3591

FIRST FIVE-YEAR REVIEW REPORT FOR THE FEMP

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

INFORMATION ONLY

MARCH 2001

U.S. DEPARTMENT OF ENERGY

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LIST OF ACRONYMS
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A1PII	Area 1 Phase II
ARAR	applicable or relevant and appropriate requirement
AWR	Accelerated Waste Retrieval
AWWT	advanced wastewater treatment facility
BRSR	Baseline Remedial Strategy Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	constituents of concern
CRARE	comprehensive response action risk evaluation
D&D	decontamination and dismantling
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
FEMP	Fernald Environmental Management Project
FRL	final remediation level
FS	feasibility study
GMA	Great Miami Aqufier
HEAST	Health Effects Summary Tables
HI	hazard index
HWMU	hazardous waste management unit
IAWWT	Interim Advanced Wastewater Treatment
IC	Institutional Control
ILCR	incremental lifetime cancer risk
IEMP	Integrated Environmental Monitoring Plan
IRDP	Integrated Remedial Design Package
IRIS	Integrated Risk Information System
IROD	Interim Remedial of Decision
ISER	Integrated Site Environmental Report
LCS	leachate collection system
LDS	leachate detection system
LTS	Long-Term Steward
MCLs	maximum contaminant levels
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NTS	Nevada Test Site
OEPA	Ohio Environmental Protection Agency
OMMP	Operations and Maintenance Master Plan
OSDF	on-site disposal facility
OU	operable unit

LIST OF ACRONYMS
(Continued)

PCB	polychlorinated biphenyl
PCDF	permitted commercial disposal facility
PSR	Prioritization and Sequencing Report
RCRA	Resource Conservation and Recovery Act
RD/RA	remedial action/remedial action
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SERA	Sitewide Ecological Risk Assessment
SWRB	storm water retention basin
SWU	southern waste units
TBC	to be considered-based
TCLP	Toxicity Characteristic Leaching Procedure
WAC	Waste Acceptance Criteria
WAO	Waste Acceptance Organization
WPRAP	Waste Pits Remedial Action Project
m^3	cubic meters
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
pCi/L	picoCuries per liter
yd^3	cubic yards

1.0 INTRODUCTION

Section 121(c) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requires that selected National Priority List sites conduct a five-year review of remedial actions. The five-year review is statutorily required at National Priority List sites such as the Fernald Environmental Management Project (FEMP), that implement remedial actions resulting in hazardous substances, pollutants, or contaminants remaining at the site above levels allowed for unlimited use and unrestricted exposure. Other sites meeting certain conditions may require a five-year review as a matter of policy, rather than statutorily, as defined in CERCLA. For sites where the U.S. Department of Energy (DOE) is the lead agency, and where a statutory review is required, DOE is responsible for conducting the review. The findings are documented in a report to the U.S. Environmental Protection Agency (EPA), as cited in CERCLA (Section 120 and 121 as well as Executive Order 12580).

1.1 PURPOSE AND OBJECTIVES

This report documents the findings of the FEMP's first five-year review of its remedial actions for each of the five operable units (OU) that are in various stages of implementation. The FEMP utilized the DOE draft guidance for CERCLA five-year reviews (DOE 2000a), the EPA's draft comprehensive guidance document, and input from EPA's Region V Remedial Project Manager as guides for conducting the five-year review. The DOE's draft guidance was developed to clarify five-year review objectives and is intended to serve as a companion document to the EPA's draft comprehensive guidance. The DOE's guidance is fully consistent with the intent of EPA's guide; however, it is tailored to the unique challenges posed by DOE sites such as the FEMP and reflects the planned activities of the Long-Term Stewardship (LTS) Monitoring Program (DOE 2000e). The DOE has three primary objectives for its five-year reviews:

1. Ensuring the long-term effectiveness of those engineered or institutional measures put in place to protect human health and the environment
2. Optimizing the effectiveness of remedy controls and the implementation of remedy requirements to minimize life cycle costs
3. Minimizing redundant documentation and paperwork.

In regard to the third objective, this report includes an overview of background information from the operable unit Records of Decision (RODs) to facilitate review of the report by stakeholders less familiar with the CERCLA actions taken to date.

1.2 OVERVIEW OF THE CERCLA FIVE-YEAR REVIEW

DOE is responsible for conducting the five-year review at sites under its jurisdiction, while EPA is responsible for concurrence with the review. The FEMP review is being jointly coordinated and performed by DOE and Fluor Fernald, Inc., the prime contractor to DOE responsible for remediation and closure of the site (as defined by the prime contract). The review team consists of Fluor Fernald, Inc. personnel in each major remediation project responsible for implementing the selected remedy for each of the site's five operable units, as well as DOE personnel with oversight responsibility for each operable unit.

EPA guidance suggests that a CERCLA five-year review should include a full assessment of remedial action data and remedial status for each operable unit. However, it is appropriate to minimize duplicative information that has been reported in existing CERCLA or DOE documents related to remedial actions. Through the duration of CERCLA activities at the FEMP, DOE has proactively developed several forums and channels to frequently report environmental and operational data and remedial action status to EPA and the Ohio Environmental Protection Agency (OEPA). Consequently, the regulatory agencies have played an active oversight role in all phases of FEMP remedial actions. At present, EPA and OEPA's involvement at the FEMP includes weekly teleconference calls, full regulatory review of all remediation documents, a comprehensive split/confirmatory sampling program, and day-to-day interaction with DOE-FEMP personnel. This situation is unique compared to other National Priority List sites undergoing CERCLA actions conducted and funded by private parties. Therefore, extensive discussion of issues of which of the regulatory agencies and all stakeholders have already been informed of through existing channels is not necessary.

This five-year review was conducted through review of remedial objectives and the selected remedy documented in each operable unit ROD. This information was compared to subsequent remediation documents and performance and confirmatory data collected throughout the remediation process. As a result of the ongoing EPA involvement, there are no special site inspection or interviews necessary to support the five-year review as specified in the EPA guidance.

For sites with multiple operable units, the five-year review clock is triggered by the onset of construction for the first operable unit remedial action that will result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. Of all the FEMP operable units, the site preparation construction to support the Waste Pit Remedial Action Project under the OU1 ROD (DOE 1995b) was the first such action. This construction began on April 1, 1996; consequently, the current five-year review report due date is April 1, 2001. As required by

the EPA draft guidance, all operable units must be reviewed at a site when the first statutory five-year review is triggered for one operable unit. 3591

Because the FEMP was divided into five operable units at the onset of the remedial investigation/feasibility study phase, a question arises concerning whether the five-year review should be conducted for each operable unit individually, or if the scope of all operable units should be combined into one review. Under the EPA guidance document, this decision is left to the discretion of each individual site. The FEMP has opted to combine the required five-year review for all five operable units into one document, since there is an increasing level of integration among projects that were formerly separated into operable units (as discussed in Section 1.3). This action will place the entire site on the same five-year review schedule for the duration of remedial actions and the post-closure stewardship-monitoring period.

1.3 OVERVIEW OF SITE HISTORY AND OPERABLE UNITS

In 1951, the Atomic Energy Commission (predecessor of DOE) began building the Feed Materials Production Center on a 1,050-acre (425-hectare) tract of land outside the small agricultural 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 that produced nuclear weapons for the nation's defense. The uranium metal production, which took place from 1952 through 1989, resulted in releases to the environment and, consequently, contamination of soil, surface water, sediment, and groundwater on and around the site.

In 1986 DOE initiated 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. In 1991 the site mission officially changed from uranium production to environmental remediation and site restoration under CERCLA. The site was renamed the 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. EPA Region V and the Southwest District Office of OEPA provide regulatory oversight.

To facilitate the CERCLA 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, as follows:

- Operable Unit 1: waste pits 1 through 6, the clearwell, and the burn pit
- Operable Unit 2: the active and inactive flyash piles and other South Field disposal areas, the lime sludge ponds, and the solid waste landfill
- Operable Unit 3: the former production area and associated facilities, equipment and wastes
- Operable Unit 4: Silos 1, 2, 3, and 4, their berms, and the decant tank system
- Operable Unit 5: all environmental media, including groundwater, perched water, surface water, soils, sediment, flora and fauna, both on and off site.

The remedy selection process culminated in 1996 with approval of the final ROD for OU3, although the ROD for OU4 was amended in 2000 based on a re-evaluation of the treatment methods for the materials in Silos 1 and 2. FEMP activities are now being directed toward safely and efficiently implementing remediation, including facility decontamination and dismantling operations, treatment and off-site disposal of wastes, contaminated wastes and soil excavation, construction of the on-site disposal facility, and environmental restoration. Table 1-1 provides an abbreviated chronology of the major FEMP milestones.

Following approval of each ROD, 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 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 ROD. Table 1-2 describes each operable unit and its associated remedy and provides a crosswalk between each operable unit and the current project organizations responsible for implementing each selected remedy.

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TABLE 1-1

ABBREVIATED SITE CHRONOLOGY

Year	Major Fernald Events and Milestones
1951	Construction of the Feed Materials Production Center began.
1952	Uranium production started.
1986	EPA and DOE signed the Federal Facilities Compliance Agreement, thus initiating the remedial investigation/feasibility study process.
1989	Uranium production was suspended and the Fernald site was placed on the National Priorities List for clean up under CERCLA.
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. The site was renamed the FEMP.
1994	Decontamination and dismantling of the first building was completed under the OU3 Interim ROD.
1996	The last operable unit's ROD was signed, signifying the end of the 10-year remedial investigation/feasibility study process (the OU4 ROD was later re-opened and amended). Construction began in support of the OU1 selected remedy. Soil remedial excavations began as part of the OU5 selected remedy.
1997	Construction of the on-site disposal facility Cell 1 took place, and the first waste placement began in December.
1998	OU2 remedial excavations began.
1999	Excavation of the waste pits under the OU1 ROD was initiated, and the first rail shipment of waste was transported to Envirocare of Utah, Inc. Safe Shutdown was completed ahead of schedule.
2000	The Amended ROD for OU4 is signed, thus establishing a new selected remedy for OU4.

TABLE 1-2

CROSSWALK BETWEEN FEMP OPERABLE UNITS AND PROJECT RESPONSIBILITIES FOR REMEDY IMPLEMENTATION

Operable Unit	Description	Remedy Overview[a]	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	Waste Pits Remedial Action Project is responsible for rail upgrades, 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.) Soil and Disposal Facility Project 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. Aquifer Restoration Project is responsible for final treatment of contaminated runoff, perched water collected during waste pit excavation, and processing wastewater discharges. Each project is responsible for transporting remediation wastewater to the headworks of the advanced wastewater treatment facility for treatment. Decontamination and Demolition Project 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	Soil and Disposal Facility Project is responsible for excavating and disposing of waste from all Operable Unit 2 subunits and certifying the footprints. This project is also responsible for the ongoing design, construction, and closure of the on-site disposal facility that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil and debris, and Operable Unit 3 debris. Waste Acceptance Organization is responsible for field oversight of soil excavations, for reviewing and signing manifests for impacted material delivered to the on-site disposal facility for placement, and for rejecting any unacceptable shipments. Aquifer Restoration Project 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, concrete from specific locations, and any other material exceeding the on-site disposal facility waste acceptance criteria; and on-site disposal for material that meets the on-site disposal facility waste acceptance criteria	Decontamination and Demolition Project is responsible for decontamination and dismantling of all above-grade portions of buildings and facilities at the FEMP. Soil and Disposal Facility Project is responsible for excavation and certification of soil beneath facilities and for removal of at- and below-grade structures. This project is also responsible for design, construction, and closure of the on-site disposal facility that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil, and Operable Unit 3 debris. Waste Acceptance Organization is responsible for reviewing facility decontamination and dismantling planning documents. This organization is also responsible for field oversight of debris sizing, segregation of on-site disposal facility material categories and prohibited items; completing field tracking logs, completing manifests for material bound for the on-site disposal facility, and compiling final records of decontamination and dismantling debris placed in the on-site disposal facility. Aquifer Restoration Project is responsible for treating decontamination and other wastewaters during decontamination and dismantling activities and processing wastewater discharges; each decontamination and dismantling project is responsible for transporting remediation wastewater to the head works of the advanced wastewater treatment facility for treatment.

TABLE 1-2
(Continued)

Operable Unit	Description	Remedy Overview[a]	Project Organization/Responsibilities
4	– Silos 1 and 2 (containing K-65 residues) – Silo 3 (containing cold metal oxides) – Silo 4 (empty and never used) – Decant tank system – Berms and soil within the operable unit boundary	Record of Decision Approved: December 1994 Record of Decision Amendment for Silos 1 and 2 Approved: July 2000 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, 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 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. Silo2 1 and 2 Project is also responsible for decontamination and dismantling of the Silo 1, 2, 3, and 4 structures, the Decant Sump Tank and its associated piping, the transfer tank Area, Radon Control Syatem, and all other ground Operable Unit 4 remediation facilities and piping. Soil and Disposal Facility Project is responsible for certification, excavation, and disposition of contaminated soil beneath the silos and for removal of subsurface structures with the exception of the Decant Sump Tank (i.e K-65 trench and piping). 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 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.
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 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 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 Organization 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. Decontamination and Demolition Project 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.

1.4 STATUS OF OPERABLE UNIT REMEDIAL ACTIONS

The selected remedies for each operable unit at the FEMP are at different points in the implementation phase due to the unique nature of the remedy and remedial objectives. Table 1-3 provides a summary level overview of the status of each of the remedial projects underway for each of the five operable units.

TABLE 1-3

STATUS OF THE FIVE OPERABLE UNITS AT THE FEMP

Operable Unit	Status
1	The ROD was signed in March of 1995. Construction of facilities necessary to support the selected remedy began in April of 1996 and is now complete. The implementation of the selected remedy is ongoing. As of January 1, 2001, approximately 30 percent of the waste pit material has been excavated and shipped off site for disposal.
2	The ROD was signed in June of 1995. As of January 1, 2001, remediation of the southern waste units is nearing completion; remediation of the solid waste landfill and the lime sludge ponds has not yet begun. Construction of the liner systems for the on-site disposal facility Cells 1, 2, and 3 is complete, and waste placement into Cell 1 is complete.
3	The ROD was signed in September of 1996. The implementation of the selected remedy is ongoing, and as of January 1, 2001, 90 of the site's 200 plus structures have been demolished.
4	The ROD, as amended for Silos 1 and 2, was signed in June of 2000. Construction of facilities for retrieval of Silo 1, 2, and 3 material has begun in support of the selected remedy.
5	The ROD was signed in January of 1996, and implementation of the selected remedy for groundwater, soil and sediment is ongoing. As of January 1, 2001, approximately 42 percent of the site has been certified as meeting the final remediation levels for soil. Four of six groundwater remediation modules, consisting of extraction and re-injection wells, are currently in operation with the first module becoming operational in 1993. A total of 19 extraction wells (17 of which are active) and five re-injection wells have been installed within the four groundwater remediation modules.

1.5 THE FIVE-YEAR REVIEW SCHEDULE

This is the first CERCLA five-year review conducted for the FEMP. It will cover all remedial activities that have taken place to-date for each operable unit, regardless of the implementation phase of the selected remedy. As discussed in Section 1.2, the start of construction for the OU1 remedy triggered this five-year review report. The next five-year review will be submitted to EPA by April 1, 2006, and will cover all remedial activities not covered under the current review up through the time that the review in 2006 is submitted.

1.6 ROLE OF THE IEMP AND LONG-TERM STEWARDSHIP MONITORING PLAN

A major element of the ongoing performance evaluation of the selected remedies is conducted through the Integrated Environmental Monitoring Plan (IEMP) particularly for OU5 (DOE 2001b). The IEMP assesses site environmental conditions through sampling of various media, including groundwater, surface

water, sediment, air, and biota. These data are reviewed to assess the collective overall site environmental conditions as well as the impacts that individual remedial projects are having on their surrounding environment. This program provides ongoing monitoring of remedial actions and their impact on potential exposure pathways, and provides an early indication of adverse impacts such as upward contamination trends. The IEMP also establishes a decision process to assess adverse impacts and to take appropriate corrective measures up to and including interim shutdown.

The IEMP also serves as the mechanism for assessing the remedial action performance of:

- The groundwater remedy for the Great Miami Aquifer (OU5)
- Wastewater treatment operations (OU5)
- The on-site disposal facility leak detection program (primarily serves OUs 2, 3 and 5).

The monitoring results are presented in IEMP quarterly status reports and in annual integrated site environmental reports, which are made available to the public. IEMP monitoring data are also made available to the regulatory agencies as they become available through an internet-based source, the IEMP Data Information Site.

The IEMP program and related reporting process will eventually be transitioned to the LTS Monitoring Program following closure of the FEMP. This program will provide a mechanism for monitoring and evaluation of any aspect of the FEMP selected remedy deemed necessary post-closure. Subsequent five-year reviews will be one of the reporting mechanisms for data collecting under the LTS Monitoring Program. DOE has created an office with the explicit purpose of developing a program to monitor and maintain the effectiveness of its remedies over time.

1.7 INSTITUTIONAL CONTROLS

The DOE defines Institutional Controls (ICs) as: "any mechanism used to restrict inappropriate uses of land, facilities, and environmental media by limiting exposure to residual contamination left behind as part of a CERCLA or Resource Conservation and Recovery Act Remedy" (DOE 2000a). Because ICs are relevant to the entire site (i.e., they are not specific to the operable units), they will be covered here in the introduction. DOE has committed to implementing ICs to protect the general public from residual contamination exposure in each ROD. DOE has also committed to addressing ICs as part of its LTS planning for the FEMP.

DOE is currently developing a Comprehensive LTS Plan for the FEMP that will include the range of ICs to be implemented at the FEMP as well as the approach to implementation. The Comprehensive LTS Plan will make reference to a detailed Institutional Control Plan that will be developed and issued closer to closure of the FEMP. DOE is planning to implement layered ICs, meaning different kinds of ICs implemented concurrently to minimize impacts if one IC would happen to fail. For example, DOE will ensure deed restrictions regarding development of the property are in place at the same time that zoning restrictions are in place.

Institutional controls will be implemented at the FEMP in conjunction with access controls such as perimeter fencing and fencing around controlled/contamination areas. Physical barriers are not considered ICs because they do not involve an administrative or legal barrier, but should be utilized in conjunction with IC's to further ensure protectiveness. The types of ICs that will be generally implemented include: continued Federal ownership of the FEMP, restricted access to the on-site disposal facility, land use/deed restrictions to prevent the residential or agricultural use of the FEMP property, and regular monitoring and inspection of the on-site disposal facility. The effectiveness of ICs will be evaluated as part of each five-year review conducted at the FEMP.

1.8 REPORT ORGANIZATION

The following five sections of this CERCLA five-year review each cover the status of one of the five operable units at the FEMP. To avoid repeating information already provided in other CERCLA and DOE reports, this report includes summary level information regarding operable unit descriptions and remedial action objectives. Section 2.0 covers the Waste Pit Remedial Action Project, responsible for the OU1 remedy. Section 3.0 covers the OU2 waste units, along with the on-site disposal facility because it was first included with the OU2 selected remedy. Section 4.0 covers the OU3 activities, including decontamination and dismantling of all at- and above-grade structures at the FEMP, and associated Facilities Closure and Safe Shutdown operations. Section 5.0 provides an update on the OU4 silo remediation. Finally, Section 6.0 covers OU5 environmental media, with key subsections further subdivided to cover groundwater remedial activities separately from soil/sediment remedial activities.

Sections 2.0 through 6.0 all maintain approximately the same format, involving a project description, summary of ROD commitments and the selected remedy, remedial action status, and an assessment of the selected remedy including remedy optimization opportunities.

2.0 OPERABLE UNIT 1

2.1 PROJECT DESCRIPTION

2.1.1 Operable Unit 1 Characteristics

Operable Unit 1 (OU1), also referred to as the Waste Pits Remedial Action Project (WPRAP), is a 37.7-acre (15.3-hectare) area in the northwest quadrant of the Fernald Environmental Management Project (FEMP) site. Large quantities of liquid and solid wastes were generated by various chemical and metallurgical processing operations during the production era (1952 through 1989). These wastes were stored or disposed of in six waste pits (referred to as Waste Pits 1, 2, 3, 4, 5, and 6), the burn pit, and the clearwell. The WPRAP mission is cleanup of those components as well as miscellaneous structures and facilities such as berms, liners, concrete pads, underground piping, utilities, railroad tracks, and fencing, as well as soil located within the WPRAP boundary. Radionuclides (e.g., uranium and thorium) are the primary contaminants of concern, although the pit waste is also contaminated with trace metals and organics.

An estimated 600,000 cubic yards (yd^3) (458,760 cubic meters [m^3]) of waste material (i.e., pit wastes, cover materials, and pit liner) will be excavated and dispositioned. In addition, some portion of the soils beneath the waste pits are assumed to be contaminated, although the extent of this contamination is unknown because soil sampling would have involved boring through the liner, creating a potential conduit for contaminant migration. For estimating purposes, however, the Feasibility Study Report for Operable Unit 1 (DOE 1994a) assumed that approximately three feet of soil from below the pits would need to be excavated and dispositioned (or approximately 84,000 yd^3 [64,226 m^3] of soils).

WPRAP is tasked with remediation of all components within the WPRAP boundary in a timely, efficient and cost-effective manner. WPRAP activities must ensure compliance with all applicable or relevant and appropriate requirements (ARARs) and protect human health and the environment in accordance with the Record of Decision (ROD) for Remedial Actions at Operable Unit 1 (DOE 1995b) and the Remedial Design/Remedial Action (RD/RA) Work Plans (DOE 1997c) and Packages. In addition, in an effort to integrate FEMP remediation efforts, WPRAP also manages waste materials from other FEMP remedial projects that are similarly destined for off-site disposal.

2.1.2 Roles and Responsibilities

Fluor Fernald, Inc. is responsible for implementing OU1 remedial activities under contract to the U.S. Department of Energy (DOE). Performance of the remedial action work activities is apportioned between Fluor Fernald personnel and International Technology (IT) Corporation. IT Corporation is responsible for:

- Excavation of materials from the waste pits (including soils from beneath the pits)
- Waste preparation, including any necessary sorting, crushing, shredding, or pre-dryer blending for homogeneity or optimum moisture levels
- Treatment by thermal drying, if required; post-dryer blending to achieve a uniform product
- Loadout of material (certified to meet the Envirocare of Utah, Inc. waste acceptance criteria [WAC]) into railcars
- Decontamination and dismantling of all facilities used to complete IT's work scope.

Fluor Fernald is responsible for subcontract management and project oversight, including the various regulatory requirements defined therein. Fluor Fernald Radiological Control personnel are responsible for administering radiological safety for all on-site WPRAP activities.

2.2 SUMMARY OF REMEDIAL ACTION OBJECTIVES

Following are the elements of the selected remedy from the OU1 ROD. These steps describe the approach to remediation of the aforementioned elements of WPRAP. The key elements of the approved OU1 ROD include:

- Construction of waste processing and loading facilities and equipment
- Removal of water from open waste pits for treatment at the site's wastewater treatment facility
- Removal of waste pit contents, caps and liners, and excavation of surrounding contaminated soil
- Preparation (e.g., sorting, crushing, shredding) of waste
- Treatment of the waste by thermal drying as required to meet Envirocare WAC
- Waste sampling and analysis prior to shipment to ensure that the WAC are met
- Off-site shipment of waste for disposal at Envirocare
- Decommissioning and removal of the drying treatment unit and associated facilities, as well as miscellaneous structures and facilities within the operable unit

- Disposition of remaining WPRAP residual contaminated soils in the on-site disposal facility, consistent with the selected remedy for contaminated process area soils as documented in the OU5 ROD

- Backfilling excavations and constructing of a cover system.

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2.2.1 Project Execution Phases

Implementation of the above-defined remedy can best be assessed through a correlation with the following identifiable project execution phases:

Site Preparation Activities

Site improvement activities needed to support remediation facilities and activities were initiated on April 1, 1996. Initiation of these activities demonstrated the beginning of substantial, continuous, on-site remedial action (in accordance with the Comprehensive Environmental Response, Compensation and Liability Act [CERCLA]) within 15 months of signing the OU1 ROD (i.e., by June 1, 1996), as required under CERCLA. Initiation of these OU1 activities also triggered this five-year review report, as discussed in Section 1.2. The site improvements included activities to directly support installing and operating the remediation facility, such as the installation of the rail scale, site clearing and grading, and construction of a storm water management system. These improvements also included construction of an on-site rail system (e.g., track installation, on-site trestle upgrades, etc.) to support the off-site shipment of wastes to Envirocare, and upgrades to three off-site trestles needed to safely support the proposed additional train traffic. These activities were essentially completed in December 1997.

Facility Construction

IT Corporation began limited construction activities in July 1998, while the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA) completed their review of the RD Package. These were essentially site preparation activities that would not be impacted by RD Package comments/issues raised by EPA and OEPA. On November 13, 1998, full construction activities began following approval of the RD Package. These activities were essentially completed in November 1999.

First Loadout

On February 23, 1999, WPRAP initiated loadout activities, thereby achieving the March 1, 1999 Enforceable Milestone for initiating operations (i.e., loading of waste). This first loadout activity represented the first phase of a sequenced approach to bringing the WPRAP remediation facility into full production, allowing material to be processed while the remaining facility construction was being completed. Under the first loadout, soils and soil-like materials from Soil Piles 6 and 7 were transferred via conveyor to the material handling building for blending and eventual loadout into railcars within the

railcar loadout building. The approach for the performance of first loadout was detailed in the First Loadout Work Plan for WPRAP, which was reviewed and approved by EPA and OEPA.

