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December 19, 2007

Mr. Timothy Fischer
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Region V-SRF-6J
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

EMCBC-00183-08

Mr. Thomas Schneider, Project Manager
Ohio Environmental Protection Agency
401 East 5th Street
Dayton, Ohio 45402-2911

Dear Mr. Fischer and Mr. Schneider:

SUBMISSION OF THE INTERIM REMEDIAL ACTION REPORT FOR OPERABLE UNIT 5

Reference: 1) USEPA Letter, James Saric to Johnny Reising, "Area 6 Waste Pits Final Certification Report," dated November 6, 2007

2) Fact Sheet, "Development of CERCLA Remedial Action Closeout Reports for the Fernald Closure Project," dated April 2005

3) E-Mail, James Saric to Frank Johnston and Johnny Reising, "Remedial Action Reports," dated November 29, 2004

4) USEPA Letter, James Saric to Johnny Reising, "Closure Report Strategy," dated January 15, 2004

5) DOE Letter DOE-0013-04, Glen Griffiths to James Saric, "Request for Concurrence with Fernald Closure Project Strategy for Submitting Final and Interim Remedial Action Reports," dated October 16, 2003

As requested in the November 6, 2007 letter from the United States Environmental Protection Agency approving the last soil certification report, enclosed is the Interim Remedial Action Report for Operable Unit 5 (OU5) for your review and approval. DOE has previously

submitted and obtained approval for the final Remedial Action Reports for Operable Units 1, 2, 3, and 4.

Also, enclosed with this transmittal letter are two attachments discussing OU5 related concerns that developed related to the On-Site Disposal Facility and elevated Total Uranium levels in a small surface water area west of the former Pit 3. These narratives will be inserted into the appropriate sections of the OU5 Remedial Action Report prior to finalization.

After your final approval of this document, the signature page (located at the end of the document) will be signed by DOE. Further distribution of the Interim Remedial Action Report for OU5 will be made once the signature page has been completed.

If you have any questions, please contact me at (513) 648-3139.

Sincerely,

Johnny Reising

Johnny W. Reising
Director

Enclosures:

cc w/enclosures:
T. Schneider, OEPA-Dayton (three copies of enclosures)
M. Cullerton, Tetra Tech
M. Shupe, HIS GeoTrans
AR Coordinator, Wanda Sumner

cc w/o enclosures:
F. Johnston, Stoller
R. Norton, Fluor

OSDF Cell 7 and 8 Surface Concern Discussion

As a result of a December 18, 2006 quarterly routine On-site Disposal Facility (OSDF) inspection, both U.S. Environmental Protection Agency (EPA) and Ohio EPA raised a concern related to the "transition" area between Cell 7 and Cell 8 and the surface of the south facing slope of Cell 8. These concerns were reviewed and evaluated, and the areas were monitored through the winter and spring. Routine maintenance was performed on the OSDF.

The maintenance that was conducted related to the areas of concern consisted of backfilling erosion rills with topsoil by hand, broadcast seeding with the OSDF seed mix, and hand mulching with straw. In addition, a portion of the Cell 8 south slope that did not appear to have adequate grass germination was broadcast seeded as well. The south slope of Cell 8 was subsequently irrigated to promote germination.

Geosyntec, the designer of the OSDF, was asked to evaluate the concerns that had been raised. As a result, Geosyntec prepared a memorandum dated December 2 1, 2006 that was followed up by a memorandum dated April 9, 2007. These memorandum indicated that the OSDF had been constructed and was functioning per the approved design and that the maintenance that had been performed was effective.

On June 29, 2007 a field review of the OSDF was conducted with representatives of USEPA, OEPA, Tetra Tech, Geosyntec, Fluor Daniel, Stoller, DOE-LM and DOE EM followed by a meeting to discuss the findings.

As a follow-up to the meeting, Dr. J.D Chiou of Fluor Daniel, who has been affiliated with the design, construction, operations and closing of the OSDF, generated an e-mail describing his overall interpretation relative to the findings. His overall finding was that the OSDF was functioning as designed.

Based upon the above, DOE believed the OSDF was functioning as designed. Per the requirements of the Legacy Management and Institutional Control Plan, the OSDF will continue to be monitored and maintained to insure proper performance.

Elevated Total Uranium Levels In
Surface Water West of Former Waste Pit 3

During routine sampling of surface water locations west of the former waste pit 3 area, total uranium concentrations were observed above the surface water final remediation level (FRL) of 530 ppb. The location in question is a series of small pools and drainage ditches due west of the center of former waste pit 3, which drain generally south to a depression near the former cement pond. The overall size of this area is roughly ½ acre. Uranium concentrations observed indicated the highest concentrations at the northern end of the swale and diminishing to the south. There is no direct outlet of this drainage swale to Paddys Run.

All soil certification samples from this area were well below the soil certification FRL. However, acting on an assumption that the leachability characteristics of the soils in questions were perhaps different, a leachability study was developed in January 2007 for the soils in this area. The study was conducted in February 2007 and the results shared with the regulatory agencies in March 2007. The results of the study confirmed DOE's theory that the residual uranium in this area has greater leachability than anticipated; however, it is less than the high leachability areas identified within former production area. The study also confirmed the soil certification data was valid and the source of the higher leachability uranium is in the upper six inches of the soil.

DOE implemented a limited excavation of the area as a part of ongoing maintenance and erosion control activities in the waste pits area. This limited excavation removed approximately six inches of the surface of the area suspected as being the source of the higher leachability uranium. The material was transported to a high spot in an area adjacent to former waste pit 5 and distributed sufficiently to facilitate more rapid dissipation of the residual uranium. The spoils material was graded and seeded. The excavated area was graded to mitigate ponding, treated with phosphate, and will be revegetated during the 2008 growing season.

This activity was completed in September 2007 and allowed for the final approval of the Area 6 Waste Pits 1, 2, and 3, the Burn Pit, the Clear well and the Areas west and North of the Waste Pits" soil certification package. DOE has agreed to continue to monitor this area as a part of continued maintenance of the site during legacy management.

Interim Remedial Action Report for Operable Unit 5

CONTENTS

Section 1 On-Site Disposal Facility
Section 2 Site-Wide Soils and Sediment
Section 3 Aquifer Restoration

EXECUTIVE SUMMARY

This document serves as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Interim Remedial Action Report (closeout report) for Operable Unit 5 at the United States Department of Energy's (DOE's) Fernald Closure Project (FCP) located near Cincinnati, Ohio. This closeout report has been prepared to meet United States Environmental Protection Agency (EPA) guidance for CERCLA site closeout as described in EPA Office of Solid Waste and Emergency Response (OSWER) Directive No. 9320.2-09A-P, *Closeout Procedures for National Priorities List (NPL) Sites* (January 2000). As stated in this directive, the aim of the guidance is to communicate EPA's key principles and expectations for remedial action closeout along with "best practices" based on CERCLA program experience that should be consulted for closing out NPL sites in a consistent and reasonable manner across the program. The guidance recommends a standard closeout report outline that has been followed in the preparation of this Operable Unit 5 Interim Remedial Action Report.

In accordance with agreements reached between DOE and EPA, the Interim Remedial Action Report for Operable Unit 5 is designed to document the status of the remediation relative to the On-Site Disposal Facility, remediation of contaminated soils and sediments, and the groundwater/surface water remedial actions.

An Interim Remedial Action Report is appropriate for Operable Unit 5, as final groundwater restoration activities are ongoing and are projected, based on modeling simulations, to require continuation to the year 2026. The ongoing groundwater restoration activities also have a direct impact on completing related portions of the remedy associated with surface water and sediment. Discharges to the Great Miami River will continue until groundwater restoration is complete, precluding the ability to certify achievement of final remediation levels for surface water and sediment in the river until such time that aquifer related discharges are complete. In addition, achievement of final remediation levels for soil within the footprints of the requisite groundwater infrastructure cannot be certified until the above-grade groundwater infrastructure is removed following completion of the remedy.

DOE is also addressing the On-Site Disposal Facility through this Operable Unit 5 Interim Remedial Action Report. While the construction and operation of the On-Site Disposal Facility was originally within the province of Operable Unit 2 (proposed specifically for the disposal of Operable Unit 2 wastes), the Operable Unit 5 Record of Decision (ROD) finalized the concept of a site-wide On-Site Disposal Facility for the disposal of the relatively less contaminated wastes including contaminated soils (Operable Unit 5) and debris (Operable Unit 3) in addition to the Operable Unit 2 wastes. The Operable Unit 2 ROD identifies a 30-year monitoring requirement for the On-Site Disposal Facility and the long term monitoring and care of the facility to meet such requirements is a specific component of the Operable Unit 5 ROD.

The Interim Remedial Action Report for Operable Unit 5 has been prepared in three distinct stand-alone sections: Section 1 addresses the On-Site Disposal Facility, Section 2 addresses site-wide soil and sediment, and Section 3 addresses aquifer restoration. These sections follow.

Interim Remedial Action Report for Operable Unit 5 (Section 1) – On-Site Disposal Facility

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1.0 INTRODUCTION

This document serves as Section 1 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Interim Remedial Action Report (closeout report) for Operable Unit 5 at the U.S. Department of Energy's (DOE's) Fernald Closure Project (FCP) located near Cincinnati, Ohio. As a stand-alone section of the Interim Operable Unit 5 closeout report, this report covers construction, operation, and closure of the On-Site Disposal Facility (OSDF) at the FCP.

The full closeout report for Operable Unit 5 is divided into three separate stand-alone sections as part of one integrated document. In addition to Section 1 covering the OSDF, the Interim Operable Unit 5 closeout report also includes closeout reporting for the remediation of site-wide soil and sediment in Section 2, and for the restoration of the Great Miami Aquifer in Section 3. Remediation requirements for the FCP's environmental media were defined in the 1996 Record of Decision (ROD) for Operable Unit 5 [DOE 1996a].

Section 1 has been prepared to meet U.S Environmental Protection Agency (EPA) guidance for CERCLA site closeout as described in EPA OSWER Directive No. 9320.2-09A-P, *Closeout Procedures for National Priorities List (NPL) Sites* (January 2000). The aim of this EPA directive is to communicate EPA's key principles and expectations for remedial action closeout, along with "best practices" based on CERCLA program experience that should be consulted for closing out NPL sites in a consistent and reasonable manner across the program. EPA's guidance recommends a standard closeout report outline that has been followed in the preparation of each of the three sections of the Operable Unit 5 Interim Remedial Action Report.

The OSDF is an integral part of DOE's balanced approach to remediation waste management at the FCP wherein small volumes of more highly contaminated waste were shipped off site for disposal, while larger volumes of less contaminated soil and debris were disposed on site in an engineered disposal facility. The OSDF received wastes primarily from Operable Unit 2, Operable Unit 3, and Operable Unit 5. The separate provisions of the three associated RODs explicitly established that waste meeting identified waste acceptance criteria (WAC) would be disposed of in an on-site disposal facility. In addition, the Operable Unit 1 and Operable Unit 4 RODs included a provision that impacted soil outside of the waste units (i.e., Waste Pits and Silos) would be addressed using relevant Operable Unit 5 ROD provisions, thus allowing on-site disposal.

In accordance with agreements reached between DOE and EPA to communicate the overall remedial action closeout report strategy across the operable units, the closeout report for the OSDF has been included as part of the Operable Unit 5 Interim Remedial Action Report. This is appropriate due to the OSDF long-term care and monitoring requirements that will continue beyond the 2006 baseline closure date.

During the fall of 2004, EPA and DOE identified the manner in which the time-sequenced individual closeout reports would be coordinated across the five operable units. This approach recognizes that the source-control remedial actions (i.e., Operable Units 1, 2, and 4), decontamination and dismantlement (D&D) and legacy waste disposition activities (Operable Unit 3), the majority of soil remediation (part of Operable Unit 5), and the closure of the OSDF are all targeted for completion in 2006, while groundwater restoration (part of Operable Unit 5) will continue beyond 2006. The remaining activities that extend beyond 2006 are: 1) continued restoration activities for the Great Miami Aquifer; 2) the performance monitoring and final certification activities necessary to demonstrate completion of aquifer restoration; and 3) the final D&D and removal of groundwater-related facilities and any affected soil above final remediation levels (FRLs) beneath the groundwater facilities as required. As the mechanism to communicate the agreed-to closeout report strategy, EPA and DOE issued a fact sheet in the spring of 2005 describing the coordination approach across the operable units which is described in detail in Section 1.5 of this closeout report. Section 1 of the Interim Operable Unit 5 closeout report has been prepared in accordance with that strategy.

This closeout report is organized into ten major sections and nine appendices. Section 1.0 provides an overview of the FCP and the overall remedial activities comprising the FCP's site-wide cleanup program. Section 2.0 provides an overview of the OSDF and the remedial actions that included on-site disposal and were selected in the Operable Unit 2, Operable Unit 3, and Operable Unit 5 RODs. Section 3.0 addresses OSDF construction activities and Section 4.0 provides an annotated chronology of the key events contributing to successful completion and documentation of the OSDF construction. Sections 5.0 and 6.0 address performance standards, quality control, and final inspections and certifications, while Section 7.0 summarizes operations and maintenance information, as appropriate. Section 8.0 summarizes remedy cost information, and, to the extent possible, compares actual remedial costs with the original estimates contained in the applicable RODs. Section 9.0 identifies lessons learned during remedy implementation, and Section 10.0 summarizes key OSDF contact information.

1.1 Fernald Closure Project Overview

The FCP is a 1050-acre government-owned contractor-operated facility located in southwestern Ohio approximately 18 miles northwest of downtown Cincinnati. The facility is located just north of Fernald, Ohio, a small farming community, and lies on the boundary between Hamilton and Butler counties. Of the total site area, approximately 850 acres are in Crosby Township in Hamilton County and 200 acres are in Ross and Morgan Townships in Butler County.

The Atomic Energy Commission (AEC), predecessor to the U.S. Energy Research and Development Administration (ERDA) and then the DOE, established the Feed Materials Production Center (FMPC) in conformance with AEC orders in the early 1950s. In 1951, National Lead Company of Ohio, Inc., (now NLO) entered into a contract with the AEC as the Management and Operations Contractor for the facility. This contractual relationship lasted until January 1, 1986. Westinghouse Materials Company of Ohio (WMCO), a wholly owned subsidiary of Westinghouse Electric Corporation, then assumed management responsibilities for the site operations and facilities. In 1991, Westinghouse renamed this subsidiary the Westinghouse Environmental Management Company of Ohio (WEMCO). During that same year, DOE renamed the site the Fernald Environmental Management Project (FEMP) to reflect the site's revised mission. On December 1, 1992, Fernald Environmental Restoration Management Company (FERMCO) (now Fluor Fernald) assumed

responsibility for the site as the Environmental Restoration Management Contractor for DOE. The FEMP was renamed the Fernald Closure Project (FCP) on January 27, 2003.

1.2 Mission of the Site

The primary mission of the FMPC during its 37 years of operation was the processing of uranium feed materials to produce high purity uranium metal. These high purity uranium metals were then shipped to other DOE or U.S. Department of Defense facilities for use in the nation's weapons program. Manufacture of the uranium metal products generally occurred in seven of the FCP's more than 50 production, storage, and support buildings that comprised what was known as the 140-acre production area. During the 37 years of production operations, nearly 500 million pounds of uranium metal products were produced. The site also served as the nation's key federal repository for thorium-related nuclear products, and it also recycled uranium used in the reactors at the Hanford site. These recycled reactor returns were the source of technetium-99, a radiological contaminant that is prevalent at the site.

In accomplishing the site mission, liquid and solid wastes were generated by the various operations between 1952 and 1989. Before 1984, solid and slurried wastes from FMPC processes were deposited in the on-property waste storage area. This area, located west of the former production areas, includes six low-level radioactive waste storage pits; two earthen-bermed concrete silos containing K-65 residues; one concrete silo containing metal oxides; one unused concrete silo; two Lime Sludge Ponds; a Burn Pit; a Clearwell; and a Solid Waste Landfill. After 1984, wastes produced from operations were containerized for eventual shipment to off-site disposal facilities. Contaminants from material processing and related activities were released into the environment through air emissions, wastewater discharges, storm water runoff, and leaks and spills.

1.3 Regulatory History

The CERCLA Remedial Investigation/Feasibility Study (RI/FS) process at the FEMP began in 1986, in accordance with a Federal Facility Compliance Agreement (FFCA) between DOE and EPA to cover environmental impacts associated with the FEMP. The FFCA was intended to ensure that environmental impacts associated with activities at the facility would be thoroughly and adequately addressed. In response to the FFCA, a site-wide RI/FS was initiated pursuant to CERCLA, as amended by the Superfund Amendment and Reauthorization Act (SARA). Production operations at the facility were suspended in 1989 and the facility was placed on the NPL. The FFCA was amended in April 1990 by a Consent Agreement (under §120 106[a] of CERCLA) that revised the milestone dates for the RI/FS and provided for implementation of removal actions. The Consent Agreement was amended in September 1991 to revise schedules for completing the RI/FS process. This amended Consent Agreement provided for implementation of the operable unit concept. The FEMP was partitioned into five operable units to promote a more structured and expeditious cleanup. The schedule for preparation of RI/FS reports for each operable unit was included in the amended Consent Agreement.

The Ohio Environmental Protection Agency (Ohio EPA) Office of Federal Facilities Oversight (OFFO) also oversees cleanup activities at the site as a support agency primarily through the December 1988 Consent Decree and its January 1993 amendment. Ohio EPA conducts environmental monitoring, public outreach, and restoration and remediation oversight at the FCP, as well as maintaining authority for Resource Conservation and Recovery Act (RCRA) enforcement. The June 1996 Director's Final Findings and Orders between the DOE/Fluor Fernald and the Ohio EPA provide orders for closure activities relative to several Hazardous Waste Management Units (HWMUs) established at the site to satisfy both RCRA and CERCLA requirements.

1.4 Site-Wide Operable Units and Cleanup Strategy

For purposes of investigation and study, the remedial issues and concerns that were similar in location, history, type/level of contamination, and inherent characteristics were grouped into operable units under the 1991 amended Consent Agreement. Specifically, the site was divided into five operable units. Four of the operable units (1 through 4) are considered contaminant "source" operable units as they represent the physical sources of contamination that have affected the site's environmental media. The fifth operable unit (Operable Unit 5) is considered the "environmental media" operable unit as it represents the environmental media affected by past production operations and waste disposal practices (i.e., beyond the contaminant "source" operable unit boundaries), as well as the pathways of contaminant migration at the site. The four contaminant "source" operable units and the fifth environmental media operable unit are described below:

- Operable Unit 1: Waste Pit Area. Waste Pits 1 through 6, Clearwell, Burn Pit, berms, liners, and affected soil residing within the operable unit boundary.
- Operable Unit 2: Other Waste Units. The Active and Inactive Flyash Piles, the South Field disposal area, north and south Lime Sludge Ponds, the Solid Waste Landfill, and the berms, liners, and affected soil residing within the operable unit boundary. The Active and Inactive Flyash Piles and South Field area are collectively known as the "Southern Waste Units" because they are collocated in close geographic proximity to one another.
- Operable Unit 3: Former Production Area. Former production and production-associated facilities and equipment (including all above- and below-grade improvements), including, but not limited to, all structures, equipment, utilities, drums, tanks, solid waste, waste, product, thorium, effluent lines, a portion of the K-65 transfer line, wastewater treatment facilities, fire training facilities, scrap metal piles, feedstocks, and coal pile. Note that all affected soil beneath the facilities resides within Operable Unit 5.
- Operable Unit 4: Silos 1 through 4. Contents of Silos 1, 2, and 3 (Silo 4 has remained empty); the silos structures, berms, decant sump tank system, and affected soil residing within the operable unit boundary.
- Operable Unit 5: Environmental Media. Affected groundwater, surface water, all soil not included in the definitions of Operable Units 1, 2, and 4, sediment, flora, and fauna.

During the time period 1994 to 1996, DOE and EPA signed the final RODs for each operable unit – in cooperation with the Ohio EPA and the Fernald Citizen's Advisory Board – which set in motion the major cleanup requirements and approaches that collectively define the FCP cleanup. The RODs employ a combination of off-site and on-site disposal, under which approximately 77 percent of the remedial waste volume (the site's lower concentration, higher volume materials) are to be disposed of in the engineered OSDF while approximately 23 percent (the site's higher concentration, lower volume materials) are to be sent off site for disposal, primarily at permitted facilities in Utah and Nevada.

At the time the RI/FS activities were completed and the RODs put in place, an estimated 31 million pounds of uranium products, 2.5 billion pounds of waste, 255 buildings and structures, and 2.75 million cubic yards of contaminated soil and debris were identified as requiring action. In addition, a 223-acre portion of the Great Miami Aquifer was found to be contaminated at levels above radiological drinking water standards. Under the site-wide approach, the final remedial actions contained in the operable unit RODs are:

- Production and support facility D&D
- On-site disposal of contaminated soil, above- and below-grade debris, and Operable Unit 2 waste unit materials, provided OSDF WAC are met
- Off-site disposal of the contents of the silos, the waste pit materials, nuclear product inventories, containerized low-level and mixed waste inventories, and the quantities of soil and debris that do not meet OSDF WAC

- Extraction and treatment of contaminated groundwater to restore the contaminated portions of the Great Miami Aquifer to meet Safe Drinking Water Act requirements

At completion, approximately 975 acres of the 1,050-acre property will be restored for use as an undeveloped park, the target land use selected in the Operable Unit 5 ROD, and approximately 75 acres will be dedicated to the footprint of the OSDF. The Great Miami Aquifer will be restored to drinking water standards, and long-term stewardship actions and requisite institutional controls will be put in place consistent with the target land use. Groundwater restoration for the Great Miami Aquifer is estimated to be complete in 2026, based on modeling projections.

Taken together, the individual RODs for the operable units provide a site-wide cleanup approach that encompasses all contaminant source areas and all affected environmental media at the site. Collectively the RODs provide a natural link between the remediation of the sources of contamination and the media affected. Each ROD progressively built on the decisions of the earlier RODs, yielding a cohesive and comprehensive remedy for the FCP. The ROD signature dates and progressive sequence of decisions adopted under the RODs are shown below:

- Operable Unit 3 ROD for Interim Remedial Action (July 22, 1994) – Provided accelerated approval for the D&D of the FCP's buildings and structures.
- Operable Unit 4 ROD for Final Remedial Action (December 7, 1994) – Provided for the remediation of Silos 1 through 4, affected soil within the operable unit boundary, and other sources of contamination within the boundary. The D&D of all remedial facilities constructed for the Operable Unit 4 remedial action are to be addressed as part of Operable Unit 3.
- Operable Unit 1 ROD for Final Remedial Action (June 8, 1995) – Provided for the remediation of the waste pit contents, caps and liners, affected soil within the operable unit boundary, and other sources of contamination within the boundary. The D&D of all remedial facilities constructed for the Operable Unit 1 remedial action are to be addressed as part of Operable Unit 3.
- Operable Unit 2 ROD for Final Remedial Action (June 8, 1995) – Provided for the remediation of the Active and Inactive Flyash Piles, South Field disposal area, the two Lime Sludge Ponds, Solid Waste Landfill, affected soil within the operable unit boundary, and other sources of contamination within the boundary. This decision set in motion the approval of on-site disposal at the FCP and the construction of the OSDF; however, at the time it was formally limited to the disposal of the Operable Unit 2 wastes since the Operable Units 5 and 3 decisions related to waste disposition (on site or off site) were not yet final.
- Operable Unit 5 ROD for Final Remedial Action (January 31, 1996) – Provided for the remediation of the FCP's on-site and off-site environmental media. This ROD addressed the cleanup of the Great Miami Aquifer at all locations, and the remediation of affected site-wide soil and sediment outside the source operable unit boundaries. It also addressed the monitoring of air, surface water, groundwater, sediment, and biota. The Operable Unit 5 ROD finalized the concept of a site-wide OSDF, and further incorporated the "balanced approach" concept into FCP on-site and off-site waste disposition decisions. The D&D of all remedial facilities constructed to support the Operable Unit 5 groundwater remedial action were to be addressed as part of Operable Unit 3.
- Operable Unit 3 ROD for Final Remedial Action (September 24, 1996) – Provided a final disposition decision for the D&D materials generated through the Interim Remedial Action ROD. Consistent with the Operable Unit 5 decision, this final decision document adopted on-site disposal as the selected remedy for disposition of the D&D debris. It also adopted earlier decisions as part of the "balanced approach" to send the FCP's containerized waste inventories and nuclear materials off site. The ROD also acknowledged that the D&D of new remedial facilities constructed at the site would be addressed as part of Operable Unit 3.

1.5 Site-Wide Remedial Action Closeout Report Strategy – Spring 2005 Fact Sheet

In the spring of 2005, DOE and EPA developed a fact sheet to describe the strategy for producing the closeout reports for the CERCLA operable unit remedial actions completed for the FCP [DOE 2005a]. Where affected media (primarily soil within an operable unit boundary) was a part of the source operable unit remedy, it was determined to be appropriate to accommodate the documentation of the remediation of that soil under the Operable Unit 5 closeout report. Therefore, only the source waste material would be addressed in their respective Final Remedial Action Reports, while the contaminated media within the source operable unit boundaries would be addressed under Operable Unit 5. In essence, this fact sheet adopted the following strategy for submitting remedial action closeout reports for EPA approval (and summarized in Figure 1-1 on the following page):

- Proceed with formal closeout of Operable Unit 1 when the waste pit contents and liners have been successfully dispositioned off site. The remaining operable unit scope (soil remediation within the Operable Unit 1 boundary, and D&D of Operable Unit 1 remediation facilities) would be documented in the closeout reports for Operable Units 5 and 3, respectively.
- Proceed with formal closeout of Operable Unit 2 when the waste materials from the Solid Waste Landfill, Lime Sludge Ponds, Fly Ash Piles, and the South Field area have been successfully placed in the OSDF, or dispositioned off site as necessary based on OSDF WAC restrictions. The remaining operable unit scope (soil remediation within the Operable Unit 2 waste unit boundaries) would be documented in the closeout report for Operable Unit 5.
- Proceed with formal closeout of Operable Unit 3 when the D&D of site-wide facilities – including the remediation facilities constructed for Operable Units 1 and 4 – are complete and all legacy-era containerized wastes have been successfully dispositioned off site.
- Proceed with formal closeout of Operable Unit 4 when the silo contents for Silos 1, 2, and 3 have been successfully dispositioned off site. The remaining operable unit scope (soil remediation within the Operable Unit 4 boundary, and D&D of Operable Unit 4 remediation facilities and the empty silo structures) would be documented in the closeout reports for Operable Units 5 and 3, respectively.
- Proceed with an Interim Remedial Action report for Operable Unit 5 that recognizes that Great Miami Aquifer restoration activities will continue beyond DOE's 2006 baseline closure date. As an Interim Remedial Action Report, the three major subsections will address completion of soil restoration activities (including those within the Operable Units 1, 2 and 4 boundaries) and closure of the OSDF, but will also need to recognize that ongoing aquifer restoration activities, future D&D of groundwater infrastructure, and final soil remediation (as necessary beneath the remaining groundwater infrastructure) remain as open items that will be closed out with a future final Remedial Action Report for Operable Unit 5 once groundwater actions are complete (estimated completion date in 2026, based on modeling projections). The Interim Remedial Action Report under Operable Unit 5 will therefore consist of three independent subsections: soil and sediment remediation, OSDF closeout, and aquifer restoration activities.

Figure 1-1 Summary of CERCLA Remedial Action Closeout Reports and Schedule

Operable Unit	Key Closeout Activity	Where Documented	Remaining Scope	Where Documented
Operable Unit 1 Waste Pits	Waste pit contents successfully dispositioned off site	Final Remedial Action Report for Operable Unit 1 (Summer 2006)	Soil Remediation within Operable Unit 1 boundary	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)
			D&D of Operable Unit 1 Remediation Facilities	Final Remedial Action Report for Operable Unit 3 (Winter 2007)
Operable Unit 2 Other Waste Units	Wastes from Solid Waste Landfill, Lime Sludge Ponds, Fly Ash Piles, and South Field area successfully placed in OSDF or dispositioned off site as required	Final Remedial Action Report for Operable Unit 2 (Fall 2006)	Soil Remediation within Operable Unit 2 boundary	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)
Operable Unit 3 Production Area Facilities	D&D of site-wide facilities (except for groundwater infrastructure); completion of Legacy Waste disposal	Final Remedial Action Report for Operable Unit 3 (Winter 2007)	None	NA
Operable Unit 4 Silos	Silo 3 material successfully dispositioned off site; Silos 1&2 material successfully treated, packaged, and transported off site into temporary storage.	Final Remedial Action Report for Operable Unit 4 (Fall 2006)	Soil Remediation within Operable Unit 4 boundary	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)
			D&D of Operable Unit 4 Remediation Facilities	Final Remedial Action Report for Operable Unit 3 (Winter 2007)
			Permanent off-site disposal of Silos 1&2 material	Addendum to the Final Remedial Action Report for Operable Unit 4 (post-closure)
Operable Unit 5 Environmental Media	Groundwater remediation infrastructure is installed and operating.	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)	D&D of groundwater facilities once groundwater remedy is complete; certification of surface water and sediments	Final Remedial Action Report for Operable Unit 5 (post-closure)
	Completion of all soil remediation site wide, except for beneath long-term groundwater facilities	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)	Soil remediation and certification beneath groundwater facilities	Final Remedial Action Report for Operable Unit 5 (post-closure)
	The On-Site Disposal Facility is capped	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)	Long-term care and monitoring	Final Remedial Action Report for Operable Unit 5 (post-closure)

2.0 OSDF BACKGROUND

During the remedy evaluation and selection processes for Operable Units 1 through 5, it was recognized that off-site disposal of all FCP waste was both cost prohibitive and potentially not implementable due to political pressures in the disposal States. This prompted the development of the balanced approach to waste management described above in Section 1.4 and the need for the OSDF. This balanced approach was formally endorsed by the Fernald Citizen's Advisory Board and by the regulators.

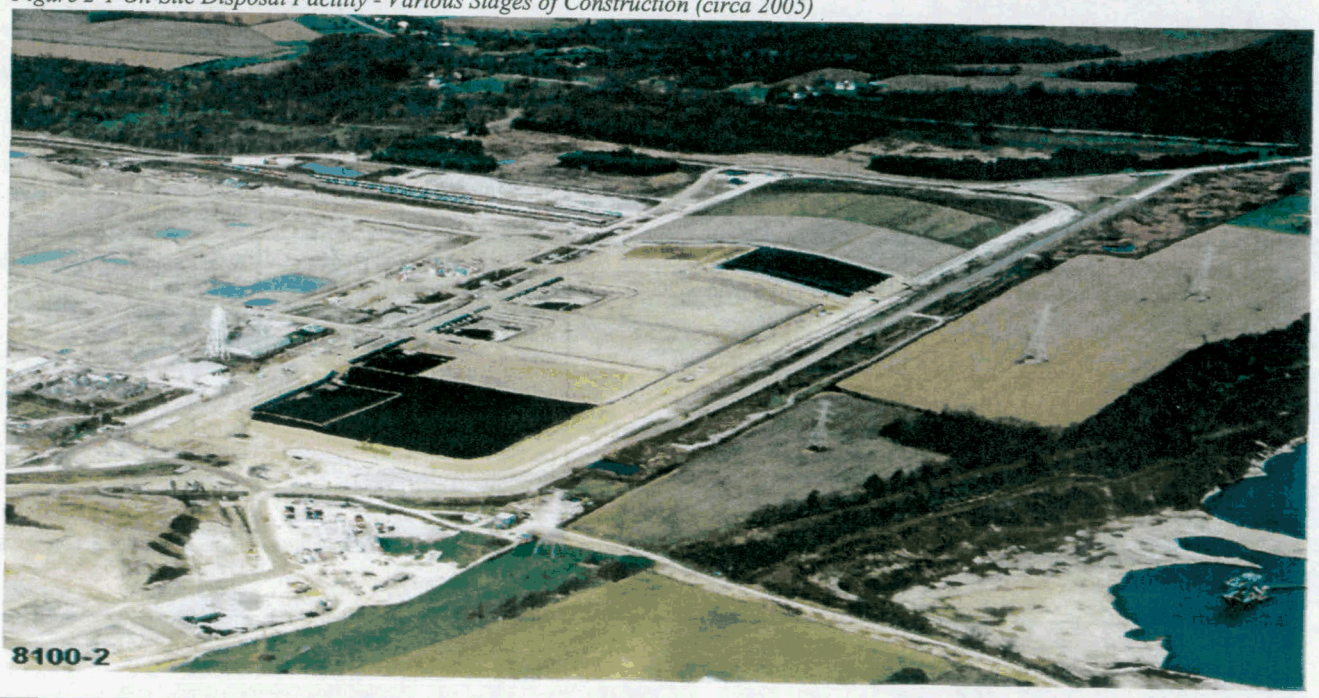
As discussed above, the Operable Unit 2 ROD preceded the ROD decisions for Operable Units 5 and 3 by nearly a year. As a result, the costs, waste volumes, size, and configuration of the OSDF represented in each of the RODs are specific to that operable unit only, since the on-site disposal decisions for Operable Units 2, 5, and 3 were made at different times. Ultimately, however, once all the on-site disposal decisions were finalized, the OSDF was sized and designed to accommodate all three operable units resulting in a greater economy of scale and a combined site-wide design, siting, and implementation approach.

2.1. Results of the Feasibility Studies

On-site disposal was evaluated as a remedial alternative in the Operable Unit 2, Operable Unit 3, and Operable Unit 5 Feasibility Studies. As part of this remedy, all materials disposed on site must meet the OSDF WAC. The OSDF WAC were established to protect the Great Miami Aquifer, which underlies the FCP, by ensuring that no Federal drinking water standards would be exceeded as a result of disposing waste on site. A certain percentage of waste from each operable unit would not meet the OSDF WAC and would be shipped off site for disposal.

In 1988, EPA determined that the Great Miami Aquifer was a sole or principal source of drinking water and that contamination of this aquifer would create a significant hazard to the public health. During the evaluation of compliance with applicable or relevant and appropriate requirements (ARARs), it was determined that siting a

Figure 2-1 On-Site Disposal Facility - Various Stages of Construction (circa 2005)



disposal facility at the FCP would violate Ohio regulations that prohibited locating a new solid waste landfill over a sole-source aquifer or an aquifer capable of sustaining a yield of 100 gallons per minute for a 24-hour period to an existing or future water supply well located within 1,000 feet of the limits of solid waste placement. The Feasibility Studies identified that either an exemption from these regulations was needed from Ohio EPA or a CERCLA waiver of these requirements was needed from EPA. As part of this determination, DOE committed to locating the disposal facility within the area of the FCP that exhibited the best hydrogeologic conditions, which is defined as the area where the most gray clay existed between the bottom of the OSDF and the aquifer (but was a minimum of 12 feet thick) and where there was the least amount of interbedded granular material (e.g., sand) within the gray clay. These factors were considered during the remedial design and determined the location of the OSDF.

2.2. On-Site Disposal Selected Remedy

As identified in the Operable Unit 2 ROD [DOE 1995a], Operable Unit 5 ROD, and the Operable Unit 3 ROD for Final Remedial Action [DOE 1996b], key components of the on-site disposal selected remedy include:

- Construction of the engineered OSDF
- Establishment of maximum WAC for the OSDF
- On-site disposal of materials from Operable Units 2, 3, and 5 that meet the OSDF WAC (including RCRA regulated materials using the Corrective Action Management Unit mechanism)
- Selected on-site disposal of soils from Operable Units 1 and 4
- Implementation of institutional controls such as access restrictions (fencing) and groundwater monitoring at the OSDF, for at least 30 years following closure
- Maintenance of the OSDF, including the final cover system and leachate collection system. Because this remedy results in contaminants remaining on site in an engineered disposal facility, a review will be conducted no less often than every five years after the initiation of remedial action in accordance with CERCLA §121(c) to ensure that the remedy continues to provide adequate protection of human health and the environment. This review will continue until determined that it is no longer needed to maintain protectiveness of the disposal facility.

In order to construct the OSDF over a sole-source aquifer capable of sustaining a yield of 100 gallons per minute, an Ohio EPA exemption or an EPA CERCLA waiver was needed from the State of Ohio siting prohibitions. It was determined that a CERCLA waiver was the appropriate regulatory strategy. The waiver request was based on the ability of the selected remedial action to attain a standard of performance that is equivalent to that required by the ARARs. The criteria in determining a CERLCA ARAR waiver based on equivalent standard of performance were degree of protection, level of performance, reliability into the future, and time required to achieve remedial action objectives (40 CFR 300.430 (f)(1)(ii)(C)(4)). CERCLA waivers were requested, justified, and granted through the approval of the Operable Unit 2, Operable Unit 3, and Operable Unit 5 RODs. Therefore, EPA granted three CERCLA waivers to allow construction of the OSDF at the FCP and on-site disposition of materials from Operable Units 2, 3, and 5 (and selected materials from Operable Units 1 and 4).

In general, application of the WAC allowed materials from each of the operable units to be disposed of in the OSDF as follows:

Operable Unit 1

- Waste Pit 4 cover material
- Impacted soils below or outside the waste pits that otherwise meet the OSDF WAC

Operable Unit 2

- Waste materials meeting the OSDF WAC from the North and South Lime Sludge Ponds, the Solid Waste Landfill, the Inactive Fly Ash Pile, the Active Fly Ash Pile, and the South Field area

Operable Unit 3

- D&D debris meeting the OSDF WAC and not otherwise prohibited

Operable Unit 4

- Impacted soils and debris not containing silos materials that otherwise meet the OSDF WAC
- D&D debris from Silo 4

Operable Unit 5

- Site-wide impacted soils, sediments, and debris meeting the OSDF WAC and not otherwise prohibited

The OSDF WAC consisted of three elements: chemical/radiological-specific limits, material prohibitions/ restrictions, and physical size criteria. It should also be noted that the ROD prohibited off-site waste from disposal in the OSDF. Material that was disposed on-site must have met all three of these categories of WAC. Table 2-1 summarizes the chemical/radiological-specific limits.

Table 2-1 OSDF Radiological and Chemical Waste Acceptance Criteria

WAC Constituent	Maximum Concentration Limit
Radiological WAC for Concrete Debris	
Technetium-99	105 grams total
Radiological/Chemical WAC for Soil	
Neptunium-237	3.12×10^{9} pCi/g
Strontium-90	5.67×10^{10} pCi/g
Technetium-99	29.1 pCi/g
Total Uranium	1,030 mg/kg
Carbazole	7.27×10^{4} mg/kg
Bis(2-chloroisopropyl)ether	2.44×10^{-2} mg/kg
Alpha-chlordane	2.89 mg/kg
Bromodichloromethane	9.03×10^{-1} mg/kg
Chloroethane	3.92×10^{5} mg/kg
1,1-Dichloroethene	11.4 mg/kg
1,2-Dichloroethene	11.4 mg/kg
4-Nitroaniline	4.42×10^{-2} mg/kg
Tetrachloroethene	128 mg/kg
Toxaphene	1.06×10^{5} mg/kg
Trichloroethene	128 mg/kg
Vinyl chloride	1.51 mg/kg
Boron	1.04×10^{3} mg/kg
Mercury	5.66×10^{4} mg/kg

In addition to the radiological and chemical WAC, the following items were prohibited/restricted from disposal in the OSDF:

- The contents of Silos 1, 2, and 3 from Operable Unit 4
- Concrete from Operable Unit 4 Silos 1 and 2 that exhibits highly-elevated direct radiation fields
- Waste pit contents from Operable Unit 1, including any debris found within the waste pits
- Waste pit covers and liners from Operable Unit 1 (a modification allowed the cover from Waste Pit 4 to be placed in the OSDF and defined liners as the material extending six inches below the waste-soil interface)
- Off-site waste that was not generated as a direct result of FEMP remediation (i.e., FEMP analytical residual waste from off-site laboratories is permitted)
- Lead bullets from the South Field Firing Range and the associated soil that is identified as RCRA characteristic, unless it has been treated
- Process-related metals (i.e., piping and equipment that did not pass visual inspection for the presence of product residual) as defined in the Operable Unit 3 ROD
- Product, residues, and other special materials (e.g., uranium and thorium inventories) as defined in the Operable Unit 3 ROD
- Acid brick
- Materials containing free liquids
- Whole or shredded scrap tires (those specific types of tires defined by OEPA)
- Used oils
- RCRA toxicity characteristic soil from the six geographic areas designated in the Operable Unit 5 ROD, unless it has been treated
- Lead sheeting (i.e., elemental lead from facility D&D activities within the boundaries of Operable Unit 3), unless it has been treated
- Pressurizable gas cylinders (i.e., gas cylinders that are still mechanically able to be pressurized)
- Intact drums (i.e., they must be empty and crushed)
- Transformers that have not been crushed or had their void spaces filled with grout, or another acceptable material. Used oil must be drained from all transformers.

Physical WAC were established for debris that defined the maximum length, thickness, and configuration of different categories of debris. The radiological/chemical WAC were established in the RODs, the prohibited/restricted items were identified in the RODs and the OSDF remedial design documentation, and the physical WAC were established during the remedial design and are documented in the OSDF Impacted Materials Placement Plan [DOE 1998a]. The Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility [DOE 1998b] summarized all of these requirements and presented the WAC implementation and compliance strategy.

2.3. OSDF Post-ROD Decision Changes

There was one post-ROD decision change to the Operable Unit 2 ROD that is relevant to the OSDF. CERCLA requires that changes to approved RODs be done through a formal amendment for fundamental changes, an Explanation of Significant Differences for other significant changes, or a fact sheet for minor modifications. The decision change was considered minor and was documented through a fact sheet. The decision documented in the fact sheet allowed the disposal of the lead contaminated soil from the firing range in the OSDF after successful treatment, rather than sending the material off site [DOE 1999a].

As discussed in Section 1.5, an informational fact sheet was issued in the spring of 2005 to outline how the closeout reports would be prepared to communicate the remedial action closeout process; this fact sheet assigned closeout reporting for the OSDF as part of the Interim Operable Unit 5 report.

2.4. Remedial Design Summary

The Remedial Design Work Plan (RDWP) for Remedial Actions at Operable Unit 2 [DOE 1995b] identified three distinct phases of design efforts to address Operable Unit 2. Phase 2 of this effort addressed the design deliverables and tests for the OSDF. (At the time this RDWP was prepared, on-site disposal of Operable Unit 3 and Operable Unit 5 impacted materials had yet to be formally decided but on-site disposal were the acknowledged leading alternatives.) The Remedial Action Work Plan (RAWP) for the On-Site Disposal Facility [DOE 1997a] identified the implementation strategy and schedule for completion of the construction and placement of impacted materials into the OSDF. The RAWP also identified several remedial action support plans needed to fully implement the OSDF remedial action. These plans included:

- Permitting Plan and Substantive Requirements for the On-Site Disposal Facility
- Cultural Resource Unexpected Discovery Plan
- Borrow Area Management and Restoration Plan
- OSDF Surface Water Management and Erosion Control Plan
- OSDF Construction Quality Assurance Plan
- OSDF Systems Plan
- OSDF Groundwater/Leak Detection and Leachate Monitoring Plan
- Post-Closure Care and Inspection Plan

A general description of the OSDF design is provided in the Design Criteria Package for the On-Site Disposal Facility Design [DOE 1996c]. The OSDF was designed as an above-grade unit to provide permanent disposal for affected soil, wastes, and materials generated by site remedial actions. Containment of materials in the facility minimizes the potential for direct contact or incidental ingestion/inhalation of residual contaminants. It also minimizes migration of contaminants to air and surface water and will protect groundwater for a minimum period of 200 years and up to 1,000 years.

The OSDF was originally designed for 2.5 million unbulked cubic yards (actual volume was approximately 2.9 million cubic yards), the majority of which was excavated soil and wastes from Operable Units 2 and 5. The remainder was debris from Operable Unit 3 cleanup. The facility was planned to occupy an area of approximately 800 feet by 3,700 feet. It has multilayer composite cover and liner systems with a leak detection and leachate collection system. Leachate collected in the leachate collection system was (and is) treated prior to discharge.

The OSDF design was performed in phases and each phase is documented in a separate design package.

Final Cover/Liner Design

The final cover and liner systems were constructed using both soil and geosynthetic components and meet the RCRA requirements for disposal of hazardous waste and Uranium Mill Tailings Remedial Action (UMTRA) requirements for disposal of radioactive waste. The liner system is five feet thick (not including the impacted protective layer) and consists of a double composite liner with a leachate collection system above the primary liner and a leak detection system between the primary and secondary liners. The design was based on a soil liner test pad program discussed in more detail in Section 3.0 of this report. The final cover system is 8.75 feet thick

and includes a composite cap overlain by a drainage layer, biointrusion barrier, granular filter layer, vegetative soil layer, and topsoil. The final cover and liner systems were designed considering borrow material requirements, seasonal (i.e., winter) closure, and site preparation requirements. Typical details for the final cover and liner systems are included in Appendix B.

Leachate Management System

The leachate management system collects leachate generated by the OSDF and conveys it to the Converted Advanced Wastewater Treatment (CAWWT) facility prior to being discharged to the Great Miami River. The leak detection system was installed so that a potential leak in the primary composite liner could be identified and more thoroughly investigated. Major components of the leachate management system include double-walled gravity drain pipes from each OSDF cell, leachate transmission system valve house for each cell, leak detection and leachate collection system collection tanks and associated piping and valving within the valve house, permanent double-walled gravity transmission pipe, control valve house, permanent lift station, and a till monitoring system.

