 4 dispute resolution agreement. Like the re-vegetation plots described above, this project was established in Area 8, Phase I, and can be seen from the Fernald Ecological Restoration Park. During the spring of 1999, approximately 2.5 acres (1.0 hectare) of formerly grazed pasture were cleared of existing vegetation (with herbicide) and seeded with native grasses and wildflowers. Half of the prairie was also seeded with oats to determine the effectiveness of a cover crop during prairie establishment. Continued management of the prairie involves periodic mowing to control weeds. In addition, the prairie planting research plots established in 1998 are identified on Figure 7-1.

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Glossary

10-year, Uranium-based Restoration Footprint

The 10-year, uranium-based restoration footprint shows the anticipated areal extent of the effects of aquifer restoration activities on the Great Miami Aquifer over the 10-year duration of the remediation as presented in aquifer restoration remedial design documents. The boundary of impact was developed using groundwater modeling results which shows the composite groundwater capture zone derived from the capture zones for each extraction well.

ALARA

A phrase and acronym (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.

Applicable or Relevant and Appropriate Requirements (ARARs)

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.

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.

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 bypassed around treatment and is directly discharged to the Great Miami River via the FEMP 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 FEMP's storm water retention capacity is in danger of being exceeded.

Capture Zone

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

Certification

The process by which a soil remediation area is certified as clean. Samples from the area are collected, analyzed, and the contaminant levels compared to the final remedial levels (FRLs) established in the Operable Unit 5 Record of Decision. Not all soil remediation areas on 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 that 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. The FEMP ecological receptors were: the white-footed deer mouse, the western meadow vole, pine trees, and shiners.

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 health-effects risk of 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 a receptor organism.

Flyash

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

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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	How much light 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 potentially 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.

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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.

Remedial Response
A long-term action potentially involving site characterization, risk assessment, a technology treatability study, a feasibility study, a remedial design, and remedial implementation.

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

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

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

Source
A controlled source of radioactive material used to calibrate radiation detection equipment. Can also be used to refer to any source of contamination (e.g., a point source such as the stack on the waste pits stack, a source of radon such as the 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 FEMP'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 FEMP waste (such as the Nevada Test Site) have specific waste acceptance criteria. In addition, the FEMP on-site disposal facility has waste acceptance criteria that have been approved by the regulatory agencies. The FEMP Waste Acceptance Organization is responsible for ensuring that all waste to be placed in the on-site disposal facility meet all these criteria before waste placement.

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