WPRAP Rail Operations

WPRAP rail operations include the coordination of empty and full railcar movements; maintenance of railcars, locomotives, and trackage; coordination with CSX Transportation/Union Pacific Railroad relative to receipt/return of trains, as well as tracking during transport; coordination with Envirocare for final disposal; and planning for and support of emergency response planning activities. The first train to leave the FEMP transporting contaminated materials from WPRAP to Envirocare left on April 29, 1999.

Excavation of Waste Pit Material

Initiated in September 1999, this phase involves excavating Waste Pits 1, 2, 3, 5, 6, and the clearwell. Excavated material is transported to the material handling building for processing, as necessary, to meet Envirocare WAC (i.e., for moisture content and contaminant levels). The material is then transferred into the railcar loadout building storage bins, sampled to ensure WAC compliance, and loaded into railcars for shipment to Envirocare.

Dryer Startup and Operations

Of the approximately 600,000 tons of WPRAP waste materials, a substantial portion will probably require moisture reduction beyond that which can be achieved by mechanical blending. In December 1999, WPRAP initiated dryer operations, to process pit waste through one of two gas-fired, indirect dryers. This reduces waste material moisture levels to meet Envirocare WAC.

Excavation of the Burn Pit and Waste Pit 4

The pit excavation activities discussed above did not include either Pit 4 or the burn pit. Pit 4 was segregated for individual work activity planning because of its unique inventory characteristics (e.g., thorium fines). Pit 4 excavation activities could begin as early as Fall 2001. The burn pit was segregated due to evidence that NEC solvents were disposed of in environmental media within, or adjacent to, the burn pit. Prior to initiating excavation activities in the burn pit, a sampling and remediation plan to address this NEC solvent disposal will be prepared and implemented, including the potential removal of any impacted material.

Directed Excavation of Waste Pit Soils

After all waste materials are removed, IT Corporation will begin directed excavation of the soils below the pits. Specific methods for executing this work activity, and controls over the interface between IT Corporation and the Soil & Disposal Facility Project (who will provide the assistance and direction) will be developed as out-year activities. IT Corporation will receive direction on whether the soils are to be transferred to the material handling building, for shipment to Envirocare, or to the on-site disposal facility.

Decontamination & Dismantling of the IT Corporation Facilities

After all required excavation and remediation activities are complete, IT Corporation will decontaminate and dismantle (D&D) all above-grade facilities that it has constructed to support the WPRAP remediation effort. A D&D implementation plan will be developed and submitted to EPA and OEPA for review and approval. This plan is currently scheduled to be submitted to EPA and OEPA in Spring 2004, with D&D planned to begin in Fall 2004.

2.2.2 Required Monitoring

Monitoring to support the aforementioned phases can be segregated into the following broad categories:

Waste Monitoring: The WPRAP Sampling and Analysis Plan (SAP) for Waste Pit Materials defines the characterization needed to ensure the waste material meets Envirocare WAC and U.S. Department of Transportation requirements for shipping the waste as Low Specific Activity-I material prior to railcar loadout.

The SAP for Environmental Media was developed to provide the criteria associated with sampling and analysis of environmental media, including storm water, excavation water, wastewater, and air. The objectives of the SAP for Environmental Media are to:

- Specify the basis for determining the sampling and analysis requirements for the identified environmental media
- Ensure compliance with the requirements of the OU1 ROD, including ARARs
- Ensure that WPRAP activities do not degrade the environment through unauthorized releases
- Provide timely data to operations so as to facilitate the reliability and cost effectiveness of the above objectives.

The SAP for Environmental Media thus provides the basis for which the sampling and analysis results may be compared to ensure the above objectives have been met. For example, the sampling and analysis objectives for water discharge criteria are established in the SAP. They are intended to ensure the limits have not been exceeded, to determine the adequacy of the IT wastewater treatment system, and to determine whether certain other constituents are present in the discharges from the wastewater treatment system to the bio-surge lagoon.

Industrial Hygiene: Industrial hygiene monitoring is directed by the WPRAP Air Monitoring Program and includes the following monitoring activities: dust monitoring (total particulate); general air sampling (chemical); and breathing zone monitoring (chemical). Data from these monitoring efforts are used to make decisions pertaining to worker safety requirements, including respiratory posting requirements and the need for additional sampling.

Water Monitoring: The WPRAP SAP for Environmental Media defines the characterization efforts needed to ensure that waters generated through the WPRAP remediation activities (i.e., non-contact storm water, wastewater, excavation water, and contact storm water) meet established discharge criteria. Specifically, this characterization is used to support decisions to discharge non-contact storm water (from the storm water management pond) to Paddys Run, and to discharge wastewater, excavation water, and contact storm water into the bio-surge lagoon after treatment through the IT wastewater treatment system.

Dryer Stack Air: Dryer stack air monitoring is directed by the WPRAP SAP for Environmental Media. Analyses for radon and radiological isotopes are used for compliance, environmental, and process control purposes. The data are used by the FEMP Environmental Monitoring group to demonstrate compliance with the National Emissions Standards for Hazardous Air Pollutants and is also reported in the Integrated Environmental Monitoring Plan (IEMP) reports.

Section 2.4 discusses the data gathered from these monitoring activities.

2.3 REMEDIAL ACTION STATUS

The selected remedy for OU1 is in the implementation phase. As discussed in Section 2.2.1, waste-processing activities began on February 23, 1999, and the first shipment of materials for off-site disposal left the FEMP on April 29, 1999. In September 1999 pit excavation activities began, with dryer operations beginning in December 1999. Table 2-1 provides the status of the WPRAP remedial action for excavation and loadout activities, with the percent complete based on a comparison to quantities reflected in the IT contract.

TABLE 2-1

WPRAP STATUS SUMMARY AS OF FEBRUARY 2001

Source	Railcar Loaded (ton)	Water Removed by Thermal Dryer Unit (ton)	Approximate Percent Complete as of February 2001
Other FEMP Projects	50,094	0	55%
Pit 1	42,468	0	50%
Pit 2	513	150	5%
Pit 3	112,169	10,600	50%
Pit 4	0	0	0
Pit 5	0	0	0
Pit 6	0	0	0
Clearwell	0	0	0
Burn Pit	0	0	0
TOTAL	205,244	10,750	30%

This status includes materials processed during the first loadout, as well as materials from Pits 1, 2, and 3. Material excavated from Pit 5 was so minimal it was not included in these calculations. No non-typical waste has been processed to date.

2.4 ASSESSMENT OF CONFIRMATORY DATA AND/OR PERFORMANCE DATA

2.4.1 Identify the Scope of the Review

This assessment of the WPRAP remedial actions is focused primarily on the removal of the waste material from the pits and its shipment off site in accordance with established remediation schedules, while managing this material for WAC compliance upon receipt at Envirocare. The assessment focuses on meeting other discharge requirements for secondary wastes generated through this remediation effort, such as wastewater and stack emissions.

The data used in performing this assessment are gathered through the SAP for Environmental Media and the SAP for Waste Pit Materials. The objectives for the SAP for Waste Pit Materials are to satisfy requirements of the OU1 ROD for additional Resource Conservation and Recovery Act testing of WPRAP materials and Envirocare's requirements for waste generators to adequately complete the Radioactive Waste Profile Record and characterize their waste materials prior to shipment to the Envirocare facility. The SAP for Waste Pit Materials, in conjunction with the Envirocare profile, ensures that the analytical requirements have been met.

2.4.2 Assessment of Remedial Actions

Is the remedy operational and functioning as intended in the ROD?

Table 2-2 provides a summary of the bin sample analytical data for the 2000 calendar year, including the minimum and maximum results. Bin sampling of waste takes place after the waste has been mixed or processed through the dryer. Sampling is performed as the material is being loaded into the bins of the railcar loadout building.

TABLE 2-2

BIN WASTE ANALYTICAL DATA VERSUS OU1 WASTE PROFILE

	Summary of Bin Sample Concentrations		OU1 Waste Profile
	Maximum	Minimum[b]	Concentration Range
pH	12.59 SU	7.32 SU	3.80 – 14.0 SU
Percent Moisture	35.8%	14.3%	10.0 – 40.0 %
Arsenic	0.92 mg/L	0.014 mg/L	0.0 – 1.350 mg/L
Barium	3.460 mg/L	0.0895 mg/L	0.0 – 12.800 mg/L
Beryllium	2.3 mg/kg	0.348 mg/kg	0.0 – 5.00 mg/kg
Cadmium	0.145 mg/L	0.0015 mg/L	0.0 – 0.204 mg/L
Chromium	0.314 mg/L	0.0035 mg/L	0.0 – 4.520 mg/L
Copper	0.23 mg/L	0.0021 mg/L	N/A
Lead	1.3 mg/L	0.0105 mg/L	0.0 – 1.480 mg/L
Mercury	0.019 mg/L	0.000067 mg/L	0.0 – 0.007 mg/L
Selenium	0.25 mg/L	0.0151 mg/L	0.0 – 0.218 mg/L
Silver	0.3 mg/L	0.0025 mg/L	0.0 – 2.340 mg/L
Zinc	7.53 mg/L	0.0024 mg/L	0.0 – 2.26 mg/L
Cesium-137	1.12 pCi/g	0.1 pCi/g	0.7 – 450 pCi/g
Lead-210	264 pCi/g	2.5 pCi/g	0.0 – 2,950 pCi/g
Neptunium-237	3.73 pCi/g	0.1 pCi/g	0.0 – 85.0 pCi/g
Potassium-40	14.8 pCi/g	2.7 pCi/g	0.0 – 34.0 pCi/g
Radium-226	1862 pCi/g	2.1 pCi/g	1.4 – 2,950 pCi/g
Radium-228	177 pCi/g	1.6 pCi/g	1.3 – 558 pCi/g
Thorium-228	177 pCi/g	1.6 pCi/g	N/A
Thorium-230	5233 pCi/g	42.5 pCi/g	2.0 – 18,400 pCi/g
Thorium-232	177 pCi/g	1.6 pCi/g	N/A
Uranium-234	18100 pCi/g	59.1 pCi/g	1.2 – 33,413 pCi/g
Uranium-235	172 pCi/g	2.5 pCi/g	0.2 – 900 pCi/g
Uranium-238	18100 pCi/g	59.1 pCi/g	1.2 – 35,212 pCi/g
Paint Filter Liquids Test	Pass	NA	NA

[a]All analysis of metals (except beryllium) were performed using the Toxicity Characteristic Leaching Procedure.
[b]NA = not applicable
[c]SU = Standard units; mg/L = milligram/liter; pCi/g = picocuries/gram

For comparison purposes, Table 2-2 also presents the concentration range, as approved by Envirocare, for the OU1 waste profile. This profile reflects the expected range of characteristics for the OU1 wastes, and is a subset of the Envirocare WAC. The values represented in Table 2-2 demonstrate that, to date, WPRAP has been able to process all pit wastes such that the material loaded into railcars meets the Envirocare WAC. Envirocare sampling of this material, upon receipt, has also shown that all WPRAP materials transported to Envirocare, and unloaded to date, meet the Envirocare WAC. Although screening of the waste pit materials has indicated higher than expected levels of thorium-230, WPRAP has been able to blend this material such that it meets the Envirocare WAC.

The sampling results for stack monitoring are already reported to EPA and OEPA on a routine basis, either through the IEMP quarterly status reports or, in the case of radon and isotopic stack data, electronically as the data become available. To date, the stack emissions as represented by this data, have been well below any established regulatory limits. The water sampling performed in accordance with the SAP for Environmental Media is generally used for process control. It also ensures that the water discharged from the IT wastewater treatment system (to the bio-surge lagoon) will not adversely affect the operations of the advanced wastewater treatment facility and its ability to meet established discharge criteria.

As shown in Table 2-1, WPRAP has excavated and processed over 150,000 tons of material from the waste pits, as well as another 50,000 tons of material from other FEMP projects, for disposal at Envirocare. Using the estimated quantity of 626,500 tons of waste material to be processed through the WPRAP facility, this quantity to date indicates that about one third of the total waste material has been processed to date. At this rate, WPRAP is generally on schedule to meet the planned completion date for excavation activities of September 30, 2004. However, WPRAP has experienced higher than expected moisture content and material density levels, which could result in as much as 200,000 additional tons of processed pit material. This additional tonnage could delay completion of the remediation.

Although there have been numerous design changes to the WPRAP remediation facilities, the existing design, and the process developed for implementation of the selected remedy, is consistent with the intent of the OU1 ROD and RA Work Plan. The facility provides for necessary pretreatment of the waste materials, drying capability (as necessary), and sampling of the material to demonstrate compliance with Envirocare WAC. In addition, the remediation process has the demonstrated capability to collect and treat waters generated from waste pit remediation activities to meet established criteria. The facilities and processes needed to support the shipping of this material off site for disposal also have been demonstrated to meet the intent of the OU1 ROD. Therefore, WPRAP should be able to complete the remediation of the

waste pits consistent with the overall intent of the OU1 ROD, although this effort may take longer than expected if the additional quantities identified above are realized.

2.4.3 Validity of ROD Assumptions

Are the critical assumptions (to ensure protection of human health and the environment) used at the time of remedy selection still valid?

To carry out the remedy prescribed by the OU1 ROD, various critical assumptions were made regarding the success of the project, including:

- The waste material could be excavated using mechanical excavation techniques
- The waste material could be transferred using conventional material handling equipment
- Excavation sequencing would allow for material to be blended to achieve optimum moisture
- The waste material could be dried, as necessary
- Large debris could be segregated from the waste
- Non-typical waste could be segregated
- Appropriate waste, water and air monitoring activities could be conducted effectively.

To date, all available data indicate that the processes/facilities designed and used in accordance with the above assumptions, and were put in place to support the remediation of the waste pits, are functioning in a manner which would allow WPRAP to meet the intent of the OU1 ROD. The discussion presented in Section 2.4.2 essentially supports this conclusion. Although there is a potential that there may be additional tonnage of materials to be processed, it is unrelated to the overall functionality of the facilities and processes.

The EPA guidance for five-year reviews states that only the ARARs and the to-be-considered (TBC) requirements relevant to the final protectiveness of the remedy need to be re-evaluated during the review. Because only the OU2 and OU5 remedies pertain to the on-site disposal facility and restored environmental media to remain at the FEMP after all remedial actions are complete, these two operable unit sections of the report address the re-evaluation of ARARs and TBCs that are relevant to protectiveness.

2.4.4 Remedy Optimization

The OU1 remediation process is simple, in that conventional equipment is used to remove the wastes from the pits, and proven technologies are used to treat the waste, as necessary, to meet the Envirocare WAC. There does not appear to be any means available to optimize these facilities/processes to enhance the performance of the waste pits' remediation.

The other major facet of the selected remedy is that all of the contaminated waste material (i.e., the source) will be removed and dispositioned off site. There is no reason to question either the decision to remove this source material, or to dispose of this source material off site.

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2.5 FINDINGS & RECOMMENDED ACTIONS FROM CURRENT REVIEW

As discussed above, the remediation process and facilities put in place to support the remediation of OU1 are effectively supporting the remediation of the waste pits consistent with the intent of the OU1 ROD. The potential increase in material tonnage, as discussed in section 2.4.2, could impact the established remediation schedule. However, the increased tonnage does not impact the effectiveness of the remediation process or the current operation of the facilities. The recommended actions as a result of the potential increase in tonnage will be addressed when sufficient moisture and density data are available on the remaining pit wastes in order to project any potential schedule impact.

2.6 PROTECTIVENESS STATEMENT

The selected remedy for OU1 is expected to be protective of human health and the environment, and immediate threats have been addressed. The remedy has thus far been accomplished within the confines of the design assumptions discussed above, in accordance with ARARs and in accordance with monitoring requirements imposed on the remedial activities. Remedial actions have been accomplished in a manner consistent with the remedial action objectives and in accordance with sampling and analysis requirements and parameters. All available data indicate compliance with regulatory requirements and with Envirocare WAC.

3.0 OPERABLE UNIT 2

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3.1 PROJECT DESCRIPTION

3.1.1 Operable Unit 2 Characteristics

As defined in the Record of Decision (ROD) for Remedial Actions at Operable Unit 2 (OU2) (DOE 1995d), OU2 consists of the following components:

- The solid waste landfill is approximately 1 acre (0.4047 hectare) in size. It was reportedly used to dispose of waste from non-process areas of the site, as well as cafeteria waste, rubbish, and debris from construction/demolition activities.

- The north and south lime sludge ponds received sludges originating from wastewater treatment plant operations, as well as coal pile storm water runoff and boiler plant blow down. The dimensions of each pond are 125 x 226 feet (38 x 69 meters). Both ponds, which are separated by an earthen berm, have been taken out of service and are now overgrown with grasses and shrubs. The western side of the north pond is often covered with water. The volume of sludge and berm material is estimated at 16,500 cubic yards (yd^3) (12,500 cubic meters [m^3]) of lime sludge and 5,600 yd^3 (4,300 m^3) of berm material.

- The inactive flyash pile was used to dispose of boiler plant ash and other non-process wastes, as well as building rubble such as concrete, gravel, asphalt, masonry and steel rebar. The total quantity of ash disposed of in this pile was estimated at 43,600 yd^3 (33,300 m^3).

- The South Field is approximately 11 acres (4.5 hectares) in size. It was reportedly used as a burial site for Fernald Environmental Management Project (FEMP) non-process wastes such as flyash, construction/demolition debris, and soils that may have contained low levels of radioactivity. The volume of material disposed of in the South Field was estimated at 120,000 yd^3 (91,800 m^3). A slope at the southwest border of the South Field was used as a backstop for the FEMP security firing range for 35 years. Lead ammunition used during target practice was embedded in the slope.

- The active flyash pile was the disposal area for flyash and bottom ash from the boiler plant. Approximately 65,000 yd^3 (49,700 m^3) of ash was placed in the pile. The active flyash pile was taken out of service in 1995 but was still called active for purposes of distinction.

These five components covered a total of approximately 21.5 acres (8.6 hectares) and contained an estimated 109,000 yd^3 (83,000 m^3) of ash, 16,000 yd^3 (12,000 m^3) of sludge, and 193,000 yd^3 (147,000 m^3) of soil and debris in the form of berms, cover, and fill material.

When the site was reorganized into remediation areas, the inactive and active flyash piles and the South Field were grouped in Area 2, Phase I (A2PI) and were re-named the southern waste units (SWUs). Additional details on the remedial design/remedial action in the SWUs are provided in the A2PI Integrated Remedial Design Package (IRDP) (DOE 1998a).

The lime sludge ponds are addressed in a separate IRDP. The solid waste landfill will be remediated within the scope of Area 6.

Design and construction of the on-site disposal facility (OSDF) is another provision of the OU2 ROD. The OSDF was established as part of the balanced approach to waste disposal, in that low-level radioactive waste will be disposed of at the FEMP, while higher radioactive and chemically contaminated materials, such as the K-65 Silo contents, nuclear production residues, process wastes, and waste pit materials, are to be sent off site for disposal.

3.1.2 Roles and Responsibilities

Fluor Fernald, Inc. is responsible for implementing OU2 remedial activities under contract to the U.S. Department of Energy (DOE). Fluor Fernald's Soil and Disposal Facility Project personnel directly oversee the FEMP labor force (during site preparation phase) and manage the excavation contractor (during the excavation phase) performing the remedial action work. When excavation is complete, the Soil and Disposal Facility Project personnel will sample the area to ensure final remediation levels (FRLs) have been met for all contaminants of concern identified in the ROD. Additional details are provided in the IRDPs addressing the respective OU2 components.

Most of the material excavated from OU2 is expected to meet the waste acceptance criteria (WAC) established for the OSDF. Accordingly, most of the material excavated to date has been disposed of in the OSDF as defined in the Impacted Material Placement Plan (DOE 1999a). Excavation, loading, hauling, unloading and placement of OU2 waste material in the OSDF is performed by the excavation contractor, with oversight from Fluor Fernald's Waste Acceptance Organization. Excavation monitoring of impacted material with real-time gamma spectroscopy equipment confirm WAC attainment along with visual observations in the field by Waste Acceptance Organization.

3.2 SUMMARY OF REMEDIAL ACTION OBJECTIVES

As stated in the ROD, the selected remedy for OU2 is as follows:

- Excavation of all material with contaminants of concern above the established cleanup levels
- Material processing for size reduction and moisture control as required
- On-site disposal of material meeting OSDF WAC
- Off-site disposal of any material that does not meet OSDF WAC
- Continued federal ownership of the FEMP with access restrictions.

Following excavation and certification that OU2 soils meet FRLs, OU2 components will be restored under the Natural Resources Restoration Plan (DOE 1999c).

According to the ROD, the estimated volume of OU2 material to be placed in the OSDF was 314,700 yd^3 (240,619 m^3). A key component of the OU2 and OU5 RODs is the establishment of OSDF WAC, which were derived to ensure long-term protection of the Great Miami Aquifer underlying and down gradient of the OSDF. The primary goal was to ensure that water quality be maintained below groundwater FRLs over the 1,000-year design life of the facility.

3.2.1 Southern Waste Units

As prescribed in the OU2 and OU5 RODs, and detailed in the A2PI Implementation Plan, remediation of the SWUs involves removal and disposition of impacted material, including any material stockpiled while preparing the area for excavation. Impacted material is defined as all material that was placed in the SWUs as fill material and all non-fill material with above-FRL contaminant levels. Impacted material that does not meet the OSDF chemical/radiological WAC was placed in a temporary staging area for ultimate shipment off site to a permitted commercial disposal facility. Impacted material excavated as of this report that meets the OSDF chemical, radiological, and physical WAC has been transferred to the OSDF or temporarily stockpiled.

The final excavation grades to be achieved for the SWUs are specified as: 1) the original 1951 ground elevations that existed prior to initial waste placement, 2) the ground elevations required to reach FRLs, as defined in the OU2 and OU5 RODs, and 3) the graded slope necessary to drain the area and provide stable slopes. The final excavation extent is to be based on actual field conditions, radiological field survey measurements, and physical certification sampling results.

3.2.2 Lime Sludge Ponds and Sanitary Waste Landfill

As prescribed in the OU2 ROD and the draft IRDP, the lime sludge ponds will be excavated to the depths required to remove all lime sludge. The solid waste landfill will be excavated to the depth established in the Remedial Investigation/Feasibility Study Report for OU2 (DOE 1995h). Excavated material that meets the OSDF WAC will be transported to the OSDF for disposal; any remaining material will either be treated to meet WAC or transported off site to a permitted commercial disposal facility, as appropriate. Final restoration of the lime sludge ponds will occur after certification activities are completed, including final seeding (as needed) and re-vegetation.

3.2.3 On-Site Disposal Facility

As discussed in the OU2 ROD, the OSDF Design Criteria Package (DOE 2000f), as well as other OSDF documents, the OSDF was placed on the eastern side of the FEMP. Upon final closure, the facility will contain an estimated 2.5 million yd^3 (1.9 million m^3) of impacted material from the operable units in six to

seven disposal cells. A multi-layer cap and liner system with both natural and synthetic components is being utilized to protect the underlying Great Miami Aquifer. The cap and liner system incorporates a leachate collection/detection system. Any waste brought to the OSDF for disposal is required to meet the WAC established in the OSDF WAC Attainment Plan (DOE 1998f) and the Impacted Material Placement Plan OSDF (DOE 1999a). Monitoring of any leachate or drainage from the OSDF is conducted in accordance with the OSDF Operation and Maintenance Plan (DOE 1996d), and reported through Integrated Environmental Monitoring Plan (IEMP) reports.

3.3 REMEDIAL ACTION STATUS

3.3.1 Southern Waste Units

The selected remedy for the OU2 SWUs is in the implementation phase and nearing completion. Excavation will be completed in the SWUs in Spring 2001, with contaminated materials hauled to and disposed of in the OSDF. This includes treatment and disposal of the lead-contaminated soil from the firing range area of the South Field, as discussed in Section 3.4.2. The actual excavated volume of material is greater than that estimated in the OU2 ROD because, when the FEMP was reorganized into remediation areas, OU2 components were excavated concurrently with OU5 soils, drainage ditches, debris, etc.

A total of 390,000 yd^3 (298,000 m^3) of soil, including the lead-stabilized soil, have been removed from A2PI at the time of this review. Materials meeting the WAC were ultimately placed in the OSDF, and materials failing these criteria were placed in Stockpile 7 for eventual off-site disposal. A total of 6,100 yd^3 (4,600 m^3) will be transported to the OSDF from the soil stockpiles within the SWUs in Spring 2001. In addition, 21,000 yd^3 (16,000 m^3) of above-FRL impacted material will be excavated from the South Field and sent to the OSDF for disposal.

A draft certification report has been submitted to the U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (OEPA) for the active flyash pile and adjacent areas (DOE 2001a).

3.3.2 Lime Sludge Ponds and Solid Waste Landfill

The selected remedy for the OU2 lime sludge ponds and solid waste landfill has not yet begun. The schedule for remediation of the lime sludge ponds and the solid waste landfill depends on the FEMP's final closure plan, which is currently in development.