Waste Placement

Impacted (i.e., contaminated) materials disposed in the OSDF were assigned to one of the five following categories, which then determined the procedures that were used to place it in the OSDF:

- Category 1 impacted materials are soils and soil-like material that do not contain hard agglomerations greater than 12 inches in the greatest dimension. These impacted materials are readily compactable using standard construction equipment.
- Category 2 impacted materials are materials that can be transported, placed, spread, and compacted *en masse*. Examples of these materials include broken-up concrete foundations (i.e., concrete rubble) or impacted soil mixed with broken up concrete. This category also includes general building rubble and debris or irregularly shaped metals or other components of the superstructure or substructure with a maximum length of 10 feet and a maximum thickness of 18 inches.
- Category 3 materials are materials that must be individually handled and placed in the OSDF, and that are suitable for having Category 1 material placed around and against them. These impacted materials have a maximum cross-sectional dimension of no more than 4 feet and are essentially incompressible using standard compaction equipment. An example of these materials is broken concrete foundation members (i.e., larger slabs or monoliths) that meet the physical WAC.
- Category 4 impacted materials are high in organic content and/or prone to decomposition. Examples of these materials are municipal solid wastes from the Solid Waste Landfill and green waste from clearing, stripping, and grubbing operations around the FCP.
- Category 5 impacted materials are materials that require special handling due to their specific nature. Examples of these materials include double-bagged asbestos and sludges.

Impacted material placement procedures are documented in the Impacted Material Placement Plan for the On-Site Disposal Facility and the OSDF Impacted Material Placement Plan for Winter Months [DOE 2004a].

Groundwater Monitoring

The OSDF Groundwater/Leak Detection and Leachate Monitoring Plan [DOE 1997b] was designed to meet the regulatory requirements for groundwater monitoring in both the Great Miami Aquifer and the perched groundwater system. These detection monitoring requirements constitute the first tier of a three-tiered detection, assessment, and corrective action monitoring strategy required for engineered disposal facilities. The OSDF monitoring strategy is responsive to monitoring needs both during the active remediation of the site and during the

post-remediation period when restoration activities are complete. Prior to waste placement, the initial baseline condition of the perched water and the Great Miami Aquifer beneath each cell was defined. Throughout the construction of the OSDF, analytical results and trend analyses for the leachate collection system, the leak detection system, perched groundwater, and the Great Miami Aquifer are compared with one another and against the baseline conditions to evaluate the overall performance of each cell and to determine whether a release from the facility has occurred.

3.0 CONSTRUCTION ACTIVITIES

The general sequence of activities for construction of the OSDF liner and final cover systems can be summarized as follows:

Liner System Construction Sequence

- Preparation of construction packages for construction of OSDF cell/liner system and submission to regulatory agencies for approval
- Procurement and conformance testing of construction materials including high-density polyethylene (HDPE) geomembrane liner (GML), geosynthetic clay liner (GCL), geotextile, drainage layer, and HDPE pipe for the leak detection system, leachate collection system, redundant leachate collection system and horizontal monitoring wells
- Screening, stockpiling, and conformance testing of clay material for clay liner
- Construction of the horizontal monitoring well approximately 12 months before start date for impacted material placement in each OSDF cell
- Site preparation including installation of erosion and sediment controls, clearing and grubbing, general site work, roads, drainage ditches, and drainage structures
- Excavation and subgrade preparation for the liner system
- Construction of three-foot thick clay liner
- Installation of in-let boxes for the leak detection system, leachate collection system, and redundant leachate collection system
- Installation of secondary liner system (GCL, GML, and geotextile)
- Installation of leak detection system pipeline and 12-inch thick drainage layer
- Installation of primary liner system (GCL and GML)
- Performance of leak detection testing on GML
- Installation of geotextile
- Installation of leachate collection system pipeline, redundant leachate collection system pipeline, 12-inch thick drainage layer, and geotextile
- Tie-in of leak detection system, leachate collection system, and redundant leachate collection system pipelines with the valve house piping
- Placement of 12-inch thick drainage rock layer and geotextile filter in the catchment area
- Construction Quality Control (CQC) testing and verification field surveys during construction of liner system
- Video inspection of leak detection system
- Certifying engineer acceptance and regulatory agency approval for placement of impacted material in OSDF cell
- Placement of 12-inch thick impacted material protective layer
- Submission of Construction Quality Assurance (CQA) Report to the regulatory agencies
- Placement of select impacted material layer and continue placement of impacted material
- Dust suppression activities conducted throughout

Final Cover System Construction Sequence

- Preparation of construction packages for construction of OSDF cell/final cover system and submission to regulatory agencies for approval
- Procurement and conformance testing of construction materials including GML, GCL, geotextile, drainage layer, biointrusion barrier, filter layer, and chowking layer

- Screening, stockpiling, and conformance testing of clay material for clay cap
- Site preparation including installation of erosion and sediment controls, clearing and grubbing, general site work, roads, drainage ditches, and drainage structures
- Final grading and verification field survey of select impacted material layer
- Placement of 12-inch thick soil contouring layer
- Subgrade preparation for clay cap
- Construction of 24-inch thick drainage layer and geotextile
- Placement of 3-foot thick biointrusion, 6-inch thick chowking, and 6-inch thick filter layers
- Placement of 21-inch thick vegetative and 6-inch thick top soil layers
- Installation of jute netting
- Seeding
- CQC testing and verification field surveys during construction of final cover system
- Submission of CQA Report to the regulatory agencies
- Quarterly inspection of the final cover system
- Dust suppression activities conducted throughout

Placement of contaminated materials was according to the requirements of the impacted material placement plans. In very general terms, waste placement occurred in controlled lifts that were limited based on the type of materials being placed. In addition, within individual lifts placement occurred in grids established according to a surveyed coordinate system. Archived records document placement of material by lift and individual grid. Catchment basins were maintained in a quadrant of each cell for the management of runoff. As placement proceeded, the catchment areas were filled with impacted material and inter-cell berms allowed runoff to flow into the catchment area of the subsequent cell.

The major OSDF construction activities were summarized on an annual basis in the CQA Certification Reports that were prepared by GeoSyntec. This section provides a summary of the information presented in those reports.

Pursuant to the ARARs for the Operable Unit 2 ROD, a soil test pad program was performed in 1996 to evaluate the suitability of the on-site clay material proposed for use in the OSDF liner and final cover systems. Based on the findings from the test pad program, construction requirements for borrow material preparation, clay liner and clay cap placement and compaction, and conformance and performance testing were determined and specified in the technical specifications. These requirements were further amended in 1999 based on variations of on-site clay borrow materials encountered and lessons learned during construction of the OSDF Cell 1 liner system. The operation of the on-site borrow area was documented in the OSDF Borrow Area Management Plan [DOE 2001a].

The first year (1997) of actual field construction included the liner system for Cell 1 and the overall Leachate Management System projects. The Leachate Management System projects consisted of the following:

- The OSDF leachate transmission system component that included Manholes 1, 2, and 3, for Cells 1, 2, and 3, respectively, and a dual-containment HDPE gravity piping system from Manhole 1 to the permanent lift station
- The leachate conveyance system that consisted of a force main from the permanent lift station to the biosurge lagoon

The interface between the Cell 1 liner system and the overall Leachate Management System was at the stub-outs of the manholes for Cell 1 leachate collection and leak detection systems. Construction of the liner system for Cell 1, the OSDF leachate transmission system and the leachate conveyance system occurred between August and December 1997.

The second year (1998) of construction consisted of the liner system for Cell 2 and placement of impacted materials in Cells 1 and 2. Construction of the Cell 2 liner system occurred between June and November 1998. Placement of impacted materials in Cells 1 and 2 began in July 1998 and November 1998, respectively.

The third year (1999) of construction consisted of the Cell 3 liner system and placement of impacted material in Cells 1, 2, and 3. Construction of the Cell 3 liner system occurred between April and October 1999. Placement of impacted materials began in Cell 1 in August 1999 and in Cell 2 in June 1999, while impacted materials placement in Cell 3 began in November 1999.

The fourth year (2000) of construction included placement of impacted materials in Cells 1, 2, and 3. Impacted materials placement began in Cells 1, 2, and 3 in March 2000 and was completed in September 2000 when Cell 1 was brought to final grades to facilitate construction of the final cover system. The fourth year of construction also included the Enhanced Permanent Leachate Transmission System project that consisted of a permanent leachate transmission system gravity line from Cell 1 to the permanent lift station, valve houses for each OSDF cell, a control valve house near the permanent lift station, and tie-in of the dual-containment pipes from Cells 1, 2, and 3 to the newly constructed valve houses 4, 5, and 6, respectively.

The fifth year (2001) of construction consisted of Cell 1 final cover construction and placement of impacted materials in Cells 2 and 3. Construction of the Cell 1 final cover system occurred between April and December 2001. Placement of impacted materials in Cells 2 and 3 began in August 2001.

The sixth year (2002) of construction consisted of liner systems for Cells 4 and 5 and placement of impacted materials in Cells 2, 3, 4, and 5. Construction of the Cell 4 and 5 liner systems and ancillary structures occurred between April 2002 and April 2003. Placement of impacted materials in Cells 2 and 3 began in April 2002, and continued with placement of impacted protective layer materials in Cells 4 and 5 in November 2002.

The seventh year (2003) of construction consisted of Cell 2 final cover and Cell 6 liner systems construction and placement of impacted materials in Cells 3, 4, 5, and 6. Construction of the Cell 2 final cover system occurred between April and October 2003. Construction of the Cell 6 liner system and ancillary structures occurred between March and October 2003. Placement of impacted materials in Cells 3, 4, and 5 began in April 2003, while placement in Cell 6 began in November 2003.

The eighth year (2004) of construction consisted of Cells 3 and 4 final cover systems, Cells 7 and 8 liner systems, and placement of impacted materials in Cells 4, 5, 6 and 7. Construction of the Cell 3 final cover system began in May 2004 and was completed in October 2004. Cell 4 final cover system construction began in September 2004 and ended in December 2004. Construction of the Cell 7 and 8 liner systems and ancillary structures occurred between March 2004 and December 2004. Placement of impacted materials in Cells 3, 4, 5, and 6 began in February 2004, while placement in Cell 7 began in September 2004.

The ninth year (2005) of construction included the placement of impacted materials in Cells 5, 6, 7, and 8 and the completion of final cover systems for Cells 4, 5, and 6

The tenth year (2006) of construction included the placement of impacted materials through September 7, 2006 when the last placement occurred. Final cover systems for Cell 7 and 8 with the Cell 8 final cover system completed in October 2006 culmination the ten years of OSDF placement and construction activities.

In addition to the above, several other "non-routine" construction activities were undertaken. In 1999, because of construction deficiencies observed in the double-wall, HDPE leachate transmission system pipeline between Manhole 3 west of OSDF Cell 3 and the OSDF permanent lift station, an interim leachate transmission system was installed between Manhole 3 and the permanent lift station before installation of the Enhanced Permanent Leachate Transmission System. Installation of the interim leachate transmission system also included the installation of a slip lining in the leachate transmission system pipeline between Manholes 1 and 3.

An Enhanced Permanent Leachate Transmission System pipeline to replace the original leachate transmission system pipeline between Manhole 3 and the permanent lift station was installed in 1999 and 2000. Installation of the Enhanced Permanent Leachate Transmission System included replacement of Manholes 1, 2, and 3 for OSDF Cells 1, 2, and 3 (with valve houses 1, 2, and 3), construction of valve houses 4 through 8 and the control valve house north of the permanent lift station, and installation of SDR 11 double-wall HDPE pipeline between valve house 3 and the permanent lift station.

Further, to lower the impact of the perched groundwater on the OSDF leak detection system, an interceptor subdrain system was installed west of OSDF Cells 1 and 2 in 2002 and 2003. Based on the groundwater monitoring data, the perched groundwater level west of OSDF Cells 1 and 2 was lowered significantly.

To verify the performance of components of the final cover system, drainage layer, and vegetative layer, a settlement monitoring system was installed in the OSDF Cell 1 final cover system in 2001. The monitoring system consisted of three sub systems: sensors/devices, data transmission system, and the data logger system. Monitoring sensors/devices included the following:

- Installation of seven pressure transducers and thermo-couples in the drainage layer to measure flow and temperature in the drainage layer.
- Installation of ten soil moisture content sensors and thermo-couples to measure the soil moisture content and metric potential and temperature in the vegetative layer. Two types of sensors were installed in pairs at four different depths within the vegetative layer.
- Placement of a set a three settlement plates at four locations. These plates were installed at the interfaces of the drainage layer and the biointrusion barrier, the chowking layer and the filter layer, and the filter layer and the vegetative layer for measuring settlement of the individual layers by ground penetrating radar.
- Installation of settlement rods at four locations to measure total settlement of the final cover system.

Evaluation of monitoring data collected over two years indicated that performance of components of the final cover system and overall performance of the cover system is within the acceptable range of the design criteria. It was subsequently determined that this monitoring system was no longer needed and removed from service in October 2006.

In addition, extensive air monitoring was conducted at the FCP fenceline near the OSDF as part of the site-wide air monitoring program. The results of this monitoring were presented in the Integrated Environmental Monitoring Plan annual reports and demonstrated that emissions from the OSDF have not had any substantive off-site impact and were significantly below the regulatory limit of 10 mrem established by the National Emission Standards for Hazardous Air Pollutants (NESHAP).

Annual OSDF placement rates, as well as those of impacted material excavation, were successfully increased to meet project goals. Tables 3-1 and 3-2 summarize the impacted material placement volumes by disposal cell and material category, respectively, for each year of placement.

Table 3-1 Yearly Impacted Material Placement Quantities (by Disposal Cell) (In-Place Cubic Yards)

Year	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7	Cell 8	Total
1997	13,000	0	0	0	0	0	0	0	13,000
1998	157,814	32,700	0	0	0	0	0	0	190,514
1999	71,644	117,927	38,029	0	0	0	0	0	227,600
2000	71,825	41,757	53,858	0	0	0	0	0	167,440
2001	0	59,290	10,210	0	0	0	0	0	69,500
2002	0	122,867	87,941	34,123	10,714	0	0	0	255,645
2003	0	2,600	179,728	172,790	22,954	34,143	0	0	412,215
2004	0	0	2,773	163,887	173,697	129,303	34,499	8,701	512,860
2005	0	0	0	0	153,995	196,373	317,665	237,353	905,386
2006	0	0	0	0	0	0	20,492	181,569	202,061
Total	314,283	377,141	372,539	370,800	361,360	359,819	372,656	427,623	2,956,221

Table 3-2 Yearly Impacted Material Placement Quantities (by Material Category) (In-Place Cubic Yards)

Year	Category 1	Category 2	Category 3	Category 4	Category 5	Total
1997	13,000	0	0	0	0	13,000
1998	166,114	21,300	500	2,600	0	190,514
1999	186,002	34,791	90	6,118	599	227,600
2000	148,943	9,850	171	3,700	4,776	167,440
2001	57,226	11,096	0	719	459	69,500
2002	214,298	40,493	0	854	0	255,645
2003	323,667	78,999	5,297	1,714	2,538	412,215
2004	426,083	80,924	283	245	5,325	512,860
2005	713,837	184,394	0	2,012	5,143	905,386
2006	165,172	36,427	0	462	0	202,061
Total	2,414,342	498,274	6,341	18,424	18,840	2,956,221

4.0 CHRONOLOGY OF EVENTS

The following table provides a summary of the events for OSDF design and construction, and associated dates of those events, starting with approval of the RODs.

Table 4-1 Summary of Events for Operable Unit 2 Remediation

Event	Date
OSDF Decision Related Documents	
Approval of Operable Unit 2 Record of Decision	June 1995
Approval of Operable Unit 5 Record of Decision	January 1996
Approval of Operable Unit 3 Record of Decision	September 1997
Fact Sheet Related to Firing Range	July 1999
OSDF Remedial Design Documents	
Remedial Design Work Plan for Remedial Actions at Operable Unit 2	December 1995
Design Criteria Package for the On-Site Disposal Facility	October 1996
OSDF Phase I Design Package	October 1996
OSDF Phase II Design Package	November 1997
OSDF Enhanced Permanent Leachate Transmission System Design Package	March 2000
OSDF Phase III Design Package	May 2000
OSDF Phase IV Design Package	August 2001
OSDF Phase V Design Package	January 2002
Cell 8 Expansion Supplemental Calculation Package	June 2004
OSDF Remedial Action Documents	
Remedial Action Work Plan for the On-Site Disposal Facility	May 1997
Construction Quality Assurance Plan for the On-Site Disposal Facility	May 1997
Borrow Area Management and Restoration Plan	May 1997
Post-Closure Care and Inspection Plan for the On-Site Disposal Facility	July 1997
Groundwater/Leak Detection and Leachate Monitoring Plan for the On-Site Disposal Facility	August 1997
Impacted Material Placement Plan for the On-Site Disposal Facility	January 1998
Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility	June 1998
OSDF Impacted Material Placement Plan for Winter Months	January 2004
Remedial Action Field Activities	
Test Pad Program	Summer/Fall 1996
Start of Cell 1 Liner Construction	May 1997
First Waste Placement	December 1997
Start of Cell 2 Liner Construction	June 1998
Start of Cell 3 Liner Construction	April 1999
Start of Enhanced Permanent Leachate Transmission System Construction	May 2000
Completion of Enhance Permanent Leachate Transmission System Construction	June 2001
Completion of Cell 1 Final Cover System	December 2001
Start of Cells 4 and 5 Liner Construction	April 2002
Start of Cell 6 Liner Construction	March 2003
Start of Cell 7 Liner Construction	October 2003

Table 4-1 Summary of Events for Operable Unit 2 Remediation

Event	Date
Completion of Cell 2 Final Cover System	November 2003
Start of Cell 8 Liner Construction	January 2004
Completion of Cell 3 Final Cover System	April 2004
Completion of Cell 4 Final Cover System	April 2005
Completion of Cell 5 Cover System	September 2005
Completion of Cell 6 Cover System	December 2005
Completion of Cell 7 Cover System	October 2006
Last Waste Placement	September 7, 2006
Completion of Cell 8 Cover System	October 2006

5.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

A discussion of performance standards and construction (and post-construction) quality control for the OSDF is most appropriately presented in two parts: 1) issues related to construction performance of the OSDF, and 2) issues related to placement of impacted material within the open cells of the constructed OSDF.

5.1. OSDF Construction

The Construction Quality Assurance Plan for the OSDF [DOE 2001b] established the CQC activities for the OSDF. This Plan addressed requirements for the liner system, leachate collection system, leak detection system, and the final cover system. More specifically, the Plan established the required conformance testing, monitoring, and performance testing for the various components of the OSDF. The rate of leakage through the liner system was, and is, an important performance standard for the OSDF. An action leakage rate of 200 gallons per acre per day (gallons/acre/day) was established during the design of the OSDF. Moreover, DOE agreed to a significantly more conservative "initial action leakage rate" of 20 gallons/acre/day in the leak detection system.

Accumulation rates in the leak detection system (LDS) are evaluated weekly for each of the eight disposal cells. Typically, the highest rate is observed near the time the disposal cell cap has been completed and then diminishes over time. Table 5-1 summarizes the maximum leakage rates observed in the disposal cells. As Table 5-1 indicates, this initial action leakage rate has never been exceeded.

Table 5-1 – Maximum Observed Accumulation Rate in the Leak Detection System

Disposal Cell	Maximum Accumulation Rate (Gallons/Acre/Day)	Period of Evaluation
1	1.47	June 2001 – September 2006
2	2.09	June 2001 – September 2006
3	1.56	July 2002 – September 2006
4	6.4	November 2002 – September 2006
5	13.13	November 2002 – September 2006
6	13.87	January 2004 – September 2006
7	16.59	September 2004 – September 2006
8	5.5	December 2004 – September 2006

The accumulation rate in the LDS will continue to be evaluated (See Section 7). If this rate is exceeded, DOE must, in conjunction with the regulators, evaluate what, if any, corrective action must be taken.

Fluor Fernald hired a CQC Consultant (i.e., GeoSyntec Consultants) to be responsible for monitoring, testing, confirming compliance, and documenting activities related to construction of the OSDF. The activities are conducted independent of the Fluor Fernald construction management and associated organizations. Documentation of these efforts is discussed in Section 6.0.

5.2. Impacted Material Placement

There are three OSDF support plans that functioned together to define the requirements and associated implementation methodologies for impacted material (i.e., waste) acceptance, placement, and compaction activities. These plans, which also addressed quality assurance/quality control activities, are:

- Impacted Material Placement Plan for the OSDF
- OSDF Impacted Material Placement Plan for Winter Months
- Waste Acceptance Criteria Attainment Plan for the OSDF

The Impacted Material Placement Plan for the OSDF was originally submitted in October 1996 and defined the material size and configuration considerations associated with waste placement in the OSDF. It also provided the engineering-based requirements for material conditioning, segregation, placement, and compaction to enhance the long-term integrity and performance characteristics of the facility. The corresponding plan for winter months addressed the same topics for January through March waste placement. The Impacted Material Quality Assurance Plan (part of the Impacted Material Placement Plan) established the specific quality control requirements and documentation practices to be used to monitor and test impacted materials that are placed in the OSDF. The scope of the Impacted Material Quality Assurance Plan included:

- Fluor Fernald's Waste Acceptance Organization (WAO) duties related to impacted materials placement
- CQC Consultant duties related to impacted materials placement and compaction
- Monitoring, testing, and documentation procedures that were used in confirming that impacted material placement and testing were in accordance with the requirements of the Impacted Material Placement Plan.

WAO confirmed that impacted material arriving at the OSDF was properly manifested with all required information on waste origin properly documented. WAO representatives also typically performed visual inspections of the waste as it was being placed as a confirmatory check that no prohibited materials were being placed and that the placed materials matched the description in the manifest.

The CQC Consultant was responsible for monitoring compliance with the Impacted Material Placement Plan requirements and the suitability of materials for placement, compaction of materials, and compaction testing. The CQC Consultant also prepared as-placed records and schematics and provided formal CQC certifications (see Section 6.0).

The WAC Attainment Plan described the material-specific approaches for demonstrating the attainment of the radiological, chemical, and physical WAC for all materials placed in the OSDF. The document also described the quality assurance, quality control, and organizational responsibilities required to ensure WAC attainment. Fluor Fernald's WAO organization provided oversight independent of the project organization to ensure the WAC Attainment Plan was followed. WAO personnel worked during characterization and at the time (and place) of waste generation.

WAO was charged with verifying that analytical data for excavation sites met the chemical and radiological WAC. WAO also implemented the manifesting system used to track material and associated analytical data from excavation to disposal, making field decisions on material engineering categories and size restrictions for OSDF placement, and for providing oversight and support in identifying and removing OSDF-prohibited items from the excavated wastes at the excavation sites and, as a second independent check, at the point of placement in the OSDF. WAO also identified the off-site disposition pathway and handling requirements for shipping OSDF prohibited items and above-WAC materials to the appropriate off-site disposal facilities. WAO also produced daily records of material quantities removed and placed, and oversaw the administrative management of the FCP's interim soil and debris stockpiles and material transfer locations. Finally, since the completion of the removal of the wastes was verified both by engineering survey data as well as visual observation of the materials remaining at the excavation sites, WAO served as the primary observing entity to ensure that visual completion obligations were satisfied.

6.0 FINAL INSPECTIONS AND CERTIFICATIONS

As discussed in the previous section, the Construction Quality Assurance Plan for the OSDF established the CQA activities for the OSDF. These include the requirements for final inspections and certifications. GeoSyntec Consultants (the designers of the OSDF) was selected to confirm that CQA activities were completed as required.

Inspections required by the CQA Plan were conducted on an ongoing basis as work was completed. CQA activities were documented as they were conducted using daily field reports, CQA monitoring and data forms, non-conformance reports (as required), and photographic documentation. Fluor Fernald and GeoSyntec elected, with regulator concurrence, to complete CQA Reports on an annual basis to cover the major OSDF construction activities completed during that year. These reports contained the following:

- Summaries of CQA activities
- CQA monitoring forms and data forms including sample location plans
- Laboratory test results
- Problem identification and corrective measures reports
- A descriptive summary of any changes from construction drawings and technical specifications
- A summary statement indicating compliance with construction drawings and technical specifications that is signed and sealed by the CQA Certifying Engineer

The Construction Quality Assurance Plan and CQA Final Reports established that the individual OSDF cells were constructed in accordance with the plans and specifications. The following CQA Final Reports, taken together, document the successful completion of the OSDF construction.

- Construction Quality Assurance Final Report for the OSDF Phase I – Cell 1 liner system and Overall Leachate Management System [DOE 1998c]
- Construction Quality Assurance Final Report for the OSDF Phase II – Cell 2 Liner System [DOE 1998d]
- Construction Quality Assurance Final Report for the OSDF Phase II – Cell 3 Liner System [DOE 1999b]
- Construction Quality Assurance Final Report for the Enhance Permanent Leachate Transmission System [DOE 2001c]
- Construction Quality Assurance Final Report for the OSDF Phase III Final Cover Construction [DOE 2002]
- Construction Quality Assurance Final Report for the OSDF Phase IV – Cells 4 and 5 Liner Systems [DOE 2003]
- Construction Quality Assurance Final Report for the OSDF Phase IV Cell 2 Final Cover Construction and Phase V Cell 6 Liner System [DOE 2004b]
- Construction Quality Assurance Final Report for the OSDF Phase V - Cell 7 and 8 (including expansion) liner systems, and Cell 3 and 4 (partial) final cover systems, and Valve House 7 and 8 [DOE 2005b]
- Construction Quality Assurance Final report for the OSDF Phase V – Cell 4, 5, 6, and 7 East Final Cover Systems [DOE 2006a]
- Construction Quality Assurance Final Report, Phase V, Cell 7 and 8 Final Cover Systems [DOE 2006b]

In addition, WAO documented that impacted materials placed in the OSDF were consistent with all relevant requirements. An evaluation of the leakage rates for each of the individual cells (discussed in Section 5.0) indicates the OSDF is operating successfully. Adherence with all these performance standards indicates the OSDF is operating as intended.

7.0 OPERATION AND MAINTENANCE ACTIVITIES

The inspection, monitoring, and maintenance activities necessary to ensure the continued proper performance of the OSDF after construction of the final cover system on the last cell are defined in the Post-Closure Care and Inspection Plan for the On-Site Disposal Facility (Attachment B of the FCP's Comprehensive Legacy Management and Institutional Controls Plan (LMICP) [DOE 2006c]). The facilities and structures covered under the Post-Closure Care and Inspection Plan include:

- OSDF security systems (e.g., fences, gates, warning signs)
- Permanently surveyed benchmarks
- OSDF run-on/run-off controls
- OSDF final cover
- Leachate collection system
- Leak detection system
- Leachate transmission system
- Other appurtenances as necessary

The Post-Closure Care and Inspection Plan defines requirements (including ARARs) and general processes for key activities including environmental monitoring, leachate management, routine scheduled inspections, unscheduled inspections, custodial maintenance and contingency repair, corrective actions, and emergency notification and reporting. In addition, the Post-Closure Care and Inspection Plan addresses circumstances that might require plan modifications as well as public involvement. The information presented in the remainder of this document summarizes what can be found in the Post-Closure Care and Inspection Plan.

7.1. Institutional Controls and Security Measures

The FCP's LMICP provides the details behind the institutional controls required for the OSDF, consistent with the RODs. The Operable Unit 2 and Operable Unit 5 RODs required indefinitely continued ownership and maintenance of the OSDF by the Federal government. Also required are OSDF access controls including fences, locked gates, and warning signs containing specified information. Further, if ownership of a portion of the FCP is transferred in the future (note: this is not allowed for the OSDF) restrictions will be included in the deed and proper notifications will be provided as required by the appropriate rules and regulations. A preliminary draft of such notice in deed is provided in the Post-Closure Care and Inspection Plan.

7.2. Environmental Monitoring

The Integrated Environmental Monitoring Plan and the OSDF Groundwater/Leak Detection and Leachate Monitoring Plan (Attachment C of the LMICP) details the environmental monitoring of the OSDF that will continue post-closure. This monitoring consists of groundwater monitoring, leachate monitoring and leak detection monitoring that will be used to continually evaluate the performance of the OSDF.

7.3. Leachate Management

The Post-Closure Care and Inspection Plan covers:

- Procedures for collecting, handling, and disposing of leachate, if any, during the post-closure period in order to prevent excess accumulation of leachate in the system
- Such procedures are to remain in effect until leachate is no longer detected
- The Director of the Ohio EPA may allow the management of leachate to cease if it is demonstrated that leachate no longer poses a threat to human health or the environment.

7.4. Routine Scheduled Inspections

Routine scheduled inspections cover security systems (e.g., fences, signs, etc.), final cover system, run-on and run-off control systems, and surveyed benchmarks. The Post-Closure Care and Inspection Plan establishes the frequency and timing of inspections, the required makeup of the inspection team, and the focus and process of the inspections.

The focus of these inspections, which will be conducted each year for at least the first five years post-closure, is to identify potential problems at an early stage prior to the need for significant maintenance or repairs. A fundamental part of the inspection will be the detection of change. The inspection checklist will include the following:

- Security of fences, gates, and locks, as well as the condition of applicable warning signs
- General health and density of the vegetative cover
- Evidence of burrowing by animals on the cover
- Presence, depth, and extent of erosion or surface cracking, indicating possible final cover deterioration
- Visibly noticeable subsidence, either localized or over a large area
- Presence and extent of visible settlement, including a determination of whether observed settlement is sufficient to pond water
- Presence and extent of any leachate seeps
- Integrity of run-on and run-off control features
- Integrity of benchmarks

The handling of concerns arising from these inspections is addressed in Section 7.6 below.

7.5. Unscheduled Inspections

Unscheduled inspections may be triggered by reports or information that the site and/or OSDF integrity has been compromised. Two types of unscheduled inspections are anticipated: followup inspections and contingency inspections. Followup inspections investigate and quantify specific problems encountered during routine, scheduled inspections, special studies, or other relevant activities. These will better document or investigate in more detail a previously noted issue. Contingency inspections are unscheduled, situation-unique inspections ordered by the DOE when it receives new information site integrity has been or may be threatened. Examples include vandalism, tornados, etc.

7.6. Custodial Maintenance and Contingency Repair

The Post-Closure Care and Inspection Plan explains the procedures to be used by DOE to determine when maintenance or contingency repairs are used at the OSDF. Custodial maintenance, which is performed on a routine basis according to a schedule established in the Post-Closure Care and Inspection Plan addresses normal "wear and tear" issues such as signage, disrepair, growth of woody species on the cover, etc. Contingency repair is on an as needed basis to address more significant damage to the OSDF such as slope instability, encroachment of stream/drainage channels into the OSDF buffer area, etc. The need for such action will be primarily determined through inspections.

7.7. Emergency Notification and Reporting

The Post-Closure Care and Inspection Plan establishes protocols for emergency notification and reporting. Unforeseen events could create problems that could affect the OSDF's ability to remain in compliance with applicable standards. Therefore, the DOE has requested notification from local, state, and Federal agencies of discoveries or reports of any purposeful intrusion or damage at the site, as well as occurrence of earthquakes, tornados, or floods in the area of the disposal facility. Such notification would trigger a contingency inspection, as discussed in Section 7.5.

8.0 SUMMARY OF PROJECT COSTS

The 1996 Operable Unit 5 ROD identifies the selected remedy for soil and sediment, along with the other environmental media included in Operable Unit 5. The selected remedy was *Alternative 3A – Engineered Disposal Facility* from the Operable Unit 5 Proposed Plan, using the *Undeveloped Park User* as the selected target land use/receptor scenario. A summary of the estimated costs for the selected remedy at the time of its selection was provided in the ROD, with the details and backup provided in the Operable Unit 5 Feasibility Study Report [DOE 1995c].

This section of the OSDF closeout report compares the original estimated costs as contained in the ROD with the actual costs experienced on the project. Consistent with EPA's closeout guidance, an explanation is to be provided when the actual costs fall outside the range of –30 to +50 percent of the estimate. Appendix A provides the supporting information and tabular summaries supporting the descriptions and findings presented below.

Readers should note that for all of the cost evaluations presented in the FCP's individual operable unit closeout reports (including this Operable Unit 5 interim closeout report), the evaluations focus on those direct and indirect remedial costs specifically associated with the individual remedies conducted for the operable unit of interest. The cost evaluations do not include FCP administrative or overhead costs for managing the site as a whole, such as for oversight, site administration and management, communications and reporting, site-wide utilities, office space, and other such landlord costs. The comparisons are therefore aimed at the specific direct and indirect costs (such as engineering) required to complete the individual remedies required by the FCP's CERCLA process across the five operable units. In this way, users of this report will be able to more readily compare costs from other sites within the Superfund program for like remedies with those experienced at Fernald. This also permits the cost comparisons presented in the closeout reports to remain consistent with how the ROD cost estimates were originally developed back in the 1990s, when the cleanup remedies for Fernald were first envisioned.

8.1 Summary and Analysis of the Original Operable Unit 5 ROD Costs

The original ROD cost estimate for the selected remedy is presented in Table 9-2 on page 9-21 of the December 1995 Operable Unit 5 ROD. The estimated costs presented in the ROD encompass cleanup costs for all of the environmental media (soil, sediment, groundwater and surface water) comprising Operable Unit 5 and were summarized in the ROD for the entire remedy as follows:

Construction costs (constant 1995 dollars)	$430 million
Operation and maintenance costs (constant 1995 dollars)	$340 million
Postremediation costs (constant 1995 dollars)	$70 million
Total cost (constant 1995 dollars)	$840 million
Present worth cost	$580 million
Total cost with escalation (27 year remedy)	$2.11 billion

The ROD went on to explain that "the total cost of the remedy ($840 million) represents the total amount, in constant 1995 dollars necessary to implement the selected remedy assuming no inflation occurs over the life of the remedy. The present-worth cost ($580 million) represents the total estimated present worth cost of the remedy assuming a discount rate of 2.8 percent. The present worth cost represents the sum of money which must be placed in an interest bearing account (e.g., a bank) at the onset of remedial activities at a net interest rate to progressively pay for the entire scope and duration of remedial actions. The total cost with escalation

($2.11 billion) represents the total estimated cost of remedial actions assuming the funding is provided on an annualized basis and an annual escalation rate of 3.7 percent prevails throughout the duration of the remedy." Note that the escalation rate is a factor applied in the analysis to examine the effects of inflation and the decline in the dollar's purchasing power with the passage of time (in this case over a period of 27 years, as considered in the feasibility study for remedial decision making) for engineering projects with long durations.

As background in the use of the various estimates for cost evaluation, readers should understand that the "present worth" cost estimate provided in the ROD is typically used to support initial remedy decision making – its use is for relative cost ranking purposes, and serves as the government's preferred means to evaluate remedial alternatives with differing durations or completion timeframes to then identify and select a preferred alternative from a common starting point. Present-worth cost evaluation techniques for remedy selection are required under CERCLA guidance to compare remedial alternatives, and are used during the feasibility study to help identify and evaluate the preferred alternative for inclusion in the ROD (this is how the preferred remedy was evaluated for Operable Unit 5 at the time of the ROD). The present-worth technique does not actually represent how money will likely be allocated to pay for the remedy over its duration (such as year-by-year annualized funding appropriations, which do not have the ability to draw the sizeable cumulative interest accumulations like the initial up-front total project sum assumed in the present-worth calculation). Rather, the primary purpose of the present-worth calculation is to facilitate fair relative comparisons of feasible alternatives from a "common point in time" approach to identify the least cost alternative prior to implementation of the project.

The post-cleanup comparative evaluation of original ROD cost estimates with actual costs experienced during implementation of a remedy represents a different cost analysis problem not represented by the present-worth technique. In this situation, the present-worth cost estimate must be replaced by the constant dollar estimate for a given base year (in this case, 1995 as the base year, since this was the year the estimate was prepared), which is then adjusted to accommodate the impacts of inflation and the decline in the purchasing power of the dollar during the actual period of performance. This inflation adjustment is important particularly for multi-year projects of long duration, and also those projects that may have been delayed considerably from their original concept date due to funding/approval constraints. The post-cleanup evaluation therefore requires an adjustment of base year dollars to future dollars – representing the actual timeframe of project performance – that have the same purchasing power as the original base year dollars. This approach therefore recognizes the selected multi-year remedy will be implemented on an annualized funding basis and, since the actual period of performance becomes a known entity at the completion of the remedy, the base year dollars can be scaled upward to ensure they maintain "constant dollar" purchasing power. This adjustment is made using actual escalation factors available as part of the Consumer Price Index to match the actual years the work was performed -- and thereby accounting for the actual effects of inflation using backward-looking government specified escalation factors for each year of passage from the base year. Such adjustments then bring the estimates from the ROD into a form that can be directly compared to the actual dollars expended over the life of the remedy.

8.2 Adjustments to Permit Fair Comparison of ROD Costs with Actual Costs for OSDF

Based on the above discussion, the total cost estimate of $840 million in 1995 dollars summarized in the ROD serves as the starting point for the comparison with actual costs experienced during implementation of the remedy. Recognizing that the Operable Unit 5 soil and sediment and OSDF portions of the remedy began in 1995 (at ROD signature) and were completed in 2006 (with aquifer restoration ongoing), an effort was conducted to divide the Operable Unit 5 ROD cost estimate into its three component parts (Soil/Sediment Remediation,

OSDF Disposal and Closure, and Aquifer Restoration) using backup cost information from the feasibility study; these three component parts were then adjusted to bring the 1995 constant dollar estimates into current dollars, covering the actual 11 years of remedy implementation duration between 1995 and 2006. The results are summarized in the table below.

Table 8-1 – Operable Unit 5 ROD Cost Estimate

Remedy Component	1995 Constant Dollar Estimate	Escalated Estimate (1995 to 2006 actual period of performance)
Soil and Sediment Remediation/Site Restoration	$230 million (from FS)	**$268 million**
OSDF (disposal of Operable Unit 5 materials and closure of facility)	$310 million (from FS)	**$365 million**
Aquifer Restoration and Monitoring	$300 million (from FS)	Not applicable. The performance period extends beyond 2006 since this is an ongoing portion of remedy.
Operable Unit 5 Totals	$840 million (from FS and summarized in ROD)	Not applicable, until aquifer restoration complete.

The two values shown in bold in the third column ($268 million for soils/sediment and $365 million for the OSDF) represent the time- and inflation-adjusted starting points for comparison to actual costs experienced for these two Operable Unit 5 components. They will each be compared, evaluated, and reported in the respective stand-alone sections (e.g., this report for the OSDF, and the stand-alone soils/sediment section which is Section 2) of the Interim Operable Unit 5 Remedial Action Report. Once groundwater costs are tallied in the future at the completion of the aquifer restoration remedy, a similar escalation adjustment and comparison can and will be performed for that component, addressing the actual period of performance (1995 to the actual completion date) experienced for the life of the aquifer restoration remedy. In the meantime, the Aquifer Restoration section of the Interim Remedial Action Report will summarize and evaluate costs experienced to date with the groundwater remedy.

Within the Operable Unit 5 OSDF costs are the following work scope items: OSDF engineering, design, and permitting; construction of cell liners, caps, and other engineered features; waste placement activities for WAC-compliant soil and debris delivered to the OSDF; oversight and inspection; and facility closure and care. As the next adjustment, the cost "add ins" from the other operable units needed to bring the 1995 adjusted estimates in alignment with the closeout decisions accompanying the spring 2005 Fact Sheet were made so that the costs associated with the completion of the individual work scopes match the particular closeout reports where the work completion is being documented. These adjustments also account for how the work was executed and tracked in the field, during actual implementation. For example, much of the at-and below-grade debris removal from Operable Unit 3 was conducted concurrently with Operable Unit 5 excavation work using the same equipment, staff, and techniques. Similarly, site-wide restoration activities were accomplished concurrently in all areas as an Operable Unit 5 soil activity, and off-site shipment and disposal of above-WAC materials via the SP-7 stockpile was accomplished for the site as a whole as an Operable Unit 5 soil activity.

These "add ins" are summarized in the respective soil and sediment and OSDF sections of the Operable Unit 5 interim closeout report as required. The following table shows the required "add ins" subset for this OSDF report, starting with the corresponding constant 1995-dollar estimates for the individual "add ins" and then making the necessary escalation adjustments to render them current with actual costs. These escalated values for the "add ins" are then added to the $365 million Operable Unit 5 ROD escalated estimate for the OSDF to achieve the grand total for ultimate comparison to actual costs.

Table 8-2 Adjusted Cost Estimate for the OSDF Construction

"Add In" Component	Original 1995 Dollar Estimate	Escalated Estimate for Use in Comparisons
At-, above-, and below-grade debris placement costs from Operable Unit 3	$58.1 million	$68 million
Waste placement costs for WAC-compliant materials from Operable Unit 2	$91.4 million	$106 million
"Add Ins" Escalated Subtotal		$174 million
Escalated Subtotal from Operable Unit 5 ROD		$365 million
New Grand Total With "Add Ins" Included		**$539 million**

Overall these last adjustments ensure representative cost comparisons are conducted for each operable unit as required in Section 8 for the individual reports, and allow the operable-unit closeout reports to remain integrated and consistent in their tracking, documentation, and reporting of both work-scope and cost completion information.

8.3 Results of the Comparison of Actual Costs with the ROD-Estimated Costs for the OSDF

Based on all the adjustments and escalations described above, the ROD-adjusted cost estimate for use in the comparison with actual costs for the OSDF is $539 million. Collectively, the OSDF actual costs sum to a grand total of $224.2 million, which is approximately 58 percent less than the estimated cost of $539 million estimate from the table above. Appendix A contains a tabulation of all of the actual costs experienced in executing the OSDF component of the Operable Unit 5 remedy (including the "add in" elements from Operable Units 2 and 3 described in Table 8-2) as well as further discussion of the significant cost savings experienced.

9.0 OBSERVATIONS AND LESSONS LEARNED

Lessons learned from OSDF construction activities were continuously incorporated into the planning for subsequent cells to ensure that remedial activities met all applicable requirements and achieved the highest quality level possible. These lessons learned are presented here and in Appendix A:

- Use of screeners in the Borrow Area to screen the clay material and add moisture prior to stockpiling reduced the need for rock pickers in the cell to meet compacted clay specifications and minimized the adjustment of moisture content in clay during compaction of the liner.
- Establishing moisture-density curves for each clay material stockpile (approximately 10,000 cubic yards) in the Borrow Area helped in meeting the acceptable permeability zone for a wide variation of clay content in the clay material.
- An optimization plan was implemented for impacted material placement in each cell based on the OSDF liner and final cover construction schedule, soil excavation schedule, and D&D schedule, along with impacted runoff management.
- When ordering the textured geomembrane material, the procurement specification must specifically require that the edges of the roll be smooth so that the overlapping sheets can be welded together properly.
- The biointrusion barrier stone was changed to a Type D riprap from a Type C riprap after researching standard industry practice for radioactive waste disposal facilities. The smaller Type D riprap was easier to place during cap construction.
- The Impacted Material Placement Plan originally required a 4-foot intervening layer of soil be placed between each layer of debris. This was re-evaluated and was reduced to a 2-foot intervening layer without compromising the performance of the OSDF final cover and liner systems.

10.0 CONTACT INFORMATION

Remedial Action Contacts

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Public Information Fernald Closure Project U.S. Department of Energy P.0. Box 538705 Cincinnati, OH 45253-8705 513-648-3153	Fernald Closure Project Fluor Fernald P.O. Box 538704 Cincinnati, OH 45253-8704 513-648-4898
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APPENDIX A – COST AND PERFORMANCE SUMMARY

The project costs for the design, construction and placement of waste in the OSDF is presented in Table A.1. In addition to the costs associated with the construction of the liners and caps and the placement of waste, the costs below include the leachate system, borrow area management, and other infrastructure such as roads and utilities. Indirect costs include engineering, project management, and OSDF monitoring and data management.

Table A.1 OSDF Project Costs

Total Actual Direct Costs	Total Actual Indirect Costs	Total Placement Cost
$132,514,730	$60,482,455	$31,213,305
	Total	**$224,210,490**

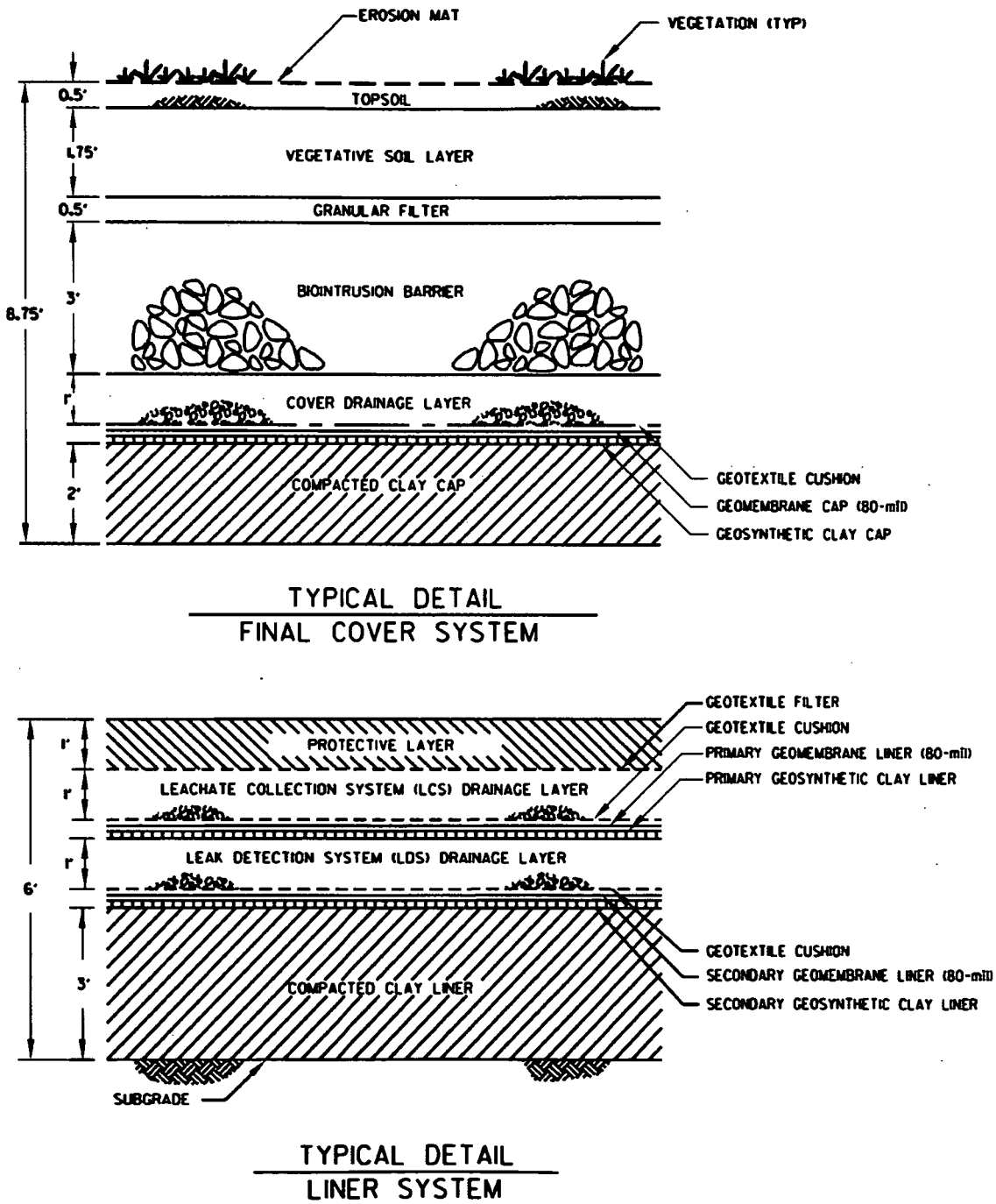
Since the cost savings are greater than 30 percent, an explanation of the difference is offered per U.S. EPA guidance. The significant savings are due to the following process improvements that have caused the production rates and cost of the OSDF to improve over the ROD-based estimate. These improvements and enhancements are presented from a qualitative standpoint as a quantitative analysis is not possible.

- Design changes have caused the work to be completed in a more efficient manner such as the reduction of the Category 1 intervening layer thickness from 4 feet to 2 feet and the increase of the Category 2 debris grid size up to 200 feet by 200 feet.
- The contracting methodology was change to self perform from construction management in FY 2002. This caused a savings in subcontractor markups.
- Final cover improvements included more efficient screening equipment to improve the borrow area screening operation.
- Changed the biointrusion material (riprap) from larger Type C type riprap to a smaller Type D riprap. Type D can be spread with a D-6 dozer while Type C needs a D-8 and a track hoe. Benefits included less production loss, less void to fill and improved quality of the product.
- Changed the final cover specification for the 12-inch contouring layer from contaminated to non-contaminated. This allowed better constructability of placing the 12-inch contouring layer and the clay liner interface.
- Final Cover and Liner Work: The use of Global Positioning System (GPS) dozers to fine grade cap and liner lifts. The use of GPS dozers reduced survey costs, increased production, and provided a higher quality product.
- Dust Control: The use of portable 12,000-gallon water towers. Before beginning the use of the portable 12,000-gallon water towers, it would take about 20-25 minutes to fill up a water wagon truck. This meant less water for dust control and more water wagons and fill stations to keep up. Since starting to use the portable 12,000-gallon water towers, the trucks fill up in 5-6 minutes, which means more water for dust control per day.
- A more efficient transite panel and asbestos-containing material placement approach were adopted to improve production rates.

- A Design Change Notice for lower inter-cell berms allowed for cells to be constructed simultaneously (Cells 4 and 5) and (Cells 7 and 8). The slopes were minimized to 10:1 to allow geomembrane to continue to be placed in the same direction as the floors of the cell. Remembrance seams must be placed in the direction of the slope when slopes are steeper than 10:1. This saved time, because the installer did not have to cut shorter pieces and place the remembrance across the beam in a north-south direction. The installer was able to continue over the 10:1 beam in an east-west direction.
- The construction season was lengthened when some placement activities were allowed in the winter period.
- Maximizing the number of cells open allowed more flexibility of construction work forces to receive more impacted fill.
- Concrete crushing was allowed to create more Category 1 material.
- Purchasing geotextile in large bulk quantities caused the material cost to be lower than expected.
- The ROD states that the OSDF will be constructed over 20 years. It was envisioned that there would be one cell per year rather than the eight cells as currently designed. There is an economy of scale by building eight cells, as the cost of material will be less if it purchased and installed in larger portions. It was assumed that the construction subcontractor would be mobilized and demobilized each year. The number of setups was reduced to eight from 22 when the existing OSDF was designed.
- The ROD stated that a staging area would be built for the material needed for the liners and final covers. This facility was never built because we used existing facilities, such as asphalted parking lots, for storage.

APPENDIX B – OSDF DESIGN SCHEMATICS

Figure B-1 - OSDF Cell Liner and Cap System Schematic



APPENDIX C – HWMU CLOSURES

There were no Hazardous Waste Management Units directly associated with the OSDF.

APPENDIX D – REMOVAL ACTIONS

Under CERCLA, a removal action is defined as a "short-term cleanup often completed prior to a more formal ROD process." There were no removal actions directly associated with the OSDF.

APPENDIX E – LEGAL AGREEMENTS

The DOE has conducted operations at the Fernald site under several legal agreements, beginning with the 1986 Federal Facility Compliance Agreement and including the Consent Agreement and Amended Consent Agreement under CERCLA 121 and other agreements such as Ohio EPA Directors Findings and Orders and Consent Decrees. Implementation of these agreements resulted in the RODs for the various operable units that provide for the OSDF either directly (for Operable Units 2, 3, and 5) or indirectly (for Operable Units 1 and 4). There are no other legal agreements specific to the OSDF.

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APPENDIX G – OSDF PHOTOS

FigureG-1 Installation of Geosynthetic Liner Over Clay Liner

Figure G-2 Installation of LDS and LCS for Cell One

Figure G-3 Placement of Category 1 Material

Figure G-4 Placement of Category 2 Material

Figure G-5 Construction of Cell 1 Cover System

APPENDIX H – LIST OF ACRONYMS

ACA	Amended Consent Agreement
ACM	asbestos containing material
AEC	Atomic Energy Commission
ANSI	American National Standards Institute
ARAR	applicable or relevant and appropriate requirements
ASQC	American Society of Quality Control
ASME	American Society of Mechanical Engineers
AWWT	Advanced Wastewater Treatment
BSL	bio surge lagoon
CAWWT	Converted Advanced Wastewater Treatment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CQA	construction quality assurance
CQC	construction quality control
D&D	decontamination & dismantlement
DF&O	Director's Findings & Orders
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
ERDA	U.S. Energy Research & Development Administration
ESD	explanation of significant differences
FCP	Fernald Closure Project
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Company
FFCA	Federal Facilities Compliance Agreement
FMPC	Feed Materials Production Center
FRL	final remediation levels
GCL	geosynthetic clay liner
GML	geomembrane liner

GPS	global positioning system
HDPE	high-density polyethylene
HWMU	Hazardous Waste Management Unit
IEMP	Integrated Environmental Management Plan
LMICP	Legacy Management and Institutional Controls Plan
mg/l	milligrams/liter
NESHAP	National Environmental Standards for Hazardous Air Pollutants
NLO	National Lead of Ohio
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NQA	National Quality Assurance
NTS	Nevada Test Site
O&M	operations and maintenance
OFFO	Office Federal Facilities Oversight (Ohio EPA)
Ohio EPA	Ohio Environmental Protection Agency
OSDF	On-site Disposal Facility
OSWER	Office of Solid Waste and Emergency Response (U.S. EPA)
OU	Operable Unit
QA/QC	quality assurance/quality control
QAJSP	Quality Assurance Job Specific Plan
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RM	Requirements Manual
RSE	Removal Site Evaluation
SARA	Superfund Amendments and Reauthorization Act
SCQ	Site-wide CERCLA Quality Assurance Plan
SEP	Site-wide Excavation Plan
SP	stockpile (soil stockpile)
SWRB	storm water retention basin

TCLP	toxicity characteristic leaching procedure
μg/L	micrograms per liter
UMTRA	Uranium Mill Tailings Remedial Action
VOC	volatile organic compound
WAC	waste acceptance criteria
WAO	Waste Acceptance Organization
WEMCO	Westinghouse Environmental Management Company of Ohio
WMCO	Westinghouse Materials Company of Ohio
WPRAP	Waste Pits Remedial Action Project

APPENDIX I – SIGNATURE PAGE

I certify that the remedial actions as described within this report have been completed.

_____

Johnny W. Reising, Director
United States Department of Energy
Fernald Closure Project

Interim Remedial Action Report for Operable Unit 5 (Section 2) – Site-Wide Soil and Sediment

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1.0 INTRODUCTION

This document serves as Section 2 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) interim Remedial Action Report (closeout report) for Operable Unit 5 at the U.S. Department of Energy's (DOE's) Fernald Closure Project (FCP) located near Cincinnati, Ohio. As a stand-alone section of the interim Operable Unit 5 closeout report, this section covers closeout requirements for the remediation of site-wide soil and sediment at the FCP. Remediation requirements for soil and sediment and other environmental media were defined in the 1996 Record of Decision (ROD) for Operable Unit 5 [DOE 1996a].

The full closeout report for Operable Unit 5 is divided into three separate stand-alone sections as part of one integrated document. In addition to Section 2 covering site-wide soil and sediment, the interim Operable Unit 5 closeout report also covers construction, operation, and closure of the FCP's On-Site Disposal Facility (OSDF) in Section 1, and restoration of the Great Miami Aquifer in Section 3.

Section 2 has been prepared to meet U.S. Environmental Protection Agency (EPA) guidance for CERCLA site closeout as described in EPA OSWER Directive No. 9320.2-09A-P, *Closeout Procedures for National Priorities List (NPL) Sites* (January 2000). As stated in this directive, the aim of the guidance is to communicate EPA's key principles and expectations for remedial action closeout, along with "best practices" based on CERCLA program experience that should be consulted for closing out NPL sites in a consistent and reasonable manner across the program. The guidance recommends a standard closeout report outline that has been followed in the preparation of each of the three sections of the Operable Unit 5 interim Remedial Action Report.

During the fall of 2004, EPA and DOE identified the manner in which the time-sequenced individual closeout reports would be coordinated across the five operable units. This approach recognized that the source-control remedial actions (i.e., Operable Units 1, 2, and 4), decontamination and dismantlement (D&D) and legacy waste disposition activities (Operable Unit 3), the majority of soil remediation (part of Operable Unit 5), and the closure of the FCP's OSDF were all targeted for completion in 2006, while groundwater restoration (part of Operable Unit 5) will continue beyond 2006. The remaining activities that extend beyond 2006 are: 1) continued restoration activities for the Great Miami Aquifer; 2) the performance monitoring and final certification activities necessary to demonstrate completion of aquifer restoration; and 3) the final D&D and removal of groundwater related facilities and any affected soil above final remediation levels (FRLs) beneath the groundwater facilities, as required. As the mechanism to communicate the agreed-to closeout report strategy, EPA and DOE issued a fact sheet in the spring of 2005 [DOE 2005] describing

the coordination approach across the operable units, which is described in detail in Section 1.5. Section 2 of the interim Operable Unit 5 closeout report has been prepared in accordance with that strategy.

This closeout report is organized into ten major sections and nine appendices. Section 1.0 provides an overview of the FCP and the overall remedial activities comprising the FCP's site-wide cleanup program. Section 2.0 provides an overview specific to the remediation of site-wide soil and sediment as required by the Operable Unit 5 ROD. Section 3.0 addresses construction activities associated with soil remediation, and Section 4.0 provides an annotated chronology of the key events contributing to successful completion and documentation of the associated work. Sections 5.0 and 6.0 address performance standards, quality control, and final inspections and certifications, while Section 7.0 summarizes operations and maintenance information, as appropriate. Section 8.0 summarizes remedy cost information, and compares actual remedial costs with the original estimates contained in the applicable RODs. Section 9.0 identifies lessons learned during remedy implementation, and Section 10.0 summarizes key soil and sediment remedial action contact information.

1.1 Fernald Closure Project Overview

The FCP is a 1050-acre government-owned contractor-operated facility located in southwestern Ohio approximately 18 miles northwest of downtown Cincinnati. The facility is located just north of Fernald, Ohio, a small farming community, and lies on the boundary between Hamilton and Butler counties. Of the total site area, approximately 850 acres are in Crosby Township in Hamilton County and 200 acres are in Ross and Morgan Townships in Butler County.

The Atomic Energy Commission (AEC), predecessor to the U.S. Energy Research and Development Administration (ERDA) and then the DOE, established the Feed Materials Production Center (FMPC) in conformance with AEC orders in the early 1950s. In 1951, National Lead Company of Ohio, Inc., (now NLO) entered into a contract with the AEC as the Management and Operations Contractor for the facility. This contractual relationship lasted until January 1, 1986. Westinghouse Materials Company of Ohio (WMCO), a wholly owned subsidiary of Westinghouse Electric Corporation, then assumed management responsibilities for the site operations and facilities. In 1991, Westinghouse renamed this subsidiary the Westinghouse Environmental Management Company of Ohio (WEMCO). During that same year, DOE renamed the site the Fernald Environmental Management Project (FEMP) to reflect the site's revised mission. On December 1, 1992, Fernald Environmental Restoration Management Company (FERMCO) (now Fluor Fernald) assumed responsibility for the site as the Environmental Restoration Management Contractor for DOE. The FEMP was renamed the Fernald Closure Project (FCP) on January 27, 2003.

1.2 Mission of the Site

The primary mission of the FMPC during its 37 years of operation was the processing of uranium feed materials to produce high purity uranium metal. These high purity uranium metals were then shipped to other DOE or U.S. Department of Defense facilities for use in the nation's weapons program. Manufacture of the uranium metal products generally occurred in seven of the FCP's more than 50 production, storage, and support buildings that comprised what was known as the 140-acre production area. During the 37 years of production operations, nearly 500 million pounds of uranium metal products were produced. The site also served as the nation's key federal repository for thorium-related nuclear products, and it also recycled uranium used in the reactors at the Hanford site. These recycled reactor returns were the source of technetium 99, a radiological contaminant that is prevalent at the site.

In accomplishing the site mission, liquid and solid wastes were generated by the various operations between 1952 and 1989. Before 1984, solid and slurried wastes from FMPC processes were deposited in the on-property waste storage area. This area, located west of the former production areas, includes six low-level radioactive waste storage pits; two earthen-bermed concrete silos containing K-65 residues; one concrete silo containing metal oxides; one unused concrete silo; two Lime Sludge Ponds; a Burn Pit; a Clearwell; and a Solid Waste Landfill. After 1984, wastes produced from operations were containerized for eventual shipment to off-site disposal facilities. Contaminants from material processing and related activities were released into the environment through air emissions, wastewater discharges, storm water runoff, and leaks and spills.

1.3 Regulatory History

The CERCLA Remedial Investigation/Feasibility Study (RI/FS) process at the FEMP began in 1986, in accordance with a Federal Facility Compliance Agreement (FFCA) between DOE and EPA to cover environmental impacts associated with the FEMP. The FFCA was intended to ensure that environmental impacts associated with activities at the facility would be thoroughly and adequately addressed. In response to the FFCA, a site-wide RI/FS was initiated pursuant to CERCLA, as amended by the Superfund Amendment and Reauthorization Act (SARA). Production operations at the facility were suspended in 1989 and the facility was placed on the National Priorities List. The FFCA was amended in April 1990 by a Consent Agreement (under §120 106[a] of CERCLA) that revised the milestone dates for the RI/FS and provided for implementation of removal actions. The Consent Agreement was amended in September 1991 to revise schedules for completing the RI/FS process. This amended Consent Agreement provided for implementation of the operable unit concept. The FEMP was partitioned into five operable units to promote a more structured and expeditious cleanup. The schedule for preparation of a remedial investigation report and feasibility study report for each operable unit was included in the amended Consent Agreement.

The Ohio Environmental Protection Agency (Ohio EPA) Office of Federal Facilities Oversight (OFFO) also oversees cleanup activities at the site as a support agency primarily through the December 1988 Consent Decree and its January 1993 amendment. Ohio EPA conducts environmental monitoring, public outreach, restoration and remediation oversight at the FCP, as well as maintaining authority for Resource Conservation and Recovery Act (RCRA) enforcement. The June 1996 Director's Final Findings and Orders between the DOE/Fluor Fernald and the Ohio EPA provide orders for closure activities relative to several Hazardous Waste Management Units (HWMUs) established at the site to satisfy both RCRA and CERCLA requirements.

1.4 Site-Wide Operable Units and Cleanup Strategy

For purposes of investigation and study, the remedial issues and concerns that were similar in location, history, type/level of contamination, and inherent characteristics were grouped into operable units under the 1991 amended Consent Agreement. Specifically, the site was divided into five operable units. Four of the operable units (1 through 4) are considered contaminant "source" operable units as they represent the physical sources of contamination that have affected the site's environmental media. The fifth operable unit (Operable Unit 5) is considered the "environmental media" operable unit as it represents the environmental media affected by past production operations and waste disposal practices (i.e., beyond the contaminant "source" operable unit boundaries), as well as the pathways of contaminant migration at the site. The four contaminant "source" operable units and the fifth environmental media operable unit are described below:

- Operable Unit 1: Waste Pit Area. Waste Pits 1 through 6, Clearwell, Burn Pit, berms, liners, and affected soil residing within the operable unit boundary.

- Operable Unit 2: Other Waste Units. The Active and Inactive Flyash Piles, the South Field disposal area, north and south Lime Sludge Ponds, the Solid Waste Landfill, and the berms, liners, and affected soil residing within the operable unit boundary. The Active and Inactive Flyash Piles and South Field area are collectively known as the "Southern Waste Units" because they are collocated in close geographic proximity to one another.
- Operable Unit 3: Former Production Area. Former production and production-associated facilities and equipment (including all above- and below-grade improvements), including, but not limited to, all structures, equipment, utilities, drums, tanks, solid waste, waste, product, thorium, effluent lines, a portion of the K-65 transfer line, wastewater treatment facilities, fire training facilities, scrap metal piles, feedstocks, and coal pile. Note that all affected soil beneath the facilities resides within Operable Unit 5.
- Operable Unit 4: Silos 1 through 4. Contents of Silos 1, 2, and 3 (Silo 4 has remained empty); the silos structures, berms, decant sump tank system, and affected soil residing within the operable unit boundary.
- Operable Unit 5: Environmental Media. Affected groundwater, surface water, soil not included in the definitions of Operable Units 1, 2, and 4, sediment, flora, and fauna.

During the time period 1994 to 1996, DOE and EPA signed the final RODs for each operable unit – in cooperation with the Ohio EPA and the Fernald Citizen's Advisory Board – which set in motion the major cleanup requirements and approaches that collectively define the FCP cleanup. The RODs employ a combination of off-site and on-site disposal, under which approximately 77 percent of the remedial waste volume (the site's lower concentration, higher volume materials) are to be disposed of in the engineered OSDF while approximately 23 percent (the site's higher concentration, lower volume materials) are to be sent off site for disposal, primarily at permitted facilities in Utah and Nevada.

At the time the RI/FS activities were completed and the RODs put in place, an estimated 31 million pounds of uranium products, 2.5 billion pounds of waste, 255 buildings and structures, and 2.75 million cubic yards of contaminated soil and debris were identified as requiring action. In addition, a 223-acre portion of the Great Miami Aquifer was found to be contaminated at levels above radiological drinking water standards. Under the site-wide approach, the final remedial actions contained in the operable unit RODs are:

- Production and support facility D&D
- On-site disposal of contaminated soil, above- and below-grade debris, and Operable Unit 2 waste unit materials, provided on-site waste acceptance criteria (WAC) are met
- Off-site disposal of the contents of the silos, the waste pit materials, nuclear product inventories, containerized low-level and mixed waste inventories, and the quantities of soil and debris that do not meet OSDF WAC
- Extraction and treatment of contaminated groundwater to restore the contaminated portions of the Great Miami Aquifer to meet Safe Drinking Water Act requirements

At completion, approximately 975 acres of the 1,050-acre property will be restored for use as an undeveloped park, the target land use selected in the Operable Unit 5 ROD, and approximately 75 acres will be dedicated to the footprint of the OSDF. The Great Miami Aquifer will be restored to drinking water standards, and long-term stewardship actions and requisite institutional controls will be put in place consistent with the target land use. Groundwater restoration for the Great Miami Aquifer is estimated to be complete in 2026, based on modeling projections.

Taken together, the individual RODs for the operable units provide a site-wide cleanup approach that encompasses all contaminant source areas and all affected environmental media at the site. Collectively, the RODs provide a natural link between the remediation of the sources of contamination and the media affected.

Each ROD progressively built on the decisions of the earlier RODs, yielding a cohesive and comprehensive remedy for the FCP. The ROD signature dates and progressive sequence of decisions adopted under the RODs are shown below:

- Operable Unit 3 Record of Decision for Interim Remedial Action (July 22, 1994) – Provided accelerated approval for the D&D of the FCP's buildings and structures.
- Operable Unit 4 Record of Decision for Final Remedial Action (December 7, 1994) – Provided for the remediation of Silos 1 through 4, affected soil within the operable unit boundary, and other sources of contamination with the boundary. The D&D of all remedial facilities constructed for the Operable Unit 4 remedial action are to be addressed as part of Operable Unit 3.
- Operable Unit 1 Record of Decision for Final Remedial Action (March 1, 1995) – Provided for the remediation of the waste pit contents, caps and liners, affected soil within the operable unit boundary, and other sources of contamination within the boundary. The D&D of all remedial facilities constructed for the Operable Unit 1 remedial action are to be addressed as part of Operable Unit 3.
- Operable Unit 2 Record of Decision for Final Remedial Action (June 8, 1995) – Provided for the remediation of the Active and Inactive Flyash Piles, South Field disposal area, the two Lime Sludge Ponds, Solid Waste Landfill, affected soil within the operable unit boundary, and other sources of contamination within the boundary. This decision set in motion the approval of onsite disposal at the FCP and the construction of the OSDF; however, at the time it was formally limited to the disposal of the Operable Unit 2 wastes since the Operable Unit 5 and 3 decisions related to waste disposition (on site or off site) were not yet final.
- Operable Unit 5 Record of Decision for Final Remedial Action (January 31, 1996) – Provided for the remediation of the FCP's on-site and off-site environmental media. This ROD addressed the cleanup of the Great Miami Aquifer at all locations, and the remediation of affected site-wide soil and sediment outside the source operable unit boundaries. It also addressed the monitoring of air, surface water, groundwater, sediment, and biota. The Operable Unit 5 ROD finalized the concept of a site-wide OSDF, and further incorporated the "balanced approach" concept into FCP on-site and off-site waste disposition decisions. The D&D of all remedial facilities constructed to support the Operable Unit 5 groundwater remedial action were to be addressed as part of Operable Unit 3.
- Operable Unit 3 Record of Decision for Final Remedial Action (September 24, 1996) – Provided a final disposition decision for the D&D materials generated through the Interim Remedial Action Record of Decision. Consistent with the Operable Unit 5 decision, this final decision document adopted on-site disposal as the selected remedy for disposition of the D&D debris. It also adopted earlier decisions as part of the "balanced approach" to send the FCP's containerized waste inventories and nuclear materials off site. The ROD also acknowledged that the D&D of new remedial facilities constructed at the site would be addressed as part of Operable Unit 3.

1.5 Site-Wide Remedial Action Closeout Report Strategy – Spring 2005 Fact Sheet

In the spring of 2005, DOE and EPA developed a fact sheet to describe the strategy for producing the closeout reports for the CERCLA operable unit remedial actions completed for the FCP. Where affected media (primarily soil within an operable unit boundary) was a part of the source operable unit remedy, it was determined to be appropriate to accommodate the documentation of the remediation of that soil under the Operable Unit 5 closeout report. Therefore, only the source waste material would be addressed in their respective Final Remedial Action Reports, while the contaminated media within the source operable unit boundaries would be addressed under

Operable Unit 5. In essence, this fact sheet adopted the following strategy for submitting remedial action closeout reports for EPA approval (and summarized in Figure 1-1):

- Proceed with formal closeout of Operable Unit 1 when the waste pit contents and liners have been successfully dispositioned off site. The remaining operable unit scope (soil remediation within the Operable Unit 1 boundary and D&D of Operable Unit 1 remediation facilities) would be documented in the closeout reports for Operable Units 5 and 3, respectively. Soil remediation underlying the waste pits would be completed and documented in the Soil Remediation Area 6 Certification Report.
- Proceed with formal closeout of Operable Unit 2 when the waste materials from the Solid Waste Landfill, the two Lime Sludge Ponds, Active and Inactive FlyAsh Piles, and the South Field area have been successfully placed in the OSDF, or dispositioned off site as necessary based on OSDF WAC restrictions. The remaining operable unit scope (soil remediation within the Operable Unit 2 waste unit boundaries) would be documented in the closeout report for Operable Unit 5. Remediation of the soil underlying the Solid Waste Landfill and Lime Sludge Ponds would be completed and documented in the Soil Remediation Areas 6A and 6I Certification Reports respectively. The remediation of soil underlying the Active and Inactive Flyash Piles and the South Field area have already been completed and certified as a part of Soil Remediation Area 2 Phase 1 (Southern Waste Units).
- Proceed with formal closeout of Operable Unit 3 when the D&D of site-wide facilities – including the remediation facilities constructed for Operable Units 1 and 4 – are complete and all legacy-era containerized wastes have been successfully dispositioned off site.
- Proceed with formal closeout of Operable Unit 4 when the silo contents for Silos 1&2 and Silo 3 have been successfully dispositioned off site. The remaining operable unit scope (soil remediation within the Operable Unit 4 boundary and D&D of Operable Unit 4 remediation facilities and the empty silo structures) would be documented in the closeout reports for Operable Units 5 and 3, respectively. Remediation of the soil underlying the Operable Unit 4 boundary will be completed and documented under Soil Remediation Area 7.
- Proceed with an interim Remedial Action Report for Operable Unit 5 that recognizes that Great Miami Aquifer restoration activities will continue beyond DOE's 2006 baseline closure date. As an interim Remedial Action Report, the three major subsections will address completion of soil restoration activities (including those within the Operable Units 1, 2 and 4 boundaries) and closure of the OSDF, but will also need to recognize that ongoing aquifer restoration activities, future D&D of groundwater infrastructure, and final soil remediation (as necessary beneath the remaining groundwater infrastructure) remain as open items that will be closed out with a future final Remedial Action Report for Operable Unit 5 once groundwater actions are complete (estimated completion date in 2026, based on modeling projections). The interim Remedial Action Report under Operable Unit 5 will therefore consist of three independent subsections: soil and sediment remediation, OSDF closeout, and aquifer restoration activities.

Figure 1-1 Summary of CERCLA Remedial Action Closeout Reports and Schedule

Operable Unit	Key Closeout Activity	Where Documented	Remaining Scope	Where Documented
Operable Unit 1 Waste Pits	Waste pit contents successfully dispositioned off site	Final Remedial Action Report for Operable Unit 1 (Summer 2006)	Soil Remediation within Operable Unit 1 boundary	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)
			D&D of Operable Unit 1 Remediation Facilities	Final Remedial Action Report for Operable Unit 3 (Winter 2007)
Operable Unit 2 Other Waste Units	Wastes from Solid Waste Landfill, Lime Sludge Ponds, Flyash Piles, and South Field area successfully placed in OSDF or dispositioned off site as required	Final Remedial Action Report for Operable Unit 2 (Fall 2006)	Soil Remediation within Operable Unit 2 boundary	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)
Operable Unit 3 Production Area Facilities	D&D of site-wide facilities (except for groundwater infrastructure); completion of Legacy Waste disposal	Final Remedial Action Report for Operable Unit 3 (Winter 2007)	None	NA
Operable Unit 4 Silos	Silo 3 material successfully dispositioned off site; Silos 1&2 material successfully treated packaged, and transported off site into temporary storage.	Final Remedial Action Report for Operable Unit 4 (Fall 2006)	Soil Remediation within Operable Unit 4 boundary	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)
			D&D of Operable Unit 4 Remediation Facilities	Final Remedial Action Report for Operable Unit 3 (Winter 2007)
			Permanent off-site disposal of Silos 1&2 material	An addendum to the Final Remedial Action Report for Operable Unit 4 (post-closure)
Operable Unit 5 Environmental Media	Groundwater remediation infrastructure is installed and operating.	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)	D&D of groundwater facilities once groundwater remedy is complete; certification of surface water and sediments	Final Remedial Action Report for Operable Unit 5 (post-closure)
	Completion of all soil remediation site wide, except for beneath long-term groundwater facilities	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)	Soil remediation and certification beneath groundwater facilities	Final Remedial Action Report for Operable Unit 5 (post-closure)
	The On-Site Disposal Facility is capped	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)	Long-term care and monitoring	Final Remedial Action Report for Operable Unit 5 (post-closure)

2.0 RELEVANT BACKGROUND

Over the 38-year operating history of the site, the four source operable units (i.e., Operable Units 1 through 4) discharged contaminants that have moved to environmental media both on and off property and have impacted the soil and sediment. The remediation planned and executed under Operable Unit 5 prevents direct contact with contaminated soil and migration of contaminants to groundwater.

2.1. Results of the Remedial Investigation

Extensive soil sampling was conducted during the remedial investigation (RI) and other programs in order to characterize the nature and extent of contamination resulting from past FCP operations. Data from these investigations clearly show that uranium contamination was widespread on the FCP property. Radium-226, total thorium, and technetium-99 were also common radiological contaminants in soil. Furthermore, the extent or boundaries of uranium contamination generally included the extent of all other contaminants – including inorganic and organic contaminants.

Total uranium concentrations in surface soil within the FCP boundary typically ranged from 10 to 100 mg/kg. Above-background concentrations of total uranium (background is 3.7 mg/kg) in subsurface soil were found at depths up to 20 feet or more in the former production area. Radium-226 contamination was limited to the former production areas, waste storage areas, and isolated areas along the storm water outfall ditch and eastern slopes of Paddys Run. The only significant area of subsurface radium-226 contamination was west of the K-65 silos. Like the radium-226 contamination, total thorium and technetium-99 contamination was generally found in the production and waste storage areas. All thorium detections were within the bounds of uranium contamination, and were generally in surface soil. Subsurface thorium contamination was limited to a depth of 10 feet. In some areas of the former production area, excavation was driven by technetium-99 contamination, which is mobile in water and traveled to depths as great as those observed elsewhere for the uranium contamination.

The predominant inorganic contaminants were cadmium, beryllium, and arsenic, and they all are naturally occurring trace elements in the earth's crust. Except for isolated locations near the K-65 silos, all above-background concentrations of cadmium were located within the boundaries of uranium contamination. Cadmium was a trace constituent in the uranium ores processed at the FCP. Beryllium contamination was also primarily within the boundaries of uranium contamination, the exceptions being an area northeast of the former production area as well as near the Active Flyash Pile. Beryllium was a trace constituent in the K-65 residues, coal, and the resulting flyash when coal was burned. Low-level beryllium contamination was widespread at the FCP, probably due to emissions from the boiler plant as well as dispersion from the coal and flyash piles. Arsenic was a trace constituent in the K-65 residues, pesticides, and treatment solutions used for wood preservation. It was also used in metallurgy to harden lead, and was found in lead shot pellets that were widely used prior to switching to steel shot. At the FCP, most arsenic contamination was captured by the uranium contamination, with exceptions being an area south of the Pilot Plant drainage ditch and the former site shooting ranges, where it was associated with lead shot. It was also fairly widespread at concentrations slightly above its cleanup level, which was attributed to the use of pesticides prior to and during historic site operations.

Volatile organic and semivolatile organic compounds and polychlorinated biphenyls (PCBs) were detected in select samples in the vicinity of all major processing and supporting facilities. Generally, detections of organic contaminants were within the boundary of uranium contamination.

Uranium was the predominant contaminant in off-property soil and was mainly in the areas east, northeast, and southwest of the FCP property boundary. There were also isolated areas of significant uranium contamination located along the FEMP outfall line and along the eastern boundary adjacent to the sewage treatment plant. Isotopic thorium and radium were detected at concentrations slightly above background in off-property surface soil. For nearly all off-property soil samples, inorganic constituents were either detected at insignificant levels or analyzed for and not detected.

In general, off-property total uranium concentrations were in the 5 to 6 mg/kg range, which was slightly above the background concentration. Concentrations of approximately 20 mg/kg of uranium (approximately five times background) were identified in surface soil samples collected off property immediately adjacent to the eastern and northeastern boundary of the FCP. The source of uranium contamination was emissions of dust particles to the atmosphere from plant stacks and incinerator operations adjacent to the eastern boundary during FCP operations.

Detailed results of soil sampling efforts were presented in the Operable Unit 5 RI Report [DOE 1995a]. This report also included the results of the baseline risk assessment (as Appendix A in the RI Report) and the site-wide ecological risk assessment (as Appendix B in the RI Report). Estimates of risk presented in these assessments indicated that actual or threatened releases of hazardous substances into the soil and sediment of the FCP supported the need to take active remedial action. Based on the land use objectives and target risk scenarios presented in the Operable Unit 5 Feasibility Study [DOE 1995b], an estimated 1,792,000 cubic yards of soil required remedial action.

2.2. Removal Actions

Under CERCLA, a removal action is defined as a "short-term cleanup often completed prior to a more formal ROD process." There were two removal actions directly associated with efforts to minimize the migration of contamination in site-wide soil and sediment:

- Removal Action No. 14 – Contaminated Soil Adjacent to the Sewage Treatment Plant Incinerator
- Removal Action No. 17 – Improved Storage of Soil and Debris

Appendix D of this section provides a summary of these removal actions.

2.3. Selected Remedy

As identified in the Operable Unit 5 ROD, key components of the selected remedy for site-wide soil and sediment include:

- Excavation, using conventional construction equipment, of contaminated soil and sediment to the extent necessary to establish statistically, with reasonable certainty, that the concentrations 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 concentration-based WAC, in an on-property disposal facility. Soil exhibiting non-radiological contaminant concentrations exceeding the WAC (e.g., soil contaminated with organic constituents) will be treated before placement in the on-property disposal facility or shipped off site for disposal at an appropriate commercial or federal disposal facility. Soil exhibiting radiological contaminant concentrations exceeding the WAC will be shipped off-site for disposal. Soil from six designated areas where a reasonable potential exists for the presence of characteristic waste (as defined by RCRA) will be treated, as needed, before disposition. (Note: Placement of contaminated soil and sediment is addressed in the OSDF Remedial Action Report.)

- Site-wide restoration of impacted areas following excavation and certification sampling. Restoration will include regrading to blend with the surrounding topography and to promote positive drainage, seeding, fencing, and reestablishment of wetlands, as required.
- 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. (Note: The deed to the site property has not been amended to show restrictions. DOE does not intend to add restrictions to the deed since they will maintain ownership in perpetuity.)
- Implementation of a long-term environmental monitoring program and a maintenance program to ensure the continued protectiveness of the remedy, including the integrity of the on-property disposal facility.

As described earlier, Operable Unit 5 is one of five operable units at the FCP. Operable Unit 5 addresses the environmental media at the site and beyond the property line contaminated by releases from the four source operable units at the FCP. The source operable units contain the principal threat at the site; Operable Unit 5 consists of a large volume of contaminated media (soil and groundwater) exhibiting relatively low concentrations of contaminants compared to the source operable units.

2.4. Integrated Closeout of RCRA Hazardous Waste Management Units (HWMUs) and Underground Storage Tanks

In June 1996, Ohio EPA issued a set of Director's Final Findings and Orders (DF&O) to identify the requirements and strategy for the closeout of Fernald's RCRA HWMUs in conjunction with the site's CERCLA remediation activities. Ohio EPA has regulatory jurisdiction for the closeout of the HWMUs as part of their RCRA regulatory authority at the site. The 1996 DF&O identified the following integration approach and documentation strategy:

- All parties desire to avoid duplication of effort at the facility and to integrate the Ohio EPA RCRA hazardous waste closure requirements into the remediation requirements of CERCLA as detailed in Fernald's CERCLA Amended Consent Agreement.
- The HWMUs fall within the scope of Operable Units 1 (waste pit area) and 3 (production area). Operable Unit 5 includes the contaminated environmental media associated with the site, including the media adjacent to and underlying the HWMUs.
- Attachment A to the DF&O identifies the 30 individual HWMUs that are to be closed through a CERLCA/RCRA integrated process.
- The DF&O designated the Operable Unit 1 and 3 CERCLA remedial action closeout reports as the formal deliverables to provide certification that the removal, treatment, and/or disposal of the HWMUs identified in Attachment A of the DF&O has been completed (consistent with Ohio EPA Closure Guidance Items 3.14 and 3.16). The Final Remedial Action Record of Decision for Operable Unit 3 identifies the removal, treatment, and/or disposal requirements for the HWMUs, and the status of the units after closure (consistent with Ohio EPA Closure Guidance Items 3.14, 3.15, and 3.17).
- The DF&O designated the Operable Unit 5 remedial action closeout report as the formal deliverable to provide certification that media contamination associated with the HWMUs had been remediated to achieve health-protective remediation standards (consistent with Ohio EPA Closure Guidance Item 3.16). The Operable Unit 5 ROD provides the health-protective remediation standards for soil and groundwater for the intended post-remediation land use, and designates the use of institutional controls to achieve the intended land use (consistent with Ohio EPA Closure Guidance Items 3.11 and 3.12).

The closure of the FCP's underground storage tanks (USTs) was handled using a similar integrated approach, with Operable Unit 5 addressing the contaminated environmental media adjacent to and under the UST location.

Consistent with the DF&O, this remedial action report serves as the certification statement that affected environmental media contamination adjacent to and below the geographic footprints of the HWMUs listed in Attachment A of the DF&O (including Waste Pits 4 and 5) and the USTs identified in the Site-wide Excavation Plan has been remediated to achieve health-protective remediation standards.. The environmental media has been managed in accordance with the final remedy contained in the Operable Unit 5 ROD and in accordance with the Ohio EPA Director's closure performance standards. Note that the individual Certification Reports provide the details to demonstrate that FRLs were met. (The individual Certification Reports are adopted by reference in this Remedial Action Report). As companions to this Operable Unit 5 report, the Operable Unit 1 closeout report addresses certification that the other remaining HWMUs that reside within the Operable Unit 1 boundary have been closed, and the Operable Unit 3 report addresses certification that the above-grade structural features and components of the HWMUs have been closed.

Appendix C provides additional information on both the HWMUs and USTs that are being closed through this remedial action report, including a listing of the associated Certification Reports.

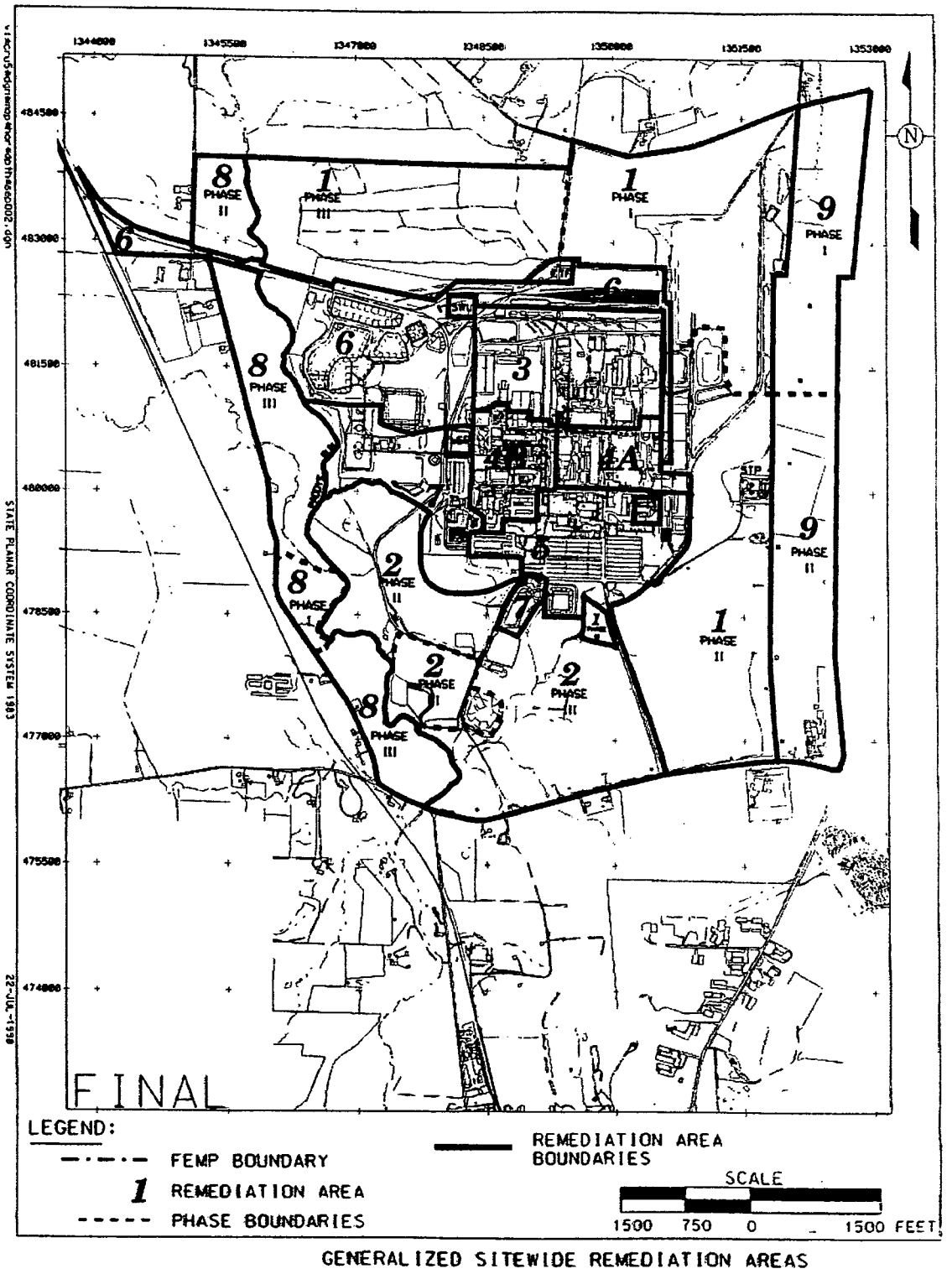
2.5. Post-ROD Changes

There were no post-ROD changes to the Operable Unit 5 remedy that affected soil and sediment remediation. As discussed in Section 1.5, a fact sheet was issued in the spring of 2005 to outline how the closeout reports would be prepared to communicate the remedial action closeout process, including the reporting for soil and sediment.

2.6. Remedial Design Summary

The Operable Unit 5 Remedial Design Work Plan [DOE 1996b] established the strategy for completion of design as it relates to remediation of site-wide soil and sediment. Although at- and below-grade debris is within the scope of Operable Unit 3, an integrated plan was developed that included removal of the at- and below-grade debris concurrent with soil excavation activities. Therefore, Operable Unit 5 remedial designs addressed the remediation of soil, sediment, and at- and below-grade debris. The general approach implemented to accomplish the excavation of waste materials, contaminated soil, and at- and below-grade debris was described in the Site-wide Excavation Plan [DOE 1998a]. The Site-wide Excavation Plan is an Operable Unit 5 remedial design document. Remediation of site-wide soil and sediment was accomplished on a geographic area basis, some with multiple phases. The Site-wide Excavation Plan identified ten general remediation areas, which are depicted in Figure 2-1. The general steps for excavation of each remediation area are described in the Site-wide Excavation Plan and include predesign investigation, remedial design, remedial action (including material handling and disposal), precertification, certification, and postremediation activities. Individual designs for the area-specific excavations were submitted and approved by EPA and Ohio EPA in the form of Integrated Remedial Design Packages (IRDPs). Section 4.0 of this report establishes the chronology of development of individual IRDPs. The IRDPs presented area-specific contamination data. As needed, additional sampling and analysis (documented in Project-Specific Plans) was conducted to supplement data from the RI on the nature and extent of contamination. Based on the extent of contamination, the IRDP presented a detailed design of the area-specific remediation elements and the lessons learned during previous phases of the site-wide remediation process. Certification of completed remediation for each remediation area is addressed in Section 6.0 of this report. The certification process followed the logic flow and documentation steps provided in the flow charts contained in Appendix B. Final grading and restoration of the site was guided by the Natural Resource Restoration Plan [DOE 2002] and is discussed in more detail in Section 3.0 of this report. Like the Site-wide Excavation Plan/IRDP interrelationship, the Natural Resource Restoration Plan provided the overall design guidelines for the site as a whole; with the detailed IRDP-specific approaches and requirements provided in individual, area-specific restoration design plans developed for each remediation area.

Figure 2-1 Generalized Site-Wide Remediation Areas



3.0 CONSTRUCTION ACTIVITIES

In order to proceed with the excavation of the contaminated soil and sediment, several foundational documents had to be prepared that would define how the excavations would be conducted, how the excavations would be sequenced, and where and how the excavated waste material would be dispositioned.

It was recognized that a site-wide sequencing plan and technical guidance document was needed to guide the excavation of soil and waste units throughout the site to ensure remediation area specific conditions were addressed as well as integrating the numerous excavations into comprehensive site-wide approach. The Site-wide Excavation Plan was developed to serve this purpose. The Site-wide Excavation Plan included remediation drivers, restoration goals, health and safety requirements, environmental controls and monitoring requirements, impacted material management programs and manifesting, and recordkeeping and data management requirements. The Site-wide Excavation Plan also described representative area specific conditions expected to be encountered based on depth and extent of contamination and types of contamination, and included methods and protocols for these conditions.

While it was concluded in the Operable Unit 5 remedy that much of the waste material excavated could be safely disposed of in the OSDF, specific WAC and waste placement methods had to be developed to ensure the OSDF was constructed to meet the required design criteria and be protective of human health and the environment. The Impacted Material Placement Plan [DOE 1996c] was written primarily to address the physical acceptance criteria of waste received and define the placement, compaction, and QA/QC activities undertaken throughout the construction, filling, and closure of the OSDF. This is addressed in more detail within the stand-alone OSDF closeout section (Section 1 of the interim Operable Unit 5 closeout report).

The WAC Attainment Plan [DOE 1998b] was prepared to complement the Impacted Material Placement Plan by describing the material management approaches for demonstrating attainment of radiological, chemical, and physical acceptance criteria for all materials destined for placement in the OSDF. The radiological and chemical WAC for soil and soil-like material were established in the Operable Unit 5 ROD. This is also addressed in the OSDF closeout report.

With these documents in place, it was then possible to develop the individual designs based on the characteristics of the waste material in each of the Operable Unit 5 geographic areas. Figure 2-1 shows the separate geographic areas by which work was planned and implemented. An IRDP was developed for each remediation area and was based on area-specific contaminants of concern, potential technetium-99 contamination (a specific OSDF WAC concern), RCRA, and above-WAC considerations determined through pre-excavation surveys and sampling as well as a data review of the remedial investigation or other data sources.