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3.3.3 On-Site Disposal Facility

The OSDF, part of the selected remedy for OU2, is under construction. Construction of Cell 1 began in June 1997, and waste placement activities began in December 1997. As of December 2000, Cell 1 was filled to capacity, with 314,283 yd^3 (240,714 m^3) of material, and the contour layer has been completed. Cell 1 will be capped with construction of the final cover during 2001. Cell 2 was 51 percent filled, with 192,384 yd^3 (147,097 m^3), and Cell 3 was 23 percent filled, with 91,887 yd^3 (70,256 m^3). Construction start schedules for Cells 4, 5, and 6 are pending. Another cell may be added depending on the total amount of impacted material that is generated in the later phases of soil remediation.

The OSDF Project was implemented in three phases. Phase 1 included the construction of an impacted material haul road from the SWUs to the OSDF. Phase 2 involved the OSDF engineering design, while Phase 3 consists of excavating materials, placing them in the disposal cells, and then closing and capping each cell when it reaches design capacity.

In order to provide containment, collection, and treatment of contaminated leachate generated within the OSDF, a leachate collection system (LCS) was incorporated into the OSDF design. This LCS consists of a gravel layer installed beneath the waste materials to collect rainwater that comes into contact with waste during cell construction as well as moisture draining from the waste following cell closure and capping. The leak detection system (LDS) is located beneath the LCS and the primary geosynthetic liner system. The LDS is designed to monitor any potential leakage from the OSDF before any material is released to the environment. Both the LCS and LDS drain to the west and extend beyond the synthetic liner systems, where they are accessible through manholes. Horizontal till wells are set beneath the compacted clay liner of each cell to permit monitoring of the perched groundwater beneath the point where the LCS and LDS system pipes emerge from beneath the liner system. In addition, the Great Miami Aquifer is monitored via monitoring wells that are installed both upgradient and downgradient of each cell.

An enhanced permanent leachate transmission system is currently being installed to replace the existing interim leachate line. At the time of this review, the installation is 95 percent complete and is scheduled for completion at the end of May 2001.

3.4 ASSESSMENT OF CONFIRMATORY DATA AND/OR PERFORMANCE DATA

3.4.1 Identify the Scope of the Review

The data examined for this report include SWU excavation monitoring data, leachate monitoring data from OSDF Cells 1, 2, and 3, as well as environmental monitoring data collected in accordance with the IEMP. The review included all relevant data that were complete as of the end of 2000.

3.4.2 Assessment of Remedial Actions

Is the remedy operational and functioning as intended in the ROD?

Southern Waste Units

As stated in the ROD, the continued evaluation and consideration of new treatment technologies is permissible if the technologies prove cost-effective and reduce soil toxicity, mobility, or volume. In March 1999, DOE developed an explanation of non-significant differences from the ROD, which had provided for off-site disposal of lead-contaminated soils from the South Field firing range. Additional sampling and analysis conducted after the ROD was signed indicated that 40 yd^3 (31 m^3) of soil was lead-contaminated, a significantly smaller waste volume than the originally estimated 300 yd^3 (229 m^3). In addition, an *in situ* technology was identified that could stabilize the soil to meet OSDF WAC. Because the alternative remedy provided the same level of protectiveness to soils and groundwater prescribed in the OU5 ROD, (DOE 1996h) EPA approved this approach.

The ROD stipulated that the total uranium concentration in OU2 materials to be sent to the OSDF could not exceed 1,030 mg/kg (i.e., the WAC limit). Excavation monitoring using real-time radiological monitoring and mapping systems has been implemented during the A2PI Project and is further discussed in Section 3.4. All monitoring data collected during excavation were used to ensure material that was transported to the OSDF met WAC. In addition, OEPA has conducted split sampling of the material, and these results confirm WAC attainment for materials placed in the OSDF.

All material that did not meet the OSDF WAC (such as the 1,030 mg/kg total uranium concentration) were transported to Stockpile 7 for interim storage until they could be shipped for treatment and/or disposal at an off-site disposal facility. The volume of soil placed in the stockpile exceeded the 3,100 yd^3 (2,370 m^3) estimated in the OU2 ROD.

Construction water (including equipment wash water) and storm water runoff were collected and pumped to the advanced wastewater treatment facility for treatment prior to discharge. At this time, surface water monitoring data collected downstream of the SWUs indicate drainage is adequately controlled and has not adversely impacted Paddys Run.

Part of monitoring during excavation and transport of impacted material to the OSDF was to ensure fugitive dust emissions did not exceed levels identified in the A2PI IRDP and the excavation contractor's dust control plan. Water application was the primary effective dust control utilized, and was effective in complying with emission limits.

OSDF Leachate and Monitoring System

As reported in the 1998 Integrated Site Environmental Report (DOE 1999b), the temporary leachate transmission pipeline from the OSDF was found to be malfunctioning and was shut down in early 1999. The pipeline connected the OSDF to the advanced wastewater treatment facility for treatment and discharge of collected leachate and storm water runoff from Cells 1, 2, and 3, where waste placement had already begun. A contingency plan was used to manually truck the collected water to the advanced wastewater treatment facility for treatment. The pipeline was repaired and returned to active use in May 1999. The enhanced permanent leachate transmission system is currently being installed, as discussed in Section 3.3.3, and will remain in place to convey leachate from the OSDF.

A monitoring program is in place to assess the performance of the OSDF liner system and to provide early warning of potential releases of contaminated leachate. Leachate volume measurements are obtained from metering of the total gallons pumped through the leachate transmission system. The LDS is also monitored for the presence of liquids (e.g., construction water and/or leachate). These results indicate that the cell liners are performing adequately, with LDS volumes consistently well below the established initial response leakage rate of 20 gallons per acre per day. Analytical data are also collected from each cell's LCS and LDS, from horizontal wells located in the till beneath each cell, and from both up- and down-gradient Great Miami Aquifer monitoring wells for each cell. As shown in Table 3-1, these results generally indicate decreasing concentrations of the detected constituents when comparing the LCS to the horizontal till wells, thus indicating that the liner systems for all three cells are performing within the constraints established in the approved design. Individual cell LCS and LDS performance results and volumes can be found in the IEMP quarterly status reports and annual integrated site environmental reports.

3.4.3 Validity of ROD Assumptions

Are the critical assumptions (to ensure protection of human health and the environment) used at the time of remedy selection still valid?

Except for the treatment of the firing range soil identified in the Explanation of Non-Significant Differences, the assumptions made in the OU2 ROD remain valid. EPA guidance for this five-year plan suggests a review of OU2 applicable or relevant and appropriate requirements (ARARs) and to be considered-based requirements to determine whether they call into question the effectiveness of the remedy. This review has been performed, and no changes were identified that would adversely affect the planned effectiveness of the OSDF following site closure as stated in the ROD.

TABLE 3-1

ON-SITE DISPOSAL FACILITY DATA SUMMARY FOR CONSTITUENTS DETECTED THROUGH SECOND QUARTER 2000

Constituent (FRL)[a]	No. of Samples with Detections	Range	No. of Samples with Detections	Range	No. of Samples with Detections	Range	Great Miami Aquifer: No. of Samples with Detections	Range	Great Miami Aquifer: No. of Samples with Detections	Range
Cell 1										
	LCS[b,c,d,e] (12338C)		LDS[b,c,d,e] (12338D)		HTW[b,c,d,e] (12338)		Upgradient[b,c,d] (22201)		Downgradient[b,c,d] (22198)	
Total Organic Carbon (NA[g] mg/L)	8/10	ND to 123	7/9	ND to 80.9	26/29	ND to 12.2	22/25	ND to 59.7	21/25	ND to 52.5
Total Organic Halogens (NA[g] mg/L)	8/10	ND to 0.23	7/9	ND to 0.361	16/28	ND to 0.077	13/25	ND to 0.308	8/25	ND to 0.0526
Boron (0.33 mg/L)	11/11	0.0642 to 2.8	9/9	0.0296 to 0.321	23/29	ND to 0.685	20/25	ND to 0.142	27/36	ND to 0.116
Technetium-99 (94.0 pCi/L)	4/10	ND to 18.28	1/9	ND to 8.92	7/30	ND to 21.1	1/25	ND to 13.41	2/36	ND to 14.8
Total Uranium (20 µg/L)	9/10	ND to 119	9/9	1.5 to 20.17	29/30	ND to 19	21/25	ND to 6.384	36/36	0.557 to 3.814
Cell 2										
	LCS[b,c,d,e] (12339C)		LDS[b,c,d,e] (12339D)		HTW[b,c,d,e] (12339)		Upgradient[b,c,d] (22200)		Downgradient[b,c,d] (22199)	
Total Organic Carbon (NA[g] mg/L)	4/7	ND to 6.25	7/8	ND to 26.1	22/27	ND to 11.1	18/20	ND to 47.6	16/20	ND to 51.8
Total Organic Halogens (NA[g] mg/L)	4/7	ND to 0.0576	4/8	ND to 0.0205	18/27	ND to 0.101	10/20	ND to 0.177	9/20	ND to 0.0386
Boron (0.33 mg/L)	7/8	ND to 0.915	7/7	0.396 to 2.22	16/27	ND to 0.0829	14/20	ND to 0.158	14/20	ND to 0.0569
Total Uranium (20 µg/L)	8/8	4.51 to 39.299	7/7	12 to 71	27/28	ND to 3.607	13/20	ND to 1.11	20/20	0.259 to 12.1
Cell 3										
	LCS[b,c,d,e] (12340C)		LDS[h] (12340D)		HTW[b,c,d,e] (12340C)		Upgradient[b,c,d] (22203)		Downgradient[b,c,d] (22204)	
Total Organic Carbon (NA[g] mg/L)	2/4	ND to 34.2			13/23	ND to 9.81	7/18	ND to 5.66	8/18	ND to 8.83
Total Organic Halogens (NA[g] mg/L)	3/4	ND to 0.178			18/23	ND to 0.158	9/18	ND to 0.213	8/18	ND to 0.165
Boron (0.33 mg/L)	4/4	0.268 to 1.51			18/22	ND to 0.24	12/18	ND to 0.0776	11/18	ND to 0.179
Technetium-99 (94.0 pCi/L)	0/4	ND to ND			2/22	ND to 38.35	1/18	ND to 8.438	0/18	ND to ND
Total Uranium (20 µg/L)	4/4	9.27 to 34.997			20/22	ND to 9.14	13/18	ND to 0.907	17/18	ND to 5.924

[a]From Operable Unit 5 Record of Decision, Table 9-4
[b]If there was more than one sample result per day (e.g., a duplicate sample), then only the maximum sample concentration was counted and compared to the FRL.
[c]Rejected data qualified with either a R or Z were not used in this comparison.
[d]ND = not detected
[e]LCS = leachate collection system
LDS = leak detection system
HTW = horizontal till well
[f]Cell 2 LDS data from December 1998 to present are suspect due to a December 1998/January 1999 back-up of leachate from the leachate transmission system line into the Cell 2 LDS layer and the resultant residual contamination of the LDS layer from the back-up
[g]NA = not applicable
[h]As of the second quarter of 2000, no water had accumulated in the Cell 3 LDS primary containment vessel; therefore, no Cell 3 LDS samples have been obtained

The OSDF performance data reviewed through the end of 2000 indicate that of the OSDF liner system is functioning as intended in the OSDF Design Criteria Package.

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3.4.4 Remedy Optimization

Has any new information come available that could allow for optimization of the selected remedy; or call into question the validity of the selected remedy?

Southern Waste Units

Throughout the remedial action of waste excavation, loading and hauling conducted at the SWUs, several operational improvements were implemented. These improvements will continue to be applied to continuing remedial actions at the SWUs as well as to similar soil excavation actions in other operable units.

The *in situ* gamma spectrometry program consists of an integrated suite of hardware and software technologies that allow for real-time radionuclide contamination detection as well as real-time data mapping and evaluation. The program was used extensively in the SWUs during excavation, expediting contamination surveys of large excavation areas to identify hot spots or above-WAC areas. *In situ* gamma spectrometry was routinely during soil excavation to provide high quality and timely radionuclide data for soil characterization and excavation operations. The *in situ* gamma spectrometry system has been routinely deployed in the SWUs to provide general area and pre-design surveys, identification of hot spots and above-WAC areas, confirmation of radionuclide contamination removal, and precertification measurements.

Additionally, *in situ* gamma spectrometry has provided precertification data for over 460 acres (186 hectares) sitewide including the footprint of the active flyash pile in the SWUs. The use of *in situ* gamma spectrometry has allowed the FEMP to achieve the stringent schedule for soil remediation over the past three years and has resulted in cost savings of approximately $15 million sitewide.

On-Site Disposal Facility

Several measures to enhance the performance of the OSDF have been implemented in OSDF construction and impacted material placement requirements since OSDF construction began in April 1997. These enhancements were documented in revisions to the OSDF Final Design Package and in design change notices approved by EPA and OEPA. These revisions and design change notices include modifications to the acceptable permeability zone criteria for the clay liner and cap construction based on the Test Pad Program Final Report - Addendum No. 1 (DOE 1999f), improvements to the impacted material

compaction methods by the use of a Caterpillar 826 self-propelled static pad-foot compactor or approved equal, inspection of the primary geomembrane and geomembrane with the use of electrical leak detection testing, use of Ohio Department of Transportation Type D dumped rock fill for the biointrusion barrier, and modifications to the IMPP to improve impacted material placement into the OSDF cells. The IMPP modifications are as follows:

- Revised the placement criteria for transite panels eliminating size reduction to minimize generation of friable asbestos
- Issued Addendum 1, Rev. 0, Specialized Placement Plan for Bagged Impacted Material to discuss placement of bagged material
- Issued Addendum 2, Rev. 1, Specialized Placement Plan for Thorium and Non-Bagged Impacted Material to discuss placement of thorium debris and non-bagged material
- Issued Addendum 3, Rev. 1, Alternative Trenching Method for Placement of Category 2 Impacted Material to discuss placement of Category 2 items by trenching method.

The DOE has formed the Fernald Integrating Stewardship Technology Team to assist the FEMP OSDF project team and stakeholders in developing a long-term, post-closure monitoring plan through the deployment of innovative technologies. A series of meetings have been held to identify technologies that can potentially be installed in the cap of Cell 1 which is planned for construction in Spring 2001. The prioritized parameters to be monitored are visual changes (through observations and aerial surveys), drainage layer outlet (using pressure transducers), settlement/subsidence (using topographic surveys, ground penetrating radar, etc.) and soil moisture (using time domain reflectometry or other technology). The Fernald Integrating Stewardship Technology Team will continue to evaluate the long-term monitoring needs for the OSDF and develop recommendations on innovative technologies.

Additionally, the installation of an enhanced permanent leachate transfer system for the OSDF, as discussed in Section 3.4.2, is expected to be operational in the summer of 2001.

3.5 FINDINGS AND RECOMMENDED ACTIONS FROM CURRENT REVIEW

Based on the review of data and remedial actions to date, there is no new information indicating a significant impact to the remedy identified in the OU2 ROD. Monitoring and other activities are taking place to ensure protectiveness of human health and the environment while the remedy is being implemented.

All impacted material is scheduled for removal from the SWUs by Spring 2001, thus eliminating the risk of fugitive emissions from the waste material. The remaining remedial activities include removing storm

water basins, ditches and associated impacted material, regrading the area to pre-waste disposal topography, and re-seeding. These activities will be monitored to ensure the remedial action complies with regulatory requirements.

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Corrective actions have been taken to ensure the OSDF leachate transmission system is functioning and protective of human health and the environment by installing an enhanced permanent system.

3.6 PROTECTIVENESS STATEMENT

The selected remedy for OU2 is expected to be protective of human health and the environment, and immediate threats have been addressed. The excavation, treatment, and disposal of materials from the SWUs have been conducted to ultimately achieve the FRLs identified for these components. Prioritizing remediation of the SWUs and surrounding soils served to eliminate OU2's greatest threat to human health and the environment because of the magnitude of contamination and the proximity of this contamination to the Great Miami Aquifer. Access restrictions and other protective measures ensure risk to human health and the environment is minimized until remedial activities can be conducted in the remaining OU2 components.

4.0 OPERABLE UNIT 3

4.1 PROJECT DESCRIPTION

Operable Unit 3 (OU3) includes the former production area buildings and equipment, all above-and below-grade improvements, containerized materials, storage pads, roads, above- and below-ground tanks and utilities not encompassed by the other operable units. OU3 does not include the soil and groundwater beneath the various former production area facilities.

Based on the results of the OU3 remedial investigation/feasibility study, materials were categorized based on type of material and the regulatory status (mixed waste, polychlorinated biphenyl waste, low-level waste, and below radiological background) to evaluate treatment and disposal options. Section 4.3.2 provides a summary of estimated volumes of OU3 materials by segregation category as detailed in the OU3 Proposed Plan (DOE 1996f).

The Fluor Fernald, Inc. Decontamination and Demolition (D&D) Project, in conjunction with demolition subcontractors, manage remediation responsibilities of OU3 with U.S. Department of Energy (DOE) oversight. Decontamination and demolition design packages, development of requests for proposals, planning and scheduling, development of implementation plans, and oversight of the demolition subcontractor is the responsibility of the D&D Project staff. The Fluor Fernald Waste Acceptance Organization performs inspections of debris to ensure conformance with the on-site disposal facility (OSDF) waste acceptance criteria (WAC) and/or criteria for off-site disposal facilities.

4.2 SUMMARY OF REMEDIAL ACTION OBJECTIVES

4.2.1 Selected Remedy (Interim Remedial Action)

The former production buildings were beyond their design lives and no future mission existed for the buildings and structures. The OU3 Record of Decision for Interim Remedial Action (IROD) (DOE 1996d) documents the selected remedy for the D&D of all above- and below-grade buildings and facilities. The final Record of Decision (ROD) established the strategy for the final disposition of the materials generated from the interim remedial action. The specific activities associated with the interim remedial action included:

- Decontamination of more than 200 structures by removing loose contamination
- Dismantling the above-grade structures
- Removal of foundations, storage pads, ponds, basins and underground utilities and other at- and below-grade structures

- Off-site disposal of no more than 10 percent by volume of the non-recoverable or non-recyclable waste and debris generated from structural D&D until the issuance of the OU3 final remedial action ROD

- Interim storage of the remaining waste and debris until final decision is reached for treatment and/or disposition.

As referenced in the first bullet, all OU3 buildings and structures will first be decontaminated and dismantled. The sequence and schedule by which the above-grade portions of all OU3 structures will undergo D&D were initially outlined in the OU3 Remedial Design Prioritization and Sequencing Report (DOE 1995e).

4.2.2 Selected Remedy (Final Remedial Action)

The selected remedy for OU3 is "Selected Material Treatment, On-Property Disposal, and Off-Site Disposition" of material generated by the OU3 interim remedial action and OU3 removal actions. The final OU3 ROD includes the following:

- Provides for unrestricted/restricted release of material, as economically feasible, for recycling, reuse, or disposal

- Permits treatment of material to meet the OSDF and/or off-site disposal facility WAC

- Requires off-site disposal of process residue, product material, and process-related metals

- Requires off-site disposal of acid brick and concrete from specific locations and any other material exceeding the OSDF WAC

- Permits disposal of remaining OU3 waste in the OSDF

- Imposes administrative controls through deed restrictions and access controls

- Incorporates post-remediation activities that include long term monitoring and maintenance of the OSDF and operation of a groundwater-monitoring network to evaluate the performance of the OSDF.

The final ROD incorporated, by reference, the decisions provided in the IROD to integrate implementation of any repetitive decisions. To ensure the proper integration of the OU3 interim and final remedial actions, the OU3 Remedial Design/Remedial Action Work Plan for interim Remedial Action (DOE 1995f) was superseded by a subsequent work plan that combined implementation strategies for the OU3 IROD with implementation strategies developed for the final OU3 ROD.

Additionally, the OU3 final remedial action incorporated the Safe Shutdown program (formerly Removal Action 12) on a programmatic basis. The Safe Shutdown program provided for the isolation and de-energizing of former production-related equipment and utilities. For each building/structure, safe shutdown was completed prior to the start of D&D activities for that building/structure.

4.2.3 Implementation Documents

In addition to routinely developing Safe Shutdown turnover reports and implementation plans for each building or complex in preparation for D&D activities, the D&D Project (or former OU3-related organizations) executes the OU3 remedial action in accordance with the OU3 Prioritization and Sequencing Report (DOE 1995e) and the OU3 Remedial Design/Remedial Action Work Plan for the IROD (DOE 1995f).

4.3 REMEDIAL ACTION STATUS

4.3.1 Safe Shutdown/Facilities Shutdown

The Safe Shutdown component of the selected remedy for OU3 is complete. The purpose of Safe Shutdown was to complete Removal Action 12 prior to remedial action for OU3. Safe Shutdown's primary goal was to remove nuclear and hazardous materials from existing equipment, ductwork, pipes and sumps in former production facilities. This would eliminate a potential criticality accident and decrease the quantity of material below the Hazard Category 3 levels as defined in DOE Order 5480.23. The material contained within the former production facilities (either as stored residual material and waste or hold-up material within equipment) lacked adequate controls in terms of loss of containment. A total of 690,050 pounds of hold-up materials were removed from nine facilities during the Safe Shutdown activities.

The Safe Shutdown activity ended in March 1999 with the completion of Plant 6. At that time, Facilities Shutdown was implemented as the successor program with a charter to perform all of the same types of shutdown functions for non-production facilities prior to, or in conjunction with, demolition activities.

4.3.2 Decontamination and Dismantling

The D&D component of the selected remedy for OU3 is in the implementation phase. D&D of former production facilities/components allows access for excavation and remediation of soils in the former production area. As of February 2001, 91 of the 233 former production facilities have been removed, as summarized in Table 4-1.

TABLE 4-1

OPERABLE UNIT 3 STRUCTURES DISMANTLED
Through February 2001

Project	Remedial Action Duration	# of Structures
Plant 1 pad Continuing Release	July 1994	3
Plant 7 Complex	August 1994 through September 1994	3
Fire Training Facility	August 1994 through October 1994	5
Plant 1 Ore silos	December 1994	1
Site Maintenance	May 1995 through June 1997	2
Plant 1 – Phase 1	April 1996 through April 1997	8
High/Low Nitrate Tanks	July 1996 through December 1996	2
Building 4A	August 1996	1
Boiler Plant/Water Plant	October 1997 through October 1998	7
Thorium-Plant 9 Complex	March 1998 through November 1998	11
Sewage Treatment Plant	July 1998 through August 1998	5
Miscellaneous Small Structures	August 1998 through September 2000	17
Maintenance/Tank Farm	April 1999 through February 2000	9
Sewage Treatment Plant Complex	June 1999 through July 1999	4
Plant 5 Complex	September 1999 through February 2001	8
Plant 6 Complex	January 2001 through February 2001	5
	TOTAL	91

Table 4-2 presents the volume of material generated by Safe Shutdown and D&D activities since January 1993. All of the materials are summarized by material categories as presented in the OU3 ROD.

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TABLE 4-2

MATERIAL GENERATED AND DISPOSITIONED UNDER OU3 INTERIM AND FINAL REMEDIAL ACTION

OU3 Category[a]	OSDF Category	Material Description[a]	Total OU3 Estimated Volume in ROD[b,c] (yd^3)	Generated Volume to Date[c]	Dispositioned Volume to Date[c]	Disposal Location
A	2	Accessible Metals	2,348 yd^3	5,257 yd^3	5,192 yd^3	OSDF
B	2	Inaccessible Metals	64,448 yd^3	2,483 yd^3	2,211 yd^3	OSDF
C	NA[d]	Process-Related Metals	5,593 yd^3	2,359,857 lbs	338,540 lbs 11,317 lbs 1,211,496 lbs 11,258 lbs	Alaron, Inc., Lockeed Martin, Inc. NTS, DOE-Portsmouth
D	2	Painted Light-Gauge Metals	265 yd^3	375 yd^3	345 yd^3	OSDF
NA[d]	NA[d]	Lead	35,400 lbs	34,113 lbs	11,258 lbs	Envirocare
E	2	Concrete	174,083 yd^3	10,286 yd^3	7,063 yd^3	OSDF[c]
NA[d]	NA[d]	Scabbled Concrete	NA[d]	472982 lbs	0	
F	NA[d]	Acid Brick	767 yd^3	38,349 lbs	0	NA[d]
G	3	Non-Regulated Asbestos-Containing Material	2,641 yd^3	2,696 yd^3	647 yd^3	OSDF
H	5	Regulated Asbestos Containing Material	2,971 yd^3	1,986 yd^3	493 yd^3	OSDF
I	2 or 4	Miscellaneous Materials	26,075 yd^3	14,192 yd^3	12,491 yd^3	OSDF
J	NA[d]	Product, Residues, and Special Materials	64,077 yd^3	5,097,002 lbs	4,414 lbs 296,782 lbs 2,556,780 lbs 645 lbs 260 lbs	Allied Signal, Inc., Envirocare, NTS, DOE- Portsmouth, Safety Kleen, Inc.
Commingled	2	Category A, B, D, and incidental materials	NA[d]	49,106 yd^3	38,747 yd^3	OSDF

[a]Refer to Table 4-2 of the OU3 ROD for category and material description breakdown.
[b]Refer to Table 4-3 of the OU3 ROD
[c]OU3 ROD estimates of material were based on volumes (yd^3). Actual quantities of material generated and disposed at the OSDF are also measured in yd^3. However, the measurement of materials requiring off-site disposal is measured in weight (lbs). A volume estimate of materials shipped off site is not provided because it would not be sufficiently accurate. This is due to shipping weight requirements that often result in containers that are not filled to capacity.
[d]NA = not applicable

4.3.3 HWMU Remediation

Remediation fieldwork for 20 of the 39 hazardous waste management units (HWMUs) (refer to Table 4-3) in OU3 have been completed under the Resource Conservative and Recovery Act (RCRA), constituting a partial closure of the FEMP facility. Applicable RCRA closure requirements under Ohio Administrative Code 3745-66 (40 Code of Federal Regulation 265, Subpart G) have been followed to formally close these units. Additionally, six (numbers 25, 28, 34, 46, 50, and 54) of the remaining 27 HWMUs have been closed under the RCRA/CERCLA integrated process.