In 1996, the regulatory agencies approved the use of *in situ* gamma spectrometry, or "real-time scanning," during soil remediation at the FCP to quickly measure the levels of radiological contamination in the soil. The results of field surveys for the FCP's primary contaminants (uranium, thorium, and radium) were generated in real-time by integrating spectroscopic, Geographic Information System (GIS), and mapping software to generate plots of soil concentration data. This information was then available to the excavation teams to decide the disposition pathway of the soil, either on site or off site, or to decide whether the cleanup levels had been reached and excavation could be halted.

Detailed protocols were developed to take real-time measurements in support of predesign investigations, soil excavation and segregation, and precertification. The objectives of the predesign investigations were: 1) to estimate the areal extent of soil that is contaminated at levels above FRLs, and 2) to delineate the extent of soil that is contaminated by uranium that exceeds the WAC for the OSDF. Both mobile NaI and stationary HPGe measurements are combined with all available data from physical samples to establish volumes of contaminated soil that must be excavated. Mobile measurements were taken to determine general patterns of contamination and more accurate stationary measurements were then used to delineate boundaries of above-WAC areas. Contaminant maps were generated to show the extent of surface contamination that must be excavated and segregated for off-site disposal.

The excavation of contaminated soil generally was accomplished in one- to three-foot layers, or "lifts." The overall objective of real-time measurements during soil excavation was to obtain real-time data on contaminant levels on each freshly exposed surface. Rapid analytical results were critical to the excavation process to ensure that excavated soil is properly classified and segregated for on-site or off-site disposal and to minimize idle time for heavy equipment. Color-coded maps displaying results were used to guide additional excavation activities.

The purpose of precertification measurements was to gain a high degree of confidence that remedial actions have reduced all contaminants to levels that are below their respective FRLs, thus signifying that an area is ready for certification sampling. Real-time measurements were performed to determine if localized areas of elevated activity, called hot spots, exist within the area scheduled for certification sampling. If a hot spot was identified, its boundary had to be accurately delineated so that the elevated activity can be removed before certification sampling begins. Precertification measurements usually involved scanning 100 percent of the area in question with mobile detectors followed by closer investigation of any elevated areas with more accurate stationary detectors.

The excavations followed a logic flow that was based on the physical and contaminant characteristics of the given geographic area. Based on the characteristics of the site, the Site-wide Excavation Plan established the following six excavation approaches, each with a separate excavation strategy and sequence:

- Approach A – Shallow excavation of impacted on-property area outside the former production area and other waste storage/management areas
- Approach B – Excavation in waste storage/management areas outside the former production area
- Approach C – Excavation of existing soil stockpiles and management of containerized soil in the former production area and Remediation Area 1, Phase I
- Approach D – Excavation following D&D in the former production area, sewage treatment plant, and Fire Training Facility
- Approach E – Off-property and non-impacted on-property area certification
- Approach F – Non-High-Density Polyethylene (HDPE) pipeline excavation outside the former production area

The details of these approaches are presented in Section 4.0 of the Site-wide Excavation Plan and the logic flow diagrams for each of these approaches are presented in Appendix B of this closeout report. Table 3-1 presents a crosswalk linking the excavation approaches to the geographic remediation areas shown in Figure 2-1.

Table 3-1 Excavation Approaches Utilized In Each Remediation Area

Remediation Area	Excavation Approach
Area 1	A, C, D, E, and F
Area 2	A and B
Area 3	B, C, and D
Area 4	D
Area 5	C and D
Area 6	A, B, and D
Area 7	A and B
Area 8	E
Area 9	E and F

In general, excavation was performed in the following sequence:

- Define extent of contamination and identify any areas containing technetium-99, RCRA characteristic material, HWMUs, USTs, and above-OSDF WAC material.
- Delineate the extent of excavation and prepare the area-specific IRDP.
- Implement run-off control and other site preparation, as needed.
- Excavate areas with soil above technetium-99 cleanup levels.
- Excavate areas with RCRA characteristic material.
- Excavate UST areas.
- Excavate remaining above-WAC areas in lifts, using real-time scanning to ensure that all above-WAC soil was excavated and segregated.
- Excavate above-FRL soil and at- and below-grade debris in lifts, using real-time scanning to ensure that all above-FRL soil was excavated.
- Install compacted clay in areas where the excavations were deep enough to breach the top of the Great Miami Aquifer.
- Use real-time scanning instruments to perform a precertification scan and excavate any additional above-FRL soil that was identified during this scan.
- Delineate the boundaries of each certification unit and HWMU/UST area.
- Prepare the certification design letter.
- Perform certification and HWMU/UST closure sampling and excavate any additional above-FRL soil that was identified during this sampling.
- Prepare the certification report and submit to regulatory agencies.
- Implement interim grading and restoration plans.

The actual amount of soil and sediments excavated and placed in the OSDF totaled approximately 1,944,484 cubic yards. The amount of soil and sediment not suitable for disposal in the OSDF or otherwise disposed of off-site totaled approximately 186,392 cubic yards.

4.0 CHRONOLOGY OF EVENTS

The following table provides a summary of the events for Operable Unit 5 soil excavation design and construction, and associated dates of those events, starting with approval of the ROD.

Table 4-1 Summary of Events for Operable Unit 5 – Site-wide Soil And Sediment Remediation

Event	Date
Operable Unit 5 Decision Related Documents	
Operable Unit 5 Record of Decision	January 1996
Operable Unit 5 Remedial Design Documents	
Remedial Design Work Plan for Remedial Actions at Operable Unit 5	August 1996
Site-Wide Excavation Plan	July 1998
Natural Resource Restoration Plan	January 2002
Operable Unit 5 Certification Reports (by Remediation Area)	
Area 1, Phase I Sediment Traps 2 and 3	June 1998
Area 1, Phase I	July 1998
Area 1, Phase II Sector 1, 2A, & Conveyance Ditch	June 1998
Area 1, Phase II Sector 2B	June 1999
Area 1, Phase II Section 2	March 2000
Area 1, Phase II (w/three addendum)	March 2005
Area 1, Phase II Dissolved Oxygen Building	October 2006
Area 1, Phase III Part Two	November 2000
Area 1, Phase III Part One	October 2001
Area 1, Phase IV Part One	May 2004
Area 1, Phase IV Parts Two and Three	September 2004
Area 1, Phase IV Decontamination Facility	October 2006
Area 2, Phase I Active Flyash Pile Footprint and Adjacent Area East of the South Construction Road	April 2001
Area 2, Phase I Former Inactive Flyash Pile, South Field, Carolina Area East, West Construction Road Equipment Wheel Wash Facility	December 2002
Area 2, Phase II Part Three Soil Stockpile 3 Footprint	April 2001
Area 2, Phase II Subareas 1, 2, and 4	June 2004
Area 2, Phase II Subarea 3	January 2006
Area 2, Phase III Part One	December 1999
Area 2, Phase III Part Two	October 2000
Area 2, Phase III Addendum	October 2006
Area 3A/3B	February 2005
Area 3A, Soil Pile 8	October 2006
Area 4A	October 2005
Area 4B Part 1	January 2006
Area 4B Part 1 Recertification Addendum	September 2006
Area 4B Part 2 & Main drainage Corridor	October 2006
Area 5, Eastern Field	November 2002
Area 5, Administration and Parking Lots	October 2006

Table 4-1 Summary of Events for Operable Unit 5 – Site-wide Soil And Sediment Remediation

Event	Date
Area 6, Phase I Part One	December 2003
Area 6, Phase I Part Two	April 2004
Area 6, Waste Pits 4, 5, and 6	March 2006
Area 6, Waste Pits 1, 2, 3, Clearwell, and Burn Pit	July 2006
Area 6, Waste Pits General Area East	July 2006
Area 6, Former Production Area and Main Drainage Corridor North	August 2006
Area 6, Former Production Area and Main Drainage Corridor North Addendum (SP-8)	October 2006
Area 6, Soil Pile 7 & Solid Waste Landfill	October 2006
Area 6, Waste Pits General Area East - Addendum	October 2006
Area 6E	October 2006
Area 6, Waste Pits General Area West	October 2006
Area 6, Rail Yard & Rail Lines	October 2006
Area 7, Silos and Support Areas	October 2006
Area 7, Outside Areas	October 2006
Area 7, Miscellaneous Areas	October 2006
Area 7, Silo3 Concrete	October 2006
Area 7, Silos 1 & 2 Remediation Facility and Temporary Transfer Area Concrete	October 2006
Area 7, Storm Water Retention Basins	October 2006
Area 8, Phase I	August 1998
Area 8, Phase II and Area 6 Triangle Area	September 1999
Area 8, Phase III South	September 2000
Area 8, Phase III North	January 2004
Area 9, Phase I	October 2002
Area 9, Phase II	March 2004
Area 9, Phase III Parts 1, 2, and 3 (Abandoned Outfall Line)	July 2005
Area Stream Corridors	December 2005
Paddys Run	October 2006
Operable Unit 5 Natural Resource Restoration Completion Dates	
Aesthetic Barrier Project	June 1998
Area 1, Phase I Wetland Mitigation Project	March 2000
Area 8, Phase II Forest Demonstration Project	February 2001
Southern Waste Units Project	May 2004
Northern Pine Project	April 2005
Wetland Mitigation Phase II and Northern Woodlot Project	August 2005
Paddys Run East Project	December 2005
Paddys Run West Project	February 2006
Former Production Area	October 2006
Waste Pit Area	October 2006
Silos Area	October 2006
On-Site Disposal Facility Perimeter	October 2006
Borrow Area Project	October 2006

5.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

DOE provided direct project oversight of the soil and sediment remediation activities to ensure they were performed according to project specifications and requirements. The DOE office of Safety Assessment assigned a Facility Representative from the Fernald Area Office whose responsibilities were to perform independent field oversight of all activities performed at the remediation area sites. Along with the Fluor Fernald Project Manager, the Facility Representative worked to ensure that the remediation subcontractors were provided with the proper direction and support necessary to meet the remediation objectives and performance standards for the soil and sediment remediation projects, and that quality assurance reviews and quality audits were conducted to assure adherence with project specifications. The Facility Representative along with the Fluor Fernald Project Manager also conducted the pre-final and final inspections of the field projects as they were completed, as the necessary precursor action to prepare the project completion reports.

Both EPA and Ohio EPA participated in continuous technical oversight of the Operable Unit 5 projects and the formal review and approval of the various regulatory submittals required by the Operable Unit 5 decision documents. Coordination with the agencies was handled via weekly conference calls among DOE, EPA, Ohio EPA, and Fluor Fernald.

The quality assurance and quality control programs necessary to ensure excavation activities were conducted in a manner to meet project goals and associated environmental monitoring data were of the necessary quality to be used for the intended objectives were defined in Appendix E "Site-wide Excavation Plan Quality Assurance Job Specific Plan (QAJSP)" of the Site-wide Excavation Plan. The quality assurance/quality control (QA/QC) program described in Appendix E of the QAJSP is derived from FCP Quality Assurance Program Description (RM-0012) and the Site-wide CERCLA Quality Assurance Project Plan (SCQ; FD-1000) [DOE 2003a]. Additional considerations in the derivation of this QA/QC program included requirements relative to 10 CFR 830.120 "Quality Assurance Requirements;" DOE Order 5700.6C "Quality Assurance;" ANSI/ASQC E4 "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs;" and ASME NQA-1, "Quality Assurance requirements for Nuclear Facilities." With the necessary programs in place, the QAJSP describes the necessary QA assessments to verify quality performance.

The QAJSP covers all remediation excavation activities carried out by Fluor Fernald employees and subcontractors. Key activities covered under the QAJSP include radiological surveys, field measurements, sampling and analysis during pre-excavation activities, preparation of data quality objectives and project specific plans, engineering controls of the remedial design, preparation of the IRDPs, soil excavations and segregation, and WAC attainment at the OSDF.

The QAJSP defines work processes for all sampling and analysis, document preparation, computer hardware, software, and database management (e.g., Site-wide Environmental Database and Integrated Information Management System). It defines objectives for design document preparation, design change control, and procurement requirements. It also defines requirements for construction quality control and inspection and acceptance testing for installed systems and earthwork as well as QC performance specifications for the *in situ* gamma technology.

As discussed in Section 3.0 of this report, both mobile and stationary real-time measurements were a central piece in the soil and sediment remediation program for determining the extent of contamination, guiding excavation

activities, identifying potential areas of above-WAC soil contamination, hot-spot identification and pre-certification of remediation areas. Specific quality assurance planes were developed for these programs.

- "User Guidelines, Measurement Strategies, and Operational Factors for Deployment of In Situ Gamma Spectrometry At the Fernald Site"
- "Real Time Instrumentation Measurement Program (SDFP-RTIMP) Quality Assurance Plan".

To support the independent field visual observations required of the soil and sediment remediation projects to verify WAC compliance, in 1997 the FCP formed an independent oversight organization known as the Waste Acceptance Organization (WAO) that was responsible for observing all excavations and all placements of waste in the OSDF, including the excavations associated with the removal of the contaminated soil and sediment. During field activities, WAO was charged with implementing the manifesting system used to track material from excavation to disposal, making field calls on material engineering categories and size restrictions for OSDF placement, and for providing oversight and support in identifying and removing OSDF-prohibited items from the excavated wastes at the excavation sites and, as a second independent check, at the point of placement in the OSDF. WAO also identified the off-site disposition pathway and handling requirements for shipping OSDF prohibited items and above-WAC materials to the appropriate off-site disposal facilities. WAO also produced daily records of material quantities removed and placed, and oversaw the administrative management of the FCP's interim soil and debris stockpiles and material transfer locations. Finally, since the completion of the removal of the contaminated material verified both by engineering survey data as well as visual observation of the materials remaining at the excavation sites, WAO served as the primary observing entity to ensure that visual completion obligations were satisfied.

The primary performance standards for soil remediation were expressed as contaminant-specific FRLs. The FRLs were established in the Operable Unit 5 ROD. The certification that remediation had achieved the FRL performance standards is addressed in the next section of this report. Standards and associated quality control for placement of impacted soil and sediment in the OSDF are separately addressed in the OSDF closeout report.

As a conscientious philosophy, the Natural Resource Restoration Plan was developed as a document fully integrated with the Site-wide Excavation Plan. The individual restoration design plans establish specific performance standards for each remediation area and the Site-wide Excavation Plan establishes the construction quality control requirements that are fully applicable to the various restoration projects. Appendix F of the Site-wide Excavation Plan (Implementation of Construction) also specifically addresses the transition from soil excavation to restoration activities.

6.0 FINAL INSPECTIONS AND CERTIFICATIONS

The intent of this stand-alone Section 2 of the interim Operable Unit 5 closeout report is to convey EPA's determination that 1) the soil and sediment work scope associated with the Operable Unit 5 remedy is complete, consistent with interim Remedial Action Report requirements; and 2) the materials generated by the remedial action activities have been dispositioned in accordance with the remedial action requirements of the Operable Unit 5 ROD.

In accordance with the intentions described above, Section 2 of the interim Operable Unit 5 closeout report provides the declaration that all of the interim soil and sediment remediation activities are complete. The remaining soil and sediment remediation activities are those associated with removal of the groundwater restoration and treatment infrastructure, which will be accomplished at the time groundwater restoration activities are completed (projected in the year 2025). At that time, the final Operable Unit 5 closeout report will be prepared, superceding this interim report.

The Site-wide Excavation Plan established the processes to be followed for certifying attainment of requirements for soil excavation activities, including:

- FRL attainment
- Hot spot attainment
- RCRA characteristic waste compliance
- HWMU closure
- UST closure

Certifying FRL attainment was documented on a certification-unit-by-certification-unit basis using analytical data developed and analyzed using statistical methods. Area-specific certification protocols were documented in Certification Design Letters approved by EPA and Ohio EPA. Sections 2 and 3 of the Site-wide Excavation Plan provide detail on the requirements for development of the Certification Design Letters. As required for individual certification units, the Certification Design Letters also defined the protocols for addressing FRL certification associated with hot spots, potential RCRA characteristic waste areas, HWMUs, and USTs.

Upon analytical confirmation that FRLs (and any other requirements) were achieved, Certification Reports were prepared as the final-step area-specific remediation deliverable. The primary objectives of the Certification Reports were to:

- Document the remedial actions that occurred
- Describe the certification process
- Present all data supporting the certification that area-specific contaminants of concern do not exceed FRLs specified in the relevant RODs
- Demonstrate that Federal and State of Ohio closure regulations have been met for HWMUs and/or USTs
- Summarize data necessary to demonstrate WAC attainment
- Describe access controls implemented to prevent recontamination

Section 4.0 of this report lists the individual Certification Reports submitted by DOE and approved by EPA for the site-wide soil and sediment remediation activities accompanying the interim closeout work scope. Taken together, all of the Certification Reports then demonstrate that the entire site has collectively gone through the process and is certified as complete.

All required above-OSDF-WAC soil and sediment remediation wastes have been sent off site for final disposal, with copies of the off-site disposal manifests retained in the FCP's Records Inventory. Likewise, all eligible below-OSDF-WAC remediation wastes were placed in the OSDF for final disposal, with copies of the on-site disposal manifests placed in the Records Inventory. At closure all of the FCP's Records Inventory related to documentation of the completion of the CERCLA remedies, including the on-site and off-site disposal manifests, will be transferred and archived with the National Archive Records Administration (NARA), who in turn will retain the records for 75 years.

EPA's approval of the individual remediation area Certification Reports signifies that no additional remedial actions are necessary to remove contaminated soil and sediment (outside of the groundwater restoration infrastructure footprints), and the areas have undergone final restoration as outlined in the Natural Resource Restoration Plan and the requirements specified in the individual remediation area restoration design plans. For the footprints below the groundwater restoration infrastructure, any additional soil excavation that needs to be conducted at the cessation of groundwater restoration activities will be documented in the Final Operable Unit 5 closeout report that will ultimately replace and supercede this interim report.

Certification of HWMU-Related Environmental-Media Closeouts within Operable Unit 5

The individual approved Certification Reports for each soil remediation area also contain the details of the environmental-media HWMU certification activities to allow this remedial action report to provide a final certification that all of the HWMUs within Operable Unit 1, the HWMUs within Operable Unit 3 with soil contamination, and the at and below grade HWMUs within Operable Unit 5 have been closed and the associated environmental media managed in accordance in the final record of decisions consistent with the June 1996 Ohio EPA Directors Findings and Orders. (Similarly, the Operable Unit 3 closeout report addresses the certification that the structural HWMU dismantlement and closeout activities have been satisfactorily completed). Appendix C provides further details related to this certification.

7.0 OPERATION AND MAINTENANCE ACTIVITIES

As an excavation and disposal remedy, there are no post-remedy operations issues or requirements for the source units/materials remediated under the scope of Operable Unit 5. Maintenance activities for these areas are generally related to controlling access to prevent re-contamination and ensuring these areas are restored in accordance with the Natural Resource Restoration Plan and area-specific design plan requirements. Maintenance of restored areas prior to closure is described in the individual restoration design packages. The following are the general maintenance activities that will be carried out in each restored area:

- Controlling invasive/noxious species per the pending maintenance plan and Natural Resource Restoration Plan requirements as determined appropriate by the Natural Resource Trustees collectively. Control will occur by spot removal using manual, mechanical, or chemical methods.
- Reseeding and/or replanting of restored areas as required by implementation monitoring and adaptive management decisions to ensure appropriate vegetative cover.
- Maintain prairie and savanna ecosystems and diversity through appropriate disturbance regimes and thatch removal. Activities may include mowing, burning, or physical disturbance.
- Correcting soil erosion problems at drainage channels, stream banks, outfall structures, or wetland berms by appropriate means that are impacting or have the potential to impact restored areas.
- Repairing wildlife structures/boxes as needed.
- Clearing debris, tripping hazards, overhanging limbs, excessive weed growth, and replacing mulch on pathways and public access areas.
- Keeping access points and parking areas in good condition including the replacement of gravel and mowing and trimming as appropriate.

Legacy management is required at the FCP to ensure that the remedial actions implemented at the site continue to be effective and protective of human health and the environment. Legacy management in restored areas will include ensuring that natural and cultural resources are protected in accordance with applicable laws and regulations. Institutional controls are also implemented to limit access and land use. Institutional controls include continued federal ownership of the FCP and placing restrictions on the use of the property on the property deed before the property could be sold or transferred to another party. All the legacy management and institutional control requirements and initiatives are defined in the Comprehensive Legacy Management and Institutional Controls Plan (LMICP) [DOE 2006]. Since the LMICP is applicable to the FCP as a whole and was derived from a compilation of requirements from all of the operable units, there are no additional institutional controls related to Operable Unit 5 that were not captured by the LMICP.

8.0 SUMMARY OF PROJECT COSTS

The 1996 Operable Unit 5 ROD identifies the selected remedy for soil and sediment, along with the other environmental media included in Operable Unit 5. The selected remedy was *Alternative 3A – Engineered Disposal Facility* from the Operable Unit 5 Proposed Plan, using the *Undeveloped Park User* as the selected target land use/receptor scenario. A summary of the estimated costs for the selected remedy at the time of its selection was provided in the ROD, with the details and backup provided in the Operable Unit 5 Feasibility Study Report.

This section of the soil and sediment closeout report compares the original estimated costs as contained in the ROD with the actual costs experienced on the project. Consistent with EPA's closeout guidance, an explanation needs to be provided when the actual costs fall outside the range of -30 to +50 percent of the estimate. Appendix A provides the supporting information and tabular summaries supporting the descriptions and findings presented below.

Readers should note that for all of the cost evaluations presented in the FCP's individual operable unit closeout reports (including the Operable Unit 5 interim closeout report), the evaluations focus on those direct and indirect remedial costs specifically associated with the individual remedies conducted for the operable unit of interest. The cost evaluations do not include FCP administrative or overhead costs for managing the site as a whole, such as for oversight, site administration and management, communications and reporting, site-wide utilities, office space, and other such landlord costs. The comparisons are therefore aimed at the specific direct and indirect costs (such as engineering) required to complete the individual remedies required by the FCP's CERCLA process across the five operable units. In this way, users of this report will be able to more readily compare costs from other sites within the Superfund program for like remedies with those experienced at Fernald. This also permits the cost comparisons presented in the closeout reports to remain consistent with how the ROD cost estimates were originally developed back in the 1990s, when the cleanup remedies for Fernald were first envisioned.

8.1 Summary and Analysis of the Original Operable Unit 5 ROD Costs

The original ROD cost estimate for the selected remedy is presented in Table 9-2 on page 9-21 of the December 1995 Operable Unit 5 ROD. The estimated costs presented in the ROD encompass cleanup costs for all of the environmental media (soil, sediment, groundwater and surface water) comprising Operable Unit 5 and were summarized in the ROD for the entire remedy as follows:

Construction costs (constant 1995 dollars)	$430 million
Operation and maintenance costs (constant 1995 dollars)	$340 million
Postremediation costs (constant 1995 dollars)	$70 million
Total cost (constant 1995 dollars)	$840 million
Present worth cost	$580 million
Total cost with escalation (27 year remedy)	$2.11 billion

The ROD went on to explain that "the total cost of the remedy ($840 million) represents the total amount, in constant 1995 dollars necessary to implement the selected remedy assuming no inflation occurs over the life of the remedy. The present-worth cost ($580 million) represents the total estimated present worth cost of the remedy assuming a discount rate of 2.8 percent. The present worth cost represents the sum of money which must be placed in an interest bearing account (e.g., a bank) at the onset of remedial activities at a net interest rate to

progressively pay for the entire scope and duration of remedial actions. The total cost with escalation ($2.11 billion) represents the total estimated cost of remedial actions assuming the funding is provided on an annualized basis and an annual escalation rate of 3.7 percent prevails throughout the duration of the remedy." Note that the escalation rate is a factor applied in the analysis to examine the effects of inflation and the decline in the dollar's purchasing power with the passage of time (in this case over a period of 27 years, as considered in the feasibility study for remedial decision making) for engineering projects with long durations.

As background in the use of the various estimates for cost evaluation, readers should understand that the "present worth" cost estimate provided in the ROD is typically used to support initial remedy decision making – its use is for relative cost ranking purposes, and serves as the government's preferred means to evaluate remedial alternatives with differing durations or completion timeframes to then identify and select a preferred alternative from a common starting point. Present-worth cost evaluation techniques for remedy selection are required under CERCLA guidance to compare remedial alternatives, and are used during the feasibility study to help identify and evaluate the preferred alternative for inclusion in the ROD (this is how the preferred remedy was evaluated for Operable Unit 5 at the time of the ROD). The present-worth technique does not actually represent how money will likely be allocated to pay for the remedy over its duration (such as year-by-year annualized funding appropriations, which do not have the ability to draw the sizeable cumulative interest accumulations like the initial up-front total project sum assumed in the present-worth calculation). Rather, the primary purpose of the present-worth calculation is to facilitate fair relative comparisons of feasible alternatives from a "common point in time" approach to identify the least cost alternative prior to implementation of the project.

The post-cleanup comparative evaluation of original ROD cost estimates with actual costs experienced during implementation of a remedy represents a different cost analysis problem not represented by the present-worth technique. In this situation, the present-worth cost estimate must be replaced by the constant dollar estimate for a given base year (in this case, 1995 as the base year, since this was the year the estimate was prepared), which is then adjusted to accommodate the impacts of inflation and the decline in the purchasing power of the dollar during the actual period of performance. This inflation adjustment is important particularly for multi-year projects of long duration, and also those projects that may have been delayed considerably from their original concept date due to funding/approval constraints. The post-cleanup evaluation therefore requires an adjustment of base year dollars to future dollars – representing the actual timeframe of project performance – that have the same purchasing power as the original base year dollars. This approach therefore recognizes the selected multi-year remedy will be implemented on an annualized funding basis and, since the actual period of performance becomes a known entity at the completion of the remedy, the base year dollars can be scaled upward to ensure they maintain "constant dollar" purchasing power. This adjustment is made using actual escalation factors available as part of the Consumer Price Index to match the actual years the work was performed -- and thereby accounting for the actual effects of inflation using backward-looking government specified escalation factors for each year of passage from the base year. Such adjustments then bring the estimates from the ROD into a form that can be directly compared to the actual dollars expended over the life of the remedy.

8.2 Adjustments to Permit Fair Comparison of ROD Costs with Actual Costs for Soil and Sediment

Based on the above discussion, the total cost estimate of $840 million in 1995 dollars summarized in the ROD serves as the starting point for the comparison with actual costs experienced during implementation of the remedy. Recognizing that the Operable Unit 5 soil and sediment and OSDF portions of the remedy began in 1995 (at ROD signature) and were completed in 2006 (with aquifer restoration ongoing), an effort was conducted to

divide the Operable Unit 5 ROD cost estimate into its three component parts (Soil/Sediment Remediation, OSDF Disposal and Closure, and Aquifer Restoration) using backup cost information from the feasibility study; these three component parts were then adjusted to bring the 1995 constant dollar estimates into current dollars, covering the actual 11 years of remedy implementation duration between 1995 and 2006. The results are summarized in Table 8-1

Table 8-1 – Operable Unit 5 ROD Cost Estimate

Remedy Component	1995 Constant Dollar Estimate	Escalated Estimate (1995 to 2006 actual period of performance)
Soil and Sediment Remediation/Site Restoration	$230 million (from FS)	**$268 million**
OSDF (disposal of Operable Unit 5 materials and closure of facility)	$310 million (from FS)	**$365 million**
Aquifer Restoration and Monitoring	$300 million (from FS)	Not applicable. The performance period extends beyond 2006 since this is an ongoing portion of remedy.
Operable Unit 5 Totals	$840 million (from FS and summarized in ROD)	Not applicable, until aquifer restoration complete.

The two values shown in bold in the third column ($268 million for soils/sediment and $365 million for the OSDF) represent the time- and inflation-adjusted starting points for comparison to actual costs experienced for these two Operable Unit 5 components. They will each be compared, evaluated, and reported in the respective stand-alone sections (e.g., this report for soils/sediment, and the stand-alone OSDF section which is Section 1) of the interim Operable Unit 5 Remedial Action Report. Once groundwater costs are tallied in the future at the completion of the aquifer restoration remedy, a similar escalation adjustment and comparison can and will be performed for that component, addressing the actual period of performance (1995 to the actual completion date) experienced for the life of the aquifer restoration remedy. In the meantime, the Aquifer Restoration section of the interim Remedial Action Report will summarize and evaluate costs experienced to date with the groundwater remedy.

Within the Operable Unit 5 Soil and Sediment costs are the following work scope items: pre-excavation investigation and design; site preparation activities; soil excavation activities; soil certification sampling and analysis activities; site restoration activities; sediment excavation and restoration; hauling of WAC-compliant materials to the OSDF for disposal; and off-site shipping and disposal of above WAC materials via the site's above-WAC stockpile known as SP-7. (Note that the OSDF disposal costs for the WAC-compliant soil and sediment materials are to be reported in the OSDF section of the interim Operable Unit 5 Remedial Action Report.)

As the next adjustment, the cost "add ins" from the other operable units needed to bring the 1995 estimates in alignment with the closeout decisions accompanying the spring 2005 Fact Sheet were made so that the costs associated with the completion of the individual work scopes match the particular closeout reports where the work completion is being documented. These adjustments also account for how the work was executed and tracked in the field, during actual implementation. For example, much of the at-and below-grade debris removal from

Operable Unit 3 was conducted concurrently with Operable Unit 5 excavation work using the same equipment, staff, and techniques. Similarly, site-wide restoration activities were accomplished concurrently in all areas as an Operable Unit 5 soil activity, and off-site shipment and disposal of above-WAC materials via the SP-7 stockpile was accomplished for the site as a whole as an Operable Unit 5 soil activity.

These "add ins" are summarized in the respective soil and sediment and OSDF sections of the Operable Unit 5 interim closeout report as required. Table 8-2 shows the required "add ins" for this soil and sediment report, starting with the corresponding constant 1995-dollar estimates for the individual "add ins" and then making the necessary escalation adjustments to render them current with actual costs. These escalated values for the "add ins" are then added to the $268 million escalated estimate for Soil and Sediment to achieve the grand total for ultimate comparison to actual costs.

Table 8-2 – Adjusted Cost Estimate for Soil and Sediment Remediation

"Add In" Component	Original 1995 Dollar Estimate	Escalated Estimate for Use in Comparisons
Soil Remediation costs from Operable Unit 1	$3 million	$3.5 million
Site Restoration costs from Operable Unit 1	$14 million	$16.3 million
At- and below-grade D&D costs from Operable Unit 3	$84.3 million	$98.1 million
At and below-grade off-site disposal costs from Operable Unit 3	$28.5 million	$33.2 million
Off-site shipping and disposal costs (via stockpile SP-7) from Operable Unit 2	$2.3 million	$2.7 million
"Add Ins" Escalated Subtotal		$154 million
Escalated Subtotal from Operable Unit 5 ROD		$268 million
New Grand Total With "Add Ins" Included		**$422 million**

Overall these last adjustments ensure representative cost comparisons are conducted for each operable unit as required in Section 8 for the individual reports, and allow the operable-unit closeout reports to remain integrated and consistent in their tracking, documentation, and reporting of both work-scope and cost completion information.

8.3 Results of the Comparison of Actual Costs with the ROD-Estimated Costs for Soil and Sediment

Based on all the adjustments and escalations described above, the ROD-adjusted cost estimate for use in the comparison with actual costs is $422 million. Appendix A contains a tabulation of the actual costs experienced in executing the soil and sediment remedy, including the site-wide restoration costs and all costs to certify the remedy is complete. The actual costs sum to $271.8 million, which can then be compared to the $422 million ROD estimate. EPA guidance indicates that if the actual cost of the remedy is within a –30% to +50% range of the ROD estimate, no further explanation of actual costs are generally necessary. The difference between the $422 million adjusted ROD estimate and the actual costs is a savings of about $150.2 million -- or about 36 percent below the ROD estimate. Since the 36 percent savings achieved in implementing the remedy falls just outside the range, an explanation of the factors contributing to the savings is provided in Appendix A.

9.0 OBSERVATIONS AND LESSONS LEARNED

Lessons learned from previous Operable Unit 2 and Operable Unit 5 remedial activities were continuously incorporated into the design for subsequent excavations to ensure that remedial activities met all applicable requirements and achieved the highest quality level possible. Some of the most important lessons include:

Pre-Design Investigation – Project Specific Plans

- Point sampling, such as Geoprobe sampling, of subsurface soil contamination can provide useful information but cannot be expected to identify all the hot spots of contamination.
- Real-time scanning can fill the data gaps regarding the extent of unexpected above-WAC materials during excavation.
- Real-time scanning can also help to identify needs to upgrade personal protective equipment requirements due to potential thorium and/or radium contamination in a uranium-driven excavation area.

Remedial Design – Integrated Remedial Design Packages

- It is better to use performance specifications instead of specific detailed drawing for temporary erosion controls.
- Requirements for necessary personal protective equipment, container, and transportation requirements of thorium and asbestos containing material should have been identified earlier in the process.

Remedial Action – Excavation, Treatment, Disposal, Restoration

- Excavate prohibited items in such a manner that they are transported to the appropriate stockpile location at the time of their removal from the excavation location (i.e., avoid double handling).
- Perform continuous visual observation of the excavation to identify and segregate special material.
- Obtain EPA consensus for field decisions made during construction.
- Change the type of equipment to conduct lift excavation, as necessary, in order to maximize the opportunity for visual inspection of the cut face and maintain production rate.
- Larger articulated trucks were more efficient than smaller articulated or road trucks.
- Intensive excavation control requirements were accomplished efficiently with a combination of visual inspection, real-time scanning, physical sampling, and on site analytical resources.
- Ensure that the area for above-WAC soil and debris storage is large enough to accommodate more material than is expected.
- On-site treatment of organic-contaminated soil can be feasible and cost-effective, even for small volumes of soil.
- Dust and erosion control efforts in an excavation area were significant and continuous and should be planned properly.
- Surface water management during the rainy season is challenging, yet critical to keeping the project on schedule. Extra planning should be done to ensure that the appropriate water control equipment is identified and quickly available during that time.
- Timing of seeding needs to be right to avoid reseeding.

10.0 CONTACT INFORMATION

Remedial Action Contacts

U.S. Department of Energy Contact	Fluor Fernald Contact
Public Information Fernald Closure Project U.S. Department of Energy P.0. Box 538705 Cincinnati, OH 45253-8705 513-648-3153	Fernald Closure Project Fluor Fernald P.O. Box 538704 Cincinnati, OH 45253-8704 513-648-4898
U.S. Environmental Protection Agency Contact	**Ohio Environmental Protection Agency Contact**
Remedial Project Manager U.S. EPA SRF-6J 77 W. Jackson Blvd. Chicago, IL 60604-3590 312-886-0992	Fernald Project Manager Ohio Environmental Protection Agency 401 E. Fifth St. Dayton, OH 45402-2911 937-285-6357

APPENDIX A – COST AND PERFORMANCE SUMMARY

The actual project costs experienced over the life of the implementation of the Operable Unit 5 soil and sediment remedy are presented in Table A.1, broken down into direct and indirect actual costs. These costs account for and include the "add in" cost categories from the other operable units discussed in Section 8.0 of this report (for example, at- and below-grade Operable Unit 3 debris removal activities) that were performed contemporaneously with the execution of the Operable Unit 5 site-wide soil remediation and natural resource restoration activities. The direct cost category includes the field costs associated with the site-wide remedy including soil characterization, construction of runoff control and remedial support facilities, soil and debris excavation, material segregation and stockpiling, load out, transportation, real-time and physical certification activities, project-specific environmental monitoring, contaminated soil and debris off-site disposal (note that the on-site disposal costs are captured in the OSDF section of the Operable Unit 5 closeout report), and natural resource restoration activities. The indirect costs include preparation of integrated remedial design plans and overarching strategy/ compliance documents, design engineering activities, development of field work plans and sampling plans, field construction management, waste acceptance oversight and material tracking, field safety and quality assurance oversight, subcontractor oversight, pre-design and certification data management, certification and closeout report preparation, and project management. Together these direct and indirect cost categories sum to the individual amounts presented in Table A.1

Table A.1 Soil and Sediment Remedy Actual Project Costs

Actual Direct Costs	Actual Indirect Costs	Total Cost
$212.5 million	$59.3 million	$271.8 million
	Total	**$271.8 million**

As discussed in Section 8.0, the adjusted ROD cost estimate for comparison purposes is $422 million. The cost savings between the actual costs over the life of the remedy ($271.8 million) and the ROD estimate ($422 million) is 36 percent. Since the cost savings are greater than the -30 to +50 percent benchmarks used in EPA guidance, an explanation of the factors resulting in the savings is provided per the guidance. The significant savings result from the process improvements qualitatively and semi-quantitatively summarized below that have caused the production rates and costs of the soil and sediment portion of the Operable Unit 5 remedy to improve over the adjusted ROD-based estimates.

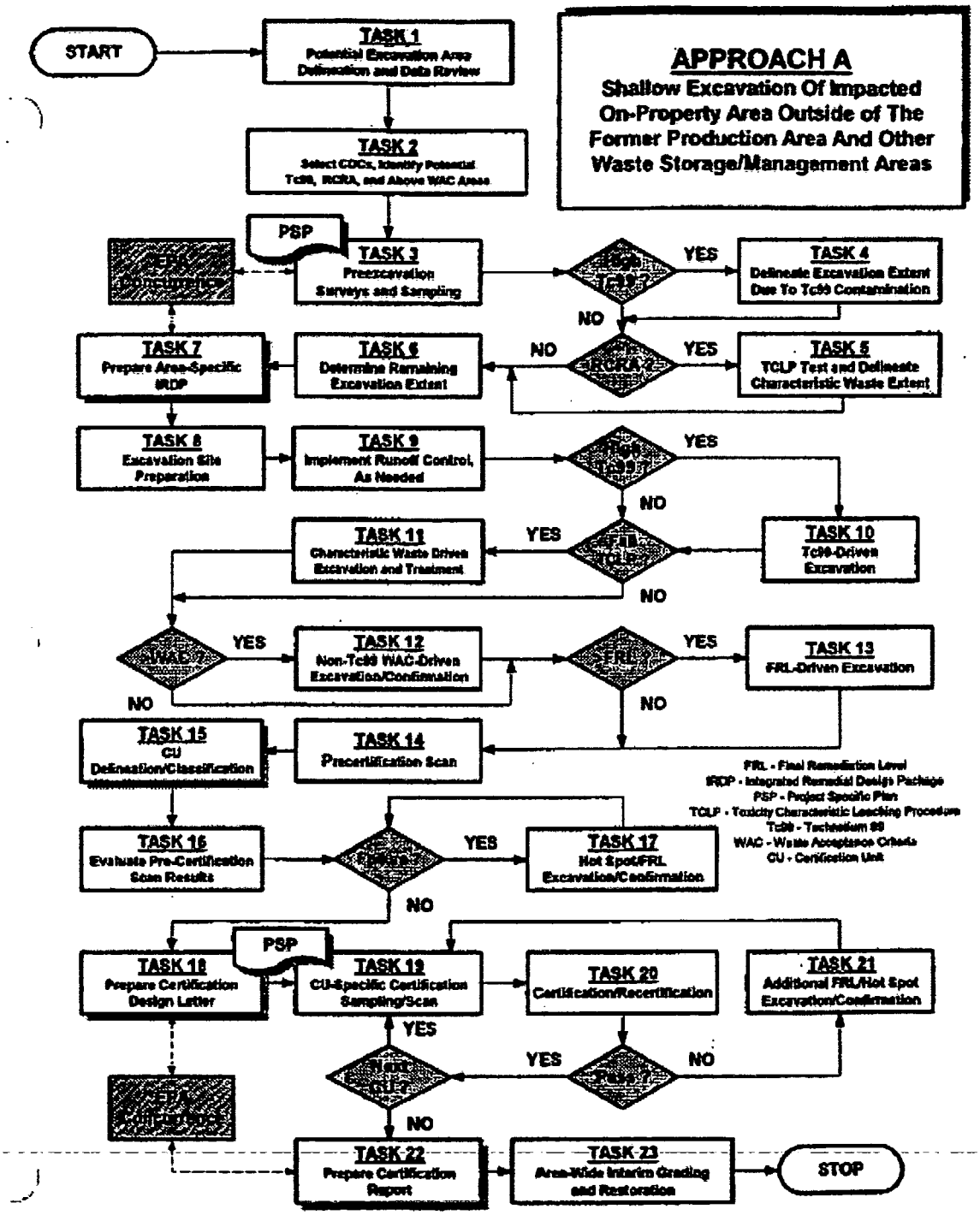
By far the largest cost savings was a direct consequence of the economies of scale obtained by combining the at- and below-grade debris removal activities from Operable Unit 3 with the soil excavation activities conducted site-wide through Operable Unit 5. This resulted in single-unit crew sizes, integrated use of construction equipment, sharing of remedial support facilities, and performance of all necessary remedial activities and certification steps in a given area in an orchestrated, "designed for single pass" fashion. All oversight functions (QA, safety, and waste acceptance) could also be combined across the Operable Unit 3 and 5 activities. The ROD-adjusted estimate for conducting at- and below-grade debris removal from Operable Unit 3 alone was $98.1 million, if the Operable Unit 3 activities were to be performed on their own and not in an integrated "single pass" fashion contemporaneously with Operable Unit 5's activities. Significant savings are directly attributable to the combining of the remedies to eliminate redundant implementation and oversight steps.

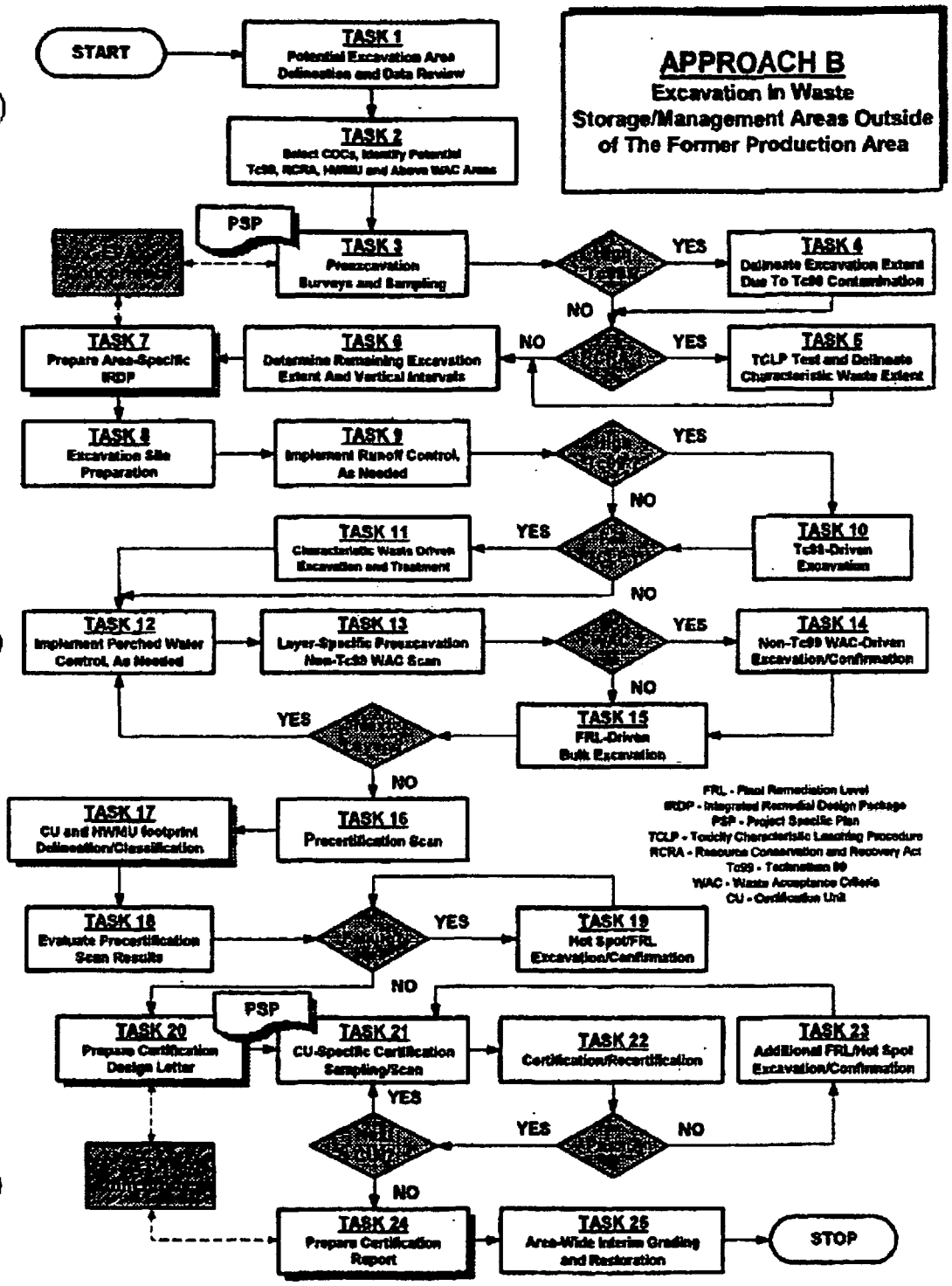
Additional field savings were also qualitatively achieved by the following improvements:

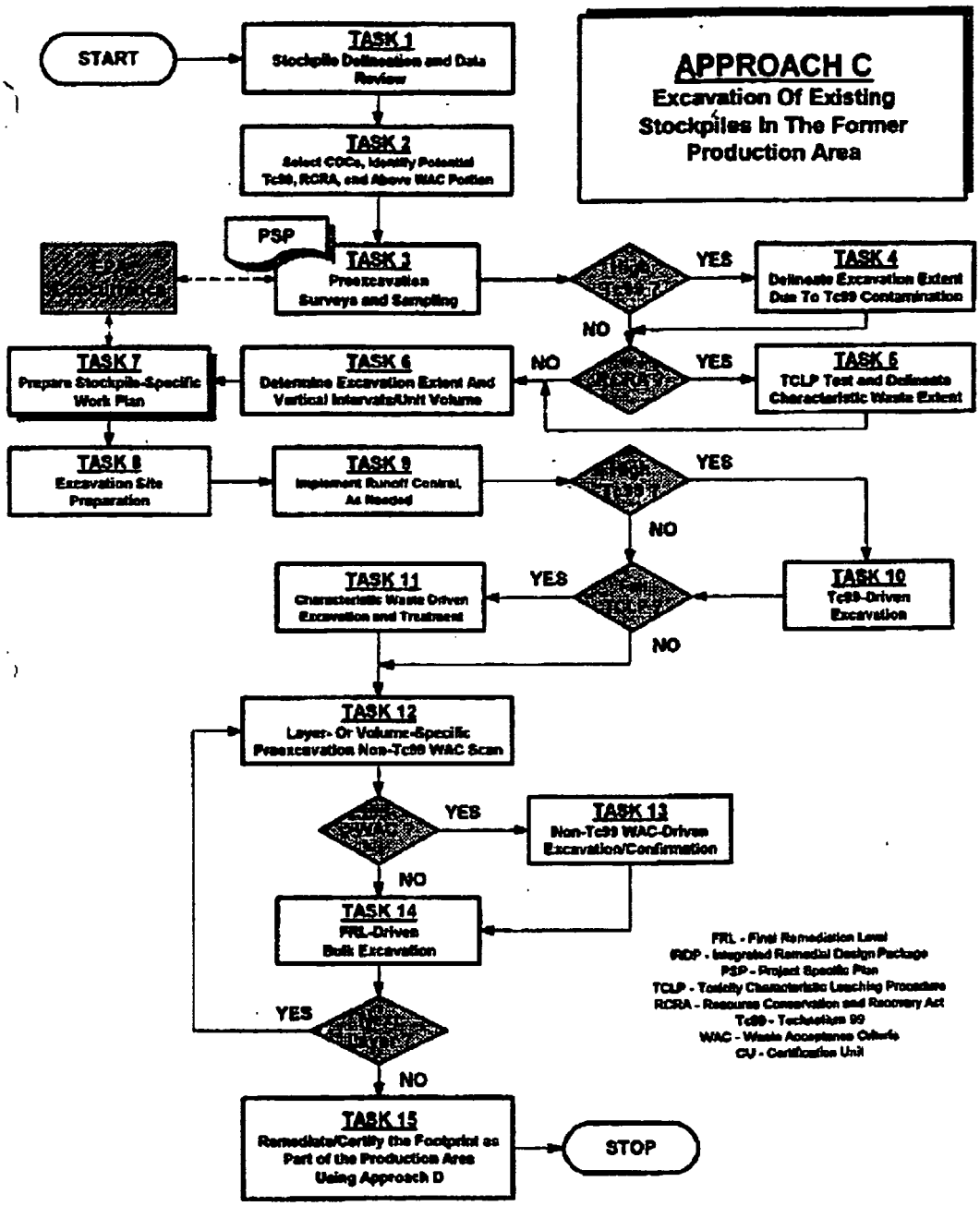
- Safety around major equipment was a concern of the job. There were over 200 pieces of heavy equipment as well as multiple ground crews and oversight personnel working the job. A heavy equipment blind spot training class was developed to give workers a better understanding of blind spots which teamster and equipment operators experience. Such efforts and training saved potential down time due to the potential for incidents and safety stand downs.
- Unit costs of production improved when scrapers were permitted on a case-by-case basis for use in the flatter areas of the excavations compared to backhoe excavation techniques.
- The WAO oversight and manifesting system approved by EPA and Ohio EPA streamlined the day-to-day oversight of field operations and material tracking paperwork.
- Productivity and material costs improved when personal protective equipment requirements were continuously reviewed and adjusted to match the documented nature of the work hazards and elimination of unknowns, as gained through progressive implementation experience.
- Costs related to delays resulting from the use of wheel washing facilities were minimized by creating contiguous working areas, transport routes, and employing effective construction and radiological boundaries to protect clean areas.
- Costs related to isolation of utilities around the process or production areas were minimized by the use of a large trencher. This equipment was capable of cutting a ten-foot deep trench around the perimeter of the process area. The benefit was a single cut around the perimeter was a quicker way to assure that all of the underground utilities were severed rather than excavating individual holes for isolation. The trench took a week while individual lines would have taken many weeks.
- The Plant 1 Pad, which served as a storage pad for waste drums for many years, was a 10-acre storage area with two layers of concrete slabs. Use of a Hoe Ram would have taken many weeks to break the total slabs using a jackhammer approach. The use of a "2000 Impactor" slab breaker greatly improved the production rate of breaking out the pad for excavation purposes. A farm tractor and an Impactor replaced the use of several machines and dust control was achieved in a less costly manner.
- Construction equipment and maintenance was a costly portion of the excavation process. Multi-year rental of heavy equipment in support of self-perform activities saved over 30 percent when compared to the usual practice of single-year lease contracts.
- During the self-performance of soil excavation, larger off-road trucks were used to move soil and debris to the OSDF from the excavations, thus increasing the volume per load over the roll-off boxes and transport trucks used initially. Roll-off boxes could be jammed at times which caused delays.
- The ROD estimate included a provision for significant backfilling for all of the excavations. Early in the schedule, the soils engineering team designed a plan to create acceptable slopes along the contour lines of the excavations. This eliminated the need for backfilling crews and equipment. This resulted in the savings of about $21 million (in 1995 dollars) of unnecessary backfilling through the alternate approach.
- The ROD estimate included a provision for constructing a central storage facility for holding material that did not meet the on-site WAC. The need for this facility was replaced by other ways to handle the material without building a new structure and requiring that structure to be demolished and disposed. Use of outdoor storage areas with controlled drainage was one of the alternate methods used, resulting in the elimination of a new man-made facility estimated to cost $32 million (in 1995 dollars).

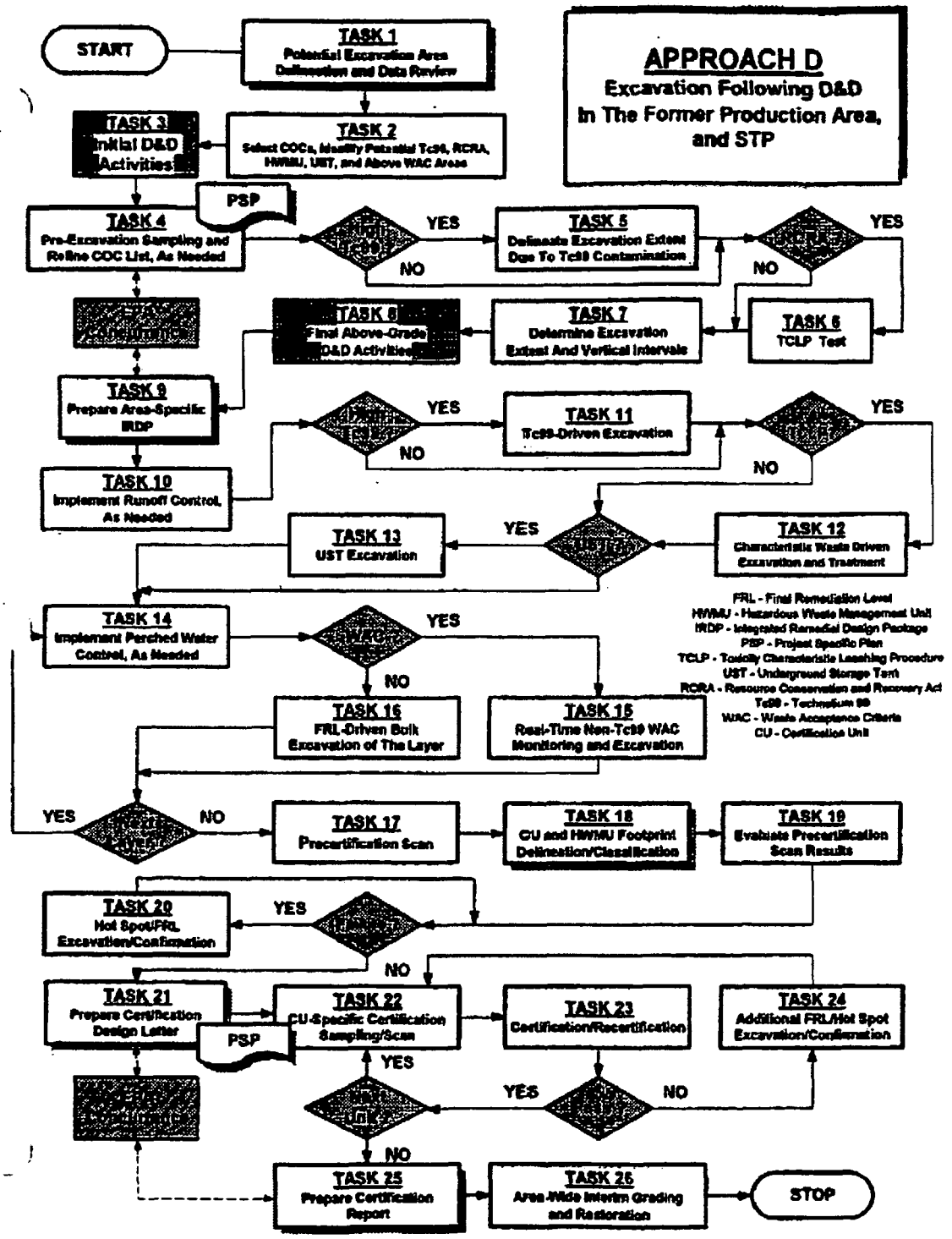
Together the site-wide economies of scale, design improvements, and individual field improvements summarized above contributed to the FCP's ability to conduct the site-side excavation and natural resource restoration activities in a way that led to a savings of about 36 percent compared to the original ROD estimates.

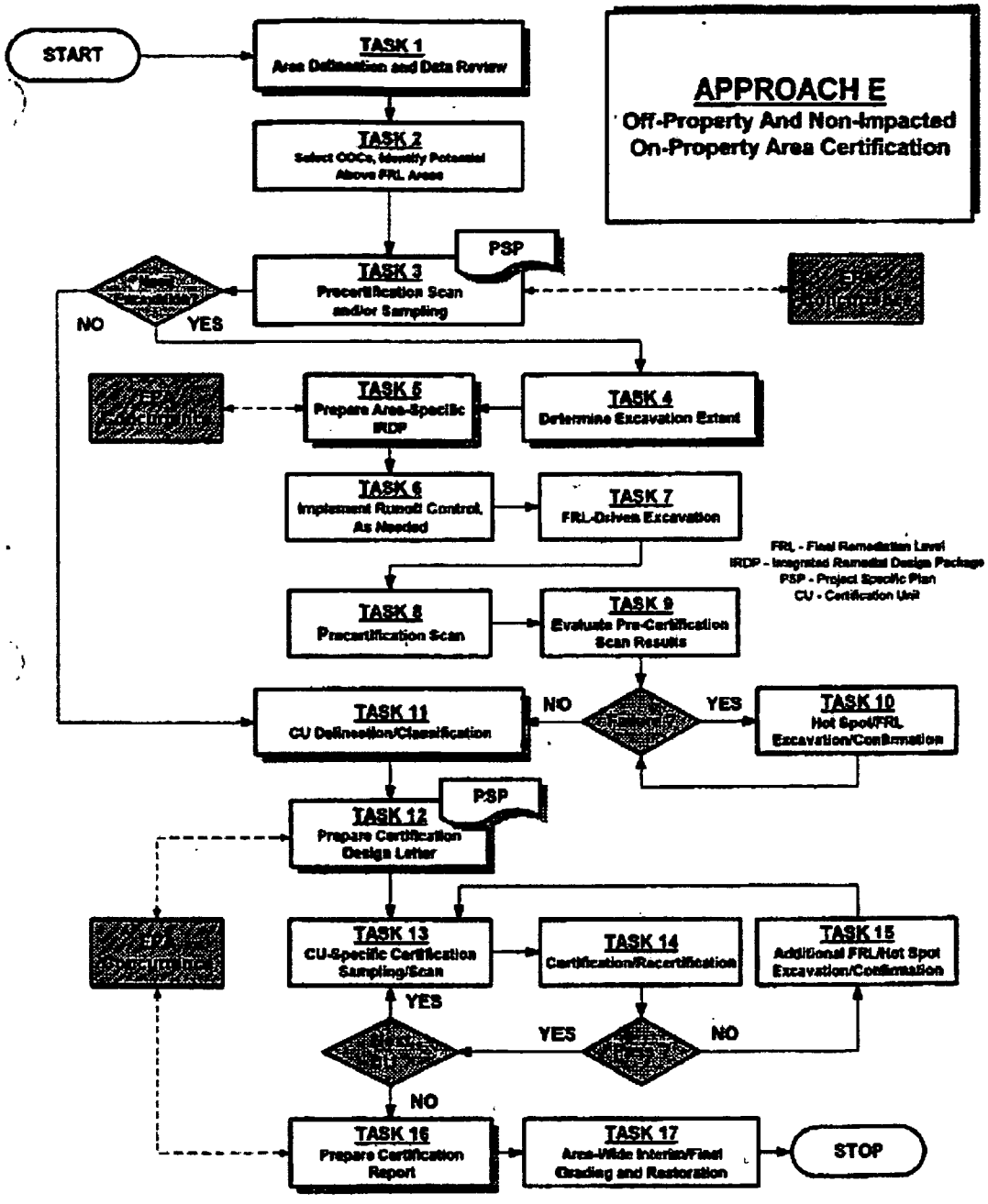
APPENDIX B – SOIL EXCAVATION LOGIC FLOW DIAGRAMS

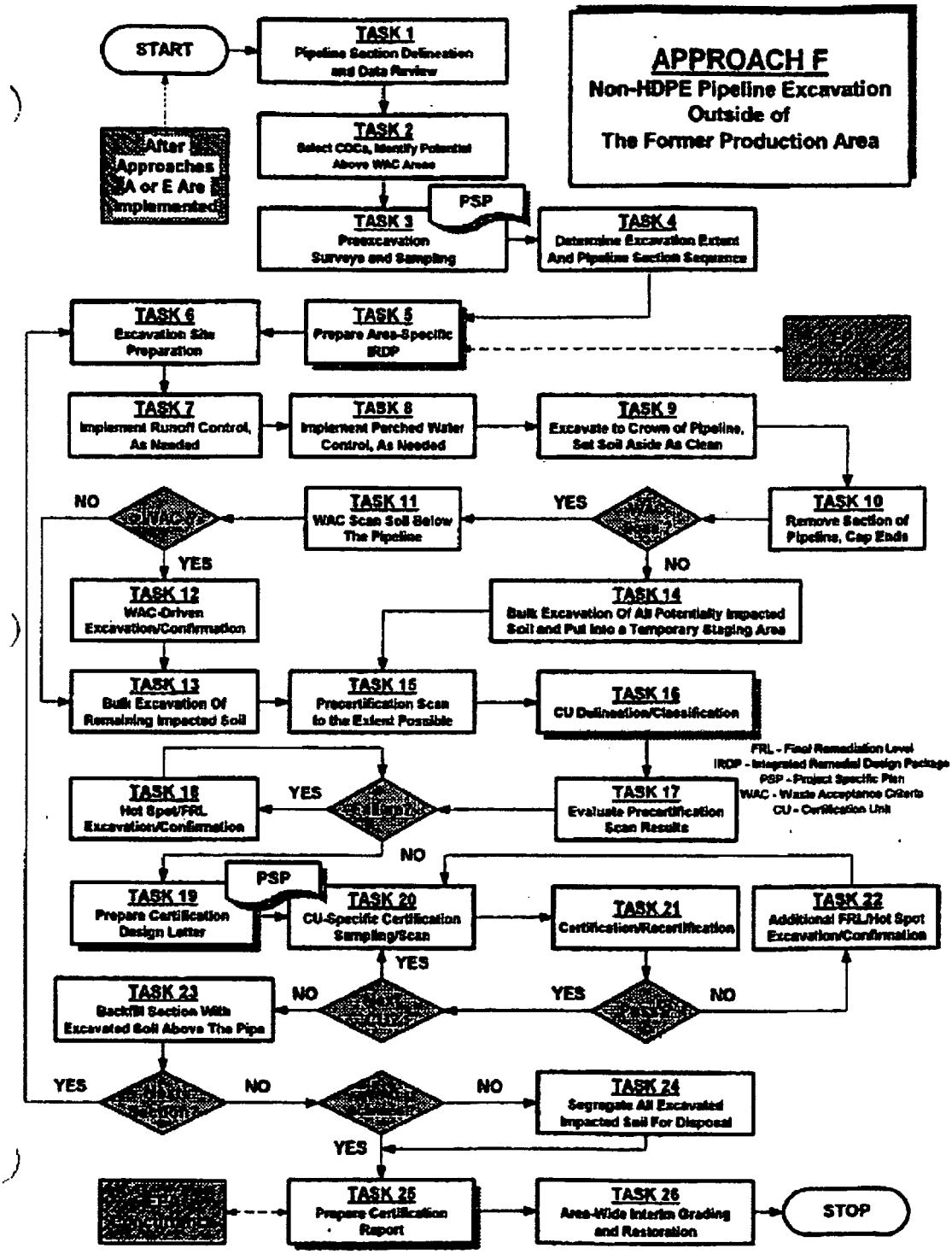



APPROACH B
Excavation In Waste Storage/Management Areas Outside of The Former Production Area
START
TASK 1
Potential Excavation Area Delineation and Data Review
TASK 2
Select COCs, Identify Potential Tc99, RCRA, HWMU and Above WAC Areas
PSP
TASK 3
Preexcavation Surveys and Sampling
YES
TASK 4
Delineate Excavation Extent Due To Tc99 Contamination
NO
TASK 7
Prepare Area-Specific IRDP
TASK 6
Determine Remaining Excavation Extent And Vertical Intervals
NO
YES
TASK 5
TCLP Test and Delineate Characteristic Waste Extent
TASK 8
Excavation Site Preparation
TASK 9
Implement Runoff Control, As Needed
YES
NO
TASK 11
Characteristic Waste Driven Excavation and Treatment
YES
TASK 10
Tc99-Driven Excavation
NO
TASK 12
Implement Perched Water Control, As Needed
TASK 13
Layer-Specific Preexcavation Non-Tc99 WAC Scan
YES
TASK 14
Non-Tc99 WAC-Driven Excavation/Confirmation
NO
YES
TASK 15
FRL-Driven Bulk Excavation
NO
TASK 17
CU and HWMU footprint Delineation/Classification
TASK 16
Precertification Scan
FRL - Final Remediation Level
IRDP - Integrated Remedial Design Package
PSP - Project Specific Plan
TCLP - Toxicity Characteristic Leaching Procedure
RCRA - Resource Conservation and Recovery Act
Tc99 - Technetium 99
WAC - Waste Acceptance Criteria
CU - Certification Unit
TASK 18
Evaluate Precertification Scan Results
YES
TASK 19
Hot Spot/FRL Excavation/Confirmation
NO
PSP
TASK 20
Prepare Certification Design Letter
TASK 21
CU-Specific Certification Sampling/Scan
TASK 22
Certification/Recertification
TASK 23
Additional FRL/Hot Spot Excavation/Confirmation
YES
YES
NO
NO
TASK 24
Prepare Certification Report
TASK 25
Area-Wide Interim Grading and Restoration
STOP


APPROACH C
Excavation Of Existing Stockpiles In The Former Production Area
START
TASK 1
Stockpile Delineation and Data Review
TASK 2
Select COCs, Identify Potential Tc99, RCRA, and Above WAC Portion
PSP
TASK 3
Preexcavation Surveys and Sampling
YES
TASK 4
Delineate Excavation Extent Due To Tc99 Contamination
NO
TASK 7
Prepare Stockpile-Specific Work Plan
TASK 6
Determine Excavation Extent And Vertical Intervals/Unit Volume
NO
YES
TASK 5
TCLP Test and Delineate Characteristic Waste Extent
TASK 8
Excavation Site Preparation
TASK 9
Implement Runoff Control, As Needed
YES
NO
TASK 11
Characteristic Waste Driven Excavation and Treatment
YES
TASK 10
Tc99-Driven Excavation
NO
TASK 12
Layer- Or Volume-Specific Preexcavation Non-Tc99 WAC Scan
YES
TASK 13
Non-Tc99 WAC-Driven Excavation/Confirmation
NO
TASK 14
FRL-Driven Bulk Excavation
YES
NO
TASK 15
Remediate/Certify the Footprint as Part of the Production Area Using Approach D
STOP
FRL - Final Remediation Level
IRDP - Integrated Remedial Design Package
PSP - Project Specific Plan
TCLP - Toxicity Characteristic Leaching Procedure
RCRA - Resource Conservation and Recovery Act
Tc99 - Technetium 99
WAC - Waste Acceptance Criteria
CU - Certification Unit


APPROACH D
Excavation Following D&D In The Former Production Area, and STP
START
TASK 1
Potential Excavation Area Delineation and Data Review
TASK 2
Select COCs, Identify Potential Tc99, RCRA, HWMU, UST, and Above WAC Areas
TASK 3
Initial D&D Activities
PSP
TASK 4
Pre-Excavation Sampling and Refine COC List, As Needed
YES
NO
TASK 5
Delineate Excavation Extent Due To Tc99 Contamination
YES
NO
TASK 6
TCLP Test
TASK 7
Determine Excavation Extent And Vertical Intervals
TASK 8
Final Above-Grade D&D Activities
TASK 9
Prepare Area-Specific IRDP
TASK 10
Implement Runoff Control, As Needed
YES
NO
TASK 11
Tc99-Driven Excavation
YES
NO
TASK 12
Characteristic Waste Driven Excavation and Treatment
YES
TASK 13
UST Excavation
TASK 14
Implement Perched Water Control, As Needed
YES
NO
TASK 16
FRL-Driven Bulk Excavation of The Layer
TASK 15
Real-Time Non-Tc99 WAC Monitoring and Excavation
FRL - Final Remediation Level
HWMU - Hazardous Waste Management Unit
IRDP - Integrated Remedial Design Package
PSP - Project Specific Plan
TCLP - Toxicity Characteristic Leaching Procedure
UST - Underground Storage Tank
RCRA - Resource Conservation and Recovery Act
Tc99 - Technetium 99
WAC - Waste Acceptance Criteria
CU - Certification Unit
YES
NO
TASK 17
Precertification Scan
TASK 18
CU and HWMU Footprint Delineation/Classification
TASK 19
Evaluate Precertification Scan Results
TASK 20
Hot Spot/FRL Excavation/Confirmation
YES
NO
TASK 21
Prepare Certification Design Letter
PSP
TASK 22
CU-Specific Certification Sampling/Scan
TASK 23
Certification/Recertification
TASK 24
Additional FRL/Hot Spot Excavation/Confirmation
YES
YES
NO
NO
TASK 25
Prepare Certification Report
TASK 26
Area-Wide Interim Grading and Restoration
STOP


APPROACH E
Off-Property And Non-Impacted On-Property Area Certification
START
TASK 1
Area Delineation and Data Review
TASK 2
Select COCs, Identify Potential Above FRL Areas
PSP
TASK 3
Precertification Scan and/or Sampling
NO
YES
TASK 5
Prepare Area-Specific IRDP
TASK 4
Determine Excavation Extent
TASK 6
Implement Runoff Control, As Needed
TASK 7
FRL-Driven Excavation
FRL - Final Remediation Level
IRDP - Integrated Remedial Design Package
PSP - Project Specific Plan
CU - Certification Unit
TASK 8
Precertification Scan
TASK 9
Evaluate Pre-Certification Scan Results
TASK 11
CU Delineation/Classification
NO
YES
TASK 10
Hot Spot/FRL Excavation/Confirmation
PSP
TASK 12
Prepare Certification Design Letter
TASK 13
CU-Specific Certification Sampling/Scan
TASK 14
Certification/Recertification
TASK 15
Additional FRL/Hot Spot Excavation/Confirmation
YES
YES
NO
NO
TASK 16
Prepare Certification Report
TASK 17
Area-Wide Interim/Final Grading and Restoration
STOP


APPROACH F
Non-HDPE Pipeline Excavation Outside of The Former Production Area
START
TASK 1
Pipeline Section Delineation and Data Review
TASK 2
Select COCs, Identify Potential Above WAC Areas
After Approaches A or E Are Implemented
PSP
TASK 3
Preexcavation Surveys and Sampling
TASK 4
Determine Excavation Extent And Pipeline Section Sequence
TASK 5
Prepare Area-Specific IRDP
TASK 6
Excavation Site Preparation
TASK 7
Implement Runoff Control, As Needed
TASK 8
Implement Perched Water Control, As Needed
TASK 9
Excavate to Crown of Pipeline, Set Soil Aside As Clean
TASK 10
Remove Section of Pipeline, Cap Ends
YES
NO
TASK 11
WAC Scan Soil Below The Pipeline
YES
NO
TASK 12
WAC-Driven Excavation/Confirmation
TASK 14
Bulk Excavation Of All Potentially Impacted Soil and Put Into a Temporary Staging Area
TASK 13
Bulk Excavation Of Remaining Impacted Soil
TASK 15
Precertification Scan to the Extent Possible
TASK 16
CU Delineation/Classification
FRL - Final Remediation Level
IRDP - Integrated Remedial Design Package
PSP - Project Specific Plan
WAC - Waste Acceptance Criteria
CU - Certification Unit
TASK 18
Hot Spot/FRL Excavation/Confirmation
YES
TASK 17
Evaluate Precertification Scan Results
NO
PSP
TASK 19
Prepare Certification Design Letter
TASK 20
CU-Specific Certification Sampling/Scan
TASK 21
Certification/Recertification
TASK 22
Additional FRL/Hot Spot Excavation/Confirmation
YES
TASK 23
Backfill Section With Excavated Soil Above The Pipe
NO
YES
NO
YES
NO
NO
TASK 24
Segregate All Excavated Impacted Soil For Disposal
YES
TASK 25
Prepare Certification Report
TASK 26
Area-Wide Interim Grading and Restoration
STOP

APPENDIX C – HWMU AND UST CLOSURES

This appendix describes and documents the process by which the FCP's HWMUs and USTs have been remediated.

C.1 Closure of FCP Hazardous Waste Management Units

In June 1996, Ohio EPA issued a set of Director's Final Findings and Orders (DF&O) to identify the requirements and strategy for the closeout of Fernald's HWMUs in conjunction with the site's CERCLA remediation activities. As discussed earlier in chapters 2.4 and 6, the Operable Unit 5 Interim Remedial Action Report (i.e., the Soil and Sediment Section) serves as the certification mechanism to formally document that the HWMUs with accompanying real or suspected environmental media contamination (as listed in the 1996 DF&O) have been successfully closed through the FCP's integrated CERCLA/RCRA strategy.

A process for closure certification required by Section V.4 of the DF&O was proposed by DOE in December 2003 [DOE 2003b] and accepted by Ohio EPA in February 2004 [Ohio EPA 2004]. The agreed strategy provided that the Operable Unit 3 Final Remedial Action Report would contain the certification of closure for all above-grade HWMUs without soil contamination. The Operable Unit 5 Interim Remedial Action Report would then provide the certification of closure for the Operable Unit 3 above-grade HWMUs with soil contamination, along with the at- and below-grade HWMUs (which were remediated concurrently with soil remediation activities). This strategy recognized that Ohio EPA's review and approval of CERCLA documents such as Operable Unit 3 Project Completion Reports and Operable Unit 5 Soil Certification Reports signified Ohio EPA's concurrence that remediation of the HWMUs had been completed in accordance with the DF&O.

Closure of the FCP's HWMU footprints under the soil remediation process involved the determination that the constituents for which the waste managed in the unit was deemed hazardous, and for which the unit itself was declared a HWMU, are below established site-specific FRLs in soil remaining in the HWMU footprint after excavation. The contaminants of concern are provided in Table 2-1 of the Site-Wide Excavation Plan. Pre-design project-specific plans for soil remediation areas containing HWMUs identified whether unit-specific contaminant of concern sampling and analysis was to be conducted during predesign to define/refine the extent of excavation. The IRDP for a particular soil remediation area presented findings of investigations to that point, referenced those investigations, and presented the excavation strategy for the area. The certification design letter for a soil remediation area addressed each (if any) of the HWMUs contained therein, and the specifics of sampling and analysis required to demonstrate soil FRL attainment and closure. Demonstration of the completion of remediation to meet the FRLs is presented in a dedicated section of the area-specific certification reports, through a presentation of the sampling design, analytical results, and the statistical analysis conducted for each HWMU.

Ohio EPA was kept apprised of the process addressing these HWMUs, culminating in the applicable remediation area soil certification report, through a cross-reference index required by Section V Order No. 2 of the DF&O. This index linked specific components of Ohio EPA's Closure Plan Review Guidance with the appropriate CERCLA document addressing those components.

In addition to removing the contaminated soil within the footprint of these HWMUs to meet established FRLs, calculations of residual risk were performed pursuant to Ohio EPA Closure Plan Review Guidance to demonstrate that no further action for a specific HWMU was required. Ohio EPA guidance was used to demonstrate that the HWMU evaluated was below the acceptable cancer risk (1.0×10^{-5}) and the non-cancer risk was less than the

hazard index (HI) of 1.0. The demonstration in the remediation area soil certification reports used the Ohio EPA guidance from 2004 using established General Cleanup Numbers.

In May 2006, Ohio EPA issued new guidance that updated the 2004 closure performance standards based on an unrestricted/residential exposure scenario and a restricted/industrial exposure scenario. The unrestricted/residential risk scenario, once met, would hypothetically allow unrestricted use of the former HWMU footprint and affected area for all purposes including hypothetical residential use, without the need for institutional controls such as environmental covenants to restrict or control future land use. Closure performance standards in the 2006 guidance could also be met through application of the restricted/industrial use scenario, which would need to be coupled per the guidance with an environmental covenant as a required institutional control to restrict future land use to the designated industrial use.

DOE used the 2004 Ohio EPA guidance in place at the time of execution of the remedy to demonstrate that no further action was required at a particular HWMU. Efforts were then made as part of remedy closeout to ascertain and document that the remedy did, in fact, also meet the unrestricted/residential exposure scenario risk levels from the new 2006 guidance, as a means to assess whether further institutional controls may be necessary to respond to residual conditions remaining in the former HWMU footprint. Table C-1 lists the HWMU closures addressed by this remedial action report and compares the risk levels documented in the individual remediation area soil certification reports against the unrestricted/residential exposure scenario parameters contained in the new 2006 guidance. The comparison demonstrates that the individual HWMU remediation activities meet the 2006 guidance parameters for unrestricted use, and as a result no additional institutional controls are necessary in the former HWMU footprints or other areas of the FCP that are triggered specifically by the HWMU closure regulations.

It is important to emphasize that although each of the HWMU closures meets the unrestricted land use exposure parameters (thereby indicating no need for additional institutional controls to address resultant residual conditions specifically from the HWMUs), the FCP as a whole is required under CERCLA to implement site-wide institutional controls for all of the FCP property consistent with the designated future land use of the property as an undeveloped park with a portion of the property dedicated to the OSDF. Therefore, by meeting the unrestricted land-use performance standard within the former HWMU footprints, along with having approved site-wide institutional controls in place for the FCP as a whole, Ohio EPA's performance standard for closure of the individual HWMUs has been met by completion of the FCP's CERCLA remedial actions. The following certification statement to document that the HWMUs have been successfully closed is provided by DOE:

> "Pursuant to the Ohio EPA Directors Findings and Orders of June 6, 1996 concerning RCRA/CERCLA Integrated Closure, Section V, Order No. 4, DOE certifies that the HWMUs encompassed by Operable Units 1, 3, and 5 have been closed and the contaminated environmental media in Operable Unit 5 has been managed, all in accordance with the final Record of Decisions and the Director's closure performance standards."

DOE's signature page for this report, provided in Appendix I, attests to this certification.

Table C-1 – HWMUs Closed Under Operable Unit 5 and Associated Risks

HWMU #	HWMU Name	Soil Certification Report Addressing HWMU	Result for Old GCN	Result for New GCN
1	Fire Training Facility	Area 6, Phase I, Part 2 Certification Report	Not presented in Certification Report	Risk = NA HI = 9.44E-04
4	Drum Storage Area Near Lab Loading Dock	Area 4B Part 1 Certification Report	Risk = 5.28E-06 HI = 7.70E-03	Risk = 3.75E-06 HI = 7.40E-02
5	Drum Storage Area South of W-26	Area 4B Part 2 Certification Report	Risk = NA HI = ND	Risk = NA HI = ND
11	Tank Farm Sump	Area 6 Former Production Area/Main Drainage Corridor Certification Report	Not evaluated pH is only COC	Not evaluated pH is only COC
17	Plant 8 East Pad	Area 4B Part 1 Certification Report	Not presented in Certification Report	Risk = NA HI = 3.18E-03
18	Plant 8 West Pad	Area 4B Part 1 Certification Report	Risk = NA HI = 2.09E-02	Risk = NA HI = 2.00E-01
20	Plant 1 Pad (with Tension Support Structures)	Area 3A/3B Certification Report	Risk = 1.40E-06 HI = 1.85E-02	Risk = 1.69E-07 HI = 2.42E-02
22	Abandoned Sump West of Pilot Plant	Area 4B Part 2 Certification Report	Risk = 2.52E-06 HI = NA	Risk = 1.79E-07 HI = NA
27	Waste Pit 4	Area 6 Waste Pits 4, 5, and 6 Certification Report	Risk = NA HI = NA	Risk = NA HI = NA
28A	Trane Incinerator	Area 4B Part 1 Certification Report	Risk = NA HI = 1.05E-03	Risk = NA 1.06E-03
28B	Trane Incinerator	Area 4B Part 1 Certification Report	Risk = NA HI = 4.23E-03	Risk = NA HI = 2.04E-02
36	Storage Pad North of Plant 6	Area 6 Former Production Area/Main Drainage Corridor Area Certification Report	Risk = NA HI = ND	Risk = NA HI = ND
41	Sludge Drying Beds	Area 1, Phase II Certification Report	Not presented in Certification Report	Risk = 6.13E-06 HI = NA
42	Waste Pit 5	Area 6 Waste Pits 4, 5, and 6 Certification Report	Risk = NA HI = ND	Risk = NA HI = ND
46	UNH Tank	Area 4B Part 1 Certification Report	Risk = NA HI = 2.95E-03	Risk = NA HI = 2.98E-02

Table C-1 – HWMUs Closed Under Operable Unit 5 and Associated Risks

HWMU #	HWMU Name	Soil Certification Report Addressing HWMU	Result for Old GCN	Result for New GCN
47	UNH Tank	Area 4B Part 1 Certification Report	Risk = NA HI = 7.72E-03	Risk = NA HI = 7.80E-02
48	UNH Tank	Area 6 Former Production Area/Main Drainage Corridor Area Certification Report	Risk = NA HI = NA	Risk = NA HI = NA
49	UNH Tank	Area 4B Part 1 Certification Report	Risk = NA HI = 7.72E-03	Risk = NA HI = 7.80E-02
50	UNH Tank	Area 4B Part 1 Certification Report	Risk = NA HI = 5.62E-04	Risk = NA HI = 5.67E-03

Notes:

- If COCs are present in the aquifer beneath the HWMU, the aquifer is considered to be impacted, per the January 5, 2006 OEPA letter to DOE. COCs have not been detected in the aquifer.
- COCs need to be below their FRL to pass the certification criteria (per the SEP) for soil in the footprint of the HWMU. A COC below its FRL meets the restricted release scenario for the undeveloped park user, as discussed in the October 1, 2004 DOE letter to OEPA.
- Result for Old GCN refers to results obtained from Appendix C of cited certification report
- Results for New GCN is obtained using April 2006 values from Table 1 in Appendix C of Closure Plan Review Guidance for RCRA Facilities (OEPA, 2006). Table 1 GCN values are derived from risk calculations for the residential use scenario (child and adult receptors), which assumes unrestricted use of the site.
- NA - Not applicable. Cancer COCs are not present in this HWMU or HI organic COCs are absent and inorganic COCs are below background levels.
- ND - Not detected. HI COCs are less than the analytical detection limit.

C.2 Closure of FCP Underground Storage Tanks

Thirteen USTs required demonstration of soil FRL attainment and completion of closure under the CERCLA remedial response action. Like the HWMUs, all of these USTs were relatively shallow with respect to the anticipated depth of excavation to achieve FRLs; unlike most of the HWMUs, all of these USTs were relatively small. Thus, the mechanism for demonstration of soil FRL attainment and completion of closure for an UST was analogous to that presented for HWMUs. Demonstration of the completion of remediation to meet the FRLs is presented in a dedicated section of the area-specific certification reports. Table C-2 lists the USTs that are closed through this interim Remedial Action Report. The table also lists the Certification Reports that presented the data demonstrating attainment of the cleanup levels.

Table C-2 Underground Storage Tanks Closed through Operable Unit 5

Number	UST Description	Document that Summarized Field Activities Completed to Achieve Closure
1	Garage – Building 31	Area 5 Production Area/Main Drainage Corridor 1st Street Certification Report
2	Garage – Building 31	Area 5 Production Area/Main Drainage Corridor 1st Street Certification Report
3	Railroad Engine House – Building 24B	Area 3A/3B Certification Report
5	Garage – Building 31	Area 5 Production Area/Main Drainage Corridor 1st Street Certification Report
6	Maintenance Shop – Building 12	Area 6 Former Production Area/Main Drainage Corridor North Certification Report
8	Garage – Building 31	Area 5 Production Area/Main Drainage Corridor 1st Street Certification Report
9	Garage – Building 31	Area 5 Production Area/Main Drainage Corridor 1st Street Certification Report
10	Garage – Building 31	Area 5 Production Area/Main Drainage Corridor 1st Street Certification Report
11	Plant 1 Truck Dock	Area 4B Certification Report
12	Plant 1 Truck Dock	Area 4B Certification Report
13	Plant 1 Truck Dock	Area 4B Certification Report
14	Plant 6	Area 4A Certification Report
17	Heavy Equipment Building – Building 46	Area 5 Production Area/Main Drainage Corridor 1st Street Certification Report

APPENDIX D – REMOVAL ACTIONS

Under CERCLA, a removal action is defined as a "short-term cleanup often completed prior to a more formal ROD process." As discussed in Section 2.2, there were two programmatic removal actions associated with Operable Unit 5 that were conducted as an effort to minimize the release or threat of release of contaminants and to accelerate cleanup activities. These removal actions were incorporated into the Operable Unit 5 Final ROD and are summarized below:

Removal Action 14 – Contaminated Soil Adjacent to the Sewage Treatment Plant Incinerator
Removal Action 14 was initiated to address contaminated soil with elevated levels of uranium adjacent to a retired incinerator at the Sewage Treatment Plant. The scope was to remove soil exhibiting uranium concentrations above a project-specific threshold. During this process, a localized area of contamination was detected off-property adjacent to the incinerator. This additional off-property soil was excavated as part of this removal action. All excavated soil was containerized and transferred to the FCP for storage and disposal.

Removal Action 17 – Improved Storage of Soil and Debris
Removal Action 17 was initiated to provide controlled storage of excess contaminated soil and debris generated during maintenance, construction, removal, and remedial actions through a soil and debris management plan. On a programmatic basis, the scope, planning, and procedures that comprise this removal action were adopted by the Operable Unit 5 ROD and incorporated into the Operable Unit 5 final remedial action. The Site-wide Excavation Plan addressed soil management practices during remedial action and contained the final strategy for excavation and interim storage/staging of contaminated materials originating from Operable Unit 5. Upon approval of the Site-wide Excavation Plan, Removal Action 17 was terminated and soil and sediment excavation activities were conducted in accordance with the approved remedial design plans.

APPENDIX E – LEGAL AGREEMENTS

The DOE has conducted operations at the Fernald site under several legal agreements beginning with the 1986 FFCA. The FFCA was executed to ensure compliance with laws and regulations under the Clean Air Act, RCRA, and CERCLA. A major component of this agreement was initiation of the RI/FS process for the site. Additionally, in 1988, DOE entered into a Consent Decree with the State of Ohio that provided for the management of water pollution and hazardous wastes. This agreement was modified in 1993 by the stipulated Amendment to the Consent Decree. Cleanup of the FEMP is being conducted under CERCLA, as amended by SARA, and to the extent practicable, under 40 CFR Part 300, the National Oil and Hazardous Substances Pollution Contingency Plan (known as the National Contingency Plan, or NCP).

To promote a more structured and expeditious cleanup of the FCP, the site was partitioned into five study areas called operable units. The division into operable units became a condition of the April 1990 Consent Agreement between EPA and DOE. This agreement was revised in September 1991 to address additional environmental issues and revise the CERCLA schedules. The revised Consent Agreement is referred to as the 1991 Amended Consent Agreement. The 1991 Amended Consent Agreement was modified on April 9, 1993 by an agreement between EPA and DOE resolving a dispute concerning EPA's denial of DOE's request for an extension of time to submit Operable Unit 2 documents. This modified agreement established new schedules extending the submittal dates of the Operable Unit 2 RI Report, Feasibility Study/Proposed Plan-Environmental Assessment (FS/PP-EA), and draft ROD and also accelerated the Operable Unit 1, Operable Unit 3, and Operable Unit 5 draft RODs submission dates by 30 days each.

Associated work ultimately culminated in the legally enforceable Operable Unit 5 ROD that defines the requirements of site-wide soil remediation.

Another legal agreement specifically applicable to site-wide soil remediation was the June 1996 Ohio EPA Director's Finding and Orders: RCRA/CERCLA Integration. This is discussed in more detail in Appendix C of this report.

APPENDIX F – REFERENCES

U.S. Department of Energy, 1995a, "Remedial Investigation Report for Operable Unit 5," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

U.S. Department of Energy, 1995b, "Feasibility Study Report for Operable Unit 5," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

U.S. Department of Energy, 1996a, "Record of Decision for Remedial Actions at Operable Unit 5," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

U.S. Department of Energy, 1996b, "Remedial Design Work Plan for Remedial Actions at Operable Unit 5," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

U.S. Department of Energy, 1996c, "Impacted Material Placement Plan for the On-Site Disposal Facility," Fernald Closure Project, DOE, Fernald Area Office, Cincinnati, Ohio.

U.S. Department of Energy, 1998a, "Site-wide Excavation Plan," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

U.S. Department of Energy, 1998b, "Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

U.S. Department of Energy, 2002, "Natural Resource Restoration Plan," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

U.S. Department of Energy, 2003a, "Site-wide CERCLA Quality (SCQ) Assurance Project Plan," Rev. 3, DOE, Fernald Area Office, Cincinnati, Ohio.

U.S. Department of Energy, 2003b, Letter DOE-0061-04, William Taylor to Paul Pardi, "Certification of Closure of Fernald Closure Project Hazardous Waste Management Units"

Ohio EPA, 2004, Letter Phillip Harris to William Taylor, "USDOE Letter Dated 12/23/2003; Certification of Closure of Fernald Closure Project Hazardous Waste Management Units"

U.S. Department of Energy, 2005, " Development of CERCLA Remedial Action Closeout Reports for the Fernald Closure Project," Fact Sheet, Fernald Closure Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 2006, "Comprehensive Legacy Management and Institutional Controls Plan," Draft Final, Fernald Closure Project, DOE, Fernald Area Office, Cincinnati, Ohio.

APPENDIX G – SOIL EXCAVATION PHOTOS

Figure G-1 – Real Time Scanning is Performed Using RTRAK – circa 2002

Figure G-2- Contaminated Soil Excavation at the Old Sewage Treatment Plant – circa 1998

Figure G-3 - Deep Excavation in the Former Production Area – circa 2005

Figure G-4 - Removing Below Grade Debris (Foundation Pilings)in the Former Production Area – circa 2004

Figure G-5 – Restored Area And Creation Of New Wetlands In Area Northeast Of Disposal Facility – circa 1999.

APPENDIX H – LIST OF ACRONYMS

ACA	Amended Consent Agreement
ACM	asbestos containing material
AEC	Atomic Energy Commission
ANSI	American National Standards Institute
ARAR	applicable or relevant and appropriate requirements
ASQC	American Society of Quality Control
ASME	American Society of Mechanical Engineers
AWWT	Advanced Wastewater Treatment
BSL	bio surge lagoon
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D&D	decontamination & dismantlement
DF&O	Director's Findings & Orders
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
ERDA	U.S. Energy Research & Development Administration
ESD	explanation of significant differences
FCP	Fernald Closure Project
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Company
FFCA	Federal Facilities Compliance Agreement
FMPC	Feed Materials Production Center
FRL	final remediation levels
GIS	Geographic Information System
HWMU	Hazardous Waste Management Unit
IEMP	Integrated Environmental Management Plan
IRDP	Integrated Remedial Design Plan

LMICP	Legacy Management and Institutional Controls Plan
mg/l	milligrams/liter
NARA	National Archives and Records Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NLO	National Lead of Ohio
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NQA	National Quality Assurance
NTS	Nevada Test Site
O&M	operations and maintenance
OFFO	Office Federal Facilities Oversight (Ohio EPA)
Ohio EPA	Ohio Environmental Protection Agency
OSDF	On-site Disposal Facility
OSWER	Office of Solid Waste and Emergency Response (U.S. EPA)
OU	Operable Unit
PCBs	Poly-chlorinated Biphenyl
PP	Proposed Plan
QA/QC	quality assurance/quality control
QAJSP	Quality Assurance Job Specific Plan
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RM	Requirements Manual
RSE	Removal Site Evaluation
RTRAK	Mobile Radiation Tracking System
SARA	Superfund Amendments and Reauthorization Act
SCQ	Site-wide CERCLA Quality Assurance Plan
SEP	Site-wide Excavation Plan
SP	stockpile (soil stockpile)
SWRB	storm water retention basin

TCLP	toxicity characteristic leaching procedure
µg/L	micrograms per liter
UST	underground storage tank
VOC	volatile organic compound
WAC	waste acceptance criteria
WAO	Waste Acceptance Organization
WEMCO	Westinghouse Environmental Management Company of Ohio
WMCO	Westinghouse Materials Company of Ohio
WPRAP	Waste Pits Remedial Action Project

APPENDIX I – SIGNATURE PAGE

I certify that the remedial actions as described within this report have been completed.