4.4 ASSESSMENT OF CONFIRMATORY DATA AND/OR PERFORMANCE DATA

4.4.1 Identify the scope of the review

This review covers the activities implemented by the Safe Shutdown, Facilities Shutdown and D&D Projects.

4.4.2 Assessment of Remedial Actions

Is the remedy operational and functioning as intended in the ROD?

There have been no major design changes or modifications to either the D&D or Safe Shutdown/Facilities Shutdown remedial action processes. Scheduled completion dates for previously dismantled buildings and structures were met and the completion dates for the buildings/structures currently being dismantled are attainable. Based on current and past OU3 activities, the selected material treatment, on-property disposal and off-site disposition of generated material should be accomplished as outlined in the ROD.

D&D activities for OU3 have been in compliance with the National Emissions Standards for Hazardous Air Pollutants Subpart H standard for radiological emissions. Compliance has been confirmed through emission modeling before each major demolition project and control of fugitive dust emissions. The Integrated Environmental Monitoring Plan property boundary air monitoring program has reported the data that supports compliance with the 10 millirem radiological dose standard for air inhalation dose to members of the public.

TABLE 4-3
OPERABLE UNIT 3 HAZARDOUS WASTE MANAGEMENT UNITS

HWMU No.	HWMUs Description	HWMU Status	Documentation Status
1	Fire Training Facility	Open	
3	Waste Oil Storage in Garage	Closed	OEPA letter June 6, 1996
4	Drum Storage Area Near Loading Dock (Lab Bldg)	Open	
5	Drum Storage Area South of W-26 (Lab Bldg)	Open	
6	Drummed HF Residue/Associated Storage Areas NW of Plant 4	Closed	OEPA letter April 28, 1995
7	Drummed HF Residue/Associated Storage Areas South of Cooling Towers	Closed	OEPA letter July 2, 1996
8	Drummed HF Residue/Associated Storage Areas South of Cooling Towers	Closed	OEPA letter July 2, 1996
9	Nitric Acid Rail Car and Area	Closed	OEPA letter April 25, 1995
10	NAR System Components	Open	
11	Tank Farm Sump	Open	
13	Wheelabrator Dust Collector (Bldg. 66)	Closed	OEPA letter April 5, 1996
14	Box Furnace	Open	
15	Oxidation Furnace #1	Open	
17	Plant 8 East Drum Storage Pad	Open	
18	Plant 8 West Drum Storage Pad	Open	
19	CP Storage Warehouse – Bldg. 56 (Butler Bldg.)	Open	
20	Plant 1 Pad	Open	
22	Abandoned Sump West of Pilot Plant	Open	
25	Plant 1 Storage Bldg. (Bldg. 67)	Closed - Integrated RCRA/CERCLA	December 31, 1997
26	Detrex Still)	Closed	OEPA letter November 27, 1995
28	Trane Thermal Liquid Incinerator	Closed - Integrated RCRA/CERCLA	October 28, 1999
29	Plant 8 Warehouse (Bldg. 80)	Open	
30	Barium Chloride Salt Treatment Facility	Closed	OEPA letter April 19, 1990

TABLE 4-3
(Continued)

HWMU No.	HWMUs Description	HWMU Status	Documentation Status
31	Tank for Bulk Storage of Solvents, T 5	Closed	OEPA letter November29, 1996
32	Tank for Bulk Storage of Solvents, T 6	Closed	OEPA letter November 29, 1996
33	Pilot Plant Warehouse (Bldg. 68)	Open	
34	KC 2 Warehouse (Bldg. 63)	Closed - Integrated RCRA/CERCLA	October 28, 1999
35	Plant 9 Warehouse (Bldg. 81)	Closed	OEPA letter June 8, 1998
36	Storage Pad North of Plant 6	Open	
37	Plant 6 Warehouse (Bldg. 79)	Open	
38	HF Tank Car	Closed	OEPA letter November 27, 1995
46	Uranyl Nitrate Tanks (NFS Storage Area)	Closed - Integrated RCRA/CERCLA	December 4, 2000
47	Uranyl Nitrate Tanks (North of Plant 2)	Open	
48	Uranyl Nitrate Tanks (Southeast of Plant 2)	Open	
49	Uranyl Nitrate Tanks (Digestion Area [2 locations])	Open	
50	Uranyl Nitrate Tanks (Raffinate Building [2 locations])	Closed - Integrated RCRA/CERCLA	May 26, 1999
52	Experimental Treatment Facility (ETF)	Closed	OEPA letter December 6, 1995
53	North and South Solvent Tanks (Pilot Plant)	Closed	OEPA letter June 24, 1996
54	Thorium Nitrate Tank (2)	Closed - Integrated RCRA/CERCLA	OEPA letter November 23, 1998

4.4.3 Validity of ROD Assumptions

Are the critical assumptions (to ensure protection of human health and the environment) used at the time of remedy selection still valid?

The following critical assumptions used at the time of remedy selection are still valid:

- The OSDF engineering design would be sufficient for the Ohio Environmental Protection Agency (OEPA) to grant a waiver to allow its siting over the Great Miami Aquifer.
- The OSDF engineering design will provide long-term (at least 200 to 1,000 years) protection of human health and the environment from OU3 materials.
- Mixed waste treatment through solidification and encapsulation will allow land disposal requirements to be met.
- Risks from radiological and chemical exposure to workers performing the selected remedy will remain within acceptable levels.

The U.S. Environmental Protection Agency (EPA) guidance for five-year reviews states that only the applicable or relevant and appropriate requirements (ARAR) and the to be considered-based (TBC) requirements that bear on the final protectiveness of the remedy need to be re-evaluated during the review. Because only the OU2 and OU5 remedies pertain to the OSDF and restored environmental media to remain at the FEMP after all remedial actions are complete, these two operable unit sections of the report address the re-evaluation of ARARs and TBCs that are relevant to protectiveness.

4.4.4 Remedy Optimization

Has any new information come available that could allow for optimization of the selected remedy, or call into question the validity of the selected remedy?

Due to limited soil quantities generated prior to, and during demolition, of the former production area, an OSDF material transfer area has been established to store resultant D&D debris until adequate quantities of soil can be excavated to meet the required soil to debris ratio for OSDF placement. Before the material transfer area was established, roll-off boxes were filled and could not be emptied until they were taken to the OSDF. At this time, full roll-off boxes are immediately transported to and emptied at the OSDF material transfer area. The roll-off boxes are then re-used at the D&D Project site. The OSDF material transfer area allows for a better waste handling process.

4.5 FINDINGS AND RECOMMENDED ACTIONS FROM CURRENT REVIEW

No findings or deficiencies have been identified in Section 4.4.2. As a result, no corrective measures are necessary.

4.6 PROTECTIVENESS STATEMENT

The remedy for Operable Unit 3 is expected to be protective of human health and the environment, and immediate threats have been addressed. The selected material treatment, on-property disposal and off-site disposition of generated material continue to eliminate radiological and hazardous substances of concern.

5.0 OPERABLE UNIT 4

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5.1 PROJECT DESCRIPTION

Operable Unit 4 (OU4) is in the southwestern portion of the waste storage area, west of the former production area. It consists of two earthen-bermed, concrete silos containing K-65 materials, a decant sump tank, one silo containing cold metal oxides, one unused silo, and various quantities of contaminated soils, perched water, and debris associated with these structures.

The OU4 silos were constructed in the early 1950's for storage of byproduct materials (as defined in Section 11(e)(2) of the Atomic Energy Act of 1954). Silos 1 and 2 contain approximately 8,012 cubic yards (yd^3) (6,126 cubic meters [m^3]) of residues, known as K-65 material, which were generated from the processing of high-grade uranium ores, and approximately 878 yd^3 (671 m^3) of BentoGrout™ clay. K-65 material is a silty, clay-like material containing significant activity concentrations of radionuclides, including radium-226, thorium-230, lead-210, and polonium-210. The material also contains levels of lead above the Resource Conservation and Recovery Act (RCRA) Toxicity Characteristic Leaching Procedure (TCLP) limits. Due to the radium content of the K-65 material, Silos 1 and 2 represent a significant source of radon-222 emanations.

A 9,000 gallon carbon steel decant sump tank remains underground adjacent to Silos 1 and 2. This tank was originally used to collect water decanted from Silos 1 and 2 during the process of slurrying the residues into the silos and was also connected to the underdrain and skirt drain system around the silos. The tank continues to collect water due to leakage from the silos and/or infiltration from groundwater. The tank also contains an estimated 1,000 gallons of solid residue from the former decant operation.

Silo 3 contains approximately 5,088 yd^3 (3,890 m^3) of material, known as cold metal oxides, that were generated at the Fernald Environmental Management Project (FEMP) site during uranium extraction operations in the 1950s. Thorium-230 is the primary radiological contaminant of concern associated with the Silo 3 material. Data from the Remedial Investigation Report for Operable Unit 4 (DOE 1994c) indicate that Silo 3 material contains arsenic, cadmium, chromium, and selenium at levels above RCRA TCLP limits.

The U.S. Department of Energy (DOE) performed a remedial investigation/feasibility study (RI/FS) for OU4, which was approved by the U.S. Environmental Protection Agency (EPA) in August 1994. The EPA signed the Record of Decision (ROD) for Remedial Actions at Operable Unit 4 (DOE 1994f) on December 7, 1994. The ROD identified vitrification and disposal at the Nevada Test site (NTS) as the

selected remedy for the contents of Silos 1, 2 and 3, and the decant sump tank. The four silos would then be demolished, decontaminated, and dispositioned.

During 1996, DOE, with input from EPA, the Ohio Environmental Protection Agency (OEPA), and the public, evaluated the results of treatability testing on the selected remedy and the technical and schedule impacts of alternatives for OU4 remediation. These evaluations culminated in a decision that Silo 3 material will be remediated separately from Silos 1 and 2 material.

An Explanation of Significant Differences for Operable Unit 4 Silo 3 Remedial Action was approved by EPA on March 27, 1998, after completion of formal public review. The Explanation of Significant Differences documented the basis for revising the treatment portion of the original selected remedy for Silo 3 from vitrification to chemical stabilization or polymer-based encapsulation.

A revised FS for Silos 1 and 2 was prepared to re-evaluate the remedial alternatives for Silos 1 and 2. A Proposed Plan was subsequently prepared, recommending chemical stabilization as the revised remedy for Silos 1 and 2. The EPA approved the Final Record of Decision Amendment for Operable Unit 4 Silos 1 and 2 Remedial Actions on July 13, 2000.

5.1.1 Roles and Responsibilities

In 1998, DOE and Fluor Fernald, Inc. initiated the Accelerated Waste Retrieval (AWR) Project to address the increasing radon concentrations in the Silos 1 and 2 headspace, 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 control radon emissions during construction and operation phases of the AWR Project, as well as during interim storage and operation of the Silos 1 and 2 full-scale chemical stabilization facility. In 1999 a contract for the AWR Project was awarded to Foster Wheeler Environmental Corporation, who are responsible for project design, construction, testing, and operation of the facilities and equipment. In addition to providing necessary operations labor, Fluor Fernald is responsible for technical oversight of design, construction, and operations activities.

On December 18, 1998, a contract for the design, construction, operation, and implementation of the Silo 3 remedy was awarded to Rocky Mountain Remediation Services. Under this contract, Fluor Fernald was responsible for providing operations labor, and transportation, and off site disposal of the packaged treated Silo 3 material. As discussed in Section 5.3, this contract has since been terminated.

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5.2 SUMMARY OF REMEDIAL ACTION OBJECTIVES

The remedial action objectives identified in the original OU4 FS include:

- Prevent direct contact with or ingestion of waste material
- Prevent release or migration of waste materials to soil, groundwater, surface water, or sediment
- Prevent exposure to waste material that may cause an individual to exceed applicable dose limits.

The selected remedy documented in the OU4 ROD (DOE 1994f) consisted of the following components:

- Removal of contents from the Silos 1, 2, and 3 structures, on-site vitrification of the silo materials, and transportation and disposal at NTS

- Decontamination and demolition of all silo structures and the vitrification facility in accordance with the approved OU3 ROD

- Excavation and treatment of contaminated soils, and treatment of perched water encountered during remedial action, in accordance with the approved OU5 ROD.

The Silo 3 Explanation of Significant Differences documented an alternate remedy for remediation of Silo 3 material defined as:

- Treatment, using either chemical stabilization/solidification or a polymer-based encapsulation process, to stabilize characteristic metals to meet RCRA TCLP limits and attain disposal facility waste acceptance criteria (WAC)

- Off site disposal at either the NTS or an appropriately permitted commercial disposal facility (PCDF).

The Explanation of Significant Differences further determined that the treatment portion of the alternate remedy may be accomplished through either on-site treatment at the FEMP to meet disposal facility WAC, or pretreatment on site as required to reduce dispersability of thorium-bearing particulates and render the material acceptable for transportation to an appropriately permitted off-site facility for treatment using chemical stabilization/solidification or a polymer based encapsulation process to meet disposal facility WAC.

During 1999, "proof-of-principle" testing was conducted on four potential processes for treatment of Silos 1 and 2 material to provide technical and cost data to support detailed evaluation of potential treatment alternatives. The results of this testing were used to support preparation of a revised FS for Silos 1 and 2, documenting the detailed analysis of the alternatives against criteria specified by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

A ROD Amendment to revise the Silo 1 and 2 remedy was approved by EPA on July 13, 2000, and identified a change in the selected remedy identified in the original OU4 ROD to the following:

- Complete removal of contents of Silos 1 and 2 and the decant sump tank system sludge followed by treatment using chemical stabilization to stabilize characteristic metals to meet RCRA toxicity characteristic limits and attain the NTS WAC
- Gross decontamination, demolition, size reduction, and packaging of concrete from Silos 1 and 2 structures followed by off-site shipment to the NTS or an appropriately PCDF
- Disposal of contaminated soil and debris, excluding concrete from Silos 1 and 2 structures, in accordance with the FEMP's on-site disposal facility (OSDF) WAC or an appropriate off-site disposal facility, such as the NTS or a PCDF.

In addition, the selected remedy includes the following components, which were not re-evaluated, and remain as documented in the original OU4 ROD:

- Off-site shipment and disposal of the chemically stabilized waste at the NTS
- Decontamination and dismantling (D&D) of all structures and remediation facilities in accordance with the OU3 ROD
- Removal of the earthen berms and excavation of the contaminated soils within the OU4 boundary to achieve the remediation levels outlined in the OU5 ROD
- Appropriate treatment and disposal of all secondary wastes at either the NTS or an appropriate PCDF
- Collection of perched water encountered during remedial activities for treatment at OU5 water treatment facilities
- Continued access controls and maintenance and monitoring of the stored waste inventories
- Institutional controls of the OU4 area such as deed and land-use restrictions.

The FEMP OSDF will be available for disposal of debris from Silos 3 and 4 and associated facilities (the silo superstructures and the radon treatment system). Soil and debris from D&D activities associated with these facilities will be disposed in the OSDF if they meet the WAC for disposal. Any soils and debris that do not satisfy the OSDF WAC will be disposed at the NTS or a PCDF.

5.3 REMEDIAL ACTION STATUS

The selected remedy for Operable Unit 4 is in the construction phase. Design of the facilities for Silo 3 remediation, and initial construction activities took place during 2000. Primary construction activities during 2000 consisted of site preparation and grading, installation of the foundations for the retrieval gantry, and installation of the Interim Storage Area pad. During late 2000, the contract with Rocky Mountain Remedial Services was terminated. During 2001, evaluation of alternatives for implementation of Silo 3 remediation was initiated and a revised path forward will be developed with input from DOE, regulators, and FEMP stakeholders. Based upon the schedule for implementing new path forward, new milestones for completion of Silo 3 remediation will be negotiated with EPA.

Design of necessary equipment and facilities for the AWR Project, and initial construction activities, took place during 2000 and final design will be completed in 2001. Construction of the radon control system, transfer tank area, and the full-scale mockup system will take place during 2001. Operation of the radon control system and full scale mockup system testing are anticipated to begin during 2002. Initial design of the Silos 1 and 2 full-scale remediation facility was initiated in early 2001.

Prior to the signing of the Amended OU4 ROD, measures were taken to minimize airborne contamination emanating from Silos 1 and 2. The Federal Facility Agreement for Control and Abatement of Radon-222 Emissions (November 1991) required the implementation of a removal action, in accordance with the Amended Consent Agreement, to reduce emissions of radon from Silos 1 and 2 until final OU4 remedial actions could be implemented. This removal action, which was completed in November 1991, involved the placement of approximately 876 yd^3 (670 m^3) of BentoGrout™ on top of the residues inside Silos 1 and 2 to provide attenuation of radon emissions. The removal action also provided for continuous monitoring of radon concentrations in the headspaces of Silos 1 and 2, and at the exclusion fence surrounding the silos, to track the effectiveness of these control measures. These data are reported to EPA, OEPA, and the public, in accordance with the Integrated Environmental Monitoring Plan (DOE 2001b) and the Amended Consent Agreement.

As discussed in greater detail in the next section, increasing radon concentrations measured in the headspaces of Silos 1 and 2 and at the K-65 exclusion fence were indicative of degrading radon attenuation performance in the BentoGrout™ layer on top of the Silos 1 and 2 residues. During 1999 DOE identified specific locations (gasketed surfaces of manway flanges, sounding ports, and other dome penetrations) where leaks were occurring. During May 1999, these locations were re-sealed using an adhesive and silicone-based sealant. Fourth quarter 1999 radon concentrations at the K-65 exclusion fence were significantly (up to 70 percent) lower than those measured during the same period in 1998, suggesting that the resealing activity contributed to a substantial reduction in radon emissions.

5.4 EVALUATION OF CONFIRMATORY DATA AND/OR PERFORMANCE DATA

5.4.1 Scope of the Review

At the time of this review, the primary elements of the OU4 remedial action are at various stages of the design, or initial construction stages. Based on the current status of design and construction activities, review of the performance of the remedy was limited to review of information regarding the performance of measures addressing the immediate threats to the environment, and the validity of the assumptions used as a basis for remedy selection.

5.4.2 Assessment of Remedial Actions

Is the remedy operational and functioning as intended in the ROD?

At the time of this five-year review, it is too early to evaluate the effectiveness of the selected remedy for OU4. The primary immediate threat to the environment from OU4 is that of chronic radon emissions from Silos 1 and 2. The data from 1999 indicate a measurable increase in radon levels at the K-65 Silos exclusion fence over time (Figure 5-1) and a marginal difference between background and western fenceline monitoring locations adjacent to the silos (Figure 5-2). It is important to note that, although increased over time, the radon concentrations in the vicinity of Silos 1 and 2 have remained well below the levels measured prior to implementation of the removal action. As reported in the 1999 Integrated Site Environmental Report (DOE 2000d), and further supported by data collected since issuance of that report, radon concentration data collected since completion of the resealing effort during May 1999 indicates that this interim measure has resulted in a reduction in radon emissions from the silos. The long-term remedy for the radon emissions from the silos is to complete installation of a radon control system as part of the Silos 1 and 2 AWR Project planned for startup in 2002.

Samples from water collected in the decant sump tank during 1991 revealed elevated concentrations of lead-210, polonium, radium, uranium, strontium and technetium. The presence of strontium and technetium is indicative of infiltration of surface water. However, analyses of groundwater from wells immediately downgradient of the silos shows no evidence of leakage from the tank.

The data described below indicate that the interim actions implemented in OU4 continue to provide adequate protection from the primary ("immediate threats") chronic radon emissions and potential contamination of groundwater, while the final remedial actions are being implemented. An evaluation of data collected to date provides no indications that the protectiveness of the selected remedy may be at risk.

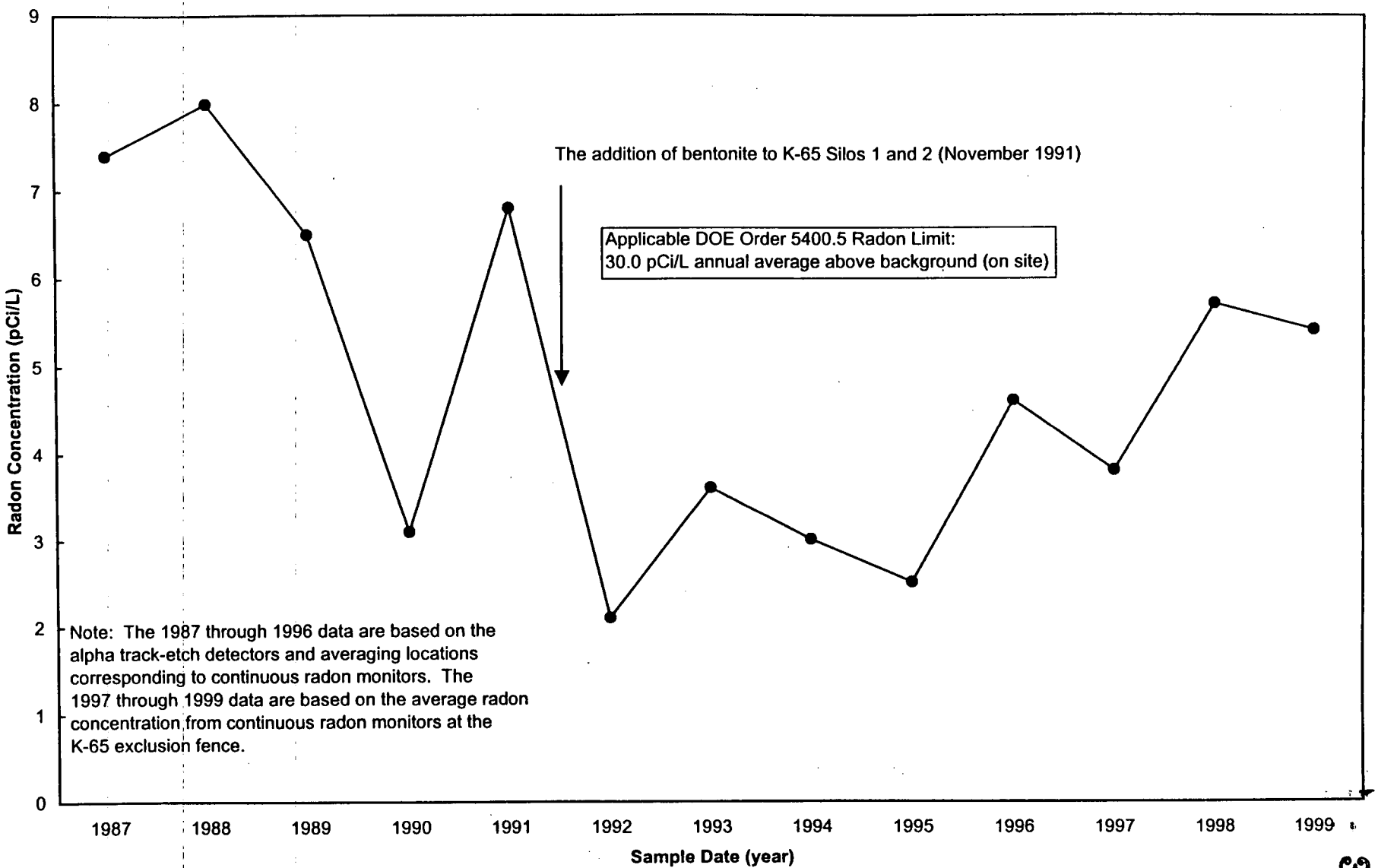

FIGURE 5-1. ANNUAL AVERAGE RADON CONCENTRATIONS
AT K-65 SILOS EXCLUSION FENCE, 1989 - 1999

FINAL

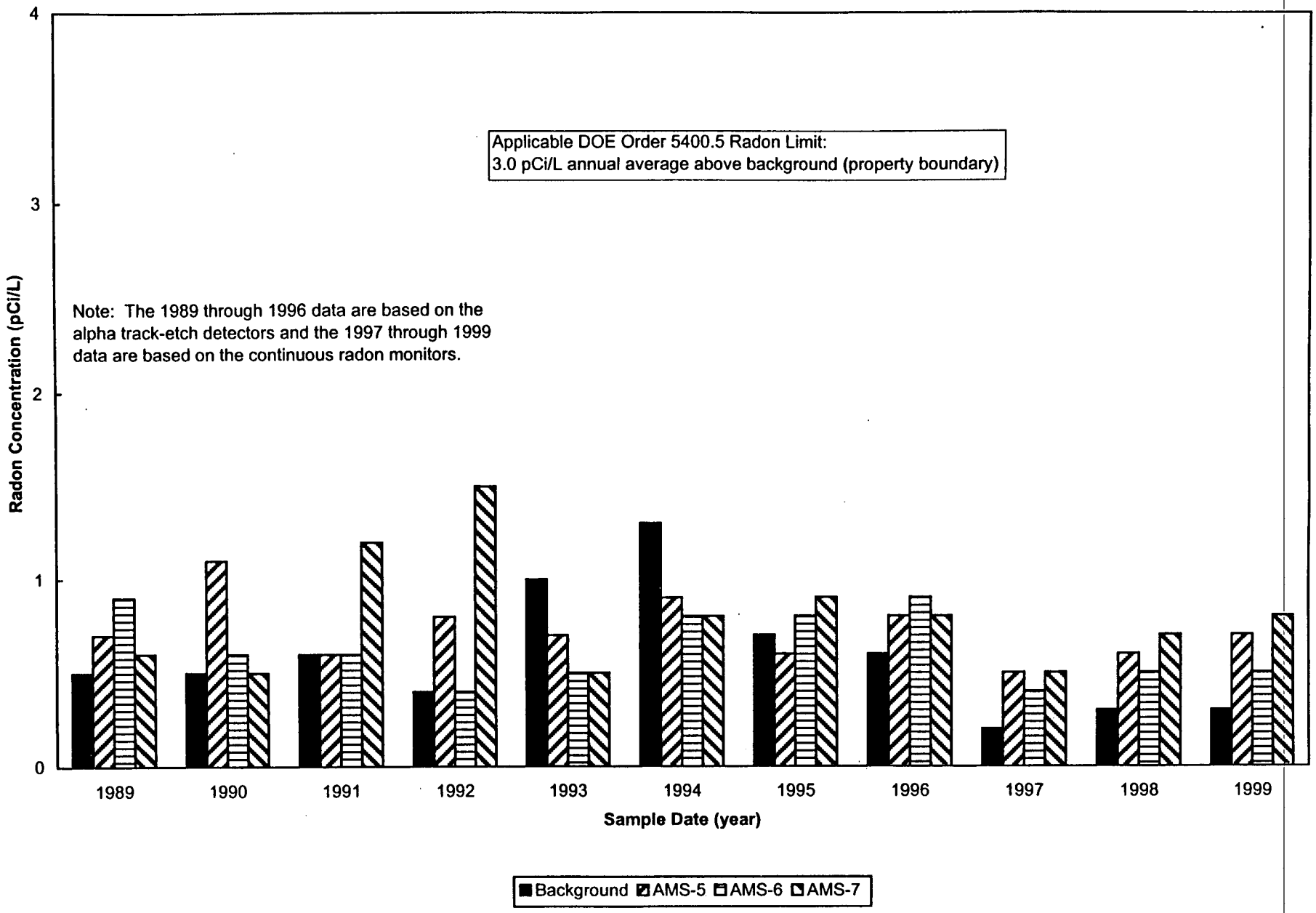

FIGURE 5-2. ANNUAL AVERAGE RADON CONCENTRATIONS AT SELECTED RADON LOCATIONS, 1989 - 1999

FINAL

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5.4.3 Validity of ROD Assumptions

Are the critical assumptions (to ensure protection of human health and the environment) used at the time of remedy selection still valid?