_____

Johnny W. Reising, Director
United States Department of Energy
Fernald Closure Project

Interim Remedial Action Report for Operable Unit 5 (Section 3) – Aquifer Restoration

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1.0 INTRODUCTION

This document serves as Section 3 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Interim Remedial Action Report (closeout report) for Operable Unit 5 at the United States Department of Energy's (DOE's) Fernald Closure Project (FCP) located near Cincinnati, Ohio. As a stand-alone section of the Interim Operable Unit 5 closeout report, this section covers the restoration of the Great Miami Aquifer at the FCP.

The full closeout report for Operable Unit 5 is divided into three separate stand-alone sections as part of one integrated document. In addition to Section 3 covering the restoration of the Great Miami Aquifer, the Interim Operable Unit 5 closeout report also covers the construction, operation, and closure of the FCP's On-Site Disposal Facility (OSDF) in Section 1, and closeout reporting for the remediation of site-wide soil and sediment in Section 2. Remediation requirements for the FCP's environmental media including the Great Miami Aquifer were defined in the 1996 Record of Decision (ROD) for Operable Unit 5 [DOE 1996a].

Section 3 has been prepared to meet United States Environmental Protection Agency (EPA) guidance for CERCLA site closeout as described in EPA Office of Solid Waste and Emergency Response (OSWER) Directive No. 9320.2-09A-P, *Closeout Procedures for National Priorities List (NPL) Sites* (January 2000). As stated in this directive, the aim of the guidance is to communicate EPA's key principles and expectations for remedial action closeout along with "best practices" based on CERCLA program experience that should be consulted for closing out NPL sites in a consistent and reasonable manner across the program. The guidance recommends a standard closeout report outline that has been followed in the preparation of this Operable Unit 5 Interim Remedial Action Report for Aquifer Restoration.

Operable Unit 5 is one of five CERCLA operable units at the FCP. Operable Unit 5 encompasses all environmental media, both on and off the FCP property, affected by the contaminants released from the FCP site. Operable Unit 5 has no operational history of it's own but reflects the impacts of the other operable units (1, 2, 3 and 4) on the soil, surface water and sediment, groundwater, plants and animals in the affected area.

In accordance with agreements reached between DOE and EPA (see Section 1.5) to communicate the overall interim and final remedial action closeout report strategy across the operable units, the Interim Remedial Action Report for Operable Unit 5 is designed to document the status of the soils, On-Site Disposal Facility, and groundwater/surface water remedial actions, and to demonstrate that the ongoing elements of the Operable Unit 5 remedy are operating properly and successfully. This section of the Operable Unit 5 Interim Remedial Action Report addresses the groundwater (and to a lesser extent surface water) aspect of Operable Unit 5.

This closeout report is organized into ten major sections and nine appendices. Section 1.0 provides an overview of the FCP and the overall remedial activities comprising the FCP's site-wide cleanup program and a definition of the scope of the interim and final Remedial Action Reports associated with these programs. Section 2.0 provides an overview specific to Operable Unit 5 groundwater remediation and treatment actions that were selected in the Operable Unit 5 ROD. Section 3.0 addresses construction activities associated with the Operable Unit 5 groundwater remediation and treatment actions, and Section 4.0 provides an annotated chronology of the key events contributing to successful completion and documentation of the Operable Unit 5 groundwater remediation and treatment actions. Sections 5.0 and 6.0 address performance standards, quality control, and final inspections and certifications, while Section 7.0 summarizes operations and maintenance information as appropriate. Section 8.0 summarizes groundwater remediation and treatment actions cost information, and compares actual remedial costs with the original estimates contained in the Operable Unit 5 ROD relative to groundwater remediation and treatment actions. Section 9.0 identifies lessons learned during remedy implementation, and Section 10.0 summarizes key operable unit contact information.

1.1 Fernald Closure Project Overview

The FCP is a 1050-acre government-owned contractor-operated facility located in southwestern Ohio approximately 18 miles northwest of downtown Cincinnati. The facility is located just north of Fernald, Ohio, a small farming community, and lies on the boundary between Hamilton and Butler counties. Of the total site area, approximately 850 acres are in Crosby Township in Hamilton County and 200 acres are in Ross and Morgan Townships in Butler County.

The Atomic Energy Commission (AEC), predecessor to the U.S. Energy Research and Development Administration (ERDA) and then the DOE, established the Feed Materials Production Center (FMPC) in conformance with AEC orders in the early 1950s. In 1951, National Lead Company of Ohio, Inc., (NLO) entered into a contract with the AEC as the Management and Operations Contractor for the facility. This contractual relationship lasted until January 1, 1986. Westinghouse Materials Company of Ohio (WMCO), a wholly owned subsidiary of Westinghouse Electric Corporation, then assumed management responsibilities for the site operations and facilities. In 1991, Westinghouse renamed this subsidiary the Westinghouse Environmental Management Company of Ohio (WEMCO). During that same year, DOE renamed the site the Fernald Environmental Management Project (FEMP) to reflect the site's revised mission. On December 1, 1992, Fernald Environmental Restoration Management Company (FERMCO) (now Fluor Fernald) assumed responsibility for the site as the Environmental Restoration Management Contractor for DOE. The FEMP was renamed the Fernald Closure Project (FCP) on January 27, 2003.

1.2 Mission of the Site

The primary mission of the FCP during its 37 years of operation was the processing of uranium feed materials to produce high purity uranium metal. These high purity uranium metals were then shipped to other DOE or United States Department of Defense facilities for use in the nation's weapons program. Manufacture of the uranium metal products generally occurred in 7 of the FCP's more than 50 production, storage, and support buildings that comprised what was known as the 140-acre production area. During the 37 years of production operations, nearly 500 million pounds of uranium metal products were produced. The site also served as the nation's key federal repository for thorium-related nuclear products, and it also recycled uranium used in the reactors at the Hanford site. These recycled reactor returns were the source of technetium-99, a radiological contaminant that is prevalent at the site.

Liquid and solid wastes were generated by the various operations between 1952 and 1989. Before 1984, solid and slurried wastes from FMPC processes were deposited in the on-property waste storage area. This area, located west of the former production area, included six low-level radioactive waste storage pits; two earthen-bermed concrete silos containing K-65 residues; one concrete silo containing metal oxides; one unused concrete silo; two Lime Sludge Ponds; a Burn Pit; a Clearwell; a Solid Waste Landfill; and a lagoon known as the bio-surge lagoon to treat wastewater. After 1984, wastes produced from operations were containerized for eventual off-site disposal. Contaminants from material processing and related activities were released into the environment through air emissions, wastewater discharges, storm water runoff, and leaks and spills.

1.3 Regulatory History

The CERCLA Remedial Investigation/Feasibility Study (RI/FS) process at the FCP began in 1986, in accordance with a Federal Facility Compliance Agreement (FFCA) between DOE and EPA to cover environmental impacts associated with the FEMP. The FFCA was intended to ensure that environmental impacts associated with activities at the facility would be thoroughly and adequately addressed. In response to the FFCA, a site-wide RI/FS was initiated pursuant to CERCLA, as amended by the Superfund Amendment and Reauthorization Act (SARA). Production operations at the facility were suspended in 1989 and the facility was placed on the NPL. The FFCA was amended in 1990 by a Consent Agreement (under 120 and 106[a] of CERCLA) (April 1990) that revised the milestone dates for the RI/FS and provided for implementation of removal actions. The Consent Agreement was amended in 1991 (September 1991) to revise schedules for completing the RI/FS process. This amended Consent Agreement provided for implementation of the operable unit concept. The FCP was partitioned into five operable units to promote a more structured and expeditious cleanup. The schedule for preparation of a remedial investigation report and feasibility study report for each operable unit, including Operable Unit 5, was included in the amended Consent Agreement.

The Ohio Environmental Protection Agency's (Ohio EPA) Office of Federal Facilities Oversight (OFFO) also oversees cleanup activities at the site as a support agency primarily through the 1988 Consent Decree (December 1988) and its amendment (January 1993). Ohio EPA conducts environmental monitoring, public outreach, restoration and remediation oversight at the FCP, as well as maintaining authority for Resource Conservation and Recovery Act (RCRA) enforcement. The 1996 Director's Final Findings and Orders (June 1996) between the DOE/Fluor Fernald and the Ohio EPA provide orders for closure activities at the site to satisfy both RCRA and CERCLA requirements. The September 2000 Director's Final Findings and Orders between the DOE/Fluor Fernald and the Ohio EPA provide for the necessary groundwater monitoring requirements.

1.4 Site-wide Operable Units and Cleanup Strategy

For purposes of investigation and study, the remedial issues and concerns that were similar in location, history, type/level of contamination, and inherent characteristics were grouped into operable units under the 1991 amended Consent Agreement. Four of the operable units (1 through 4) are considered contaminant "source" operable units as they represent the sources of contamination that have affected the site's environmental media. The fifth operable unit (Operable Unit 5) is considered the "environmental media" operable unit as it represents the environmental media affected by past production operations and waste disposal practices (i.e., beyond the contaminant "source" operable unit boundaries), as well as the pathways of contaminant migration at the site. The four contaminant "source" operable units and the fifth environmental media operable unit are described below:

- Operable Unit 1: Waste Pit Area. Waste Pits 1 through 6, Clearwell, Burn Pit, berms, liners, and affected soil residing within the operable unit boundary.
- Operable Unit 2: Other Waste Units. The Active and Inactive Flyash Piles, the South Field disposal area, north and south Lime Sludge Ponds, the Solid Waste Landfill, and the berms, liners, and affected soil residing within the operable unit boundary. The Active and Inactive Flyash Piles and South Field area are collectively known as the "Southern Waste Units" because they are collocated in close geographic proximity to one another.
- Operable Unit 3: Former Production Area. Former production and production-associated facilities and equipment (including all above- and below-grade improvements), including, but not limited to, all structures, equipment, utilities, drums, tanks, solid waste, waste, product, thorium, effluent lines, a portion of the K-65 transfer line, wastewater treatment facilities, fire training facilities, scrap metal piles, feedstocks, and coal pile. Note that all affected soil beneath the facilities resides within Operable Unit 5.
- Operable Unit 4: Silos 1 through 4. Contents of Silos 1, 2, 3 (Silo 4 has remained empty); the silos structures, berms, decant sump tank system, and affected soil residing within the operable unit boundary.
- Operable Unit 5: Environmental Media. Groundwater, surface water, all soil not included in the definitions of Operable Units 1 through 4, sediment, flora, and fauna.

During the time period 1994 to 1996, DOE and EPA signed the final RODs for each operable unit -- in cooperation with the Ohio EPA and the Fernald Citizen's Advisory Board -- which set in motion the major cleanup requirements and approaches that collectively define the FCP cleanup. The RODs employed a combination of off-site and on-site disposal, under which approximately 77 percent of the remedial waste volume (the site's lower concentration, higher volume materials) was to be disposed of in an engineered on-site disposal facility (OSDF) while approximately 23 percent (the site's higher concentration, lower volume materials) was to be sent off site for disposal, primarily at permitted facilities in Utah and Nevada.

At the time the RI/FS activities were completed and the RODs put in place, 31 million pounds of uranium products, 2.5 billion pounds of waste, 255 buildings and structures, and 2.75 million cubic yards of contaminated soil and debris were identified as requiring action. In addition, a 172-acre portion of the Great Miami Aquifer was found to be contaminated at levels above radiological drinking water standards (for uranium, 20 μg/L, the proposed drinking water standard at the time of Operable Unit 5 ROD signature in 1996). Under the site-wide approach, the final remedial actions contained in the operable unit RODs are:

- Production and support facility decontamination and dismantlement (D&D).
- On-site disposal of contaminated soil, above-and below-grade debris, and Operable Unit 2 waste unit materials, in an engineered on-site disposal facility (OSDF) and in accordance with specific OSDF waste acceptance criteria (WAC).
- Off-site disposal of the contents of the silos, the waste pit materials, nuclear product inventories, containerized low-level and mixed waste inventories, and the quantities of soil and debris that do not meet OSDF WAC.
- Extraction and treatment of contaminated groundwater to restore the contaminated portions of the Great Miami Aquifer to meet established Final Remediation Levels (FRLs). (FRLs were established based on Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs).

At completion, approximately 975 acres of the 1,050-acre property will be restored for use as an undeveloped park, the target land use selected in the Operable Unit 5 ROD, and approximately 75 acres will be dedicated to the footprint of the OSDF. The Great Miami Aquifer will be restored to drinking water standards, and long-term stewardship actions and requisite institutional controls will be put in place consistent with the target land use.

Groundwater restoration for the Great Miami Aquifer is estimated to be complete in 2026, based on modeling projections.

Taken together, the individual RODs for the operable units provided a site-wide cleanup approach that encompassed all contaminant source areas and all affected environmental media at the site. Collectively the RODs provided a natural link between the remediation of the sources of contamination and the media affected. Each ROD progressively built on the decisions of the earlier RODs, yielding a cohesive and comprehensive remedy for the FCP. The dates of ROD signature and progressive sequence of decisions adopted under the RODs are shown below:

- Operable Unit 3 ROD for Interim Remedial Action (July 22, 1994) – provided accelerated approval for the decontamination and dismantlement (D&D) of the FCP's buildings and structures.
- Operable Unit 4 ROD for Final Remedial Action (December 7, 1994) – provided for the remediation of Silos 1 through 4, affected soil within the operable unit boundary, and other sources of contamination within the boundary. The D&D of all remedial facilities constructed for the Operable Unit 4 remedial action were to be addressed as part of Operable Unit 3.
- Operable Unit 1 ROD for Final Remedial Action (March 1, 1995) – provided for the remediation of the waste pit contents, caps, liners, affected soil within the operable unit boundary, and other sources of contamination within the boundary. The D&D of all remedial facilities constructed for the Operable Unit 1 remedial action were to be addressed as part of Operable Unit 3.
- Operable Unit 2 ROD for Final Remedial Action (June 8, 1995) – provided for the remediation of the Active and Inactive Flyash Piles, South Field disposal area, the two Lime Sludge Ponds, Solid Waste Landfill, affected soil within the operable unit boundary, and other sources of contamination within the boundary. This decision set in motion the approval of onsite disposal of waste at the FCP and the construction of the OSDF; however, at the time it was formally limited to the disposal of the Operable Unit 2 wastes since the Operable Unit 5 and 3 decisions related to waste disposition (on site or off site) were not yet final.
- Operable Unit 5 ROD for Final Remedial Action (January 31, 1996) – provided for the remediation of the FCP's on-site and off-site environmental media. This ROD addressed the cleanup of the Great Miami Aquifer at all locations, and the remediation of affected site-wide soils outside the source operable unit boundaries. It also addressed the monitoring of air, surface water, groundwater, sediment, and biota. The Operable Unit 5 ROD finalized the concept of a site-wide OSDF, and further incorporated the "balanced approach" concept into FCP on-site and off-site waste disposition decisions. The D&D of all remedial facilities constructed to support the Operable Unit 5 groundwater remedial action were to be addressed as part of Operable Unit 3.
- Operable Unit 3 ROD for Final Remedial Action (September 24, 1996) – provided a final disposition decision for the D&D materials generated through the Interim Remedial Action ROD. Consistent with the Operable Unit 5 decision, this final decision document adopted on-site disposal as the selected remedy for disposition of the D&D debris. It also adopted earlier decisions as part of the "balanced approach" to send the FCP's containerized waste inventories and nuclear materials off site. The ROD also acknowledged that the D&D of new remedial facilities constructed at the site would be addressed as part of Operable Unit 3.

1.5 Remedial Action Closeout Report Strategy – Spring 2005 Fact Sheet

- DOE and EPA developed a fact sheet to describe the strategy for producing the closeout reports for the CERCLA operable unit remedial actions completed for the FCP [DOE 2005a]. In essence, this fact sheet adopted the following strategy for submitting remedial action closeout reports for EPA approval (and summarized in Figure 1-1):
- Proceed with formal closeout of Operable Unit 1when the waste pit contents and liners have been successfully dispositioned off site. The remaining operable unit scope (soil remediation within the Operable Unit 1 boundary, and D&D of Operable Unit 1 remediation facilities) would be documented in the closeout reports for Operable Units 5 and 3, respectively.

- Proceed with formal closeout of Operable Unit 2 when the waste materials from the Solid Waste Landfill, north and south Lime Sludge Ponds, Active and Inactive Flyash Piles, and the South Field area have been successfully placed in the OSDF, or dispositioned off site as necessary based on OSDF waste acceptance criteria restrictions. The remaining operable unit scope (soil remediation within the Operable Unit 2 waste unit boundaries) would be documented in the closeout report for Operable Unit 5.
- Proceed with formal closeout of Operable Unit 3 when the D&D of site-wide facilities -- including the remediation facilities constructed for Operable Units 1 and 4 -- are complete and all legacy-era containerized wastes have been successfully dispositioned.
- Proceed with formal closeout of Operable Unit 4 when the silo contents for Silos 1&2 and Silo 3 have been successfully dispositioned off site. The remaining operable unit scope (soil remediation within the Operable Unit 4 boundary, and D&D of Operable Unit 4 remediation facilities and the empty silo structures) would be documented in the closeout reports for Operable Units 5 and 3, respectively.
- Proceed with an Interim Remedial Action Report for Operable Unit 5. As an interim report, the report will address the completion status of soil restoration activities (including those within the Operable Units 1, 2 and 4 boundaries), the closure and long-term monitoring of the OSDF, and the ongoing aquifer restoration activities, future D&D of groundwater infrastructure, and final soil remediation (as necessary beneath the remaining groundwater infrastructure). The Interim Remedial Action Report for Operable Unit 5 consists of three distinct parts: soils remediation, OSDF closeout, and aquifer restoration activities. The closeout report is considered "interim" for the following reasons:
    - Aquifer restoration activities must continue until the affected portions of the Great Miami Aquifer have been remediated to Operable Unit 5 FRLs.
    - Final surface water and sediment certification in the Great Miami River cannot be completed until final discharges to the river from the groundwater remedy have been completed.
    - Soil remediation is complete in all areas, except for necessary future soil remediation beneath the required remaining groundwater infrastructure.
    - The OSDF is subject to a 30-year monitoring requirement after closure.

While the remedial goals for these activities are not yet complete, this Interim Remedial Action Report will demonstrate they are indeed operating successfully. Once groundwater restoration has been completed (estimated completion date of 2026, based on modeling projections), a future final Remedial Action Report for Operable Unit 5 will be prepared.

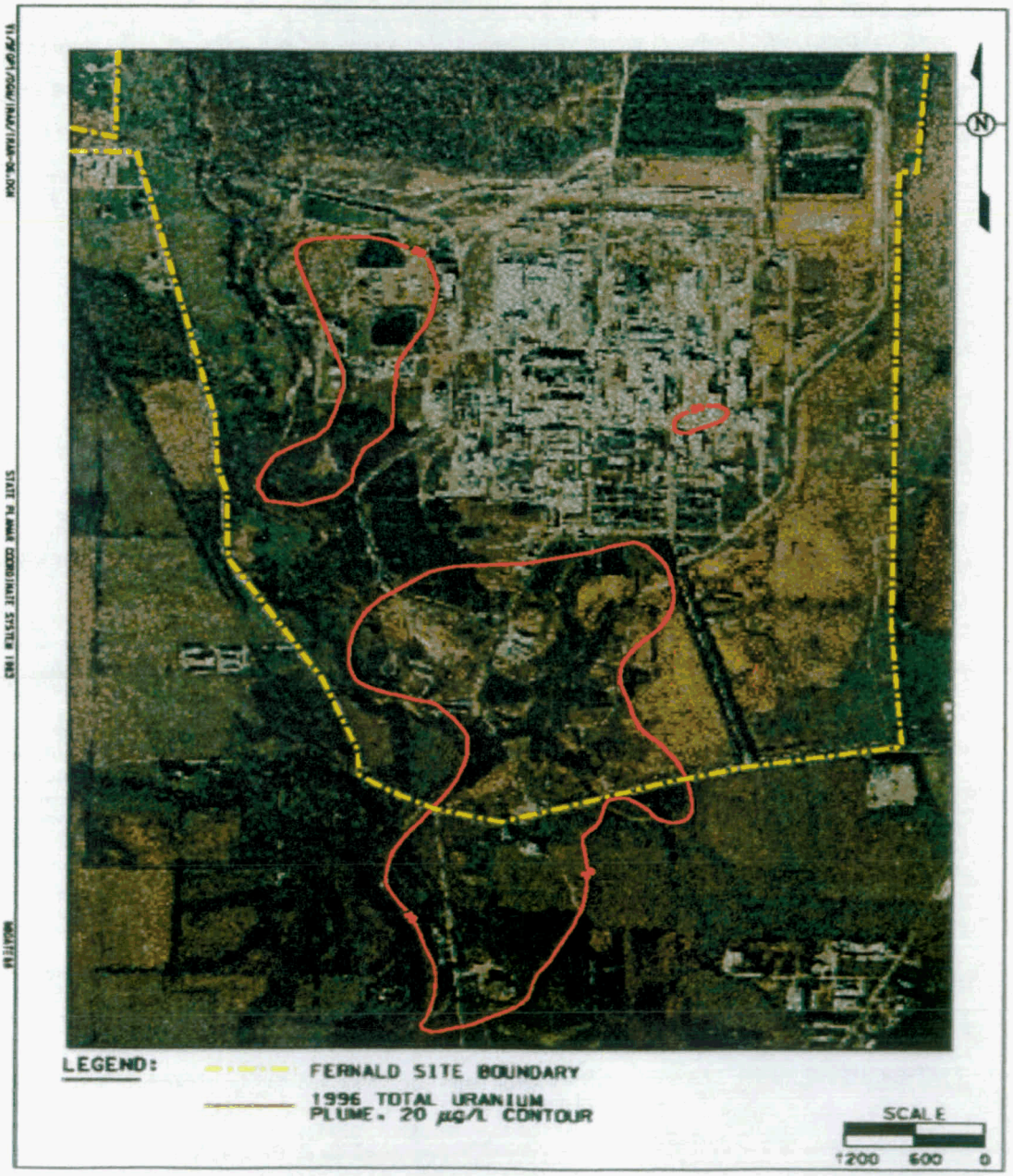
Figure 1-1 Summary of CERCLA Remedial Action Closeout Reports and Schedule

Operable Unit	Key Closeout Activity	Where Documented	Remaining Scope	Where Documented
Operable Unit 1 Waste Pits	Waste pit contents successfully dispositioned off site	Final Remedial Action Report for Operable Unit 1 (Summer 2006)	Soil Remediation within Operable Unit 1 boundary	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)
			D&D of Operable Unit 1 Remediation Facilities	Final Remedial Action Report for Operable Unit 3 (Winter 2007)
Operable Unit 2 Other Waste Units	Wastes from Solid Waste Landfill, Lime Sludge Ponds, Fly Ash Piles, and South Field area successfully placed in OSDF or dispositioned off site as required	Final Remedial Action Report for Operable Unit 2 (Fall 2006)	Soil Remediation within Operable Unit 2 boundary	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)
Operable Unit 3 Production Area Facilities	D&D of site-wide facilities (except for groundwater infrastructure); completion of Legacy Waste disposal	Final Remedial Action Report for Operable Unit 3 (Winter 2007)	None	NA
Operable Unit 4 Silos	Silo 3 material successfully dispositioned off site; Silos 1&2 material successfully treated, packaged, and transported off site into temporary storage.	Final Remedial Action Report for Operable Unit 4 (Fall 2006)	Soil Remediation within Operable Unit 4 boundary	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)
			D&D of Operable Unit 4 Remediation Facilities	Final Remedial Action Report for Operable Unit 3 (Winter 2007)
			Permanent off-site disposal of Silos 1&2 material	Addendum to the Final Remedial Action Report for Operable Unit 4 (post-closure)
Operable Unit 5 Environmental Media	Groundwater remediation infrastructure is installed and operating.	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)	D&D of groundwater facilities once groundwater remedy is complete; certification of surface water and sediments	Final Remedial Action Report for Operable Unit 5 (post-closure)
	Completion of all soil remediation site wide, except for beneath long-term groundwater facilities	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)	Soil remediation and certification beneath groundwater facilities	Final Remedial Action Report for Operable Unit 5 (post-closure)
	The On-Site Disposal Facility is capped	Interim Remedial Action Report for Operable Unit 5 (Winter 2008)	Long-term care and monitoring	Final Remedial Action Report for Operable Unit 5 (post-closure)

2.0 OPERABLE UNIT 5 AQUIFER RESTORATION BACKGROUND

As indicated above, Operable Unit 5 encompasses all environmental media, both on and off the FCP property, affected by the contaminants released from past uranium processing activities. These releases led to the contamination of areas of perched groundwater as well as portions of the underlying Great Miami Aquifer. The extent of this uranium contamination in the Great Miami Aquifer (the primary site contaminant), as defined by the 20 µg/L concentration contour characterized in 1996 is shown in Figure 2-1.

Figure 2-1. Operable Unit 5 Great Miami Aquifer Contamination *Before Remediation – Circa June 1996*



2.1 Results of the Operable Unit 5 Remedial Investigation

There were two phases of a CERCLA remedial investigation conducted for Operable Unit 5 [DOE 1995a]. Field investigation activities from 1988 through 1992 are referred to collectively as the Phase I Field Investigation while additional field investigations carried out in 1993 are called the Phase II Field Investigation. Both phases encompassed all affected media (surface water, sediment, surface soil, subsurface soil, and groundwater).

It was found that contamination of the groundwater resulted from infiltration through the bed of Paddys Run, the Storm Sewer Outfall Ditch, and the Pilot Plant Drainage Ditch. In portions of these drainages, the glacial overburden is eroded, and the sand and gravel of the aquifer are in direct contact with uranium contaminated surface water from the site. To a lesser degree, groundwater contamination also resulted where past excavations (such as the waste pits) or deep building foundations removed some of the protective clay contained in the glacial overburden and exposed the aquifer to contamination. As documented in the remedial investigation report, the primary groundwater contaminant at the site is uranium.

2.2 Removal Actions

Under CERCLA, a removal action is defined as a "short-term cleanup often completed prior to a more formal ROD process." As part of the Operable Unit 5 process, several removal actions associated with aquifer restoration were conducted, as described below.

- Removal Action No. 1: Contaminated Water Beneath FMPC Buildings
- Removal Action No. 3: South Groundwater Contamination Plume (Five Parts)
  - Part 1 – Alternate Water Supply
  - Part 2 – South Plume Groundwater Recovery Well System
  - Part 3 – An Interim Treatment System to Remove Uranium
  - Part 4 – Groundwater monitoring and Institutional Controls
  - Part 5 – Additional investigation to Identify the Leading Edge and Extent of the South Plume
- Removal Action No. 16: Collect Uncontrolled Production Area Runoff
- Removal Action No. 30: KC-2 Warehouse/Well 67

Appendix D of this Remedial Action Report provides a summary of these removal actions.

2.3 Operable Unit 5 Selected Remedy

The remedial strategy adopted for Operable Unit 5 was necessarily a multi-faceted approach to protect existing and future human and environmental receptors through implementing extensive soils excavations, excavating contaminated sediments and perched water zones containing concentrations above established final remediation levels, on-property disposal of excavated material in the OSDF (in compliance with established OSDF WAC), and restoration of the Great Miami Aquifer through pump and treat technologies. In addition, the remedy required treatment of collected storm water and process wastewater throughout remedial activities.

The portions of the selected remedy addressed in this part of the Operable Unit 5 Interim Remedial Action Report focus on the perched groundwater remediation, restoration of the Great Miami Aquifer, and implementation of the required treatment of groundwater, storm water and process wastewater to meet required discharge limits and FRLs for surface water. (Unlike groundwater, there is no direct restoration of surface water resources (i.e., Paddys Run and the Great Miami River). FRLs for surface water are required to be attained after the FCP

has been completely remediated). As identified in the Operable Unit 5 ROD, key components of this portion of the selected remedy for Operable Unit 5 include:

Perched Water

- Excavation of perched water zones necessary to ensure the continued protection of the regional groundwater aquifer.
- Disposition of the soils generated during the removal of the impacted perched water zones in a manner consistent with the methods defined for soils.
- Treatment, as required, of contaminated perched water and storm water collected during excavation operations. The treatment envisioned was via the Advanced Wastewater Treatment facility and for zones contaminated by volatile organic compounds (VOCs), the water was to be treated through activated carbon absorption.

Great Miami Aquifer Restoration

- Extraction of contaminated groundwater until such time as FRLs are attained at all points in the impacted areas of the Great Miami Aquifer. The basis of the groundwater FRLs and associated selection process was to utilize the SDWA established MCLs, proposed MCLs, or nonzero Maximum Contaminant Level Goals (MCLG). When these standards were not available for a specific contaminant other criteria were used to establish the necessary final remediation level. (1×10^{-5} Incremental Lifetime Cancer Risk (ILCR) for carcinogens; 0.2 Hazard Quotient (HQ) for noncarcinogens).
- Performance of an engineering study to examine the viability of applying re-injection techniques to enhance containment recovery from the aquifer system and application of re-injection to groundwater restoration activities where established to be economically and technically viable.
- Collection of recovered groundwater for treatment and/or discharge to the Great Miami River or re-injection (if deemed appropriate).

Treatment of Discharges

- Treatment of collected storm water, wastewater, and recovered groundwater before discharge to the Great Miami River to the extent necessary so as not to exceed FRLs for surface water in the Great Miami River.
- Treatment of the necessary wastewater, storm water, and groundwater to ensure that the maximum annual mass discharge of uranium to the Great Miami River from the effluent does not exceed 600 pounds. The 600-pound per year limit was effective upon issuance of the Operable Unit 5 ROD in January 1996.
- Treatment of the necessary wastewater, storm water, and groundwater to ensure that the maximum concentration of total uranium in the blended effluent discharged to the Great Miami River does not exceed 20 μg/L (later revised to 30 μg/L per the Operable Unit 5 Explanation of Significant Differences discussed below in Section 2.4) based upon a monthly average concentration. The concentration limit became effective January 1, 1998.
- Expansion of the Advanced Wastewater Treatment Facility (AWWT) within the confines of the existing Building 51 to provide a minimum additional design capacity of 1,800 gallons per minute (gpm).
- Disposal of treatment sludges generated from the treatment of wastewater, storm water, and groundwater in the OSDF if established waste acceptance criteria can be attained; otherwise disposal of the sludges at an appropriate off-site disposal facility.

The selected remedy also includes provisions to employ all practical measurers to minimize environmental impacts during remedy implementation, the implementation of institutional controls, and the implementation of an

environmental monitoring program during and after remedy implementation to assess short and long term effectiveness of all the remedial activities relative to the air, surface water and groundwater pathways.

2.4 Operable Unit 5 Post-ROD Decision Changes

There were four changes to the Operable Unit 5 ROD after approval in January 1996. CERCLA requires that changes to approved RODs be documented through a formal ROD Amendment for fundamental changes, an Explanation of Significant Differences (ESD) for other significant changes, or a Fact Sheet for minor modifications.

- Fact Sheet to change the Groundwater FRL for fluoride from 0.89 mg/L (background concentration) to 4 mg/L (MCL) and lead from 0.002 mg/L (background concentration) to 0.015 mg/L (SDWA Action Level). [DOE 1997a]. An action level for lead was promulgated under the SDWA rather than an MCL. An independent evaluation of this action level confirmed that the action level was an appropriately conservative value for the groundwater final remediation level at the FCP. These changes were consistent with the groundwater final remediation level selection process.
- Explanation of Significant Differences to change the Groundwater FRL for Uranium from 20 µg/L to 30 µg/L and to revise the performance based monthly average concentration limit for discharge to the Great Miami River from 20 µg/L to 30 µg/L [DOE 2001a]. The original Operable Unit 5 ROD had adopted the proposed SDWA MCL for uranium of 20 µg/L. In December 2000, the United States Environmental Protection Agency adopted 30 µg/L as the final MCL; prompting the change in the groundwater FRL for uranium.
- Fact Sheet to allow DOE to scale-down the existing AWWT complex (Phase 1, Phase 2, and Expansion Facility) to modify the AWWT Expansion Facility to serve as the long-term groundwater treatment facility [DOE 2004a]. This scaled down facility (the Converted Advanced Wastewater Treatment Facility (CAWWT)) would provide treatment of storm water and wastewater until such time as these sources are removed. Afterwards, the facility will be dedicated to groundwater treatment until such time treatment of groundwater was no longer required.
- Fact Sheet to describe the strategy for producing the closeout reports for the CERCLA operable unit remedial actions completed for the FCP. This Fact Sheet defined the scope of the required reports including this Operable Unit 5 Interim Remedial Action Report (see Section 1.5).

2.5 Remedial Design Summary

The Operable Unit 5 remedy for aquifer restoration and wastewater treatment was unique in the fact that major elements of the selected remedy were already in place and being implemented as a result of EPA approved early start initiatives and groundwater related removal actions. The remedy elements in place at the time the Operable Unit 5 ROD was signed in January 1996 included (further described in Section 3.0):

- South Plume recovery well system installed as a part of the South Plume Removal Action (Removal Action No. 3 Part 2) [DOE 1992]
- New outfall line to the Great Miami River and the dissolved oxygen tank (Removal Action No. 3 Part 2).
- The Interim Advanced Wastewater Treatment Facility (Removal Action No. 3 Part 3)
- The Advanced Wastewater Treatment Facility (Phases 1 and 2) [Ohio EPA 1992]
- The South Plume Interim Treatment System.
- The Storm Water Retention Basin (headworks facility for AWWT Phase 1) [Ohio EPA 1987a] and the Biosurge Lagoon [Ohio EPA 1987b] (headworks facility for AWWT Phase 2)
- Nine extraction wells in the South Field area [DOE 1995b]

The remedial design process then proceeded to build on this existing infrastructure and fully integrate these elements into the site-wide remediation strategy for restoration of the aquifer. The site-wide strategy envisioned in the Operable Unit 5 Feasibility Study [DOE 1995c] and Operable Unit 5 ROD included a restoration approach

using a series of area-specific groundwater restoration modules and centralized treatment capabilities of the AWWT facility and it's appurtenant facilities. These restoration modules were designed and installed as needed during the life of the groundwater remedy and withdrawn from service once remedial objectives within an area were achieved. Design of the individual groundwater modules adopted a "learn as you go" philosophy as each module was independently designed and installed. Enhancements and improvements were built into the remedy through the evaluation of groundwater re-injection technology to improve the speed and efficiency of groundwater remediation. While the ultimate objective of the remedial design was to restore the entire impacted areas of the aquifer, the restoration of the off-property portions of the aquifer received the highest priorities.

As a pump and treat remedy, all the groundwater extracted had to be treated and/or discharged to the Great Miami River (with the exception of that portion of extracted groundwater that was treated and re-injected back into the aquifer). Therefore, the groundwater remediation objectives had to be accomplished while meeting the Operable Unit 5 ROD performance-based discharge standards for uranium, National Pollutant Discharge Elimination System Permit (NPDES) effluent limits, as well as attempting to make all discharges in compliance with established FRLs for surface water.

2.5.1 Remedial Design Work Plan Summary

The Remedial Design Work Plan for Remedial Actions at Operable Unit 5 [DOE 1996b] identified eleven discrete remedial design tasks and four important studies to support remedial design efforts. Each of these tasks are summarized below.

- Update of the Baseline Remedial Strategy - Task 1: The approved RD Work Plan required the DOE to prepare a Baseline Remedial Strategy Report [DOE 1997b] that would serve as the technical basis for the detailed design of the FCP's groundwater remedy and summarize the results of the FCP's ongoing enhancement modeling simulations that were conducted following approval of the initial groundwater remedial strategy (termed the "base case" remedy) contained in the Operable Unit 5 Feasibility Study Report.
- Operations and Maintenance Plan - Task 2: A master Operations and Maintenance Plan [DOE 1997c] was developed as a means to coordinate the extraction, collection, conveyance, treatment, and discharge of all groundwater, storm water, and remediation wastewater generated on a site-wide basis over the life of the FCP's cleanup mission.
- South Field Extraction System Module Design - Task 3: the South Field Extraction System was designed under an EPA-approved project specific plan before issuance of the Operable Unit 5 ROD. The nine wells comprising this module (considered phase 1 of a two phase installation) were installed in the summer and fall of 1995.
- Injection Demonstration Module Design - Task 4: At the time of remedial design development, groundwater re-injection was being evaluated under Task 1 described above and supported by field tests. Task 4 was to complete the design of this re-injection module [DOE 1997d] should the evaluations of re-injection technology be deemed favorable. Based on the results of the field studies [DOE 2000] and in consultation with USEPA and Ohio EPA, DOE decided to incorporate re-injection into the overall groundwater remedial strategy. Task 4 was the design effort of the first-phase, five-well re-injection demonstration module that was to be used to prove out the technology at the field scale.
- South Plume Optimization Module Design - Task 5: This module was so named during the agencies' review of the April 1995 South Plume Removal Action report and signified the desire of EPA, OEPA and DOE to restore the off-property portion of the plume quickly and cost effectively. The design of the wells and accompanying infrastructure was accomplished by Task 5, as a stand-alone design package [DOE 1997d].

- Plant 6 Area Extraction Module Design - Task 6: The Plant 6 area module was originally believed to be necessary to recover contaminants from beneath and just east of the FCP's former production area. However, after evaluating the contaminants in this area, DOE in consultation with USEPA and Ohio EPA decided that this module would not be necessary [DOE 2001b].
- Waste Storage Area Extraction Module Design - Task 7: The waste storage area module was deemed necessary to recover contaminants from beneath Operable Units 1 and 4. The locations of the extraction wells for this system were finalized as part of the modeling simulations under Task 1. The design of the necessary wells and infrastructure was accomplished by Task 7 as a stand-alone design package [DOE 2001b]. (The design package was split into Phase I and Phase II packages).
- AWWT Facility Expansion Design - Task 8: As discussed in the Operable Unit 5 ROD, the existing capacity of the AWWT facility was to be expanded to the maximum achievable within the confines of Building 51. The design effort involved the installation of a nominal 1,800 gpm treatment system expansion dedicated to the treatment of groundwater only. Effluent from this system served as the re-injection water for the groundwater re-injection system contemplated under Task 4.
- Integrated Environmental Monitoring Plan - Task 9: As the environmental media operable unit, Operable Unit 5 was responsible for maintaining a baseline of environmental conditions at the site and monitoring impacts attributable to the implementation of the FCP's site-wide remedial actions. (Monitoring will also be conducted following the completion of cleanup as required to assess the continued protectiveness of the remedial actions.) A site-wide integrated environmental monitoring plan (IEMP) was developed that specified the type and frequency of environmental monitoring activities to be conducted during remedy implementation and, ultimately, following the cessation of remedial operations. [DOE 1997e]
- Remedial Action Work Plan - Task 10: A Remedial Action Work Plan for aquifer restoration was required to fulfill Amended Consent Agreement obligations. The RA Work Plan provided all information required by the Amended Consent Agreement and conveyed the enforceable RA construction schedule for the first groundwater restoration modules to be brought on line. [DOE 1997f]
- Site Closeout and Deletion of the FCP from the CERCLA National Priorities List - Task 11: Based on current funding scenarios for the FCP, the endpoint of the cleanup mission for the site will be defined by completion of the Great Miami Aquifer restoration project. Once remedial goals for the aquifer are achieved across the site (or necessary technical impracticability waivers granted by EPA), a site Final Closeout Report will be prepared and the formal documentation assembled to permit delisting of the FCP from the CERCLA National Priorities List. Assembling the delisting package, conducting required public participation activities, and meeting all reporting requirements for formal closeout of the project will be handled under this task.

There were several tests and studies identified in the Remedial Design Work Plan, which served to support the overall remedial design effort.

- Aquifer Pumping Test: The major objective of the pumping test was to supplement the RI/FS hydrogeologic database and assess hydraulic conductivity, storage, and anisotropy of the Great Miami Aquifer in the vicinity of the South Field Extraction System restoration module. [DOE 1995d].
- Uranium Desorption Measurements: During the RI/FS, numerous desorption tests were performed to establish the range of uranium desorptive characteristics for the media comprising the Great Miami Aquifer. (Desorption relates to the relative ability of the uranium contamination to be freed from the soils, sands, and gravels.) These characteristics affect the cleanup time and efficiency of the restoration system. [DOE 2004b].
- Injection Test: In October of 1995 a short-term re-injection test was performed to determine if the Great Miami Aquifer could accommodate anticipated re-injection rates without encountering undesirable geochemical interferences or physical plugging. The test demonstrated that desired re-injection rates could be maintained provided certain iron-based geochemical interactions could be overcome [DOE 1995e].

- Restoration Area Verification Sampling: The intent of the sampling was to further define the vertical and lateral extent of uranium contamination in the vicinity of Monitoring Well 3069; to evaluate all the non-uranium groundwater data, existing at the time, outside of the uranium-based restoration footprint and attempt to determine which sporadic FRL exceedances could be dismissed as non-FCP related or were not a concern; and determine, from the preceding evaluation, which sporadic FRL exceedances required additional sampling before a final decision could be made regarding whether the exceedances drove a need to expand the restoration footprint beyond that based on uranium. [DOE 1997g].

2.5.2 Groundwater Modeling

Integral to the remedial design effort and subsequent aquifer response tracking was the development and use of a groundwater model. Since modeling was conducted for the Remedial Investigation/Feasibility Study and Baseline Remedial Strategy reports, the model has undergone several changes in order to improve its capability for making water level and uranium concentration predictions. DOE has changed from the Sandia Waste Isolation Flow and Transport (SWIFT) groundwater modeling code to the Variably Saturated Analysis Model in 3 Dimensions (VAM3D) modeling code for all site groundwater modeling operations. This transition has been documented in detail in *Development and Verification of VAM3DF, a Numerical Flow and Transport Modeling Code* (1998). Because the model uses simplifying assumptions, it is supported through an extensive groundwater monitoring program where actual data relative to uranium concentration and water levels are compared to model predictions and adjustments to the model made as necessary.

Groundwater extraction, re-injection, and monitoring well locations are determined through a combination of groundwater modeling and characterization. Characterization includes the collection of groundwater samples, groundwater level measurements, and the collection of sediment samples from the aquifer.

Groundwater samples are collected and analyzed to determine if contamination is present. If contamination above FRLs is detected additional groundwater samples are collected in order to determine the dimension and extent of the plume. Water level measurements are made to establish regional and local groundwater flow directions. Aquifer sediment samples are collected to determine the geo-chemical characteristics of the aquifer. These geo-chemical conditions are a key variable in attempting to model the fate and transport of the uranium contamination.

Once the plume dimensions, groundwater flow directions, and aquifer properties have been characterized, groundwater modeling is utilized to design a remedy. Several modeling simulations are made to determine an optimal remediation design that includes, the number and location of the extraction wells and target pumping rates for each well.

2.5.3 Remedial Design Efforts to Support Post-Closure Activities

As remediation efforts were accelerated to accomplish the complete closure of the FCP by December 2006, it was recognized that the groundwater remedy would not be complete at that time. However, it was also recognized that the most cost effective infrastructure to continue the groundwater remedy could be in place at that time. Towards that end, a Comprehensive Groundwater Strategy Report [Fluor Fernald 2003] was prepared which served as the springboard to determine the most cost effective groundwater pumping and treatment system configuration required to meet regulatory commitments and satisfy stakeholder desires for a timely completion of the groundwater remedy. This report and the subsequent negotiations and consultations with the regulatory agencies and stakeholders culminated in a decision to convert the existing AWWT Expansion System to serve the site's remaining storm water/remediation wastewater treatment needs as well as the long-term (post-closure)

groundwater treatment needs. The facility is known as the Converted Advanced Wastewater Treatment System (CAWWT). A schematic of the CAWWT Facility is provided in Appendix B.

Other key decisions to support post-closure groundwater remediation include the decision to eliminate groundwater re-injection using re-injection wells and evaluate the benefits of directing clean groundwater into surface water channels where a direct connection with the aquifer sands and gravels are evident [DOE 2005b].

2.5.4 Remedial Design Efforts to Support Perched Water Remediation

Perched water zones within primarily the former production area and the former sewage treatment plant area were required to be removed during soil excavations when those zones presented an unacceptable threat to the underlying aquifer. This unacceptable threat was defined as one having a cross-media impact to the underlying groundwater that would produce concentrations of contaminants in the aquifer above FRLs. The methods of removal and management of resulting water was specified in Integrated Remedial Design Packages (IRDP) for the excavation area in question prepared under the Site-Wide Excavation Plan [DOE 1998a]. The IRDPs described the expected locations, depth, quantity, quality, control/collection system, and treatment requirements for perched water as well as procedures to minimize potential impacts to the underlying Great Miami Aquifer.

3.0 CONSTRUCTION ACTIVITIES

The following sections describe the installation, features, and operational history and status of the major components of the aquifer restoration and wastewater treatment systems.

3.1 Groundwater Extraction/Re-injection Network

Once a work plan or design was prepared and approved for drilling the required wells and the design package for the required piping, pumping, instrumentation, and other appurtenances was prepared and approved. The typical construction sequence was as follows:

- Subsurface sediment samples are collected at the selected location using a Rotosonic drilling rig. Sediment samples are collected from the depth interval being targeted for the well screen, and sieved in order to design the most optimal well screen.
- Well screens are designed and screens are procured
- Borings are drilled utilizing the cable tool drilling technique
- Screens and riser pipes are installed in the temporarily cased borehole
- As the temporary casing is withdrawn, the annular space is filled with the appropriate backfill
- Well is developed, usually through a process of surging and pumping until the sand content of the pumped water reaches and maintains acceptable levels
- Below grade piping to treatment and bypass is installed (each extraction well is equipped with a discharge header that allows extracted groundwater to be directed to treatment or directly to the Great Miami River; depending on the uranium concentration. A typical diagram of an extraction well is identified in Figure 3-1.)
- Above ground housing and hardware are installed
- Construction acceptance testing and system operability testing are performed.
- Module is turned over to operations group
- Readiness activities are completed including: operator training, procedure development/modification and maintenance/spare parts procurement
- Operation of well(s) begin
- Start-up monitoring takes place, (e.g. pumped groundwater concentrations, water levels)

The locations of the extraction and re-injection wells installed to complete the groundwater remedy are included as Figure 3-2. The chronology of placing into operation the various groundwater restoration modules is provided in Table 4-1.