Toxicity and Other Contaminant Characteristics

Assumptions regarding the contaminants of concern and toxicity characteristics of the Silos 1, 2, and 3 material are documented in detail in the original OU4 RI Report. These same assumptions remained intact as the basis for selecting the revised remedies documented in the Explanation of Significant Differences for Silo 3 and the ROD Amendment for Silos 1 and 2.

Human and Ecological Risk Assessment

Neither new exposure scenarios nor risk assessment methodologies were identified in re-evaluating the remedies for Silos 1 and 2 or for Silo 3.

Waste Disposal

The original OU4 remedy assumed that, after treatment in accordance with the selected remedy, the treated Silos 1, 2, and 3 residues would be acceptable for disposal at the DOE NTS. The ROD further assumed that, with the exception of concrete from Silos 1 and 2 exhibiting a "highly elevated direct radiation field," all concrete and debris from D&D of above ground OU4 structures would be acceptable for on site disposal in the ODSF. The assumptions regarding disposal of the treated silo materials remain valid.

The assumption for debris was re-evaluated as part of the revised FS for Silos 1 and 2. As documented in the ROD Amendment for Silos 1 and 2, all of the concrete from Silos 1 and 2 has been determined to be more appropriately managed in the same manner as "Category C, Processed-Related Metals." Therefore, concrete from Silos 1 and 2 is administratively excluded from disposal at the FEMP OSDF.

Based on the current operating schedule, however, the FEMP OSDF will not be available for disposal of soil and debris generated from D&D of the OU4 remediation facilities, which include the decant sump tank system, other below-grade appurtenances, and OU4 Area 7 soils. Therefore, the revised FS and Proposed Plan assumed for costing purposes that all soil and debris from D&D of the OU4 remediation facilities, including treatment facilities, transfer tank area, radon control system, and Pilot Plant, will be disposed at the NTS. However, should programmatic changes occur and the OSDF become operational, soil and debris meeting the OSDF WAC will be disposed in the OSDF.

ARARs and TBC Requirements

The revised FS for Silos 1 and 2 included a re-evaluation of the applicable or relevant and appropriate requirements (ARARs) and to be considered-based (TBC) requirements as documented in the original OU4 ROD. This re-evaluation determined if any new requirements existed that must be incorporated as

ARARs or TBC's for the revised OU4 remedy. This evaluation is documented in detail in Appendix A, Section A.1.3 of the revised FS. This evaluation determined that based upon evaluation of 1) the scope of and rationale for the change in remedy under consideration; 2) review of requirements promulgated since signature of the original OU4 ROD; and 3) requirements of the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), the change in remedy for OU4 did not require revision of the existing OU4 ARARs.

The EPA guidance for five-year reviews states that only the ARAR and TBC requirements that bear on the final protectiveness of the remedy need to be re-evaluated during the review. Because only the OU2 and OU5 remedies pertain to the OSDF and restored environmental media to remain at the FEMP after all remedial actions are complete, these two operable unit sections of the report address the re-evaluation of ARARs and TBCs that are relevant to protectiveness.

5.4.4 Remedy Optimization

Has any new information come available that could allow for optimization of the selected remedy; or call into question the validity of the selected remedy?

As previously discussed, the selected remedies for both of the primary subunits of OU4 (Silos 1 and 2 and Silo 3) were re-evaluated based upon technical issues identified during initial implementation of the original selected remedy. Based upon these re-evaluations, documented in the Explanation of Significant Differences for Silo 3 and the revised FS and subsequent ROD Amendment for Silos 1 and 2, both remedies were revised. Both alternate remedies were selected due to the determination that they were judged to be superior to the original remedy in their certainty of meeting the criterion of CERCLA and the NCP, consisting primarily of superior certainty of technical implementability.

5.5 FINDINGS AND RECOMMENDED ACTIONS FROM CURRENT REVIEW

The review of the OU4 remedy documented in Section 5.4 identified no new information nor data significantly impact the planned remedy. Further, the review indicates that measures are in place, and still functioning adequately to provide protection from the principle immediate threats posed by OU4 while the final remedy is being implemented. Review and subsequent amendment of the original selected remedy should provide a remedy with greater certainty of being successfully implemented in accordance with the criteria of CERCLA and the NCP, compared to the original remedy.

5.6 PROTECTIVENESS STATEMENT

The selected final remedy for OU4 is expected to be protective of human health and the environment upon completion, and immediate threats have been addressed. Interim measures in place to address the immediate threats from OU4 have proven to be effective in reducing radon-222 emanating from Silos 1 and 2.

6.0 OPERABLE UNIT 5

6.1 PROJECT DESCRIPTION

Operable Unit 5 (OU5) encompasses all environmental media, both on and off the Fernald Environmental Management Project (FEMP) property, affected by contaminants released from the FEMP site. It has no operating history of its own but reflects the impacts of the "source" operable units (1, 2, 3, and 4) on the soil, surface water and sediment, groundwater, and plants and animals in the affected area. The selected remedy to address OU5 consists of the excavation and disposal of contaminated soil and sediment and the restoration of the Great Miami Aquifer (GMA) to its full beneficial use.

6.1.1 Operable Unit 5 Characteristics

6.1.1.1 Nature and Extent of Groundwater Contamination

The GMA underlying the site is typically stratified into an upper and lower portion separated by a discontinuous clay interbed. Below the lower portion of the aquifer is bedrock. An extensive network of groundwater monitoring wells has been installed and is being maintained as necessary to monitor each of these regions of the aquifer.

Uranium, the principal site-related contaminant in the GMA, is primarily found in the uppermost portion of the aquifer. Contamination exists in several areas of the GMA including beneath the former production area, beneath the waste storage area, along the length of Paddys Run from the waste storage area to approximately one mile south (1.609 kilometers [km]) of the FEMP property, and beneath the OU2 southern waste units (SWU). Several other site-related contaminants are also present in the aquifer occurring as localized areas within the plume of uranium contamination. The estimated area of affected groundwater in the GMA at a concentration at or above 20 micrograms per liter (μg/L) total uranium is approximately 220 acres (89 hectares). Section 5.1.2 of the Record of Decision (ROD) for Remedial Actions at Operable Unit 5 (DOE 1996g) contains a more complete description of both the GMA itself as well as the types and locations of contaminants encountered.

6.1.1.2 Nature and Extent of Surface Water Contamination

The FEMP's primary drainageways are the storm sewer outfall ditch and Paddys Run. Above background concentrations of uranium and thorium have been measured in the storm sewer outfall ditch and both on-property and off-property portions of Paddys Run.

During the remedial investigation (RI), samples collected from the Great Miami River immediately down stream of the FEMP effluent line indicated concentrations of uranium slightly above background, while quickly diminishing to background within one mile (1.609 km). Additionally, volatile organics, semivolatile organics, and inorganics were detected immediately down stream of the FEMP outfall line.

No remedial activities are planned for surface water at the FEMP since the planned remediation of contamination sources at the site will result in surface water contaminant concentrations being maintained below the final remedial levels (FRLs) for surface water established in the ROD.

6.1.1.3 Nature and Extent of Soil Contamination

Soil contaminants resulting from former production operations at the FEMP include radiological, inorganic, and organic contaminants. The predominant radiological soil contaminant at the FEMP is uranium. Isotopic radium and thorium have also been detected in soil, largely concentrated in the former production area and the waste storage areas. The predominant inorganic contaminants are cadmium and beryllium, although several other metals have been identified as soil constituents of concern (COC). Isolated areas of volatile and semivolatile organic compounds and PCBs are also found within uranium contamination boundaries. Details of soil contaminant levels were initially described in the RI Report for Operable Unit 5 (DOE 1995i) and summarized in the OU5 ROD. More recently, the Sitewide Excavation Plan (DOE 1998e) and follow-up pre-design field characterization studies have refined the definition of the extent and concentration of contaminants in the major areas slated for remediation.

Under the selected remedial alternative, the total volume of soil to be excavated is estimated at 1.8 million cubic yards (yd^3) (1.37 million cubic meters [m^3]); of this volume, approximately 85 percent is expected to meet on-site disposal facility (OSDF) waste acceptance criteria (WAC).

6.1.1.4 Nature and Extent of Sediment Contamination

Sediment sampling conducted during the RI from the storm sewer outfall ditch found that total uranium and several inorganic contaminants were detected above background. On-property sediment samples from Paddys Run indicated above background detection of uranium, radium-226, volatile and semivolatile organics, and inorganics. Off-property sediment sampling in Paddys Run reveal only uranium detected above background concentrations. Sediment samples from the Great Miami River indicated concentrations of total uranium, radium-226, and total thorium at or slightly above background. The remedy for drainage areas containing sediment above FRLs includes excavation and disposal of sediment after the affected soils in the associated drainage basin have been removed and the area certified as clean.

6.1.2 Roles and Responsibilities

The Aquifer Restoration Project has the responsibility for the GMA groundwater remediation and wastewater treatment operations. The Soil and Disposal Facility Project is responsible for the excavation of contaminated soils and placement of soils into the OSDF in accordance with specific WAC and materials placement requirements. A number of support organizations are also involved, including

Analytical Laboratory Services, Sample and Data Management, and Environmental Monitoring. The specific responsibilities for implementing the OU5 remedy are defined below.

- Design and construction of the groundwater restoration infrastructure (wells, pipelines, and valving) are typically accomplished through engineering and construction subcontracts. The Aquifer Restoration Project performs operations of these systems, including the operation of all treatment systems and the OSDF leachate collection system.

- Design and excavation of soil remediation projects are typically accomplished through engineering and construction subcontracts that are managed by the Soil and Disposal Facility Project. Also, the Soil and Disposal Facility Project along with Environmental Monitoring perform required pre-design soils sampling as well as pre-certification and certification sampling.

- Soil excavation and placement of waste in the OSDF are monitored by the Waste Acceptance Organization. The design and construction of individual disposal cells, actual placement of waste, and construction of necessary interim and final OSDF capping is accomplished through construction subcontracts.

- The monitoring of environmental media at the FEMP, including groundwater, surface water, air, and OSDF leak detection monitoring is conducted by the Environmental Monitoring section of the Aquifer Restoration Project. Environmental monitoring data are published in Integrated Environmental Monitoring Plan (IEMP) quarterly status reports and annual integrated site environmental reports that are made available to the general public.

6.2 SUMMARY OF REMEDIAL ACTION OBJECTIVES

The objective of the selected remedy is to provide for the protection of existing and future human and environmental receptors through the implementation of several remedial actions. The selected alternative established an engineered waste disposal facility on FEMP property (the OSDF) with restricted use of the remaining areas of the FEMP property.

The selected remedy for OU5 is composed of the following major components:

- Excavation, using conventional construction equipment, of contaminated soil and sediment to the extent necessary to establish statistically, with reasonable certainty, that the concentration of contaminants at the entire site are below FRLs.

- Excavation, using conventional construction equipment, of contaminated soil containing perched water that presents an unacceptable threat, through contaminant migration, to the underlying aquifer.

- Placement of contaminated soil and sediment, which attain the concentration-based waste acceptance criteria, in an on-property disposal facility. Soil exhibiting contaminant concentrations above these acceptance criteria will be treated prior to on-site disposal, or shipped off site for disposal at an appropriate commercial disposal facility or federal disposal facility. Soil from six designated areas in OU5 where a reasonable potential exists for the presence of characteristic waste under the Resource Conservation and Recovery Act (RCRA) will be treated as needed prior to disposition.

- Extraction of contaminated groundwater from the GMA to the extent necessary to provide reasonable certainty that final remediation levels have been attained at all affected areas of the aquifer.

- Treatment of contaminated groundwater, storm water, and wastewater to the extent necessary to attain performance-based concentration discharge limits, mass-based discharge limits, and FRLs in the Great Miami River.

- The application of institutional controls, such as access controls, deed restrictions, and alternate water supplies, during and after remedial activities to minimize the potential for human exposure to site-introduced contaminants and ensure the continued protection of human health.

- Implementation of a long-term environmental monitoring program and maintenance program to ensure the continued protectiveness of the remedy including the integrity of the on-property disposal facility.

The general implementation strategy for OU5 remediation is contained in the Remedial Design Work Plan (DOE 1996i). This plan provided for the development and issuance of the IEMP, which addresses sitewide environmental monitoring and reporting requirements. The plan also provided for development and issuance of the Sitewide Excavation Plan (DOE 1998e), which contains detailed methods and protocols used by the Soil and Disposal Facility Project during each phase of soil remediation.

The following implementation documents the strategy for executing the major elements of the OU5 remedy:

- The Operable Unit 5 Remedial Design Work Plan (DOE 1996i) defines the tracks and schedules for developing the final construction drawings, specifications, plans, and procurement documents necessary for the implementation of the OU5 selected remedy.

- The Operable Unit 5 Baseline Remedial Strategy Report (DOE 1997b) is a remedial design document that serves as the technical basis for the detailed design and operation of the FEMP's groundwater remedy, including the location and number of wells, pumping and re-injection rates, cleanup progress tracking, and aquifer response predictions.

- The Remedial Action Work Plan for Aquifer Restoration at Operable Unit 5 (DOE 1996h) provides the implementation strategy and enforceable schedule for initiating restoration of contaminated portions of the GMA.

- The Sitewide Excavation Plan (DOE 1998e) provides technical guidance for activities related to the excavation and disposition of soil and at- and below-grade structures and debris associated with soil cleanup.

- The Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility (DOE 1997e) defines the on-site disposal requirements for materials generated by the FEMP's environmental restoration and facility D&D efforts.

- The OSDF Impacted Materials Placement Plan (DOE 1999a) describes the acceptance, placement, compaction, and quality assurance/quality control activities that will be conducted throughout construction, filling, and closure of the OSDF.

- The Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Project (DOE 1997d) establishes the operational philosophy for the groundwater and wastewater treatment systems.

- The IEMP defines monitoring requirements to assess achievement of aquifer remedy goals and the collective impact of the sitewide remedial actions on pathways, receptors, and the site's environmental media.

6.3 REMEDIAL ACTION STATUS

6.3.1 Soil and Sediment

The selected remedy for OU5 soil is in the implementation phase. As of December 2000, 838,000 yd^3 (640,735 m^3) of contaminated soil have been excavated, with more than 99 percent of this soil meeting the OSDF WAC and the remainder shipped to an off site commercial disposal facility. The first area to undergo remediation was Area 1, Phase I. This soil remediation project was accelerated to remove soil exceeding the FRLs in the northeast corner of the site. Area 1, Phase I included the area comprising the footprint of the first two OSDF cells, adjacent areas that were needed to support the construction effort, and other areas appropriately addressed as part of this action. In general, a six-inch layer of soil was excavated from 59 acres (24 hectares) of Area 1, Phase I, north and east of the former production area. A forested area to the north did not contain above-FRL contamination, and therefore, was not excavated. During the certification process, an additional 2,300 bank yd^3 (1,759 m^3) of soil were excavated when three units exceeded the FRLs. This area was certified for final land use in June 1998.

Area 1, Phase II addressed soil and debris in the southeast corner of the site, including the former sewage treatment plant and the trap range, which was a shooting range and therefore contaminated with lead. The sewage treatment plant was excavated, while the trap range soil was treated *in situ* for lead and arsenic contamination, then excavated and disposed of in the OSDF. Approximately 61,000 bank yd^3 (46,000 m^3) of soil and at- and below-grade debris was removed from Area 1 Phase II. Materials meeting the on-site radiological WAC were ultimately placed in the OSDF, and materials not meeting these criteria were placed in Stockpile 7. Clay to be used as OSDF liner material was also prepared in the borrow area. An additional 3,800 bank yd^3 (2,905 m^3) of soil was excavated from the trap range area to meet certification criteria. The Area 1, Phase II certification report was submitted to the regulatory agencies in September 2000 and is awaiting final approval of certification for final land use.

Area 1, Phase III was subdivided into three parts to make remediation more efficient. Part One is a 107.1 acre (43.3 hectare) wooded area north of the former production area. Sampling and real-time scanning data indicated no above-FRL radiological contamination in the area. Surface and at-depth debris will be

identified and removed in February 2001. A draft certification report for Part One is planned for submittal to the regulatory agencies in April 2001. Part Two is an approximately 7-acre (2.8-hectare) area north of the former fire training facility that was used as a borrow area for construction of the railyard. A total of 625 bank yd^3 (478 m^3) were excavated from Part Two to remove soil containing an organic contaminant. A draft certification report for Part Two was submitted to the regulatory agencies in November 2000.

A soil stockpile area northeast of the SWUs has also been certified for final land use. This stockpile is part of the area designated Area 2, Phase II. The footprint for Soil Stockpile 3, also part of Area 2, Phase II, has been characterized and a draft certification report was submitted to the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA) in February 2001.

Area 2, Phase III is a soil area east of the SWUs and south of the former production area. Part One was certified without the need for excavation. Approximately 5,000 bank yd^3 (3,823 m^3) of above-FRL contaminated soil was excavated from Part Two in May 2000, and a draft certification report was submitted to EPA and OEPA in August 2000.

Several soil stockpiles were established during remediation of Areas 1 and 2, as well as for Removal Action 17 (Improved Storage of Soil and Debris). A total of 130,000 bank yd^3 (99,400 m^3) of excavated impacted material were placed in these stockpiles; this material has since been disposed of in the OSDF.

Area 8 Phase I is an approximately 13-acre (5.3-hectare) area located west of Paddys Run and consists primarily of open meadow, except for wooded areas along Paddys Run, several slopes, and the drainage ditches. No production-related activities took place in this area. Historical and pre-certification, real-time scanning data indicate no above-FRL contamination. As part of the OU4 Dispute Resolution Agreement, funds were approved to for supplemental environmental projects to be located in Area 8 Phase I, including a public-accessible park and three university research projects.

Area 8 Phase II is an 18.56-acre (7.5-hectare) area located on the northwest corner of the FEMP site. The only production related land use in this area was the removal of borrow material during plant construction, and it was leased to a local farmer for cattle grazing. Area 8 Phase II was certified in order to begin work on the Forest Demonstration Restoration Project. A triangle-shaped portion of Area 6 that extends west of Paddys Run Road, and includes the railroad corridor leading from the site, was also certified so that surface water draining from this area could be used in the Forest Demonstration Restoration Project.

Area 9 is the off-property land adjacent to the eastern portion of FEMP. Area 9 Phase I is a 71.9-acre (29.1-hectare) parcel of land adjacent to remediated portions of Area 1, Phase I (the northern half [approximately] of the eastern FEMP boundary). A draft certification design letter was submitted to EPA and OEPA in January 2001. Area 9 Phase II is south of Area 9 Phase I and east of the remediated portion of Area 1 Phase II. Off-property certification needs to take place after the adjacent portion of the FEMP site is remediated and certified as attaining FRLs.

Table 6-1 summarizes the additional soil volumes that were excavated when certain area certification units did not meet the FRLs after the initial certification sampling.

TABLE 6-1

ADDITIONAL SOIL EXCAVATION VOLUMES FOLLOWING THE INITIAL CERTIFICATION SAMPLING

Area	No. of Certification Units	No. of Certification Units Above FRLs	Additional Soil Excavated (yd^3)
Area 1 Phase I	82	3	2300
Area 1 Phase II	91	3	1525
Area 1 Phase III, Part One	25	0	0
Area 1 Phase III, Part Two	4	1	625
Area 2 Phase I	6	0	0
Area 2 Phase II	2	0	0
Area 2 Phase III, Part One	22	0	0
Area 2 Phase III, Part Two	3	0	0
Area 8 Phase I	4	0	0
Area 8 Phase II/Area 6 Triangle Area	5	0	0
Area 8 Phase III -South	6	0	0

6.3.2 Groundwater (Great Miami Aquifer)

The selected remedy for OU5 groundwater is in the implementation phase. The groundwater remedy is planned to be accomplished through the installation of six distinct restoration modules. Currently, there are four operational groundwater modules:

- The South Plume Module consists of five extraction wells, installed at the leading edge of the South Plume. These five wells were installed under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Removal Action 3. Four of the five wells are currently required to contain the plume; all have been operating since August 1993.

- Two extraction wells comprising the South Plume Optimization module were installed in 1998 to further accelerate the recovery of contaminants in the main off-property portion of the South Plume.

- Phase I of the South Field Extraction System Module consists of an on-site network of 12 wells installed to remove contaminated groundwater from the South Field area. The South Field Extraction Module has operated since 1998.

- Five re-injection wells comprising the Re-Injection Demonstration Module were installed in 1998 and re-inject treated groundwater to facilitate the flushing of contamination within the aquifer.

Future modules currently planned based on the latest sampling data:

- Phase II of the South Field Extraction System Module will be installed after OU2 remedial activities for contaminated soils and source areas have been completed or sufficiently completed to allow entry into this area.

- The Waste Storage Area Extraction Module will be installed to recover contaminants from the GMA underlying the waste storage area (OUs 1 and 4)

A seventh module that was originally planned for the Plant 6 area currently does not appear to be necessary based on ongoing monitoring data. Design documents scheduled to be submitted by the FEMP to EPA and OEPA in the spring of 2001 will document the technical plans for the Plant 6 areas.

The methodology for operating the existing modules (treatment prioritization decisions, well set points for extraction and injection routes, etc.) is described in the Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Project. Table 6-2 provides a performance summary for these modules.

TABLE 6-2

AQUIFER RESTORATION SYSTEM OPERATIONAL SUMMARY SHEET (AUGUST 1993 THROUGH DECEMBER 2000)

	Gallons Pumped/Re-injected (M gal)	Total Uranium Removed/Re-Injected (lbs.)	Uranium Removal Index[a] (lbs./M gal)
South Field (Phase I) Extraction Module	2,064.735	1,332.00	0.65
South Plume Module (including South Plume Optimization)	5,451.357	1,059.99	0.19
Re-Injection Module	858.931	38.20	NA
Aquifer Restoration Systems Totals			
(Extraction Wells)	7,516.092	2,391.99	0.32
(Re-Injection Wells)	858.931	38.20	NA
(net)	6,657.161	2,353.79	NA

[a]NA = not applicable

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6.3.3 Wastewater Treatment

The FEMP operates several collection and treatment systems to achieve important treatment objectives defined in Section 9.1.5 of the OU5 ROD. Collection and treatment of contaminated storm water and wastewater resulting from site operations and remedial actions, and groundwater extracted from contaminated areas of the GMA are all key components of the selected remedy. A summary of treatment systems and the source of water treated are provided below:

- The advanced wastewater treatment facility (AWWT), Phase 1, provides treatment of contaminated storm water collected in the storm water retention basin from the former production area and southern waste unit area. Phase 1 may be used for groundwater treatment during periods of low storm water inventories.

- The AWWT, Phase 2, provides treatment of storm water, wastewater, and OSDF leachate collected in the bio-surge lagoon. Phase 2 can also be used for treating groundwater and/or storm water during periods of low inventories within the bio-surge lagoon.