As groundwater remediation has progressed, some wells have become unneeded and made inactive. Some have been replaced by newer wells. Table 3-1 provides a listing of all wells installed, the date of initial operation, and their respective operational status.

Table 3-1 - Well Field Operating Status

Module	Operations Identification	SED Identification	Date of Initial Operation	Current Status	Notes
South Plume	RW-1	3924	08/27/93	Active	
South Plume	RW-2	3925	08/27/93	Active	
South Plume	RW-3	3926	08/27/93	Active	
South Plume	RW-4	3927	08/27/93	Active	
South Plume	RW-5	3928	08/27/93	Inactive	Turned off September 1994, not needed
South Plume	RW-6	32308	08/09/98	Active	
South Plume	RW-7	32309	08/09/98	Active	
SouthField	EW-13	31565	07/13/98	Inactive	Turned off May 2001
SouthField	EW-14	31564	07/13/98	Inactive	Turned off December 2001
SouthField	EW-15	31566	07/13/98	Inactive	Turned off August 1998, replaced by EW-15A
SouthField	EW-15a	33262	07/26/03	Active	
SouthField	EW-16	31563	07/13/98	Inactive	Turned off December 2002, converted to IW16
SouthField	EW-17	31567	07/13/98	Inactive	Turned off September 2005
SouthField	EW-17A	33326	09/13/06	Active	
SouthField	EW-18	31550	07/13/98	Active	
SouthField	EW-19	31560	07/13/98	Active	
SouthField	EW-20	31561	07/13/98	Active	
SouthField	EW-21	31562	07/13/98	Inactive	Turned off March 2003, replaced by EW-21A
SouthField	EW-21A	33298	07/29/03	Active	
SouthField	EW-22	32276	07/13/98	Active	
SouthField	EW-23	32447	02/02/00	Active	
SouthField	EW-24	32446	02/02/00	Active	
SouthField	EW-25	33061	05/07/02	Active	
SouthField	EW-30	33264	07/25/03	Active	
SouthField	EW-31	33265	07/25/03	Active	
SouthField	EW-32	33266	07/25/03	Active	
Waste Storage Area	EW-26	32761	05/08/02	Active	
Waste Storage Area	EW-27	33062	05/08/02	Active	
Waste Storage Area	EW-28	33063	05/08/02	Inactive	Turned off July 2004; replaced by EW-28A
Waste Storage Area	EW-28A	33334	06/29/06	Active	
Waste Storage Area	EW-33A	33347	09/13/05	Active	
Re-Injection	IW-8	22107	09/02/98	Inactive	Turned off December 2001
Re-Injection	IW-8A	33253	11/07/02	Inactive	Turned off September 2004
Re-Injection	IW-9	22108	09/02/98	Inactive	Turned off March 2002
Re-Injection	IW-9A	33254	11/07/02	Inactive	Turned off September 2004
Re-Injection	IW-10	22109	09/02/98	Inactive	Turned off September 2004
Re-Injection	IW-10A	33255	5/22/03	Inactive	Turned off September 2004
Re-Injection	IW-11	22240	09/02/98	Inactive	Turned off September 2004
Re-Injection	IW-12	22111	09/02/98	Inactive	Turned off September 2004
Re-Injection	IW-16	31563	07/27/03	Inactive	Turned off September 2004
Re-Injection	IW-29	33263	07/27/03	Inactive	Turned off September 2004

Figure 3-1. Typical Extraction Well Construction

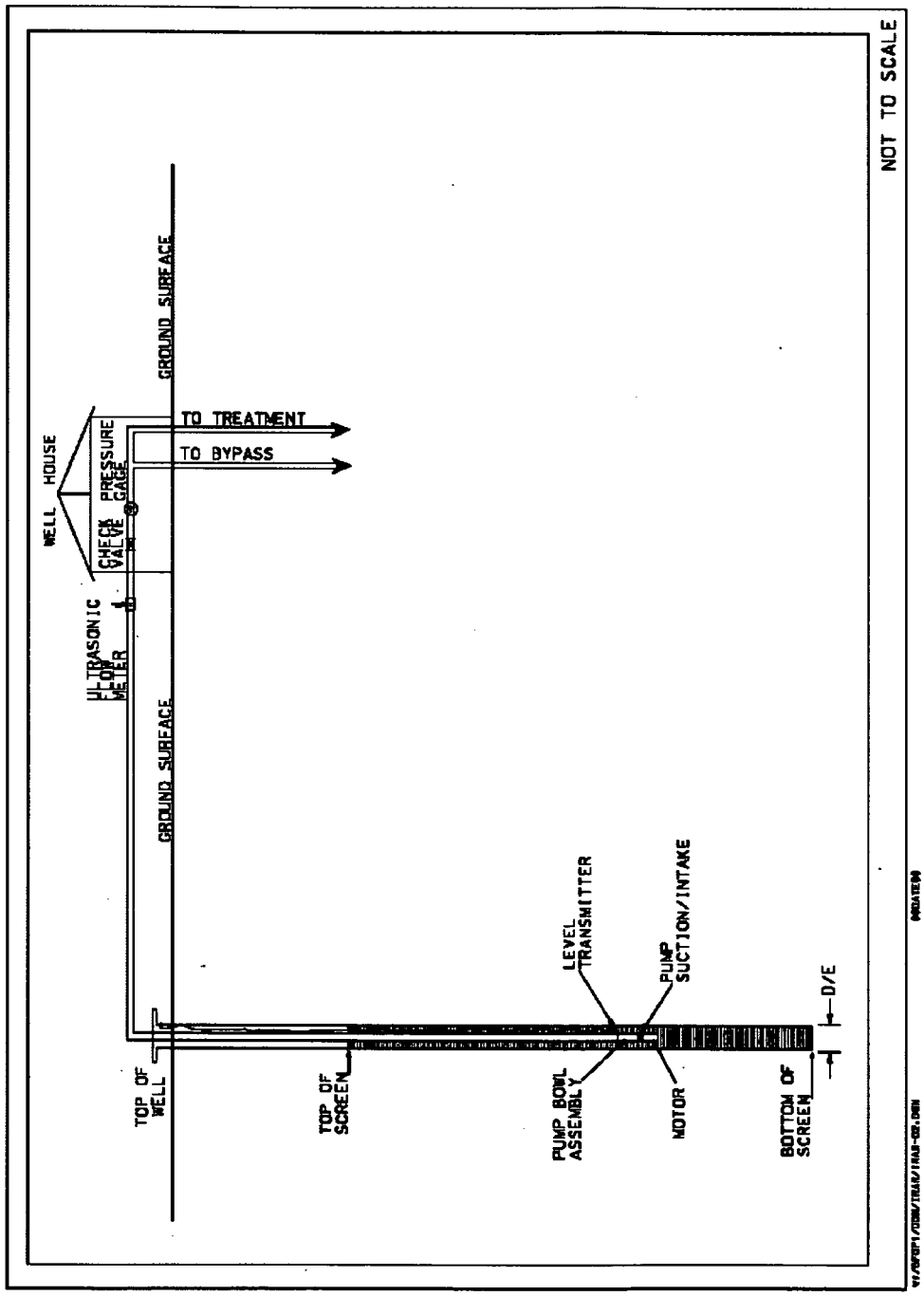
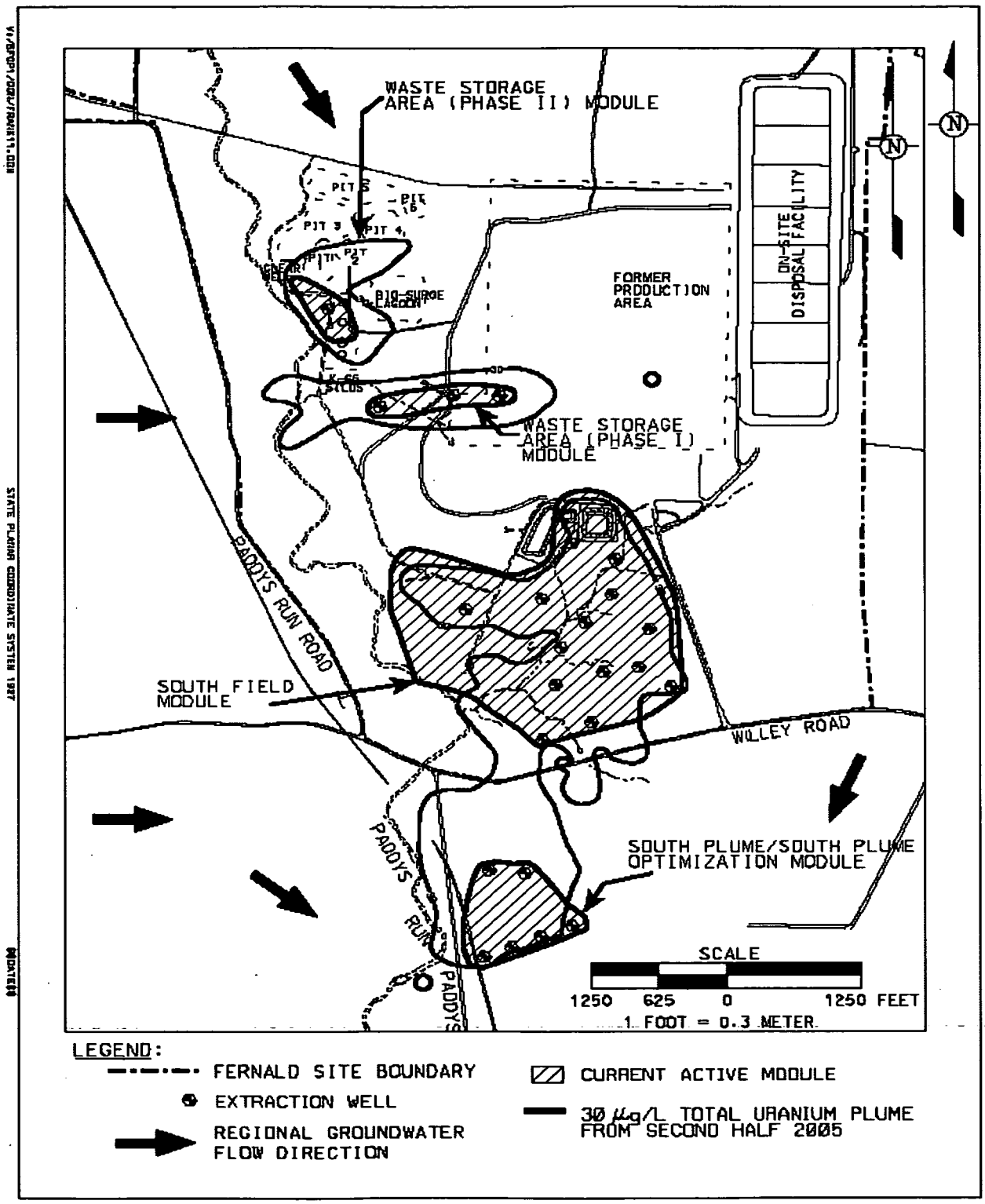


Figure 3-2. Extraction/Injection Well Locations



3.2 Treatment Systems

As indicated in Section 2 of this report, there were treatment systems and facilities in place before the signature of the Operable Unit 5 ROD and there were treatment systems and facilities brought on-line after ROD signature. Combined, all of these systems implemented the treatment portion of the Operable Unit 5 remedy. A brief chronology of when these facilities were brought on-line follows, including a brief description of the treatment operations comprising each facility.

Storm Water Retention Basin (SWRB): This basin was comprised of two chambers. The west chamber was constructed and brought on-line in 1986 and expanded in 1988 to include the east chamber. The SWRB allowed for flow equalization and settling of suspended solids. The combined retention capacity of the SWRB was approximately 10 million gallons. The basin consisted of a primary bottom bentonite liner and an upper flexible synthetic membrane liner and an under drain system beneath the synthetic liner used to monitor and collect leakage through the synthetic liner. Beginning in 1995, the SWRB served as the headworks facility for Phase I of the Advanced Wastewater Treatment Facility (AWWT). The discharge from the SWRB could be routed to AWWT Phases I, AWWT Phase II, IAWWT, or directly to the Fernald site outfall line to the Great Miami River. The west basin contained an engineered overflow that passed collected storm water exceeding the hydraulic capacity of the SWRB to Paddys Run via the Storm Sewer Outfall Ditch. The SWRB was removed from service in October 2005.

Biosurge Lagoon (BSL): This lagoon was originally installed in 1986 to provide containment, flow equalization, and settling for nitrate bearing process wastewater from the old General Sump facility and waste pit area storm water runoff requiring treatment through the old Biodenitrification Facility. Later, the BSL received OSDF leachate/storm water, and waste pit remediation wastewater/storm water. The BSL was located in the southeast section of the waste storage area and was an 8-million gallon, man-made lagoon comprised of two synthetic membrane liners and an under-drain collection system beneath each membrane liner. The BSL served as the head-works facility for Phase II of the AWWT Facility beginning in January 1995 and was removed from service in March 2005.

Interim Advanced Wastewater Treatment Systems (IAWWT): In 1992, two systems were originally placed into operation under CERCLA Removal Action No. 3. One IAWWT was located adjacent to the SWRB to remove uranium from storm water collected in the SWRB and a smaller IAWWT system located near the old Biodenitrification Facility to remove uranium from biodenitrification effluent (this smaller system was removed from service in June 1995). The IAWWT at the SWRB continued in service until July 2005 and was comprised of two trailer-mounted systems, each with a nominal throughput capacity of 150 gpm, implementing granular multimedia filtration and ion exchange technology. While the primary purpose of the IAWWT was to treat storm water from the SWRB, piping modifications were made in 1998 to allow the IAWWT to treat contaminated groundwater during periods of low storm water inventory in the SWRB.

South Plume Interim Treatment System (SPIT): In 1994 as a result of the Operable Unit 2 Dispute Resolution agreement, DOE committed to installing another interim groundwater treatment system resulting in the SPIT system. This system consisted of granular multimedia filtration for particulate removal and ion exchange for uranium removal. The treated groundwater from the SPIT system was discharged through the Fernald site outfall line to the Great Miami River. The SPIT system typically operated at 200 gpm providing an annual treatment capacity of up to approximately 105 million gallons. The SPIT system was removed from service in July 2005.

Advanced Wastewater Treatment Facility (AWWT): The original Advanced Wastewater Treatment facility was constructed in the existing Building 51 located in the southwest corner of the former production area. Construction of this facility began in March 1993 and was placed into operation in January 1995. The AWWT consisted of Phases I and II; Phase I dedicated to the treatment of contaminated storm water from the former production area (storm water collected in the SWRB) and Phase II dedicated to the treatment of remediation wastewater site-wide as well as wastewater and storm water runoff from the waste pit area (wastewater/storm water collected in the BSL).

The Phase I system consisted of the following unit processes:

- Flow equalization and pH adjustment with caustic (when required) in preparation for the downstream coagulation process
- Coagulation with alum and polymer, followed by clarification for reduction of suspended solids, uranium, and some unspecified assumed reduction in other radionuclides and heavy metals
- Filtration using multimedia filters (with backwash capability) to remove suspended solids from the clarifier overflow
- pH adjustment with sulfuric acid (as required)
- Two trains of three ion exchange resin vessels (each train) to remove uranium. The wastewater flows through two ion exchange resin vessels in lead/lag series with the third vessel in standby
- Final pH adjustment (as required) and filtration

The AWWT Phase II system consisted of the same unit operations as the Phase I system, except that carbon filtration was included in the Phase II system to provide treatment of VOCs that may have been present in the remediation wastewaters. Only one train of three ion exchange vessels is present in AWWT Phase II. Process flow diagrams for these facilities are included in Appendix B.

Piping modifications were made in 1999 to allow the treatment of groundwater through both phases of the AWWT during times when there were low inventories of water in the SWRB and BSL.

AWWT Phase I and II were removed from service in March 2005.

Advanced Wastewater Treatment Facility Expansion: As prescribed in the Operable Unit 5 ROD, the existing capacity of the AWWT facility was expanded to the maximum achievable within the confines of Building 51, to enhance the Fernald site's ability to treat groundwater. This expanded groundwater treatment capacity came online in April 1998. The unit operations of the AWWT expansion system included aeration, granular multimedia filtration, and ion exchange. The treated effluent from this facility served as the source of water for groundwater re-injection. The aeration step was included to help remove iron, thereby reducing biofouling of the ion exchange resin and re-injection well screens. A process flow diagram for the expansion facility is included in Appendix B. (Note: The expansion facility serves as the centerpiece for the CAWWT as explained below)

Slurry Dewatering Facility: This support facility was constructed and placed into operation in September 1998 to process (dewater) waste slurries and sludges from the AWWT facilities. The dewatering of miscellaneous site waste sludges (i.e., those from the SWRB, sewage treatment plant, etc.) and batch treatment of miscellaneous wastewaters (i.e., D&D wastewater, wastewater from waste management activities) were also conducted at this facility. The SDF has a design treatment capacity of approximately 30,000 gallons per day of slurry. The process consisted of slurry conditioning (pH adjustment, coagulation/flocculation, filter aid addition), thickening, and pressure filtration through an automated plant and frame filter press. The dewatered waste material was packaged

for disposal either in the OSDF or off-site disposal facilities as appropriate. A process flow diagram for this facility is included in Appendix B.

Converted Advanced Wastewater Treatment Facility (CAWWT): The AWWT Expansion system was "converted" to the long-term replacement facility for the AWWT facility. The CAWWT initially provided 1,200 gpm capacity for groundwater and 600 gpm of storm water/remediation wastewater capacity (including activated carbon treatment) to handle the last remaining storm water /remediation wastewater flows. The CAWWT will provide a dedicated long-term groundwater treatment capacity of up to 1800 gpm. (The CAWWT will continue to provide treatment of OSDF leachate until treatment is deemed no longer required in consultation with the regulatory agencies. Leachate flow is estimated to range from 1 – 5 gpm). The unit operations of the CAWWT system include granular multimedia filtration and ion exchange on all 3 trains. The CAWWT was placed into operation in March 2005. A process flow diagram for the CAWWT is included in Appendix B.

4.0 CHRONOLOGY OF EVENTS

The following table provides a summary of the key events for Operable Unit 5 Aquifer Restoration, and associated dates of those events.

Table 4-1 Summary of Events for Operable Unit 5 Remediation (Aquifer Restoration)

Event	Date
Operable Unit 5 Remedy Decision Related Documents	
Approval of Operable Unit 5 Record of Decision	January 1996
Fact Sheet for Changing the Groundwater Final Remediation Level for Fluoride and Lead FRL's	May 1997
Explanation of Significant Differences for Changing the Uranium Groundwater Final Remediation Level and Discharge Standard	November 2001
Remedial Design Fact Sheet for Operable Unit 5 Wastewater Treatment Updates (Converted Advanced Wastewater Treatment Facility)	July 2004
Fact Sheet Related to Minor Record of Decision Changes	Spring 2005
Operable Unit 5 Related Umbrella Documents	
Fernald Groundwater Certification Plan	April 2006
Operations and Maintenance Master Plan*	June 2006
Integrated Environmental Monitoring Plan*	June 2006
Operable Unit 5 Umbrella Remedial Design Documents	
Remedial Design Work Plan for Remedial Actions at Operable Unit 5	December 1995
Baseline Remedial Strategy Report	June 1997
Operable Unit 5 Remedial Action Documents	
Remedial Action Work Plan for Remedial Actions at Operable Unit 5	March 1997
Remedial Action Field Activities	
Interim Advanced Wastewater Treatment Facility Operational	June 1992
South Plume Module Operational	August 1993
South Plume Interim Treatment Facility Operational	March 1994
Advanced Wastewater Treatment Facility (Phase I and II) Operational	January 1995
South Field Extraction Module (Phase I) Operational	July 1998
South Plume Optimization Module Operational	August 1998
Advanced Wastewater Treatment Facility Expansion Facility Operational	April 1998
Groundwater Re-Injection Module Operational	September 1998
Waste Storage Area Phase I Module Operational	May 2002
South Field Extraction Module (Phase II) Operational	July 2003
Converted Advanced Wastewater Treatment Facility Operational	March 2005
Waste Storage Area Phase II Module Operational	October 2006
Storm Sewer Outfall Ditch Infiltration Operational	October 2006

*These documents are now attachments to the Legacy Management and Institutional Controls Plan discussed in Section 6

Based on groundwater modeling projections presented in the Waste Storage Area Phase II Design Report [DOE 2005c] using uranium concentration data measured at the various extraction wells, the groundwater remedy will be complete in 2023. Treatment operations are anticipated to no longer be required in 2011 to achieve the Operable Unit 5 performance based discharge standards to the Great Miami River for uranium mass loading and

uranium concentration (subject to EPA concurrence). D&D of treatment infrastructure would be complete in 2013. Groundwater pumping is projected to continue until 2023 at which time groundwater pumping would cease, the aquifer would be allowed to reach steady-state under no pumping conditions, and attainment monitoring of the Great Miami Aquifer relative to Operable Unit 5 FRLs would commence.

The strategy to demonstrate the process for achieving and verifying completion of the aquifer remedy has been established in the Fernald Groundwater Certification Plan [DOE 2006a]. This plan outlines the stages that each separate restoration module will undergo to first demonstrate the module has attained established groundwater FRLs leading to ultimately demonstrating that all affected portions of the Great Miami Aquifer are fully restored to SDWA drinking water standards. This plan predicts that the Great Miami Aquifer could be certified clean in 2026. The six distinct stages of the certification process are:

- Stage I – Pump and Treat Operations. This stage will continue until FRL constituent concentrations are achieved. Treatment operations will continue, as necessary, to ensure compliance with the NPDES discharge limits and Operable Unit 5 ROD uranium discharge limits. (When discharge limits can be achieved without treatment, a request will be made to the regulatory agencies to shut down and decommission the treatment facility.)
- Stage II – Post Pump and Treat Operations/Hydraulic Equilibrium State. Stage II will begin after pumping operations within the module have ceased. The objective of Stage II is to document that the aquifer has adjusted to steady-state conditions
- Stage III – Certification/Attainment Monitoring. The purpose of this stage is to demonstrate that no groundwater FRLs are exceeded at any monitored location. Concentration data will be collected quarterly over a three-year period to make this demonstration.
- Stage IV – Declaration and Transition Monitoring. A certification report will be prepared for each restoration module to document that the module is certified clean and re-contamination from any potential up-gradient contamination is not occurring.
- Stage V – Demobilization. During demobilization the removal of the infrastructure, as appropriate, will occur and extraction wells and monitoring wells plugged and abandoned. Soil certification including any necessary soils excavations will be conducted as infrastructure is removed.
- Stage VI – Long-Term Monitoring. Long-term monitoring will be conducted to document that any residual contamination in the vadose zone does not cause groundwater FRL exceedances.

5.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

The design, construction, operation, maintenance, and remedy performance evaluation and reporting have all been conducted in accordance with regimented and documented programs. These programs provide assurance that the overall objectives of the remedy relative to treatment and discharge standards are being met and demonstrated progress towards full restoration of the Great Miami Aquifer is experienced.

5.1 Overall Performance of the Technology Implemented in the Groundwater Remedy

The remedy being implemented is a pump and treat remedy whereby contaminated groundwater is extracted from the Great Miami Aquifer and treated and/or discharged to the Great Miami River. When the remedy is complete, the aquifer will meet Operable Unit 5 FRLs for uranium (the primary FCP contaminant) and other non-uranium constituents. (The FRLs are defined in Section 9.0 of the Operable Unit 5 ROD)

In assessing the performance of the remedy to date there are three fundamental issues to address. First, is the contaminated portion of the aquifer within the hydraulic capture zone, generated by the pumping of the extraction wells, such that further migration of the contamination does not occur? Second, once the hydraulic capture zone around the contamination is established and controlled, are the areas of groundwater contamination within this boundary showing progress towards ultimately meeting established Final Remediation levels? And third, are the treatment discharge standards being met?

In terms of overall performance, the pump and treat technology has been effective in addressing each of these issues. The installation of the South Plume Extraction Module in 1993 has successfully stopped further southern migration of the uranium plume. Figure 5-1 depicts capture of the uranium plume based on water level measurements made in the fourth quarter of 2005. (Quarterly water level measurements and maps are prepared to verify plume capture.)

Uranium concentrations within the footprint of the plume targeted for remediation are showing progress towards ultimately meeting established FRLs. Two plume maps are provided to illustrate that plume concentrations are decreasing as a result of remediation. Figure 5-2 is the 20 μg/L uranium plume map for the fourth quarter of 1997; originally published in the 1997 Integrated Site Environmental Report [DOE 1998b]. Figure 5-3 is the 30 μg/L uranium plume map for the second half of 2005; originally published in the 2005 Site Environmental Report [DOE 2004c]. This reduction is evident in the off-property South Plume area that went from being mostly over 100 μg/L to being mostly below 100 μg/L between 1997 and 2005. Table 5-1 lists the uranium concentration measured at select wells within the plume being targeted for remediation from 1997 and 2005. The average of the concentrations for 1997 was 93.1 μg/L, the average for 2005 was 56.9 μg/L a reduction of approximately 39%.

Comparing the area being targeted for clean up on each plume map is not straightforward. The reduction in area resulting from changing the uranium FRL from 20 μg/L to 30 μg/L has been offset by additional area being added to the target plume through characterization work performed to support design of the Waste Storage Area Phase-1 Remediation System and the South Field Phase II Remediation System [DOE 2002]. This is evident by comparing the plume in the Waste Storage Area between 1997 and 2005, as well as the plume on the leading edge of the South Field Plume between 1997 and 2005.

The FCP is ahead of schedule relative to the volumes of groundwater extracted and the mass of uranium extracted compared to those projections in the Baseline Remedial Strategy Report. However, there is apparently more uranium mass in the aquifer compared to that modeled in the Baseline Remedial Strategy Report and the actual

uranium concentrations within the aquifer remain higher than that predicted. Further assessment of this performance is provided in Appendix A.2.

The performance of the several treatment systems measured against the overriding goal of meeting Operable Unit 5 ROD discharge standards relative to uranium as well as NPDES effluent limits has been satisfactory. The uranium mass loading limit of 600 pounds per year (lbs/yr) has been met every year since the requirement became effective in January 1998 (Figure 5-4). As depicted on Figure 5-5, the monthly average concentration has been met every month since January 1998 with the exception of four months. The compliance rate with the limits in the NPDES Permit is in excess of 99-percent.

5.2 Quality Assurance and Quality Control

The groundwater restoration modules and all treatment systems were designed, constructed, inspected, tested, operated, and controlled under Fluor Fernald's *Quality Assurance Program Requirements Manual, RM-0012*. The standards for quality reflected in RM-0012 were derived from Department of Energy Regulations at 10 CFR Part 830 Subpart A, *Quality Assurance Requirements*. Fluor Fernald's Quality Assurance Program also incorporates appropriate requirements from Department of Energy's *Quality Assurance Management System Guide for use with 10CFR 830.120 (G 414.1-2)*. This program specified standards by which systems were designed, procured, installed, tested and operated.

Environmental data used to support the design and operation of the groundwater remedy were collected in accordance with The Site-wide CERCLA Quality Assurance Project Plan (SCQ) [DOE 2003]. The SCQ was developed for FCP environmental sampling and analysis with a twofold purpose: (1) establish minimum standards of performance for operational and analytical activities, and (2) ensure that parties covered by the plan follow those standards. The SCQ integrates CERCLA requirements into applicable sampling activities at the FCP.

Operation of the remedy has been implemented through staffing the facilities with trained operators and supervisors who are guided by standard operating procedures for operation of equipment and systems. Equipment and systems are maintained through a regimented preventative maintenance system. All operational and maintenance activities are implemented through formal Conduct of Operations protocols per Fluor Fernald's *Conduct of Operations Program Requirements Manual, RM-0029* derived from Department of Energy Order 5480.19.

5.3 Assessment of Performance Data Quality

The Integrated Environmental Monitoring Plan (IEMP), Attachment D in the Legacy Management and Institutional Controls Plan (discussed in Section 6.0), establishes an FCP-wide environmental monitoring program that is aligned with the broad range of remediation activities being implemented. This plan specifies media-specific monitoring programs through a systematic evaluation of technical considerations, pertinent regulatory drivers and stakeholder concerns. The IEMP contains a reporting mechanism whereby all media-specific data are reported annually via the Site Environmental Reports. Section three of the Site Environmental Reports summarizes groundwater data while Section four summarizes surface water and treatment related data. Environmental data are housed in an environmental database and made available to regulatory agencies through a password protected intranet site.

The IEMP includes for each medium specific sampling program the sampling procedures to be followed, the required analytical methods, preservation techniques, sampling containers, and quality assurance/quality control requirements.

The IEMP specifies appropriate laboratory and field data documentation and required validation to ensure all analytical data generated meet the required data quality objectives derived based on the ultimate end-use of the data. These programs provide assurances that reported data are useful in tracking the progress of the groundwater restoration remedy, treatment system performance, and compliance with applicable regulations and commitments.

Table 5-1 - Uranium Concentration of Select Wells

Monitoring Well	Concentration (µg/L) 4th-qtr. 1997	Concentration (µg/L) Second-half 2005	Groundwater Module	Notes
2648	48.4	41.6	Waste Storage Area	
2821	27.0	14.2	Waste Storage Area	
2008	21.0	20.2	Waste Storage Area	
2009	25.1	12.9	Waste Storage Area	
2386	31.2	17.3	South Field	
2385	87.0	272.0	South Field	
2046	254.9	61.8	South Field	
21033	28.1	13.9	South Field	
2045	290.0	96.6	South Field	
2049	99.1	59.2	South Field	
3390	107.5	39.5	South Field	2390 used in 2005
2387	161.8	108.0	South Field	
2398	22.0	3.1	South Field	
2166	61.0	50.1	South Field	
3069	224.6	87.0	South Field	
2106	42.9	7.4	South Field	
2550	65.0	49.1	South Plume	
2095	127.0	76.2	South Plume	
2060	51.0	87.3	South Plume	
2125	88.0	21.0	South Plume	3125 used in 2005
Average	**93.1**	**56.9**		

Figure 5-1 – Uranium Plume Capture (October 2005)

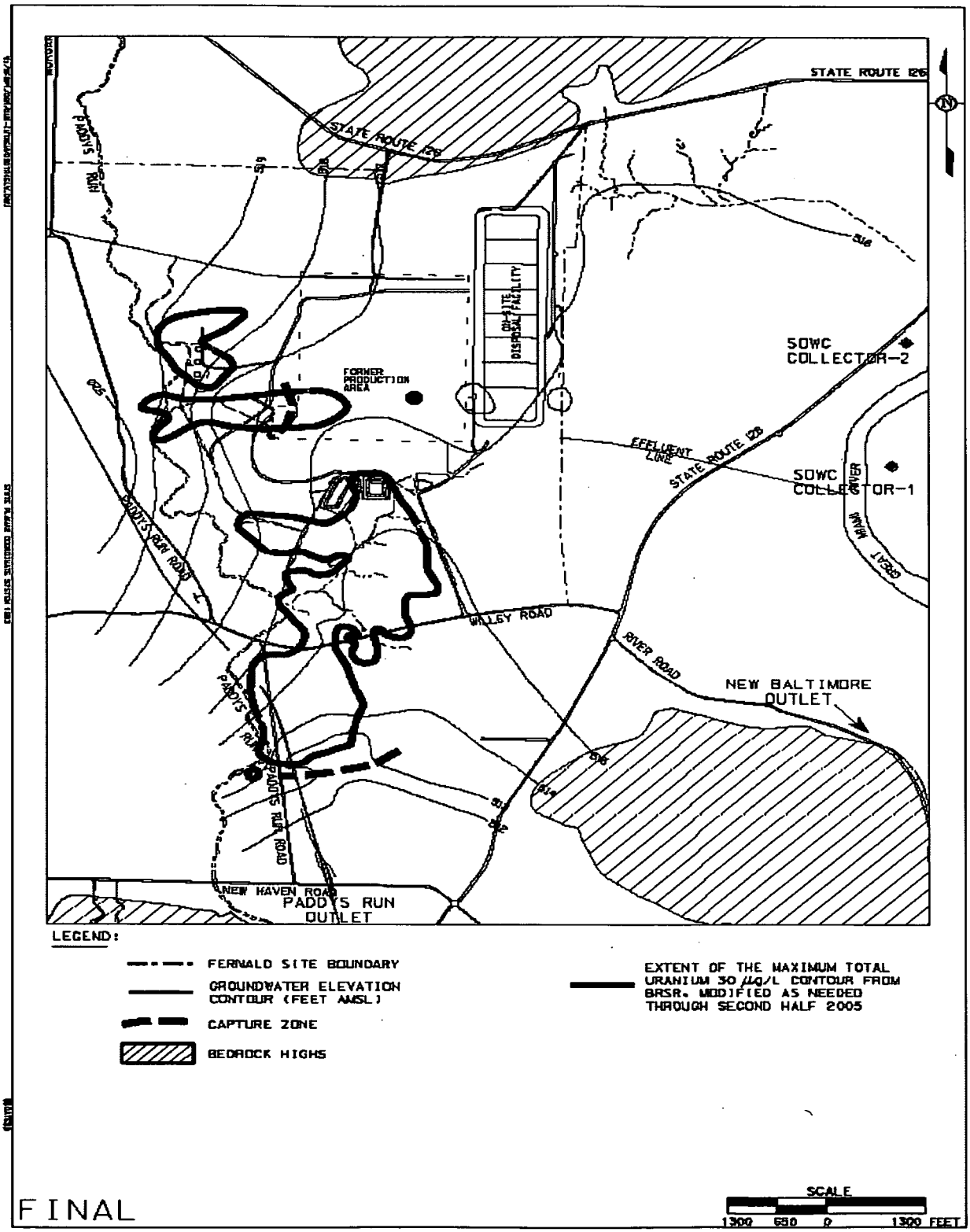


Figure 5-2 – Maximum Total Uranium Plume - December 1997

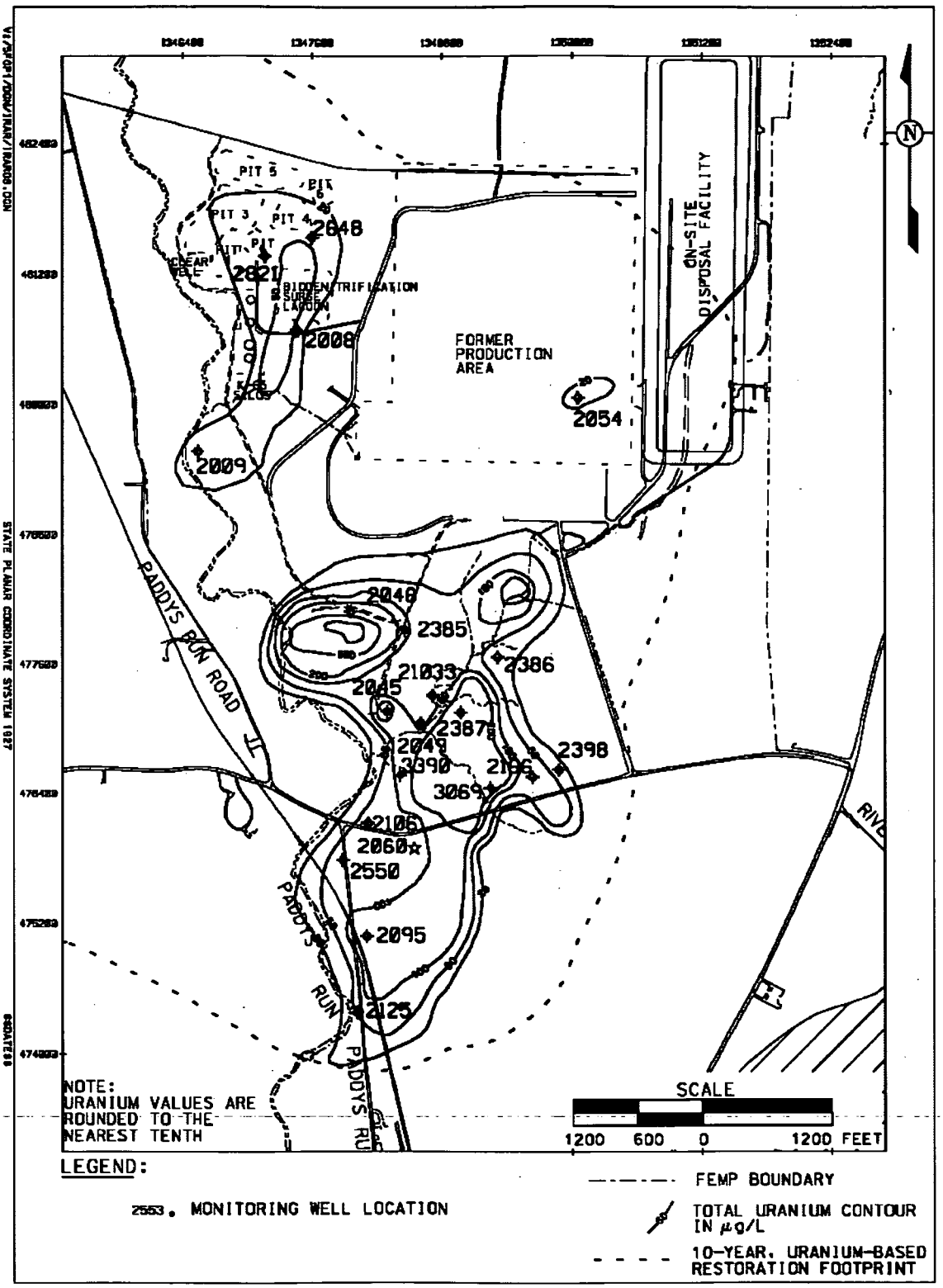


Figure 5-3 - Maximum Total Uranium Plume (Through Second Half of 2005)

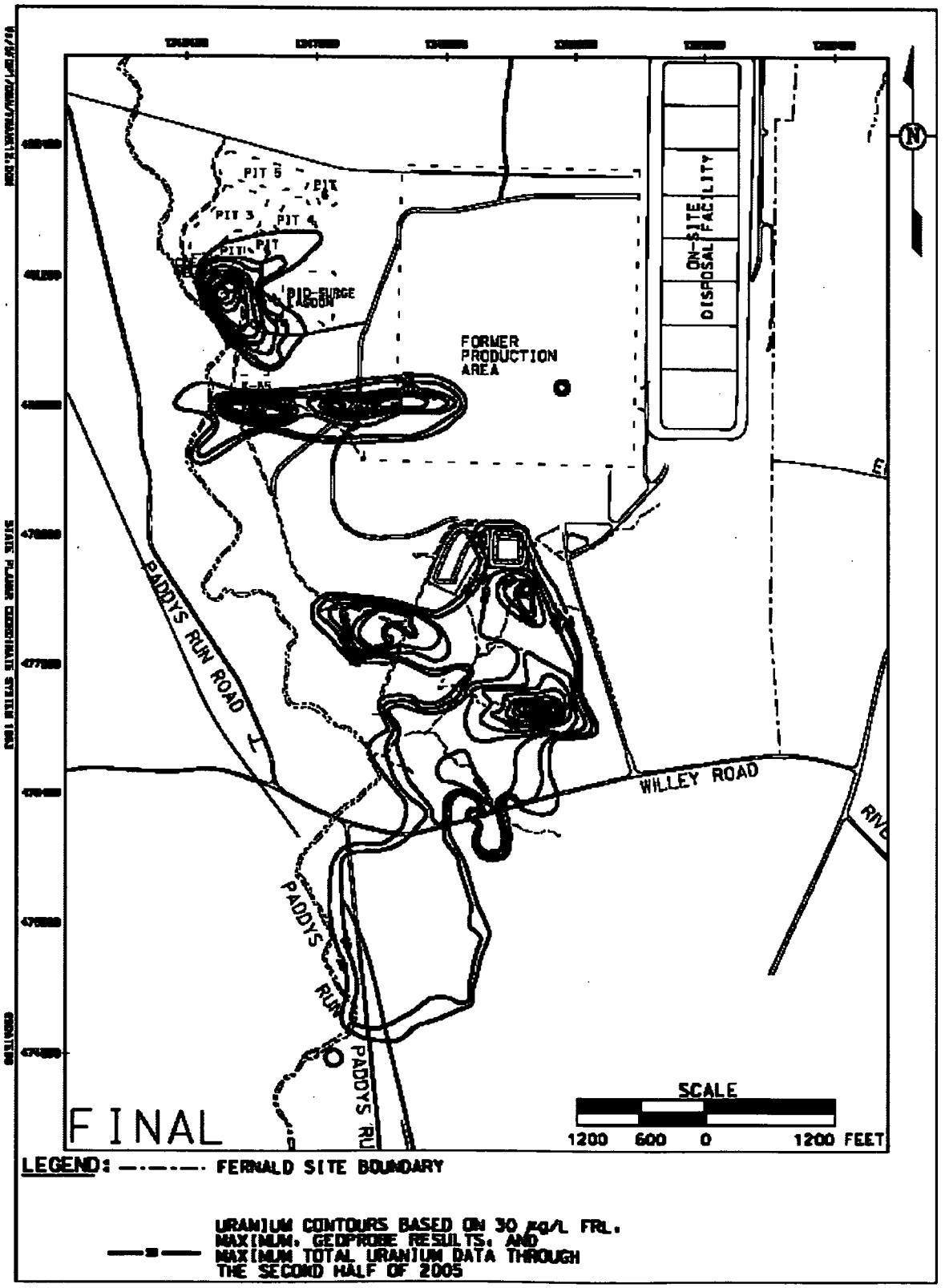


Figure 5-4 Monthly Average Uranium Concentrations (January 1998 – September 2006)

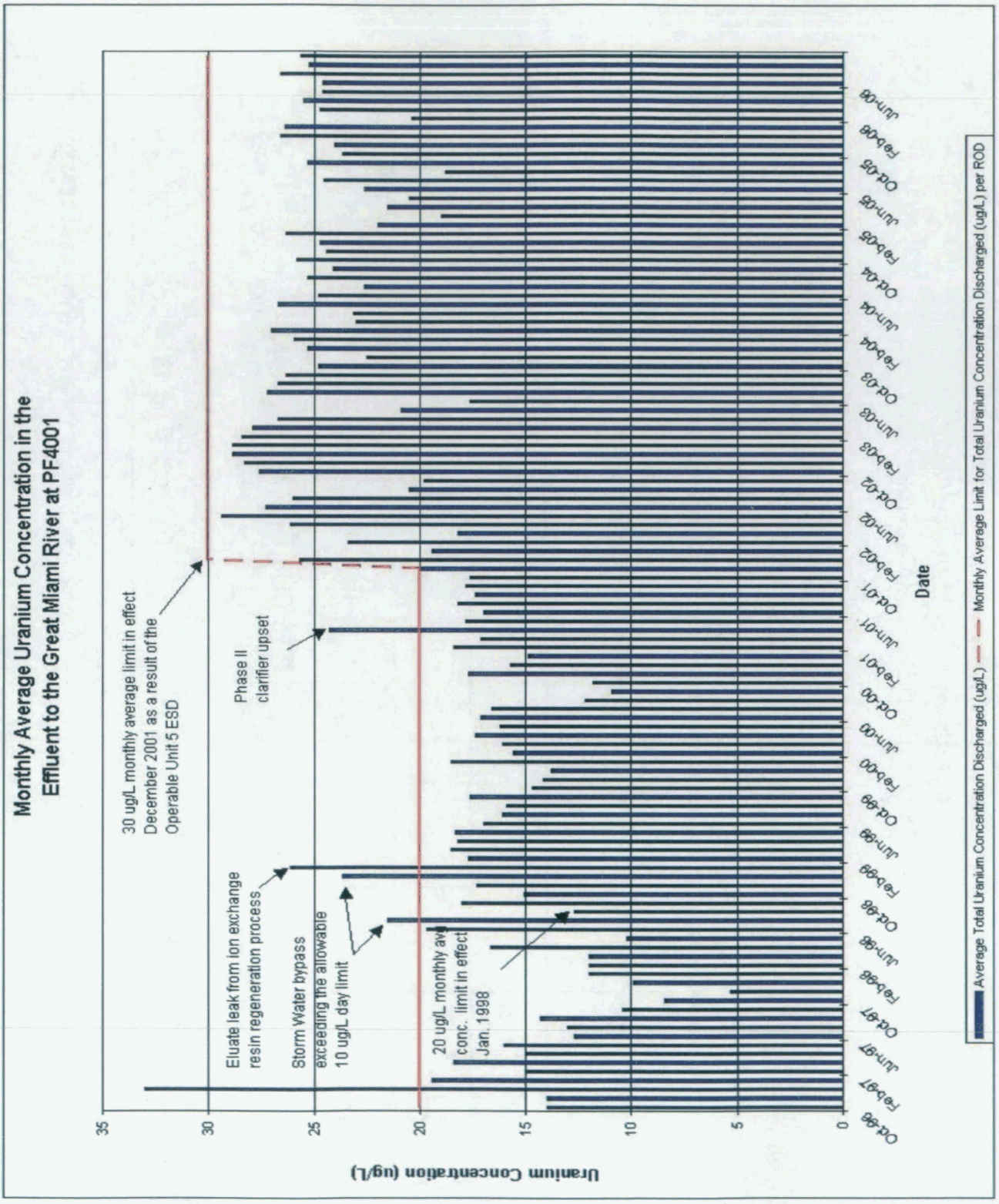
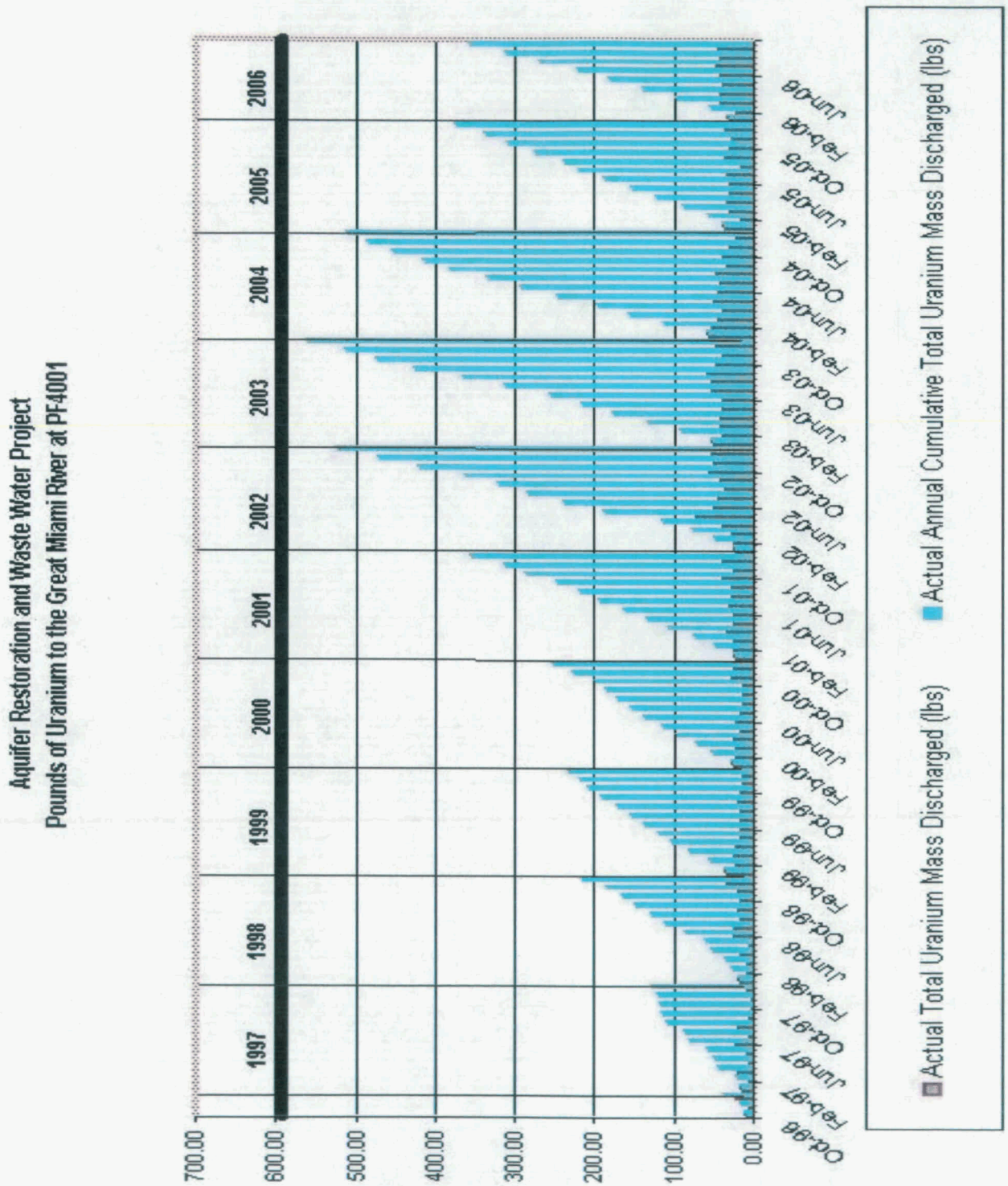


Figure 5-5 Annual Uranium Mass Discharge (1996 – 2006)



6.0 FINAL INSPECTIONS AND CERTIFICATIONS

All treatment plant and well field installations undergo a formal acceptance process by which physical construction activities are confirmed to be completed through Construction Acceptance Testing and Integrated System Operability Testing. Operations accepts these installations through a formal start-up evaluation, the DOE required Standard Start-up Review or Management Assessment, by which staffing, training, procedures, provisions for preventative maintenance activities, spare-parts, etc are evaluated and determined satisfactory by Fluor Fernald Senior and Project Management and concurrence received by the Department of Energy. The CAWWT, and all groundwater restoration modules, were subject to these acceptance and turnover requirements and have successfully been placed into operation. The internal procedures under which these systems were tested, accepted, and placed into operation include Fluor Fernald's *Engineering Design requirements Manual, RM-0061*, *Startup/Turnover and Systems Operability Testing Procedure, ED-12-6003*, *Administration and Conduct of Readiness Assessments and Operation Readiness Review Activities, QA-0020*, and *Management Assessment MS-1021*.