- The AWWT expansion facility is dedicated to the treatment of contaminated groundwater extracted from the GMA.

- The South Plume interim treatment system is dedicated to the treatment of contaminated groundwater extracted from the GMA.

- The interim advanced wastewater treatment system is used to treat contaminated storm water collected in the storm water retention basin when the storm water retention basin is above mid level. This system is normally used for the treatment of groundwater during periods of low storm water retention basin inventories.

- The sewage treatment plant treats domestic-type wastewater originating on site.

A complete description of FEMP collection and treatment systems and operational philosophy is described in the Operations and Maintenance Master Plan for Aquifer Restoration and Wastewater Project.

All discharges from these treatment systems except for AWWT expansion facility used for re-injection are discharged to the Great Miami River via the Parshall Flume, which is the final monitoring point of the combined FEMP effluents. These discharges must meet mass-based and concentration-based discharge standards for uranium specified in the OU5 ROD as well as effluent limitations for other constituents specified in the FEMP National Pollutant Discharge Elimination System (NPDES) Permit. The FEMP is limited to an annual discharge of 600 pounds of total uranium. In addition, the total uranium concentration of FEMP effluents are currently limited to 20 µg/L on a flow-weighted monthly average subject to conditions stipulated in the ROD relative to storm water bypassing and maintenance activities.

As discussed in Section 6.4.3, the FRL for total uranium in groundwater is under consideration for revision from 20 µg/L to 30 µg/L, based on EPA's recently promulgated drinking water uranium maximum contaminant level (MCL). Pending the preparation and execution of an Explanation of

Significant Differences document for OU5 formally making this change, this new standard will also be applied to the FEMP's treated discharge to the Great Miami River.

6.4 ASSESSMENT OF CONFIRMATORY DATA AND/OR PERFORMANCE DATA

6.4.1 Identify the Scope of the Review

The scope of the review covers all groundwater and soil remedial activities that are ongoing or completed at the time of this review, as well as all soil certification efforts that are ongoing or completed. Groundwater remedial activities include extraction and re-injection of groundwater through the network wells in the existing remediation modules. Soil remediation and certification includes Area 1 (Area 1 Phase I, Area 1 Phase 2, former sewage treatment plant, and trap range), Area 2 (OU5 soils around the SWUs and Area 2 Phase 3), Remedial Action 17 soil piles, Area 8, and Area 9.

6.4.2 Assessment of Soil Remedial Actions

Is the remedy operational and functioning as intended in the ROD?

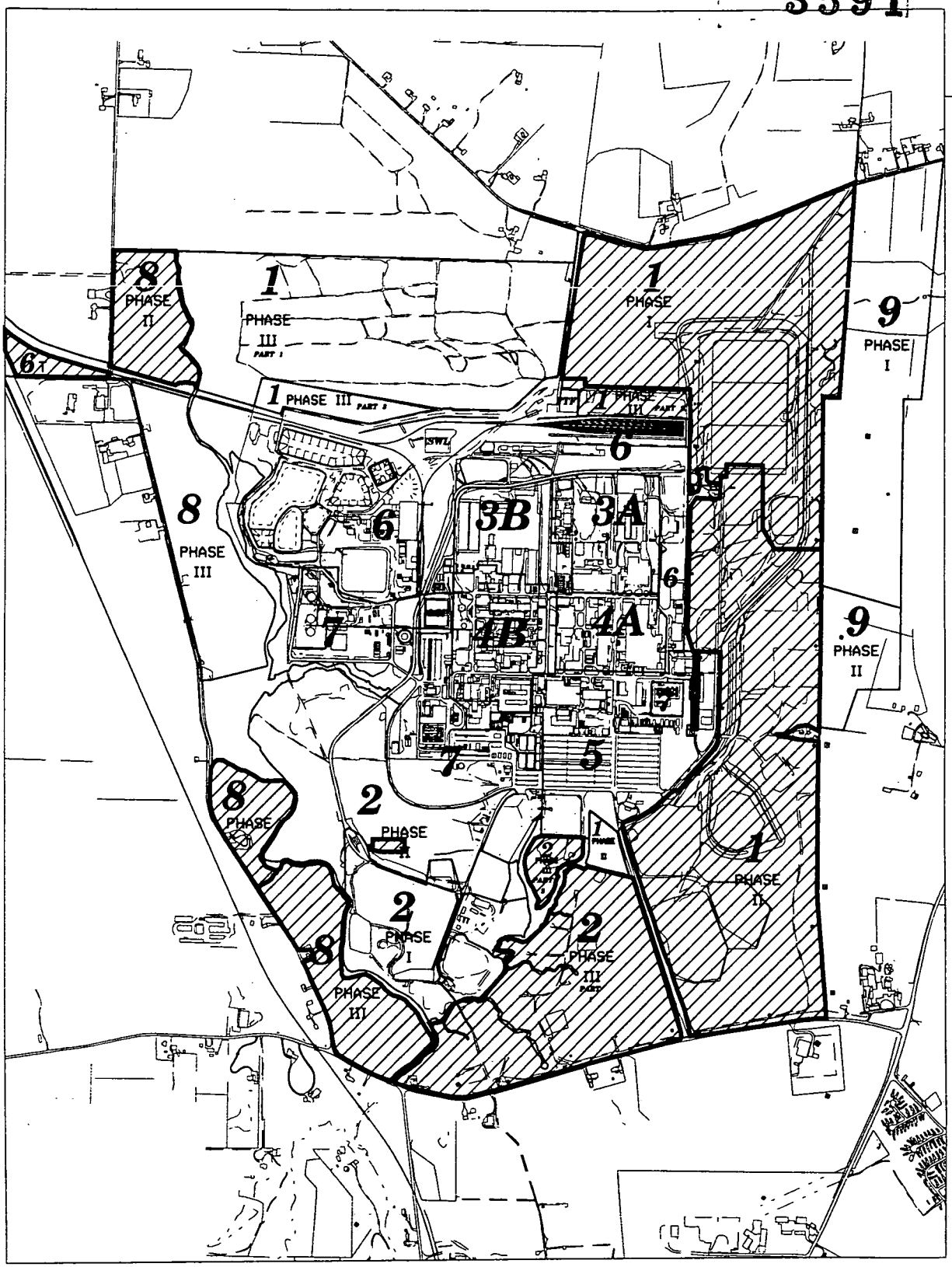
The selected remedy for soil remediation is operational and functional as intended in the OU5 ROD. Remediation and certification has taken place in the areas shown on Figure 6-1. Certification samples are used to demonstrate that FRLs have been achieved; areas containing above-FRL contaminants at the time of initial certification have been re-excavated and re-sampled to ensure FRLs are achieved.

Two significant design changes have been implemented since the OU5 ROD was signed in 1996. The first was the result of a treatability study that indicated lead-contaminated soil in the trap range could be treated *in situ* and then excavated and disposed of in the OSDF. The second change, documented in an Explanation of Non-Significant Differences issued in January 2001, updated the background subsurface soil database to allow better delineation of the extent of FEMP-introduced contamination in the off-property area. The new background soil data have been presented in a draft addendum to the CERCLA/RCRA Background Soil Study (DOE 1993). The FRLs defined in the OU5 ROD will still be applied to soils impacted by the past FEMP production activities. Therefore, the same level of protectiveness will be achieved for soil impacted by past FEMP operations with these changes. The general certification process in off-property cultivated areas, including consideration of the updated background soil conditions, will be documented in an addendum to the Sitewide Excavation Plan. Neither of these changes impacts the final remedial goals for OU5.

6.4.2.1 Validity of ROD Assumptions for Soil Remedial Actions

Are the critical assumptions (to ensure protection of human health and the environment) used at the time of remedy selection still valid?

The target final land use for the FEMP, which was used to set cleanup levels, has not changed from that originally documented in the OU5 ROD. Site remediation and restoration activities remain consistent



LEGEND:

AREAS WHERE REMEDIATION AND CERTIFICATION ARE COMPLETE

SCALE

1400 700 0 1400 FEET

FINAL

FIGURE 6-1. FEMP SOIL REMEDIATION AREAS AND AREAS CERTIFIED

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with the final land use recommended by the Fernald Citizens Task Force, which is continued government ownership of the site and maintenance of the OSDF and a surrounding buffer zone, with the remaining areas made available for use as an undeveloped park. Based on data obtained during remediation of Areas 1, 2, 8, and 9, and pre-design data obtained for Areas 3, 4, 6, and 7, the assumptions identified in the OU5 ROD remain valid with regard to the established FRLs and OSDF WAC.

A re-examination of the OU5 applicable or relevant and appropriate requirements (ARARs) and to be considered-based (TBC) requirements, relevant to the protectiveness of the soil remedy was performed as part of this five-year review. No changes were identified that would adversely affect the planned protectiveness related to soil FRLs. Section 6.4.4 provides the results of a re-examination of the site-wide risk assessment, based several recent updates to cancer slope factors and chemical toxicity factors for several of the FEMP COCs.

6.4.2.2 Remedy Optimization

Has any new information come available that could allow for optimization of the selected remedy for soil remediation; or call into question the validity of the selected remedy?

In situ gamma spectrometry has been extensively used for soil pre-certification purposes in the soil remediation areas certified to date thus ensuring nearly 100 percent coverage of certified areas and saving on sampling and analysis costs. *In situ* gamma spectrometry was routinely utilized in pre-certification activities to provide high quality and timely radionuclide data for soil characterization and excavation operations. The *in situ* gamma spectrometry program consists of an integrated suite of hardware and software technologies that allow for real-time radionuclide contamination detection as well as real-time data mapping and evaluation. The *in situ* gamma spectrometry system has been routinely deployed in OU5 remediation areas to provide general area and pre-design surveys, identification of hot spots and above WAC areas, confirmation of radionuclide contamination removal, and pre-certification measurements. Additionally, *in situ* gamma spectrometry has provided pre-certification data for over 460 acres sitewide including all of the areas certified to date. The use of *in situ* gamma spectrometry has allowed the FEMP to achieve the stringent schedule for soil remediation over the past three years and has resulted in cost savings of approximately $15 million sitewide over conventional physical sampling and laboratory analytical methods.

The remedy is also being optimized as provided for in the ROD by implementing the findings of treatability studies to reduce soil contaminant leachability for constituents regulated under RCRA and facilitate disposal of more soils in the OSDF, thus reducing overall cost of transporting waste off site as well as improving efficiency of waste management activities.

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There have been no significant changes in site physical conditions (exposure pathways, contaminant sources, or site receptors) which would call into question the protectiveness of the remedy as envisioned in the OU5 ROD. A review of contaminant characteristics as they affect the remedy is provided in Section 6.4.4.1.

6.4.3 Assessment of Groundwater Remedial Action

Is the OU5 groundwater remedy operational and functioning as intended in the ROD?

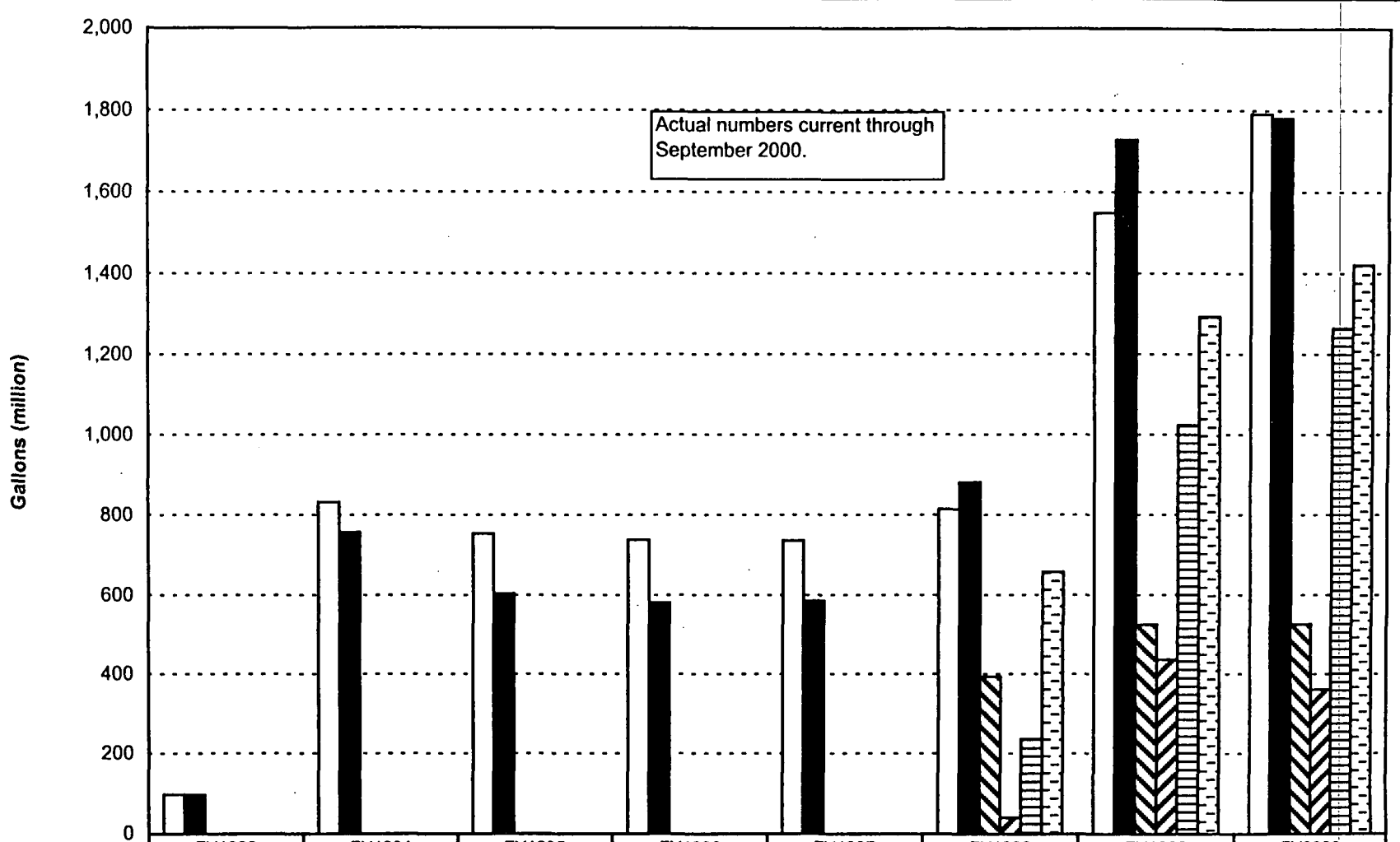
The groundwater remedy, as currently constructed and operated, is fully functional and achieving important benchmarks relative to design-based performance indicators. Moreover, the aquifer is responding in an overall predictable manner. A review of the progress and effectiveness of the groundwater remedy, through the end of 2000, was made based on three criteria:

- Basic performance indicators comparing actual groundwater pumping rates and uranium removal amounts to those projected in the Baseline Remedial Strategy Report
- An evaluation of the capture zone to reaffirm that the contamination plume is still effectively bounded
- An assessment of groundwater monitoring results to establish the degree to which the contamination in the aquifer is responding to the remedial actions undertaken.

Assessment of Performance Indicators

Performance projections for the finalized baseline strategy were presented in Section 5.3 of the Baseline Remedial Strategy Report. This finalized strategy predicted the remediation schedule could be shortened from that presented in the Feasibility Study (FS) Report for OU5 from 27 years to a period between 10 to 20 years.

A comparison of actual performance for key remedial indicators (e.g., quantities of groundwater pumped, uranium extracted, groundwater treated, and the concentration of groundwater directed to treatment) with the performance characterization predicted in the Baseline Remedial Strategy Report helps reveal how well the groundwater remediation system as a whole is operating. While the comparison does not provide an absolute measure of how the actual remediation of the aquifer is progressing, it does indicate how well the remediation system is operating with respect to estimated performance at the time of system design. Figures 6-2 through 6-6 provide these comparisons.



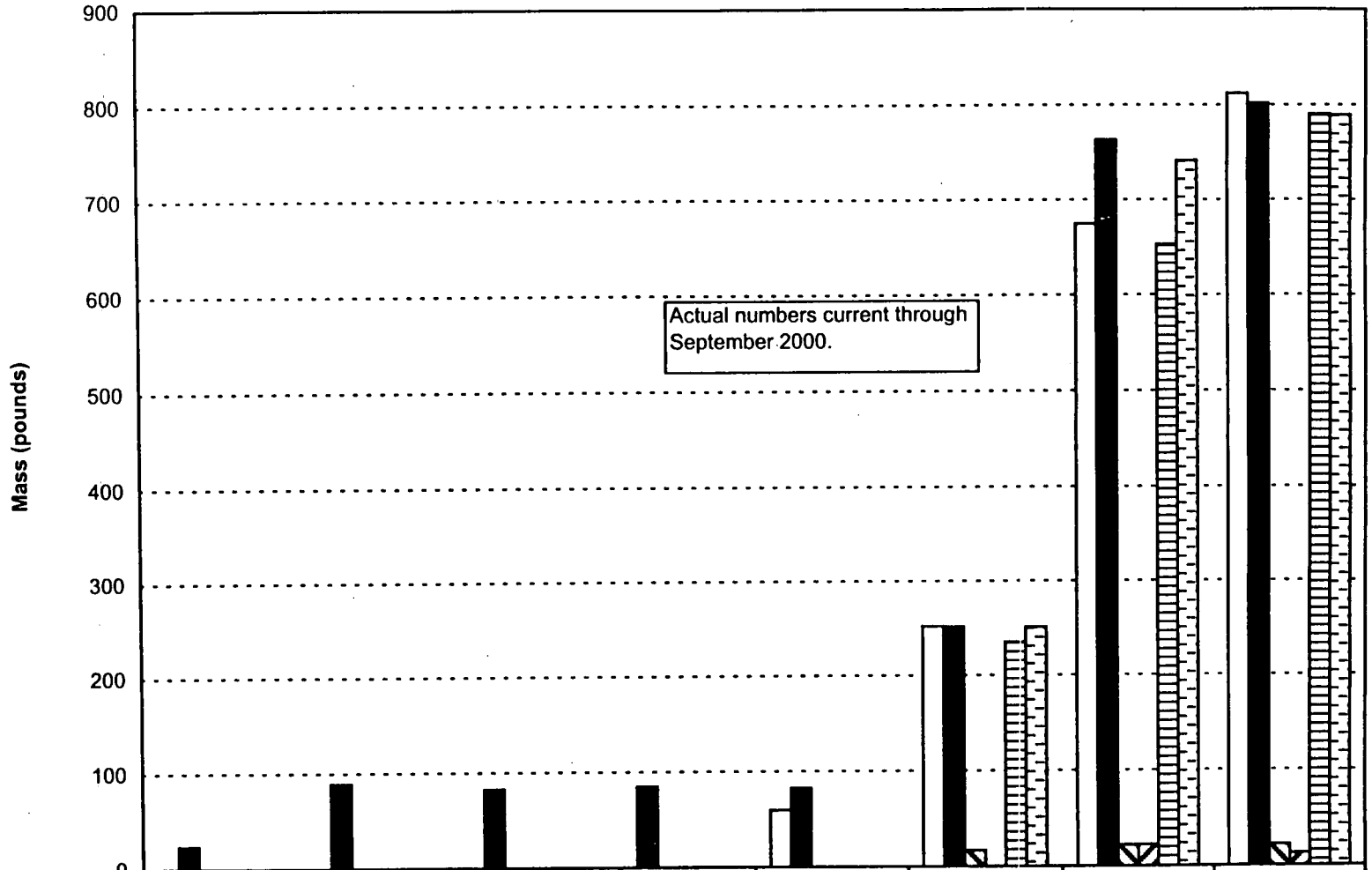
	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000
Planned Total GW Pumped (Mgal)	97.92	832.32	753.552	737.856	735.84	814.464	1548.576	1791.936
Actual Total GW Pumped (Mgal)	97.183	756.976	603.433	580.816	585.054	881.675	1727.67692	1781.524
Planned Injected GW (Mgal)	0	0	0	0	0	393.12	525.6	527.04
Actual Injected GW (Mgal)	0	0	0	0	0	39.841892	436.651748	361.051791
Planned Net GW Extracted (Mgal)	0	0	0	0	0	235.872	1022.976	1264.896
Actual Net GW Extracted (Mgal)	0	0	0	0	0	657.183808	1292.926662	1420.473

Date (fiscal year)

FIGURE 6-2. TOTAL GROUNDWATER PUMPED, INJECTED, AND NET EXTRACTED

FINAL

000074



	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000
Planned Total U Extracted from GMA (lbs)	0	0	0	0	59.6	251.7	674.8	812.3
Actual Total U Extracted from GMA (lbs)	24	89	83	85	82.64	251.29	763.59	801.8
Planned Total U Injected (lbs)	0	0	0	0	0	16.38	21.9	21.96
Actual Total U Injected (lbs)	0	0	0	0	0	0.33	22	12.3
Planned Net Total U Removed from GMA (lbs)	0	0	0	0	0	235.3	652.9	790.4
Actual Net Total U Removed from GMA (lbs)	0	0	0	0	0	250.7	741.6	789.5

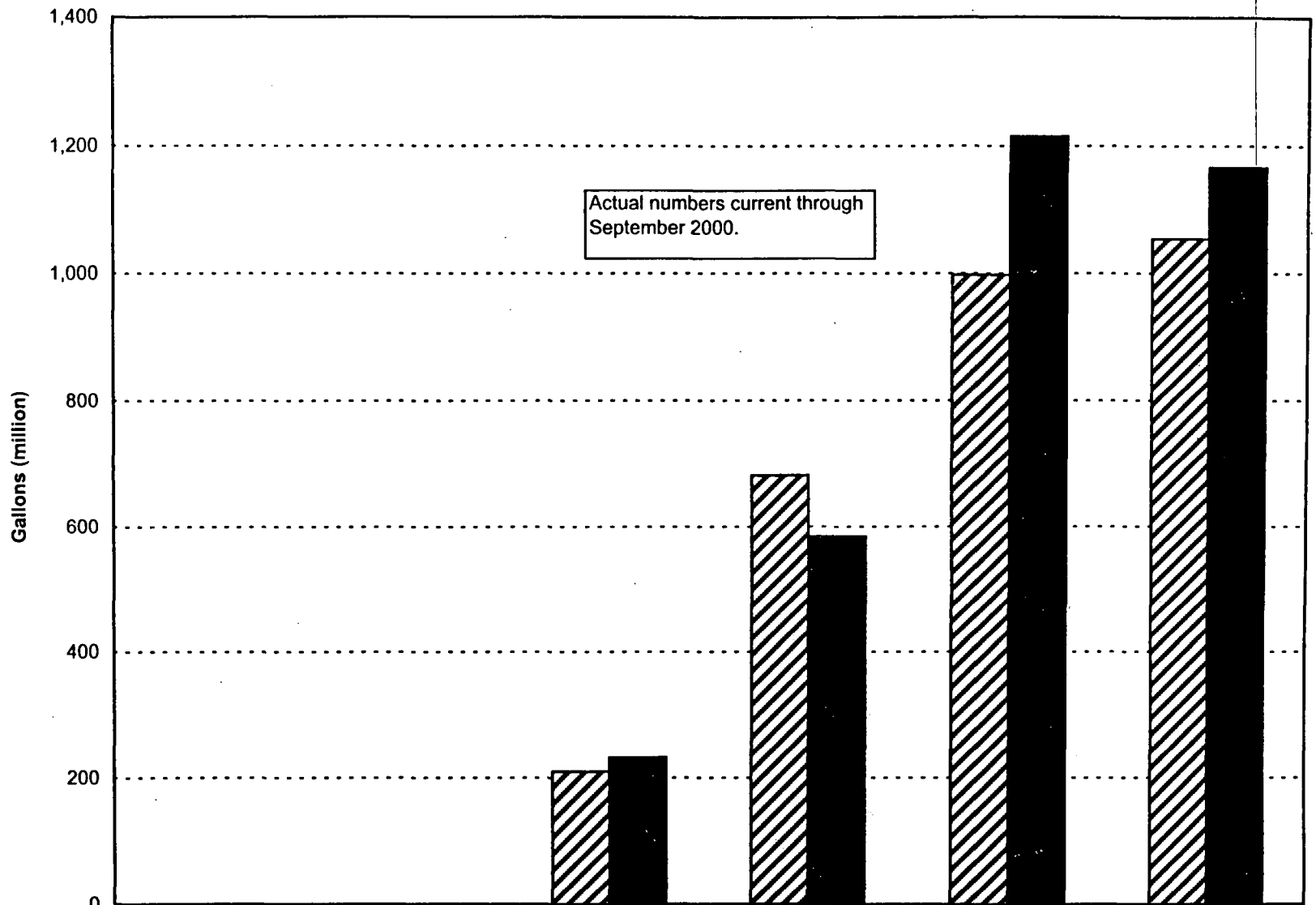
Date (fiscal year)

FIGURE 6-3. TOTAL URANIUM EXTRACTED, INJECTED, AND NET FROM GREAT MIAMI AQUIFER

FINAL

000075

1-8591



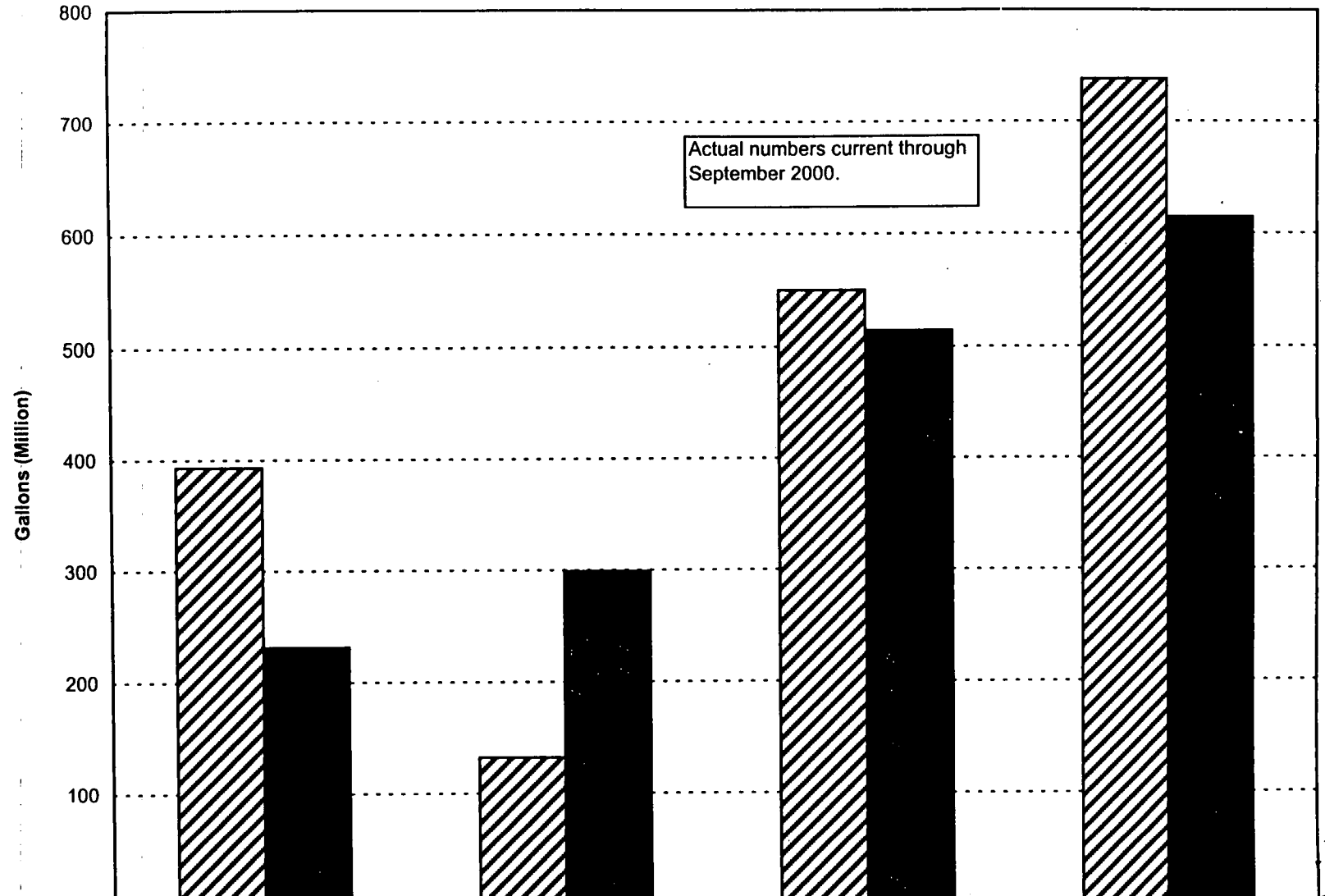
	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000
Planned GW to Treatment (Mgal)	0	0	210.24	681.984	998.208	1054.08
Actual GW to Treatment (Mgal)	0	0	232.67	584.722	1214.547	1166.106

Date (fiscal year)

FIGURE 6-4. TOTAL GROUNDWATER TREATED

FINAL

000076

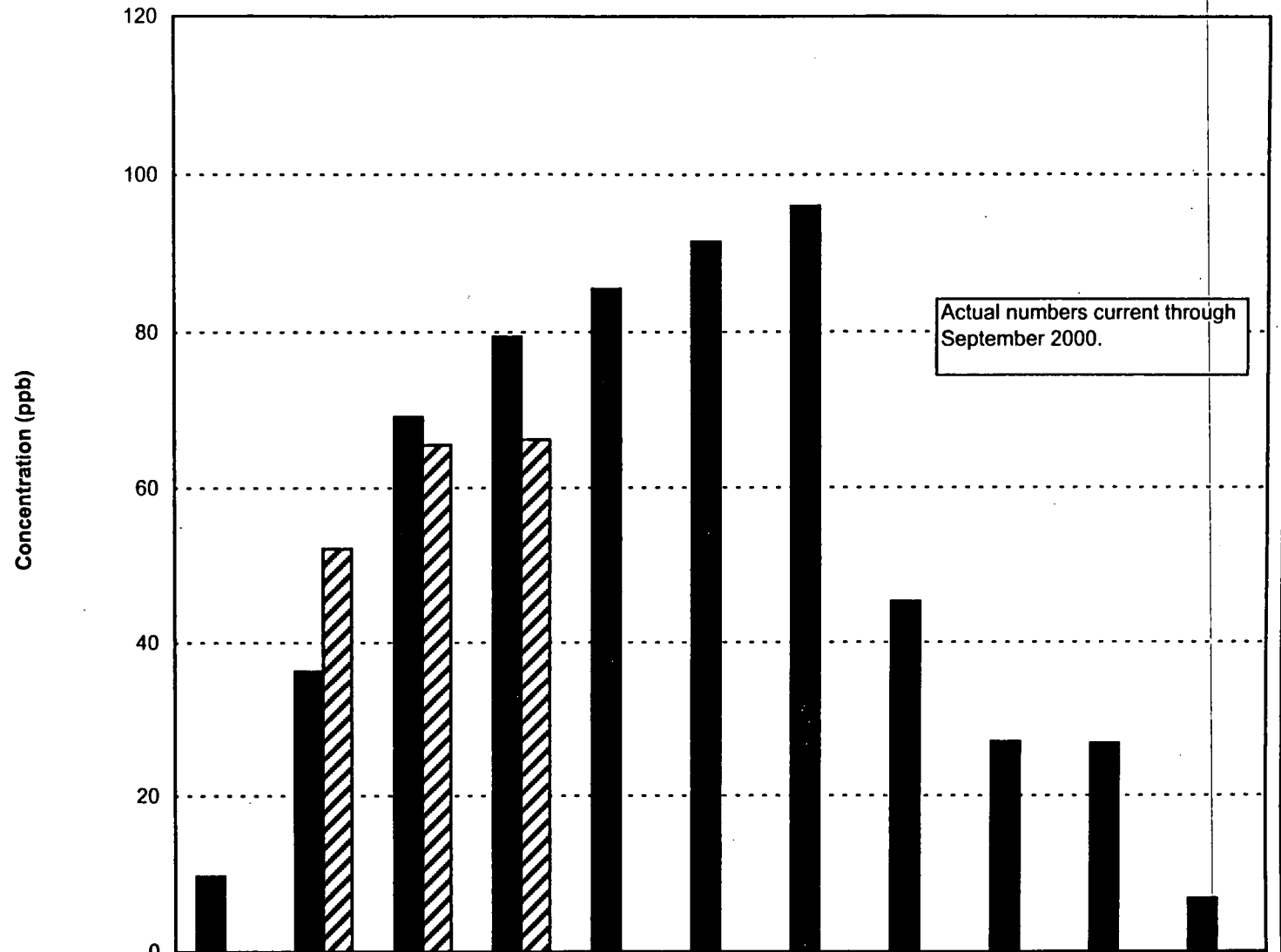


	FY1997	FY1998	FY1999	FY2000
Planned Water to Bypass (Mgal)	393.12	132.48	550.368	737.856
Actual Water to Bypass (Mgal)	231.553	299.061	514.367	614.418

Date (fiscal year)

FIGURE 6-5. GROUNDWATER NOT TREATED

FINAL



	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007
Planned Total U to Treatment (ppb)	9.7	36.3	69.2	79.4	85.5	91.5	96	45.3	27	26.8	6.8
AWWT 1800 Influent Flow-weighted Avg Actual Total U to Treatment (ppb)	0	52.2	65.5	66.2	0	0	0	0	0	0	0

Date (fiscal year)

FIGURE 6-6. TOTAL URANIUM CONCENTRATION TO TREATMENT

FINAL

000078

Assessment of Capture Zone

The primary objectives of the South Plume and South Plume Optimization Modules are to prevent the further southward movement of the contamination plume and to actively remediate the interior of the off-property portion of the plume. These modules are evaluated quarterly and the results are summarized through the IEMP reports. Detailed operational information supporting the evaluation and conclusions in meeting these primary objectives are provided in Appendix A.3 of the 1999 Integrated Site Environmental Report (DOE 2000d). Capture zone assessments have been updated via the IEMP quarterly status reports.

Figures 6-7 and 6-8 indicate that contaminant migration southward, beyond the South Plume extraction wells, has not occurred, and that active remediation of the central portion of the off-property total uranium plume continues. There is good agreement between the modeled capture zone, and the measured capture zone based on July 2000 (the most recent available) water level measurements.

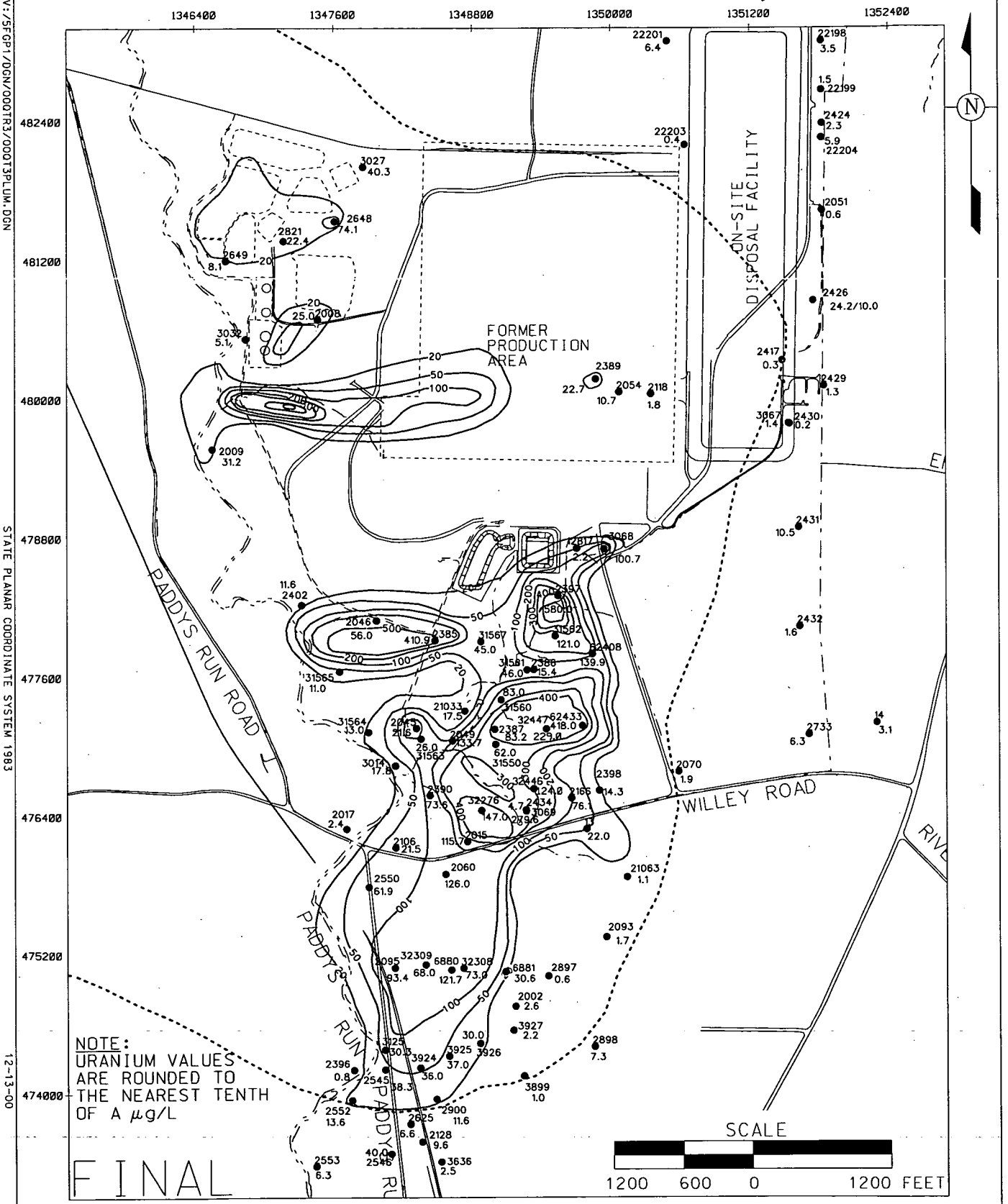
Assessment of Groundwater Monitoring Results

The FEMP implements a routine groundwater monitoring effort using a system of monitoring wells and direct push groundwater sampling techniques to track the 20 µg/L total uranium plume boundary; identify the size, shape and extent of contamination lobes; pinpoint future extraction well locations; and monitor increasing or decreasing trends in total uranium concentration. These trends, in the form of total uranium concentration versus time plots, indicate the aquifer response to the remedial pumping and re-injection.

Figure 6-9 summarizes the concentration versus time plot trends for select monitoring wells. The figure indicates a number of wells with decreasing concentrations in response to groundwater being extracted. Monitoring Wells 2049, 2385, 2397 and 3095 show increasing trends. This is indicative of plume movement towards the respective extraction wells, which is expected and provides evidence that the contamination plumes are responding as predicted.

Non-uranium constituents are also monitored as a part of the routine groundwater-monitoring network for comparison to FRLs established in the ROD. Non-uranium constituents were evaluated through a detailed selection process presented in Appendix A of the IEMP, Revision 2 (DOE 2001b). This selection process has resulted in a focus on 50 chemical constituents.

Up through 1997 there had been a number of FRL exceedances for non-uranium constituents. The majority of these exceedances occurred within the 10-year uranium-based restoration footprint. However, there were several FRL exceedances outside this footprint primarily along the eastern boundary of the FEMP. The Restoration Area Verification (RAV) Sampling Program Summary Report (May 1998) evaluated the FRL exceedances outside this footprint, based on sampling data collected in 1996 and 1997,



LEGEND:

2553● MONITORING WELL OR GEOPROBE LOCATION

5.1 TOTAL URANIUM CONCENTRATION MEASURED IN SECOND QUARTER 2000

CONTOUR CHANGES BASED ON NEW MAXIMUM SECOND QUARTER 2000 DATA

FEMP BOUNDARY

50 MAX TOTAL URANIUM CONTOUR IN μg/L FROM BASELINE MODIFIED QUARTERLY

10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

FIGURE 6-7. TOTAL URANIUM PLUME MAP, SECOND QUARTER 2000

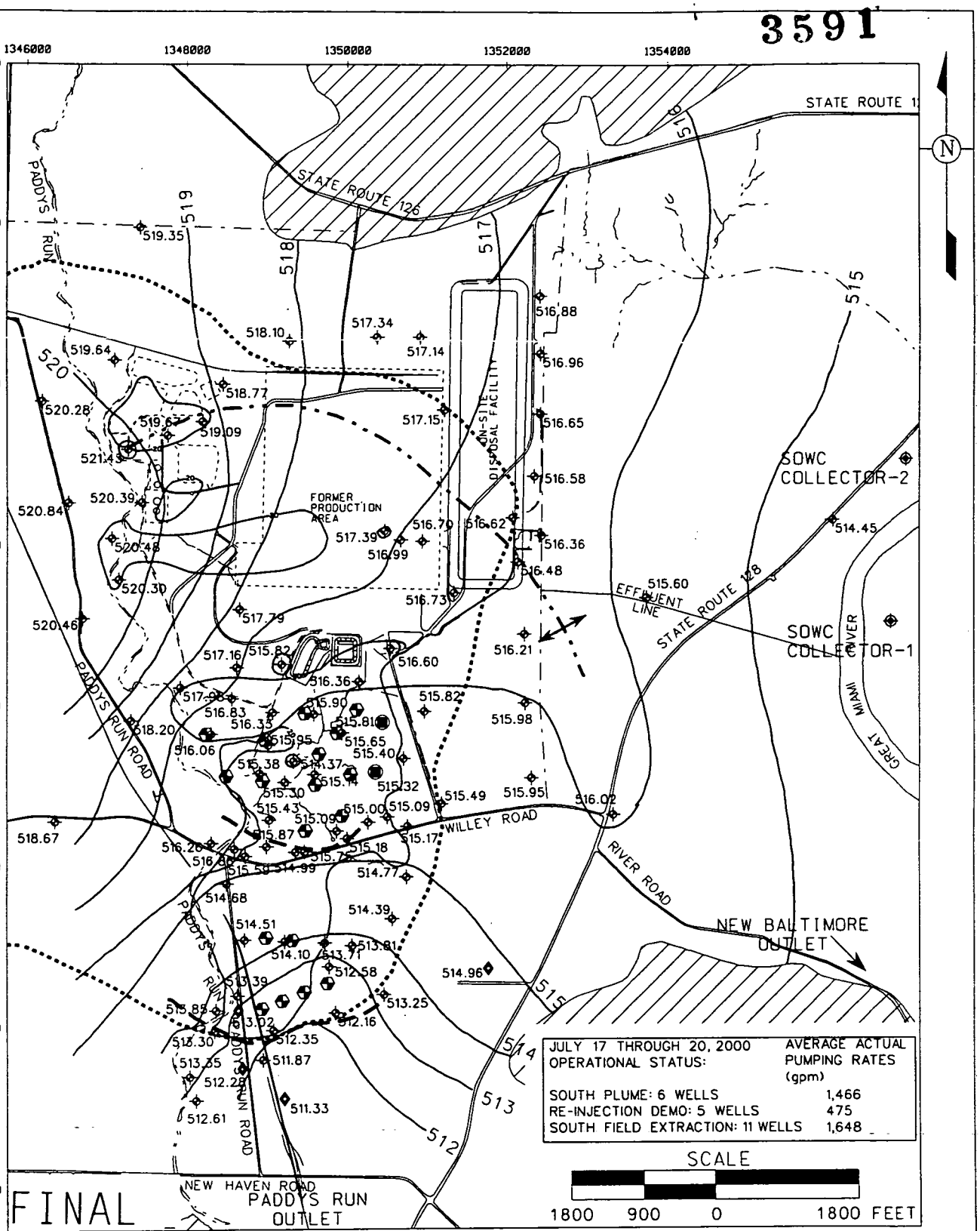


FIGURE 6-8. ROUTINE GROUNDWATER ELEVATIONS FOR TYPE 2 WELLS, JULY 2000

Y:/5FCP1/DGN/000TR3/000T3001.DGN
STATE PLANAR COORDINATE SYSTEM 1983
12-13-00

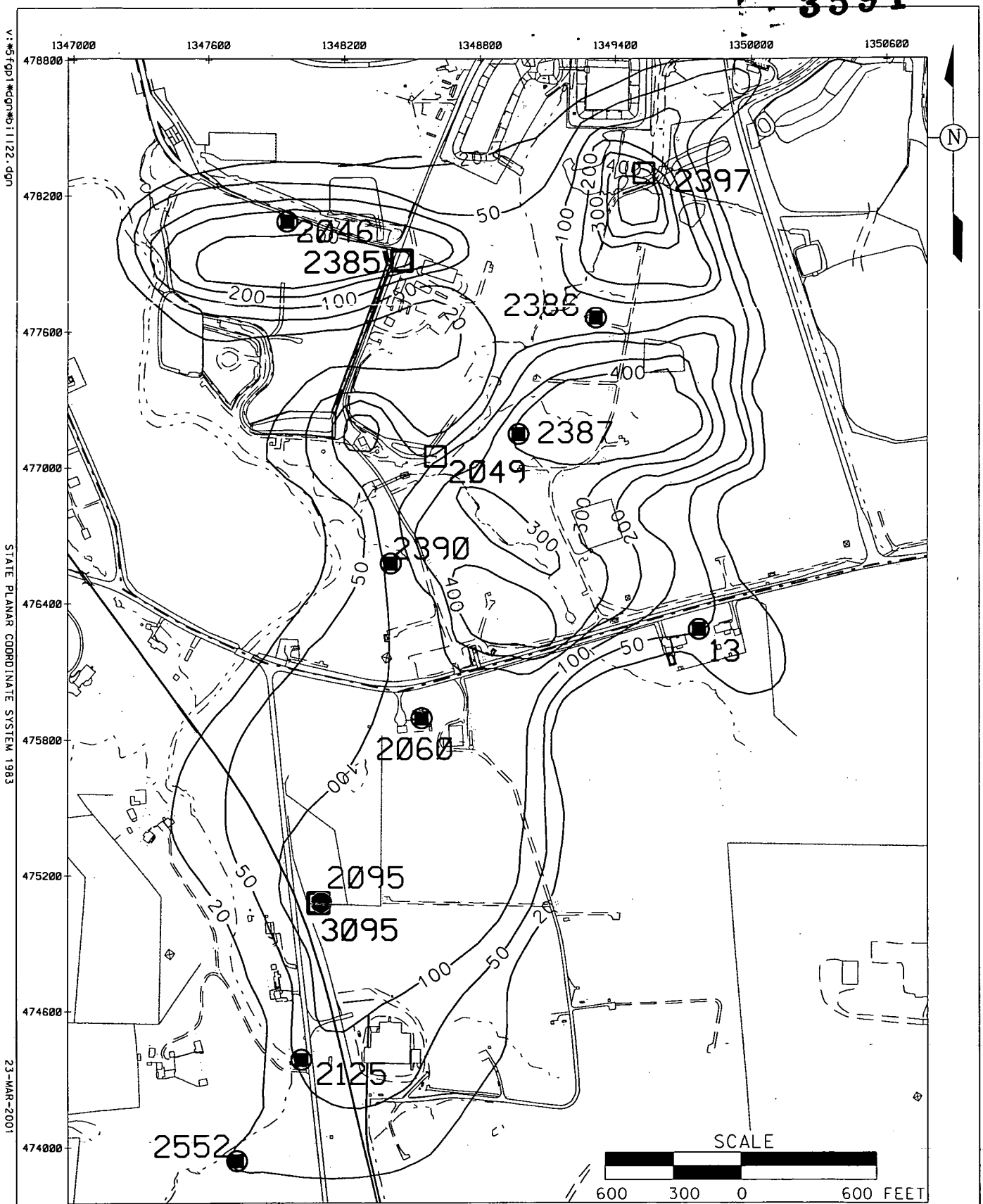


FIGURE 6-9. URANIUM TRENDS IN SELECT MONITORING WELLS

and concluded that the existing groundwater monitoring program was sufficient and no modification of the uranium-based aquifer remedy was required. Continuing evaluations are conducted annually based on the most recent data collected. The annual evaluations are presented in Appendix A.4 of each of the IEMP annual integrated site environmental reports. The conclusions to date continue to indicate that no changes to the uranium-based aquifer remedy are necessary.

Storm Water Control and Wastewater Treatment

Figure 6-10 shows that the FEMP has met the 600 pounds total uranium mass limitation every year since the ROD was signed in 1996. Since January 1, 1998, the effective date for the concentration-based limitation, the FEMP has achieved compliance with the terms and conditions relative to the 20 µg/L monthly average standard in 33 of the 36 months. In response to sequential exceedances in December 1998 and January 1999, major revisions were made to the Operations and Maintenance Master Plan for Aquifer Restoration and Wastewater Project to modify treatment operations. No exceedances have occurred since these revisions were implemented. Additionally, the FEMP has been in compliance with the NPDES effluent limitations over 99 percent of the time since January 1996.

6.4.3.1 Validity of ROD Assumptions

Are the critical assumptions (to ensure protection of human health and environment) used at the time of remedy selection for groundwater still valid?

As part of the five-year review, an assessment of critical assumptions relative to future land use, exposure pathways, and contaminant toxicity was conducted. The critical assumptions involve the exposure pathway and contaminant toxicity. The sources of residual contamination to the GMA after remediation include leaching and infiltration of storm water through soils with residual contamination and leachate from the OSDF, as well as residual contamination left in the GMA after all groundwater extraction efforts have been completed. The cumulative residual contamination remaining in the GMA from all of these sources is projected to meet the FRLs contained in Table 9-4 of the OU5 ROD. These FRLs were developed from:

- Finalized or proposed MCL values pursuant to the National Primary Drinking Water Regulations under the Safe Drinking Water Act
- Risk-based concentrations derived from reference doses and cancer slope factors in the absence of MCLs/proposed MCLs
- Background levels, if background concentrations are greater than the MCLs/proposed MCLs or the risk-based concentrations
- Analytical detection limits, if detection limits are above the risk based concentrations.

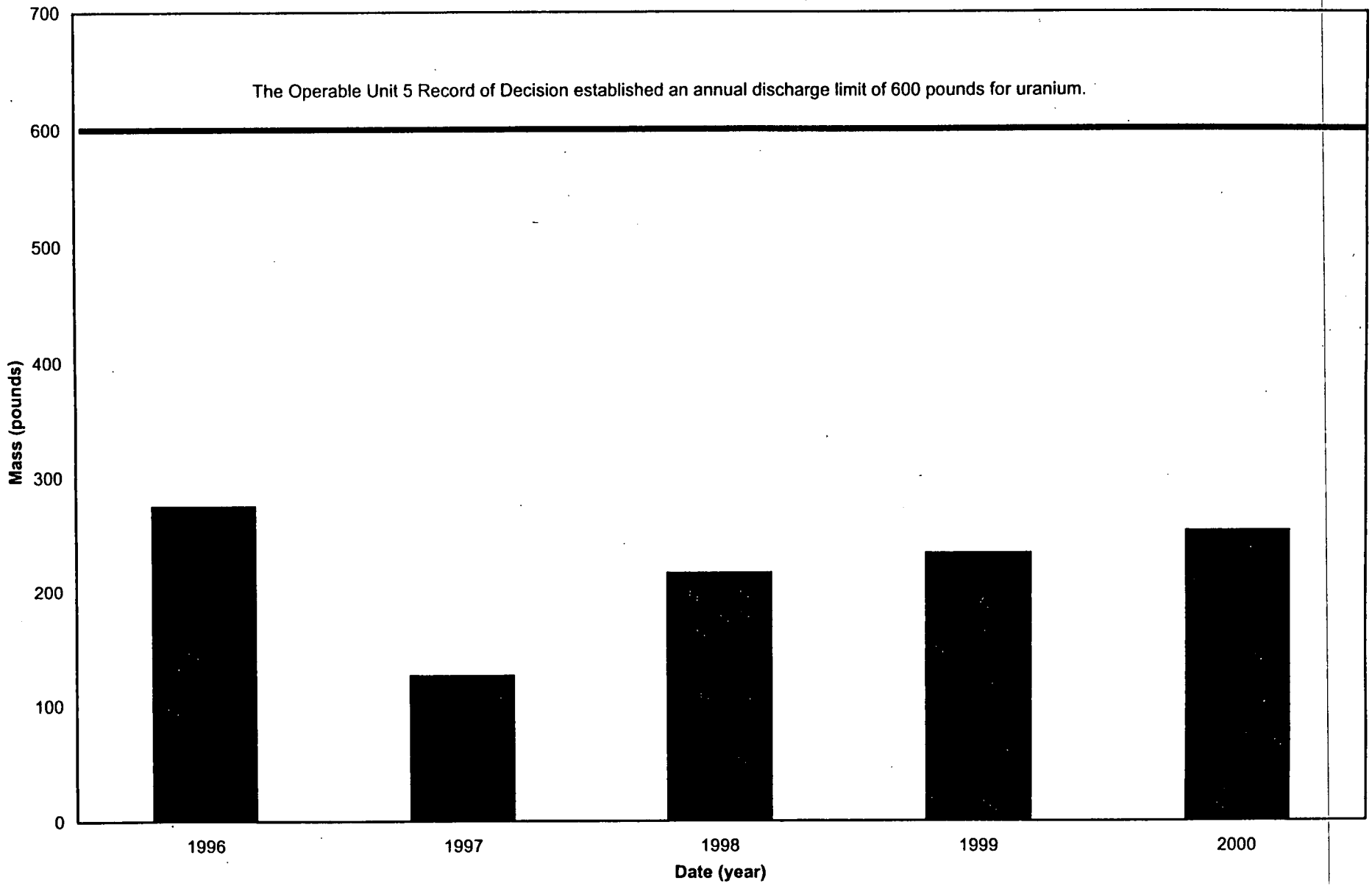


FIGURE 6-10. POUNDS OF URANIUM DISCHARGED TO THE GREAT MIAMI RIVER FROM THE PARSHALL FLUME (PF 4001) 1996 - 2000

FINAL

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The target receptors for the groundwater pathway analysis conducted for the OU5 risk assessment were the off-property adult and off-property child who used the GMA as a source of drinking water (ingestion), had dermal contact with the water through showering, and who used the water in food preparation and crop irrigation.

All of the assumptions relative to sources of residual contamination, target receptors, and exposure pathways remain valid. There has been no change to the land use objectives that formed the basis of the selected remedy.

The groundwater FRLs for the GMA (Table 9-4 of the OU5 ROD) were reviewed for consistency with current MCL values as published in the "Current Drinking Water Standards/National Primary Drinking Water Regulations" from the EPA website. The 10 radionuclides and 41 chemicals (51 total COCs) with GMA FRLs were reviewed for consistency with the most current MCLs. Of the 51 GMA COCs, 21 had published MCLs. Of these 21, the following three changes have occurred since issuance of the ROD:

- The FRL for total uranium in groundwater adopted in the OU5 ROD as 20 µg/L was based on the proposed MCL. The final MCL for total uranium was promulgated at 30 µg/L (National Primary Drinking Water Regulations; Federal Register Volume 65, Number 236; December 7, 2000).
- The FRL for arsenic in groundwater adopted in the OU5 ROD as 50 µg/L was based on the existing MCL. The MCL for arsenic was modified to 10 µg/L (National Primary Drinking Water Regulations; Federal Register Volume 66, Number 14; January 22, 2001). Note: As of March 20, 2001, EPA has proposed to withdraw the revised standard, pending independent scientific review. The timetable for resolving the final value is 60 days from the March 20, 2001 announcement of the proposed withdrawal.
- The FRL for radium-226 and radium-228 adopted in the OU5 ROD was based on a proposed MCL of 20 picoCuries per liter (pCi/L) for each isotope. The proposed MCL was not adopted and reverted to the existing MCL of 5 pCi/L combined (National Primary Drinking Water Regulations; Federal Register Volume 65, Number 236; December 7, 2000).

The FEMP plans to pursue changing the FRLs for total uranium and arsenic based on the newly established FRLs. As identified, the primary basis for the change is the promulgation of the final standard for uranium in drinking water. The ROD for OU5 adopted the proposed uranium MCL with the expectation that once finalized, the revised value would most likely be used at the FEMP.

The FRL for arsenic is also being revised by the U.S. Department of Energy (DOE) at the request of OEPA. The revised values for arsenic and uranium represent a significant change to the OU5 remedy. The most appropriate method for documenting this change is an Explanation of Significant Differences

(ESD) document, which DOE will prepare in the spring 2001. The ESD will be subject to public review as part of the approval process.

No changes to the radium-226 and radium-228 FRLs are being contemplated at this time. The risk estimate prepared at the time of the OU5 ROD utilized the original 20 pCi/L MCLs for radium-226 and radium-228, and found that the risks fall within the acceptable CERCLA risk range. Consistent with EPA CERCLA policy on MCL revisions (OERR 9234.0-01FS, May 1989), as long as a CERCLA remedy remains protective under the standard in force at the time of ROD signature, it does not have to be modified to address the revised requirement.

A comparison of cancer slope factors and chemical reference doses with the latest published information was also performed as part of the review, in order to identify changes that could result in alterations in the original assumptions driving the selected remedy for OU5. The results of the assumptions review are summarized in Section 6.4.4.

6.4.3.2 Remedy Optimization

Has any new information come available that could allow for optimization of the selected remedy for groundwater; or call into question the validity of the selected remedy?

As noted in Section 6.3.3 and 6.4.3.1, the OU5-ROD-established groundwater FRL for total uranium and the monthly average total uranium discharge limit are being revised based on EPA's promulgation of a uranium drinking water MCL at 30 µg/L. Aligning the FRL and the discharge limit with the MCL is anticipated to result in a reduction in the time and therefore cost required to cleanup groundwater at the site. Adoption of the MCL may also result in less infrastructure (wells, pipelines, etc.) being required to complete the groundwater remediation.

The need to continue to expend resources sampling for some non-mobile COCs is also being evaluated. As part of the groundwater remedy performance monitoring identified in the IEMP, this spring the site is scheduled to sample the "<N" constituents (a category of non-mobile constituents) in the GMA. The estimated cost for this sampling activity is $267,540.00. Approximately 50 percent of this cost will go toward the analysis of two dioxins (2,3,7,8-tetrachlorodibenzo-p-dioxin and octachlorodibenzo-p-dioxin). Considering the low water solubility of the dioxins, and the low probability of finding dioxin contamination in the aquifer, DOE does not believe that the negligible risk posed to the aquifer by these two constituents justifies the high cost of analysis. The revised sampling frequency for these constituents will be determined in conjunction with EPA and OEPA. The results of the determination will be documented in the IEMP annual integrated site environmental report.

The ongoing groundwater remedy performance monitoring program and pre-design monitoring tasks have been successful in providing data to refine the site groundwater remedy. Since pumping of the South Plume Optimization wells and the South Field Phase I wells began in 1998, monitoring data have indicated the following:

- One of the South Field extraction wells was ready to be shut down.
- Two additional extraction wells should be installed in the eastern portion of the South Field area.
- Extraction well pumping rates should be increased at some locations.

South Field Extraction Well 31566 was shut down in late summer 1998 due to low uranium concentrations and concerns that a recalcitrant zone of uranium contamination would be created if pumping of the well continued. Two new South Field Extraction wells (32446 and 32447) were installed in 1999 and became operational in February 2000. Pumping rates have been increased to the degree possible within the constraints imposed by the site uranium discharge limitations and well/pump specifications.

The pre-design groundwater-monitoring program has been successful in providing data to refine the location and number of extraction wells required in the planned Waste Storage Area and the Plant 6 Area Groundwater Restoration Modules. The data indicate that the aquifer restoration infrastructure required for both areas is less extensive than had been planned in the 1997 Baseline Remedial Strategy Report Remedial Design for Aquifer Restoration. However, the time period to for remediating the waste storage area plume could be considerably longer than the report had estimated. The installation of this waste storage area infrastructure is being accelerated in an attempt to mitigate against this increased remediation time.

6.4.4 Review of Post-Remedial Action Contaminant Toxicity Assumptions

Both the draft EPA and DOE five-year review guidance documents suggests the following evaluation: *"Evaluate those assumptions critical to the effectiveness of remedial measures on the protection of human health and the environment (made at the time of the remedial decision) to determine, given current information, whether these assumptions are still valid."* Thus, the assumptions and toxicity factors utilized for risk assessments conducted during the RI/FS were re-examined as part of this five-year review to ensure that the remedy for OU5 remains protective.

6.4.4.1 Human Health Risks and Remedial Design

In the OU5 Baseline Risk Assessment (Appendix A of the OU5 RI Report), risks to a series of modeled human receptors representing a variety of possible land uses were calculated. Risks to the modeled

receptors greater than 10^{-4} and/or and Hazard Index (HI) of >1 determined that remediation of the site was necessary to be protective of human health and the environment. The OU5 Baseline Risk Assessment also considered all radionuclides and chemicals that passed a preliminary screening for their presence or absence on site. Tables A.4-1 and A.4-3 of the OU5 RI Report summarize these constituents.

In the FS Report for Operable Unit 5 (DOE 1995a), the Comprehensive Response Action Risk Evaluation (CRARE) (Appendix H of the FS Report for OU5), risk calculations were performed that focused on the remedial alternatives and the risk imposed on modeled target receptors from contaminants remaining under post-remedial conditions. The target receptors evaluated in the CRARE that supported the OU5 selected remedies were: 1) undeveloped park user, 2) off-site resident farmer, and 3) off-site resident farm child. Calculated post-remedial risks to these modeled receptors were evaluated using projected residual concentrations of COCs. The human health risk to these receptors met the CERCLA upper bound limit of 10^{-4} Incremental Lifetime Cancer Risk (ILCR) and <1 HI.

After risk modeling had been completed in the CRARE, an evaluation was performed to determine which COCs were driving risk to the target receptors. As a result of the evaluation, it was found that in excess of 99 percent of the modeled post-remedial risk (ILCR and HI) to the target receptors came from 26 COCs (10 radionuclides, 12 inorganics, and four organics). In spite of this, the list of FRLs as published in the OU5 ROD were based on a more conservative screening criteria of 10^{-7} ILCR, and HI of 0.1 to the hypothetical on-property farmer receptor. This conservative approach ensured that no significant COC was ignored in the post-remedial assessment. Fourteen radionuclides and 67 chemicals (81 total) for soil, and 51 for groundwater were retained on the published list of FRLs.

6.4.4.2 Review of Radiological Cancer Slope Factors

When the Baseline Risk Assessment for OU5 was written, assumptions regarding the toxicity of evaluated contaminants, which were current at that time (1994), were utilized for the risk calculations. Cancer slope factors are published values that specify a cancer morbidity value (risk) to a receptor for a given quantity of contaminant intake, referred to as an ILCR. The resulting value, usually expressed in scientific notation, determines whether post-remedial concentrations of contaminants will result in a cancer risk that is in compliance with CERCLA guidance (10^{-4} to 10^{-6} ILCR risk range). Cancer slope factors are published for most radionuclides, and some non-radionuclide chemicals that are proven or suspected carcinogens.

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6.4.4.3 Chemical Toxicity Factors

Calculated non-cancer health risk due to exposure to non-radiological chemicals is performed by application of reference dose factors, for oral and inhalation routes of exposure. Reference doses estimate the upper bound dose of a chemical a human receptor can be exposed to chronically without suffering ill effects. When a contaminant intake for a receptor, is multiplied by the appropriate reference dose factor, a risk value results. If this number, called a HI is greater than 1, a negative health impact to the modeled receptor is anticipated. The EPA's Integrated Risk Information System (IRIS) database contains the reference dose factors.

6.4.4.4 Changes in Contaminant Toxicity Factors

As the body of knowledge increases regarding radiological and chemical toxicity, the EPA occasionally finds it necessary to change the cancer slope factors and/or reference dose factors representing a contaminant's impact on human health. At the time that the OU5 documents were written (1994), the most current cancer slope factors and reference dose factors were utilized. For this five-year review, an evaluation was conducted to determine if any changes in these values could potentially result in an alteration of post-remedial risk projections to the target receptors that represented the selected remedy.

The first step in this evaluation was to obtain from the OU5 RI Report the list of cancer slope factors for all listed COCs (Table A.4-1 of the OU5 RI). Also obtained was Table A.4-3 of the OU5 RI Report which listed available reference doses and cancer slope factors for non-radiological chemicals. These two comprehensive lists were then compared to the lists of COCs with FRLs for soil, and for the GMA. These FRLs were the starting point in conducting this evaluation.

Information regarding the most current cancer slope factors and reference doses was obtained from the Health Effects Summary Tables (HEAST) and IRIS databases, respectively, located on the EPA website. An initial review for changes was performed on all COCs with FRLs published in the OU5 ROD.

6.4.4.5 Evaluation of Radiological Toxicity

Of the current cancer slope factors for radionuclides that were reviewed, most had been updated and differed somewhat from the values that were used in the original RI/FS calculations. In general, the oral cancer slope factors (used for calculating risk from ingestion pathways) were more conservative; inhalation cancer slope factors (for inhaled particulates) were less conservative; and the external cancer slope factors (for external radiation) received minor changes in both directions. Because the primary radiological COCs (uranium-238, radium-226, and thorium-232) are major risk drivers in all of the modeled receptors, particular attention was given to changes in their values.

6.4.4.6 Evaluation of Chemical Toxicity

A review was also performed of the non-radiological toxicity factors for chemicals. The toxicity factors reviewed included oral and inhalation reference doses, and oral and inhalation cancer slope factors for proven and suspected carcinogens. The toxicity factors for all chemicals with published FRLs were reviewed for changes occurring since the RI/FS calculations were performed. After reviewing this information, it was noted that most of the values had either not changed or had been withdrawn as a result of re-assessments that were under way by EPA. For the FEMP COCs, only a limited number of parameters had changed.

6.4.4.7 Calculated Risk Changes To Target Receptors

To summarize the conclusions of the CRARE (from the FS Report on OU5), the summary risk tables indicated that most of the calculated risk was contributed by a limited number of pathways for all three of the target receptors (included the undeveloped park user, off-property farm resident adult, and off-property farm resident child) as follows:

Percent of Total Risk from FS Report for OU5

	Direct Rad.	Dairy	Fruit/Veg.	Soil Ingest.	Dermal	Total Risk
Undeveloped Park User	91%	-------	-------	3%	3%	97%
Off-Property Resident Farm Adult	76%	6%	10%	3%	<1	95%
Off-Property Resident Farm Child	41%	27%	25%	7%	<1	99%

Significant change in calculated risk to a target receptor could only result if one or more of the dominant pathways were impacted by an alteration in cancer slope factor(s) and/or toxicity factor(s). The dominant pathways for each of the three target receptors were reviewed, and where applicable the original cancer slope factors were replaced by updated versions obtained from the latest HEAST and IRIS tables. Exposure scenarios and quantitative intakes for the target receptors were not changed. Risk for these identified pathways was re-calculated for each target receptor utilizing the updated cancer slope factors. Variations in calculated risk were compared to the original values that appeared in the CRARE. Results of the re-calculations are shown in Table 6-3 for all three target receptors.

The change in total calculated risk to the undeveloped park user receptor is an increase of approximately four percent. The revised inhalation cancer slope factors would have decreased the risk slightly, but were not included in the re-calculations because the inhalation pathway (at E-8) made up less than one percent of the risk to this receptor. The undeveloped park user was designated to represent the anticipated future

TABLE 6-3

EVALUATION OF RISKS TO TARGET RECEPTORS USING UPDATED SLOPE AND TOXICITY FACTORS

	Undeveloped Park User [a,b,c]				Off-Property Resident Farm Adult [a,b,c]				Off-Property Resident Farm Child [a,b,c]			
Exposure Scenario	Percent of Total Risk	CRARE	Recalculation	Percent Change	Percent of Total Risk	CRARE	Recalculation	Percent Change	Percent of Total Risk	CRARE	Recalculation	Percent Change
Direct Radiation	91%	1.94E-5	2.03E-5	5% increase	76%	8.30E-4	8.91E-4	7% increase	41%	6.23E-5	6.65E-5	7% increase
Soil Ingestion	3%	6.33E-7	6.51E-7	3% increase	3%	2.77E-5	2.90E-5	5% increase	7%	1.07E-5	1.09E-5	2% increase
Water Ingestion (wading)	3%	7.22E-8	7.39E-8	2% increase	NA	NA	NA	NA	NA	NA	NA	NA
Fruit/Vegetable Consumption	NA	NA	NA	NA	10%	1.09E-4	1.12E-4	3% increase	25%	3.67E-5	3.70E-5	<1% increase
Dairy Consumption	NA	NA	NA	NA	6%	7.00E-5	7.74E-5	10% increase	27%	4.08E-5	4.23E-5	4% increase
TOTAL ILCR	NA	2.08E-5	2.17E-5	4% increase in ILCR	NA	1.06E-3	1.13E-3[d]	7% increase in ILCR	NA	1.50E-4	1.60E-4	6% increase in ILCR

[a]CRARE = Comprehensive Response Action Risk Evaluation
[b]ILCR = Incremental Lifetime Cancer Risk
[c]NA = not applicable
[d]Total ILCR risk including radiological and chemical background (refer to Section 6.4.4.7)

land use of the FEMP site. Most of the risk to this receptor was due to external radiation because this model does not ingest site groundwater or consume foodstuffs grown on or near the site.

The remaining two target receptors are the off-property resident farmer and farm child. Their exposure scenarios differ considerably from the undeveloped park users in that they ingest groundwater and locally grown food, which both contribute significantly to calculated risk.

When determining revised risk values for the three target receptors, calculations were performed yielding Total Risk, inclusive of radiological and chemical background components. As demonstrated in the CRARE, most of the radiological and chemical ILCR risk to the target receptors is due to the presence of natural (i.e., background) levels of radionuclides such as radium and uranium, and naturally occurring chemicals such as arsenic and beryllium in the environment. Due to the long duration and intensity of exposure of the Off-Property Resident Farm Adult, the total ILCR risk to this modeled receptor is 1.1E-3. This is greater than the allowable 10^{-4} to 10^{-6} risk range allowable under CERCLA, but 94 percent of this is attributable to radiological and chemical background. Only approximately 6 percent, or 6.1E-5, is a result of site related contaminants. The same is true for both the Off-Property Resident Farm Child (75 percent of total ILCR due to natural background), and the Undeveloped Park User (80 percent of total ILCR due to natural background). Recalculations using the revised cancer slope factors were performed using intakes from the total ILCR risk calculations for reasons of conservatism.

6.4.4.8 Calculations For Toxicity Factors & Reference Doses For Chemicals

The primary COCs contributing most of the HI and ILCR risk to the target receptors from chemical (non-radiological) pathways include arsenic, uranium, beryllium, and benzo(a)pyrene. In all cases, the reference doses and cancer slope factors were either unchanged since the original calculations were performed, or the values have been withdrawn from use.

6.4.4.9 Conclusion

As part of the CERCLA five-year review, a comprehensive comparison of cancer slope factors and chemical reference doses was performed in order to identify changes that could result in alterations in the original assumptions driving the selected remedy for OU5.

When the major pathways contributing cancer risk to the three target receptors were re-calculated utilizing the updated cancer slope factors, an overall increase in ILCR of between 4 percent and 7 percent was demonstrated. This variance is far less than the "order of magnitude" increase that would be necessary to re-examine a remediation remedy based on the post-remedial risk assumptions for this suite of target receptors.

As a result of this evaluation of the OU5 FS Risk Assessment, the original risk assumptions upon which the FEMP remedy is based remain valid. No alteration in the planned remedial design is necessary due to changes in the toxicity values of the identified COCs.

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6.4.5 Review of Benchmark Toxicity Values

The approach for addressing ecological risk at the FEMP was evaluated as part of the five-year review. In summary, the current approach is protective of ecological receptors at the FEMP. A synopsis of the evaluation is provided below. The FEMP Sitewide Ecological Risk Assessment (SERA) was conducted as part of the OU5 RI. Both radiological and non-radiological risks were evaluated. For radiological risks, dose estimates were calculated for several ecological receptors at the FEMP. These dose estimates fell well below the target level dose of 36.5 rad/year. The five-year review of the radiological risk assessment revealed that receptor organisms, exposure pathways, calculation parameters, and the target level dose are still valid.

For non-radiological risks, media-specific contaminant concentrations were compared to literature-based benchmark toxicity values (BTVs). BTVs are concentrations that are considered protective of ecological receptors. The SERA concluded that several constituents warranted further investigation. Since the evaluation of non-radiological risks was a screening-level assessment only, the OU5 ROD did not commit to any cleanup based on risk to ecological receptors. Instead, potential ecological risks would be revisited following remedial activities. The Sitewide Excavation Plan initiated the implementation of this approach by refining the non-radiological risk screening and by defining remediation areas where ecological risk may be a concern following excavation. These area-specific ecological COCs are investigated as part of the certification process following soil remediation. Surface water and sediment constituents of concern are monitored through the FEMP IEMP.

For the five-year review, the BTVs established in the SERA were compared against updated screening values. Based on this review, it was determined that the original BTVs are still valid for use at the FEMP. Therefore, the current approach described above is considered protective of ecological receptors at the FEMP.

6.5 FINDINGS AND RECOMMENDED ACTIONS FROM CURRENT REVIEW

6.5.1 Soil Remedial Actions

Based on the review of data and remedial actions to date, there is no new information indicating a significant impact to the soil remediation activities identified in the OU5 ROD at the current stage of remedial action. Monitoring and other activities are taking place to ensure protectiveness of human health

and the environment whi the remedy is being implemented. A review of critical assumptions and new information on contamin... toxicity does not change the protectiv...ess of the soil remedy being implemented.

6.5.2 Groundwater Remedial Actions

The following are conclusions from evaluating groundwater remedy performance and review of critical assumptions.

- All planned infrastructure is in place on or ahead of schedule.
- During 1999 and 2000, the actual total groundwater pumped was exceeded or within 10 percent of the planned amount, indicating the groundwater extraction modules are functioning as designed.
- More groundwater has been sent for treatment than anticipated. However, FEMP groundwater treatment capacity has been optimized to meet this additional demand.
- The amount of groundwater re-injected has fallen short of what was expected.
- Accounting for uranium extracted and the mass of uranium re-injected, the net total uranium mass extracted from the GMA is within 5 percent of that planned. However, it has required pumping a greater volume of groundwater than planned to achieve this amount of extracted uranium.
- The total uranium plume capture zone is being maintained.
- The total uranium plume concentration is generally decreasing.
- Non-uranium constituents are being closely monitored and have not required any changes to the uranium-based remedy.
- A review of critical assumptions and new information on contaminant toxicity does not change the protectiveness of the groundwater remedy being implemented.

The re-injection system has not performed to the level anticipated in the Baseline Remedial Strategy Report. Operational data collection and re-injection well investigation continues in an attempt to improve this performance. However, the less than planned re-injection well performance is not fundamentally impacting the effectiveness of the groundwater remedy or adversely impacting to an unacceptable degree the speed at which the remedy is proceeding.

6.6 PROTECTIVENESS STATEMENT

The remedy for OU5 soil is expected to be protective of human health and the environment, and immediate threats have been addressed. Soil excavation, treatment and disposal of materials from Areas 1 and 2 have been conducted to achieve the FRLs identified for these components, and remediation

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and restoration activities in Areas 8 and 9 are also proceeding in accordance with the ROD. Access restrictions and other protective measures ensure risk to human health and the environment is minimized until remedial activities can be conducted in the remaining soil remediation areas.

The remedy for OU5 groundwater also expected to be protective of human health and the environment, and immediate threats have been addressed. During remediation, protection is being achieved by providing an alternate public water supply, and through a vigorous environmental monitoring program to ensure site contaminants are not discharged in quantities inimical to human health and the environment. Groundwater monitoring data have shown a number of wells with decreasing total uranium concentrations in response to groundwater extraction, the plume has not migrated beyond the boundary of hydraulic capture, and storm water controls and wastewater treatment measures have proven effective in complying with regulatory requirements.

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