DOE affirms that the GW remedy is operational and functional. All extraction systems are operational and the aquifer is responding in a manner consistent with predicted performance. Operable Unit 5 discharge limits for uranium levels to the GMR are being met and NPDES limits are being met.

Institutional controls are defined in the Comprehensive Legacy Management and Institutional Controls Plan (LMICP) [DOE 2006b] and will be enforced by EPA and Ohio EPA. With the remedy operational and institutional controls in place, the groundwater remedy will continue to be protective of human health and the environment.

7.0 OPERATION AND MAINTENANCE ACTIVITIES

The overall coordination of the extraction, collection, conveyance, treatment and discharge of all groundwater, storm water, remediation wastewater and sanitary wastewater has been described in the Operations and Maintenance Master Plan (O&MMP). The O&MMP, a formal design deliverable identified as Task 2 in the Operable Unit 5 Remedial Design Work Plan, was first issued in November 1997; revised and re-issued in December 1999. The most current version of the O&MMP is the June 2006 version contained as Attachment A to the June 2006 LMICP. The O&MMP has served, and will continue to serve, as the comprehensive statement of management policy to ensure that planned modes of operation and maintenance are consistent with regulatory requirements and satisfy the FCP's performance commitments for groundwater restoration and wastewater treatment.

The contents of the O&MMP Plan are as follows:

Section 1.0 The Introduction presents an overview of the plan, its objectives, and its relationship to other documents, and its organization.

Section 2.0 Summary of regulatory drivers and commitments

Section 3.0 A Description of all major groundwater restoration and treatment components including major collection, conveyance, and treatment components comprising the Fernald site's system for managing the major wastewater streams

Section 4.0 Projected flows, including estimates of flow generation rates and durations for each of the major wastewater streams.

Section 5.0 The Operations Plan establishes the operations philosophy, treatment priorities and hierarchy, treatment operational decisions, well field operational objectives and decisions, maintenance priorities, controlling documentation, management and flow of operations information to successfully operate the groundwater and wastewater systems to achieve regulatory requirements and commitments.

Section 6.0 Operations and Maintenance Methods: addresses the general methods, guidelines, and practices used in managing equipment operation and maintenance; describes the key parameters used to monitor the performance of the groundwater and wastewater facilities, and describes the principal features and maintenance needs for the overall operation.

Section 7.0 Organizational roles, responsibilities, and communications.

Appendix A Standard Operating Procedures

Appendix B Groundwater Restoration Well Performance Monitoring and Maintenance Plan

Control of all treatment systems and well field operations will be through a centralized Programmable Logic Controller (PLC) based control system located in the main control room of the CAWWT. Operators will be able to establish pumping set points, valve alignments, and response to alarms, etc. from this PLC. The control room will be staffed 24 hours/day 365 days per year.

As of this writing, all treatment systems and extraction modules are installed and operational. Specific operation and maintenance activities will be focused on preventative maintenance to ensure treatment systems and groundwater extraction remains at an acceptable on-line efficiency. Much of the routine preventative maintenance and repair in the treatment systems can be accomplished without a unit shut down because of the installed spare equipment and bypass piping and valving. There may be from time to time maintenance activities that will result in treatment system outages. The Operable Unit 5 ROD provides for relief from the uranium concentration discharge limit during periods of scheduled maintenance. Advance EPA approval will be obtained whenever possible for these types of maintenance activities.

As identified above, the OMMP contains an appendix dedicated to the routine maintenance of the extraction well network and system performance monitoring to identify when more extensive maintenance activities are required.

Security of the groundwater related infrastructure is identified in the LMICP. In general, security will be implemented through the installation of fencing around treatment systems and well houses located near Willey Road, provision for appropriate postings warning against unauthorized entry and periodic inspections of the FCP site as a whole and groundwater infrastructure locations.

In addition to these general security measures, other Institutional Controls will include maintaining the FCP property under federal ownership or control through deed restrictions, continuing the environmental monitoring program to assess the short-term and long-term effectiveness of the groundwater remedy and compliance with NPDES and Operable Unit 5 discharge limits, and the continued provision of the public water supply until the affected portions of the aquifer have attained final remediation levels. These measures will ensure the continued protection of human health and the environment.

8.0 SUMMARY OF PROJECT COSTS

The selected remedy in the Operable Unit 5 ROD for the aquifer restoration subproject was alternative 3A Case 7 from the June 1995 Feasibility Study. A summary of the estimated costs for the selected remedy at the time of its selection was provided in the ROD, with the details and backup provided in the Operable Unit 5 Feasibility Study Report.

This section of the aquifer restoration closeout report compares the original estimated costs as contained in the ROD with the actual costs experienced on the project. Consistent with EPA's closeout guidance, an explanation is to be provided when the actual costs fall outside the range of –30 to +50 percent of the estimate. Appendix A provides the supporting information and tabular summaries supporting the descriptions and findings presented below.

Readers should note that for all of the cost evaluations presented in the FCP's individual operable unit closeout reports (including this Operable Unit 5 interim closeout report), the evaluations focus on those direct and indirect remedial costs specifically associated with the individual remedies conducted for the operable unit of interest. The cost evaluations do not include FCP administrative or overhead costs for managing the site as a whole, such as for oversight, site administration and management, communications and reporting, site-wide utilities, office space, and other such landlord costs. The comparisons are therefore aimed at the specific direct and indirect costs (such as engineering) required to complete the individual remedies required by the FCP's CERCLA process across the five operable units. In this way, users of this report will be able to more readily compare costs from other sites within the Superfund program for like remedies with those experienced at Fernald. This also permits the cost comparisons presented in the closeout reports to remain consistent with how the ROD cost estimates were originally developed back in the 1990s, when the cleanup remedies for Fernald were first envisioned.

8.1 Summary and Analysis of the Original Operable Unit 5 ROD Costs

The original ROD cost estimate for the selected remedy is presented in Table 9-2 on page 9-21 of the December 1995 Operable Unit 5 ROD. The estimated costs presented in the ROD encompass cleanup costs for all of the environmental media (soil, sediment, groundwater and surface water) comprising Operable Unit 5 and were summarized in the ROD for the entire remedy as follows:

Construction costs (constant 1995 dollars)	$430 million
Operation and maintenance costs (constant 1995 dollars)	$340 million
Post remediation costs (constant 1995 dollars)	$70 million
Total cost (constant 1995 dollars)	$840 million
Present worth cost	$580 million
Total cost with escalation (27 year remedy)	$2.11 billion

The ROD went on to explain that "the total cost of the remedy ($840 million) represents the total amount, in constant 1995 dollars necessary to implement the selected remedy assuming no inflation occurs over the life of the remedy. The present-worth cost ($580 million) represents the total estimated present worth cost of the remedy assuming a discount rate of 2.8 percent. The present worth cost represents the sum of money which must be placed in an interest bearing account (e.g., a bank) at the onset of remedial activities at a net interest rate to progressively pay for the entire scope and duration of remedial actions. The total cost with escalation

($2.11 billion) represents the total estimated cost of remedial actions assuming the funding is provided on an annualized basis and an annual escalation rate of 3.7 percent prevails throughout the duration of the remedy." Note that the escalation rate is a factor applied in the analysis to examine the effects of inflation and the decline in the dollar's purchasing power with the passage of time (in this case over a period of 27 years, as considered in the feasibility study for remedial decision making) for engineering projects with long durations.

As background in the use of the various estimates for cost evaluation, readers should understand that the "present worth" cost estimate provided in the ROD is typically used to support initial remedy decision making – its use is for relative cost ranking purposes, and serves as the government's preferred means to evaluate remedial alternatives with differing durations or completion timeframes to then identify and select a preferred alternative from a common starting point. Present-worth cost evaluation techniques for remedy selection are required under CERCLA guidance to compare remedial alternatives, and are used during the feasibility study to help identify and evaluate the preferred alternative for inclusion in the ROD (this is how the preferred remedy was evaluated for Operable Unit 5 at the time of the ROD). The present-worth technique does not actually represent how money will likely be allocated to pay for the remedy over its duration (such as year-by-year annualized funding appropriations, which do not have the ability to draw the sizeable cumulative interest accumulations like the initial up-front total project sum assumed in the present-worth calculation). Rather, the primary purpose of the present-worth calculation is to facilitate fair relative comparisons of feasible alternatives from a "common point in time" approach to identify the least cost alternative prior to implementation of the project.

The post-cleanup comparative evaluation of original ROD cost estimates with actual costs experienced during implementation of a remedy represents a different cost analysis problem not represented by the present-worth technique. In this situation, the present-worth cost estimate must be replaced by the constant dollar estimate for a given base year (in this case, 1995 as the base year, since this was the year the estimate was prepared), which is then adjusted to accommodate the impacts of inflation and the decline in the purchasing power of the dollar during the actual period of performance. This inflation adjustment is important particularly for multi-year projects of long duration, and also those projects that may have been delayed considerably from their original concept date due to funding/approval constraints. The post-cleanup evaluation therefore requires an adjustment of base year dollars to future dollars – representing the actual timeframe of project performance – that have the same purchasing power as the original base year dollars. This approach therefore recognizes the selected multi-year remedy will be implemented on an annualized funding basis and, since the actual period of performance becomes a known entity at the completion of the remedy, the base year dollars can be scaled upward to ensure they maintain "constant dollar" purchasing power. This adjustment is made using actual escalation factors available as part of the Consumer Price Index to match the actual years the work was performed -- and thereby accounting for the actual effects of inflation using backward-looking government specified escalation factors for each year of passage from the base year. Such adjustments then bring the estimates from the ROD into a form that can be directly compared to the actual dollars expended over the life of the remedy.

8.2 Adjustments to Permit Fair Comparison of ROD Costs with Actual Costs for Aquifer Restoration

Based on the above discussion, the total cost estimate of $840 million in 1995 dollars summarized in the ROD serves as the starting point for the comparison with actual costs experienced during implementation of the remedy. Recognizing that the Operable Unit 5 soil and sediment and OSDF portions of the remedy began in 1995 (at ROD signature) and were completed in 2006 (with aquifer restoration ongoing), an effort was conducted to divide the Operable Unit 5 ROD cost estimate into its three component parts (Soil/Sediment Remediation,

OSDF Disposal and Closure, and Aquifer Restoration) using backup cost information from the feasibility study; these three component parts were then adjusted to bring the 1995 constant dollar estimates into current dollars, covering the actual 11 years of remedy implementation duration between 1995 and 2006. The results are summarized in the table below.

Table 8-1 – Operable Unit 5 ROD Cost Estimate

Remedy Component	1995 Constant Dollar Estimate	Escalated Estimate (1995 to 2006 actual period of performance)
Soil and Sediment Remediation/Site Restoration	$230 million (from FS)	**$268 million**
OSDF (disposal of Operable Unit 5 materials and closure of facility)	$310 million (from FS)	**$365 million**
Aquifer Restoration and Monitoring	$300 million (from FS)	NA. The performance period extends beyond 2006 since this is an ongoing portion of remedy through 2026 (based on computer modeling)
Operable Unit 5 Totals	$840 million (from FS and summarized in ROD)	NA. The performance period extends beyond 2006 since this is an ongoing portion of remedy through 2026 (based on computer modeling)

The two values shown in bold in the third column ($268 million for soils/sediment and $365 million for the OSDF) represent the time- and inflation-adjusted starting points for comparison to actual costs experienced for these two Operable Unit 5 components. They will each be compared, evaluated, and reported in the respective stand-alone sections (e.g., this report for the OSDF, and the stand-alone soils/sediment section which is Section 2) of this Interim Operable Unit 5 Remedial Action Report.

The scope of the work including engineering and construction is $204,507,000 for groundwater and wastewater treatment and $23,951,500 for Great Miami Aquifer extraction. The Environmental Monitoring program (including Operable Unit 5 soils, OSDF, and aquifer) is $72,000,000. The ROD total estimated cost is $300,458,500 in 1995 dollars. The escalated cost of the Operable Unit 5 Aquifer and Environmental Monitoring scope of work is $501,218,000 for construction direct and indirect cost, engineering through 2026.

Site closure was achieved in October 2006. However, the aquifer restoration project will continue to operate after site closure until the intended groundwater FRLs are achieved (currently estimated to be 2026). The treatment portion of the project is estimated to be complete in 2012. Groundwater extraction and direct discharge of the extracted groundwater to the Great Miami River will continue until 2026. The scope of the extraction work includes the well field operation/ maintenance, utilities, and project management related costs.

The environmental monitoring and remedy performance assessment scope of work consists of the management of a laboratory and the staff to execute testing and maintain records, sample collection and analysis, and data management, air monitoring & IEMP reporting, groundwater monitoring and reporting, OSDF leak detection monitoring and reporting and well maintenance.

To compare the actual costs and projected remaining costs of the groundwater remedy implemented with that estimated in the ROD, three distinct time periods must be evaluated. The first time period is the period through site closure where the actual costs of the groundwater remedy scope are known. The second and third time period relates to 1) the period between site closure and September 2012 when treatment operations are projected to end at which time 2) the remedy becomes a pump and discharge remedy until the GMA is certified clean in 2026.

Table 8-2 – Aquifer Restoration Actual and Current Projected Costs

Time Period	Costs
Actual Costs through September 2006	$218,639,102
Projected Costs through Treatment Operations (October 2006 through September 2012)	$70,877,492
Projected Costs through GMA Certification to Operable Unit 5 ROD FRLs (October 2012 through December 2026)	$250,601,309
Total	**$540,117,903**

The EPA guideline requirements specify if the actual cost is within –30% to +50% range of the ROD estimate, no further explanation of the cost is required. The forecasted cost difference is approximately 7.8% greater than the escalated ROD estimate of $501,218,000.

9.0 OBSERVATIONS AND LESSONS LEARNED

Lessons learned from Operable Unit 5 remedial activities:

Characterization

- Collecting continuous cores using a Rotosonic Drill Rig provided more consistent recovery of sediment from the unconsolidated Great Miami Aquifer than split spoon samplers.
- Direct-push sampling provided a more cost effective way to characterize the full vertical extent of the aquifer than installing monitoring wells.
- Direct-push sampling was less intrusive on private property than installing conventional monitoring wells.
- Use of continuous multi-tube (CMT) wells provide a cost effective way to provide permanent monitoring points at several depths at one location

Design and Installation of Extraction/Re-Injection Wells

- A system with operating wells that are individually piped to the water treatment facility provides more flexibility for making water treatment decisions than a system with wells that share a common pipe to the water treatment facility.
- The slot size for an extraction/re-injection well is best sized for the aquifer if it is based on sieve results.

Operation of Re-Injection Wells

- Water injected into the aquifer must have the same basic chemistry as the groundwater in the aquifer to avoid rapid plugging of the re-injection well screen.
- Routine treatments for biofouling of the well screen are required in order to maintain efficient re-injection operations.
- The onset of plugging in re-injection wells can be anticipated by tracking the rise in water level within the re-injection well operating at a constant re-injection rate.
- If water treatment is conducted for the sole purpose of supporting re-injection operations, the cost/benefit ratio is greatly increased and reduces the cost effectiveness of the technology.

Remediation Strategies

- Pump-and-treat remedies fail to address contamination that could be sorbed to sediments in the vadose zone.
- Target operational schedules are more useful when they consider downtime due to preventive and corrective maintenance.
- Pump and treat remedies can be enhanced through the use of re-injection.
- Use of scientific visualization tools for characterization data and modeling results can contribute significantly to understanding the site and communicating significant issues to stakeholders.
- The RI/FS groundwater model at Fernald, while appropriate for RI/FS planning, was too conservative for remedy performance prediction and tracking. The RI/FS groundwater model was ultra conservative to ensure remedy selection and design was robust enough to accomplish the remediation goals. However, the remedy performance groundwater model required less conservative modeling assumptions to successfully track and predict remedy performance.

Treatment

- The performance of the ion exchange vessels and resin is adversely affected by accumulating solids and inefficient flow distribution. To address these issues multi-media filters have been added ahead of the ion exchangers and internal devices specific to improve flow distribution
- There was an observed adverse impact from increasing nitrate, chloride and sulfate ions on ion exchange performance due to their respective competition with uranium for "sites" on the ion exchange resin. Source identification, isolation and/or blending of these sources were implemented to reduce their respective concentration to an acceptable level.
- Discharge standards established based on in-stream water quality rather than SDWA concentrations would have provided the dual benefit of being protective of human health and the environment while allowing the groundwater remedy to proceed much faster. (The surface water Final Remedial Action Level for uranium is 530 μg/L compared with the uranium discharge concentration limit of 30 μg/L based on the SDWA MCL). Groundwater extraction has been throttled to a great degree in order to maintain compliance with uranium discharge standards.

10.0 CONTACT INFORMATION

Remedial Action Contacts

U.S. Department of Energy Contact	Fluor Fernald Contact
Public Information Fernald Closure Project U.S. Department of Energy P.0. Box 538705 Cincinnati, OH 45253-8705 513-648-3153	Fernald Closure Project Fluor Fernald P.O. Box 538704 Cincinnati, OH 45253-8704 513-648-4898
U.S. Environmental Protection Agency Contact	**Ohio Environmental Protection Agency Contact**
Remedial Project Manager U.S. EPA SRF-6J 77 W. Jackson Blvd. Chicago, IL 60604-3590 312-886-0992	Fernald Project Manager Ohio Environmental Protection Agency 401 E. Fifth St. Dayton, OH 45402-2911 937-285-6357

A.1 Assessment of Cost Performance

As indicated in Section 8, the actual cost incurred to implement the aquifer restoration remedy from ROD signature through September 2006 was $218,639,102. Table A.1-1 provides a general breakdown of these costs.

Table A.1-1 – Aquifer Restoration Actual and Current Projected Costs

Category	Costs
Direct Costs	$46,492,988
Indirect & Engineering Costs	$106,651,885
Operations & Maintenance	$65,494,228
Total	$218,639,102

The costs presented in Table A.1-1 do not include costs associated with wastewater treatment and groundwater related infrastructure installed prior to ROD signature in January 1996. The estimate in the ROD was based only on expanding the existing AWWT and the installation of the necessary groundwater extraction modules. Infrastructure that was in place at the time of ROD signature included the AWWT, South Plume Extraction System, IAWWT, SPIT, SWRB, BSL, and other ancillary treatment system (e.g. general sump).

Direct costs include capital construction costs of the treatment systems and appurtenances as well as the groundwater extraction infrastructure. Indirect and engineering costs include design costs, project management costs, and environmental monitoring costs. Operations and maintenance costs include start-up costs and continuing operations and maintenance for the treatment systems and groundwater extraction modules.

A.2 Assessment of Remedy Performance

A.2.1 Assessment of Treatment Performance

The centerpiece of treatment at the FCP has been the ion exchange unit operation. Ion exchange is an exchange of ions between a solid (resin) and a liquid (wastewater). The chemistry of this reaction is simply the exchange of a chloride ion from the resin with a carbonate ion (which has uranium attached), found in wastewater, storm water and groundwater. The specific ion exchange resin implemented in FCP treatment process is currently ResinTech SBG1; an equivalent resin to the original Dowex 21K resin implemented until CY 2002. These resins are an ion specific resin for uranium. Duratek Corporation first demonstrated the effectiveness of this type of resin at the bench scale in April 1990. This successful bench scale demonstration lead to a pilot study, commissioned in April 1990, using actual FCP wastewater discharges. The results of this pilot study led to the selection of Dowex 21 K as the type of resin appropriate for FCP treatment purposes [Duratek 1991].

The CAWWT process consists of three treatment trains with each train containing two ion exchange vessels. One vessel is operated in lead while the other in lag position. The actual removal efficiencies comparing influent uranium concentration to effluent uranium concentration are subject to how the lead/lag vessels are configured and how long the ion exchange resin has been in use. Removal efficiencies of a specific ion exchange vessel can be expected to drop as uranium is loaded on the resin and breakthrough is approached. Breakthrough is approached based on the degree to which the effluent concentration becomes equal to the influent concentration for a specific ion exchange vessel. An equivalent concentration comparing influent and effluent indicates no uranium removal is being achieved (exhaustion has occurred). However, CAWWT Operators monitor the individual vessel performance and replace the resin before this breakthrough condition is achieved.

Based on data collected from March 2005 through September 2006 for the CAWWT groundwater treatment train, an overall uranium removal efficiency of 79-percent has been observed with actual efficiencies achieved of greater than 99-percent. Specific efficiencies for an ion exchange vessel or treatment train are dependant largely on the relative uranium loading on the resin. Effluent concentrations increase as the loading on the resin approaches its capacity.

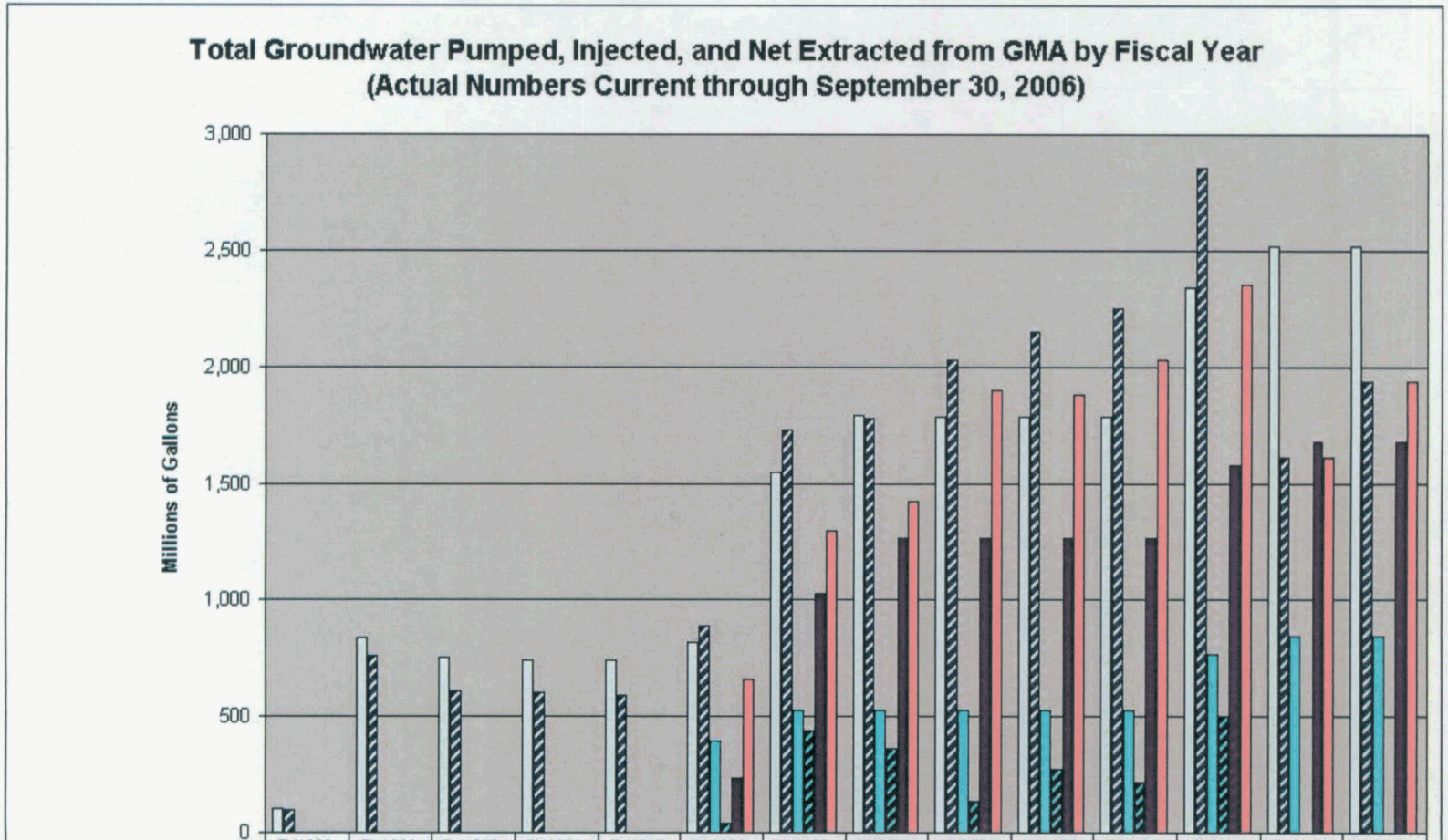
A.2.2 Assessment of Groundwater Extraction/Re-injection Performance

The overall objective of the groundwater extraction portion of the remedy was to bound the migration of any plumes of contamination and then install strategically located wells to remove the contamination to levels meeting Operable Unit 5 FRLs. While there are contaminants other than uranium in the plumes of contamination, the overall extraction effort has been to focus on uranium removal.

Performance for removing the uranium contamination can be described in terms of uranium removal index – a ratio of the amount of uranium removed to the number of gallons of groundwater pumped. This ratio is described by the term lbs. uranium/million gallons pumped (lb. U/Mgal). To establish whether a particular removal index is acceptable a basis for comparison is required. Because the characteristics of groundwater contamination are site specific due to types of contaminants encountered and aquifer specific geo-chemical characteristics, the basis for comparison is best served using the amounts of groundwater and uranium performance predicted in Section 5.3 of the Baseline Remedial Strategy Report. While this comparison does not provide an absolute measure of how the actual remediation of the aquifer is progressing, it does indicate how well the extraction system is operating with respect to estimated performance at the time of remedial design. The planned uranium removal index from FY 1997 through FY 2004 was 0.399 lb.U/Mgal. The actual removal index was 0.436 lb.U/Mgal. This indicates that amount of uranium extracted from the aquifer is more than predicted.

As shown in Figures A.2-1 and A.2-2 the volume of groundwater and mass of uranium are ahead of the schedule established in the Baseline Remedial Strategy Report. Groundwater Re-injection, which, prior to September 2004 was an integral part of the groundwater remedy, was operating behind schedule to that identified in the BRSR due to residual plugging of the wells, operational issues associated with the wells, and the need to reduce re-injection rates periodically to ensure compliance with uranium discharge limits to the Great Miami River.

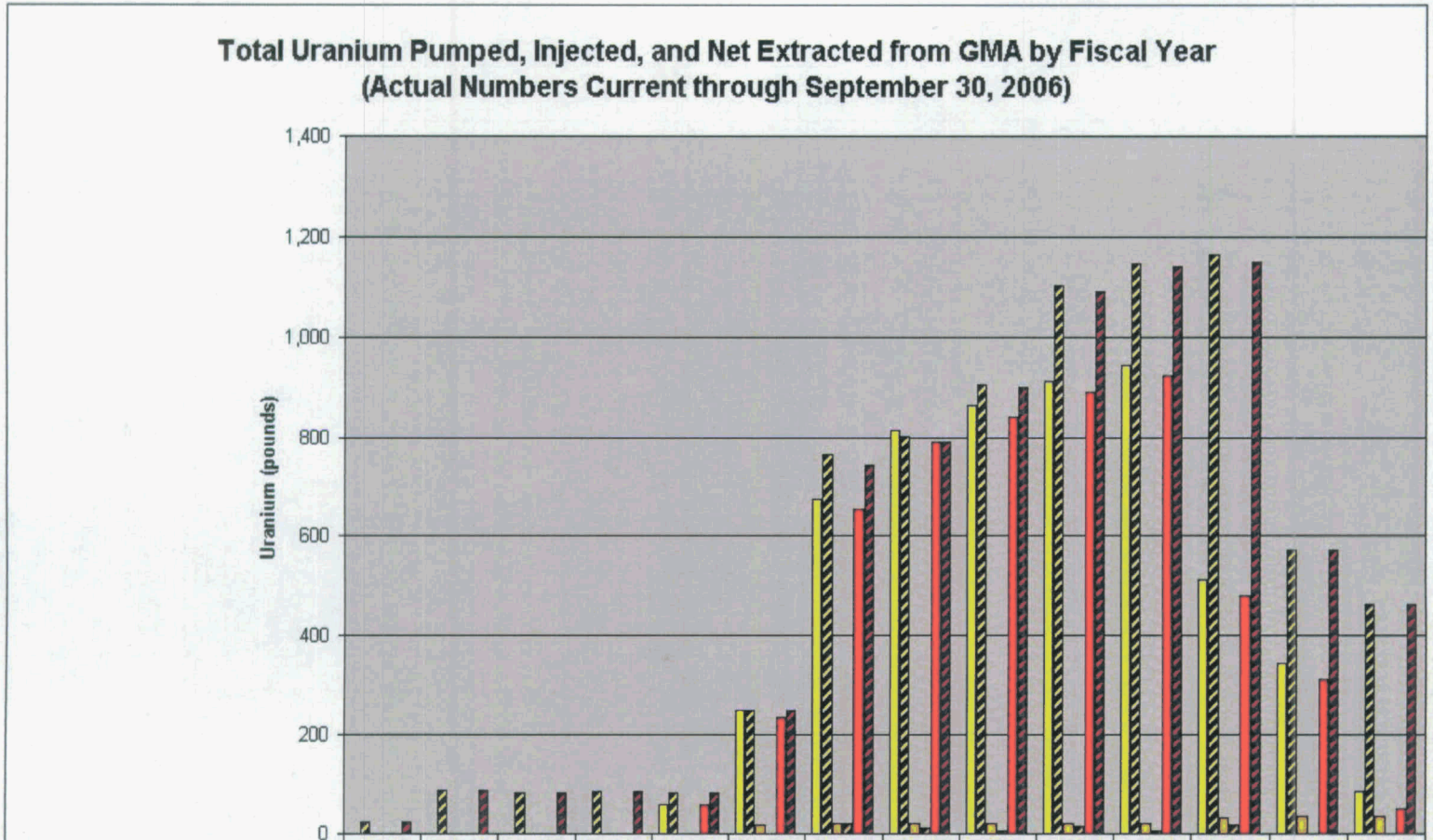
While overall the performance of the extraction/re-injection remedy has been very good, it has become apparent that there is more soluble mass of uranium in the sediments contained within the plumes of contamination than originally predicted. The interpreted extent of contamination has actually expanded from that predicted in the Baseline Remedial Strategy Report primarily due to bounding the contamination in the waste storage area as part of the Waste Storage Area Phase I Design and bounding contamination in the south field as part of the South Field Phase II Design which was not addressed in the Baseline Remedial Strategy Report. However, the uranium concentrations in the impacted areas of the aquifer have been significantly reduced.



	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006
Planned Total GW Pumped (Mgal)	97.920	832.320	753.552	737.856	735.840	814.464	1548.576	1791.936	1787.040	1787.040	1787.040	2344.320	2522.880	2522.880
Actual Total GW Pumped (Mgal)	97.183	756.976	605.541	597.200	585.123	883.804	1729.578	1781.524	2035.166	2155.971	2253.355	2855.224	1610.678	1937.859
Planned Injected GW (Mgal)	0.000	0.000	0.000	0.000	0.000	393.120	525.600	527.040	525.600	525.600	525.600	763.776	840.960	840.960
Actual Injected GW (Mgal)	0.000	0.000	0.000	0.000	0.000	39.842	436.652	361.052	132.460	273.188	216.340	499.365	0.000	0.000
Planned Net GW Extracted (Mgal)	0.000	0.000	0.000	0.000	0.000	235.872	1,022.976	1,264.896	1,261.440	1,261.440	1,261.440	1,580.544	1,681.920	1,681.920
Actual Net GW Extracted (Mgal)	0.000	0.000	0.000	0.000	0.000	657.184	1,292.927	1,420.473	1,903.095	1,882.366	2,034.642	2,355.859	1,610.678	1,937.859

Fiscal Year

Figure A-2.1 - Groundwater Extracted from the Great Miami Aquifer (1993 – 2006)



	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006
Planned Total U Extracted from GMA (lbs)	0.0	0.0	0.0	0.0	59.6	251.7	674.8	812.3	862.2	910.9	943.4	512.7	346.0	85.7
Actual Total U Extracted from GMA (lbs)	24.0	89.0	83.0	85.0	82.6	251.3	763.6	801.8	904.9	1,103.4	1,146.9	1,165.0	570.6	462.1
Planned Total U Injected (lbs)	0.0	0.0	0.0	0.0	0.0	16.4	21.9	22.0	21.9	21.9	21.9	31.8	35.0	35.0
Actual Total U Injected (lbs)	0.0	0.0	0.0	0.0	0.0	0.3	22.0	12.3	4.6	13.4	7.2	16.4	0.0	0.0
Planned Net Total U Removed from GMA (lbs)	0.0	0.0	0.0	0.0	59.6	235.3	652.9	790.4	840.3	889.0	921.5	480.9	311.0	50.7
Actual Net Total U Removed from GMA (lbs)	24.0	89.0	83.0	85.0	82.6	251.0	741.6	789.5	900.3	1090.0	1139.7	1148.6	570.6	462.1

Fiscal Year

Figure A-2.2 - Uranium Mass Extracted from the Great Miami Aquifer (1993 – 2006)

A.2.3 Assessment of Factors Affecting Cost Performance

Life cycle costs of the remedy are predominately impacted by the length of time the remedy must operate. The time necessary to remediate the aquifer is related to the uncertainties originally described in the Baseline Remedial Strategy Report. These uncertainties were:

- The hydraulic characteristics and capacity of the aquifer, which limit total pumping rates based on the need to achieve desired aquifer draw down profiles within the target cleanup zone and at neighboring off-property locations. Of prime concern is the need to minimize hydraulic impacts at the Paddys Run Road Site (where a second groundwater plume associated with that site is located) immediately south of the off-property portion of the FCP's groundwater plume.
- The geochemical processes that occur within the aquifer, which control the amount of contaminant mass removal accompanying each pore volume exchange during restoration.

It has become apparent that there is more mass of uranium than predicted and the soil/water partitioning coefficient (Kd – (L/Kg)) is higher than first predicted. It is believed that the Kd value is closer to 3.0 than the originally predicted 1.78. Modeling results using a Kd of 3.0 indicate the time required to reach the uranium clean-up level is substantially longer than the best-case estimate of 10-years noted in the Baseline Remedial Strategy Report. However, the updated estimates remain consistent with that described in the Operable Unit 5 ROD.

APPENDIX B – SCHEMATIC OF TREATMENT SYSTEMS

Schematics of the primary treatment systems are depicted.

Figure B.1 - Schematic of Converted Advanced Wastewater Treatment Facility
Figure B.2 - Schematic of Advanced Wastewater Treatment Facility - Phase I and II
Figure B.3 - Schematic of Advanced Wastewater Treatment Expansion Facility
Figure B.4 - Schematic of Advanced Wastewater Treatment Slurry Dewatering Facility
Figure B.5 - Schematic of Overall Wastewater, Storm Water, Groundwater Management Processes (1996 – 2006)

Figure B-1. Converted Advanced Wastewater Treatment Facility – Simplified Process Flow Diagram

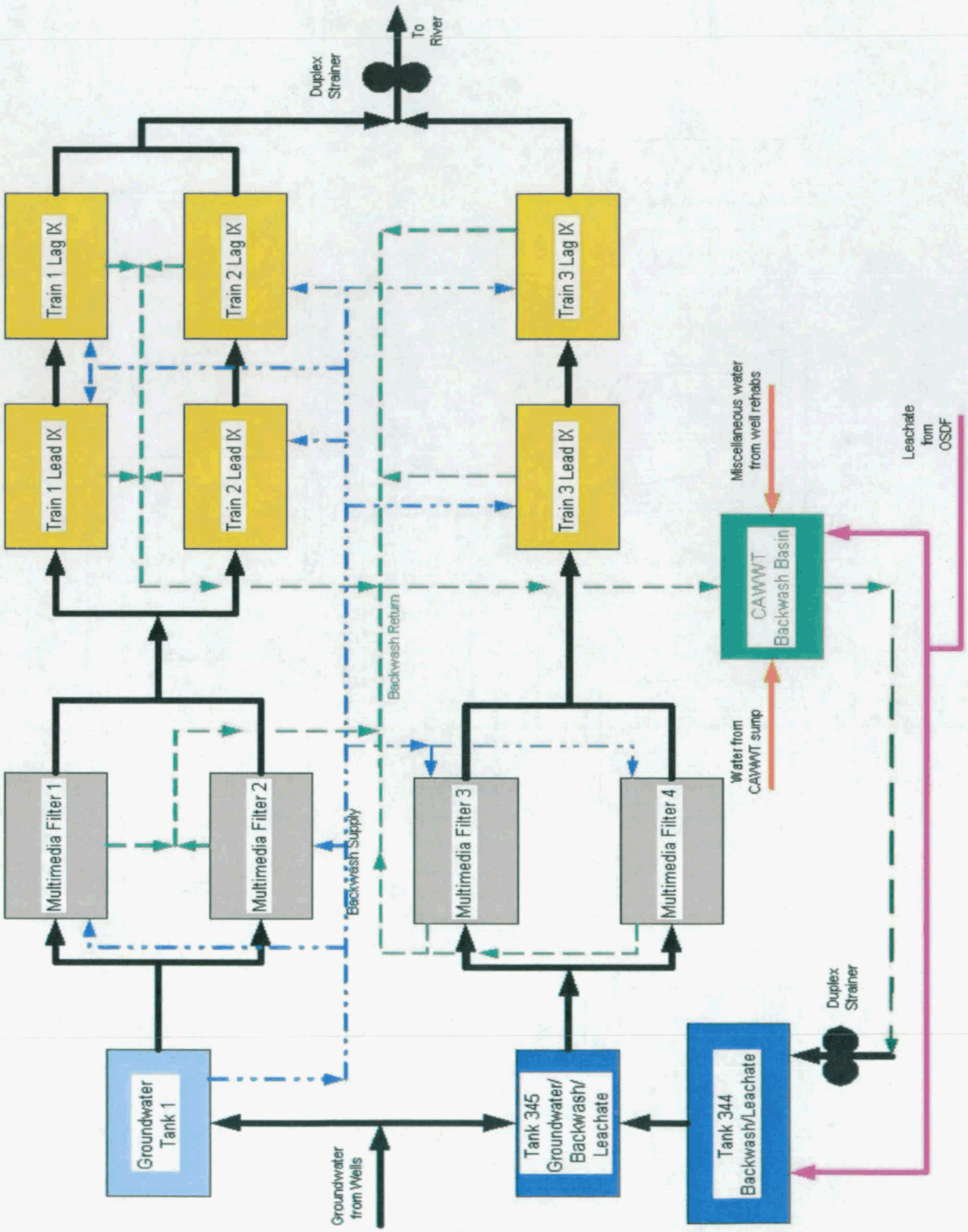
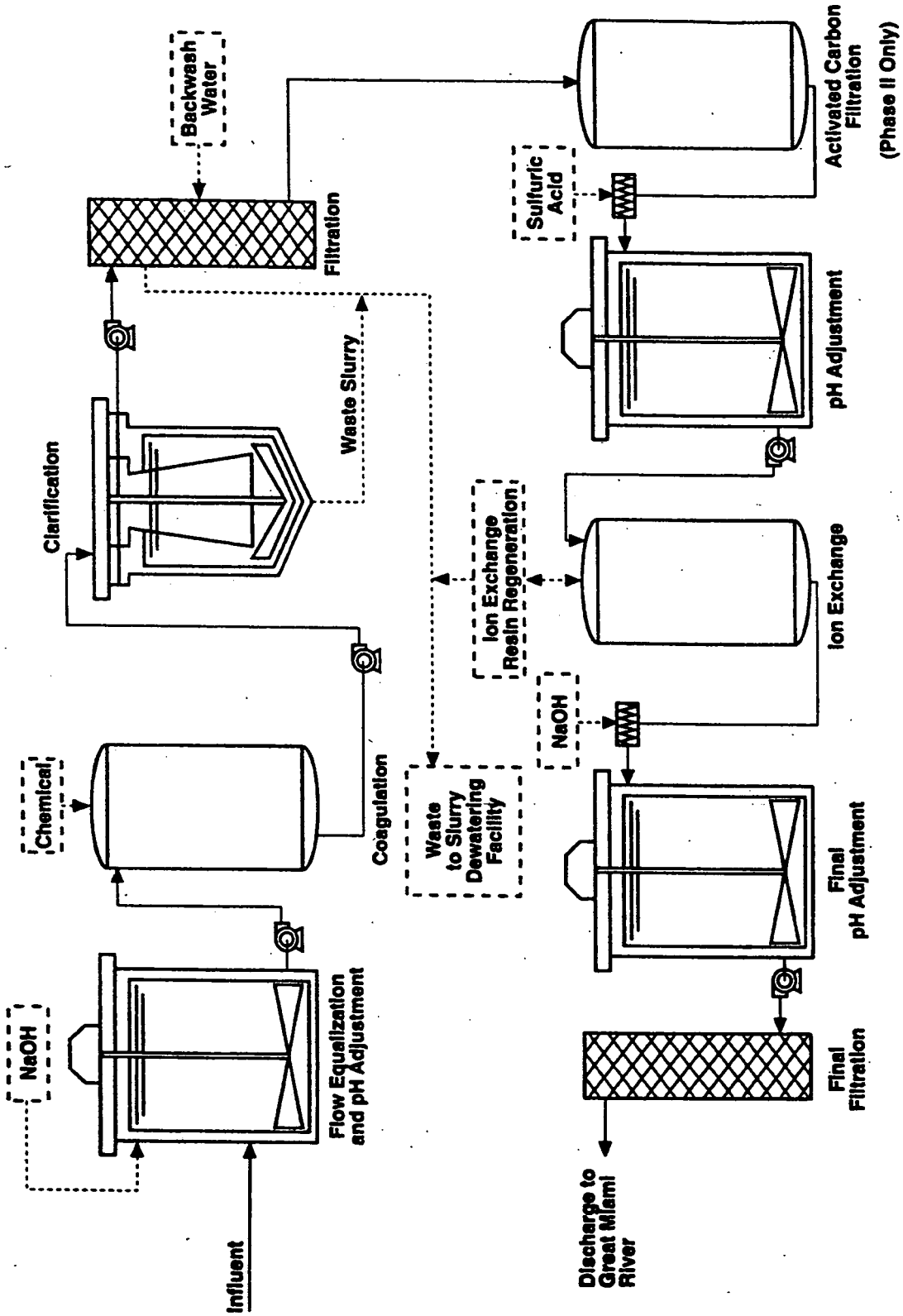


Figure B-2. Advanced Wastewater Treatment Plant (AWWT) Simplified Process



Diagram

Figure B-3. Advanced Wastewater Treatment Expansion - Simplified Process

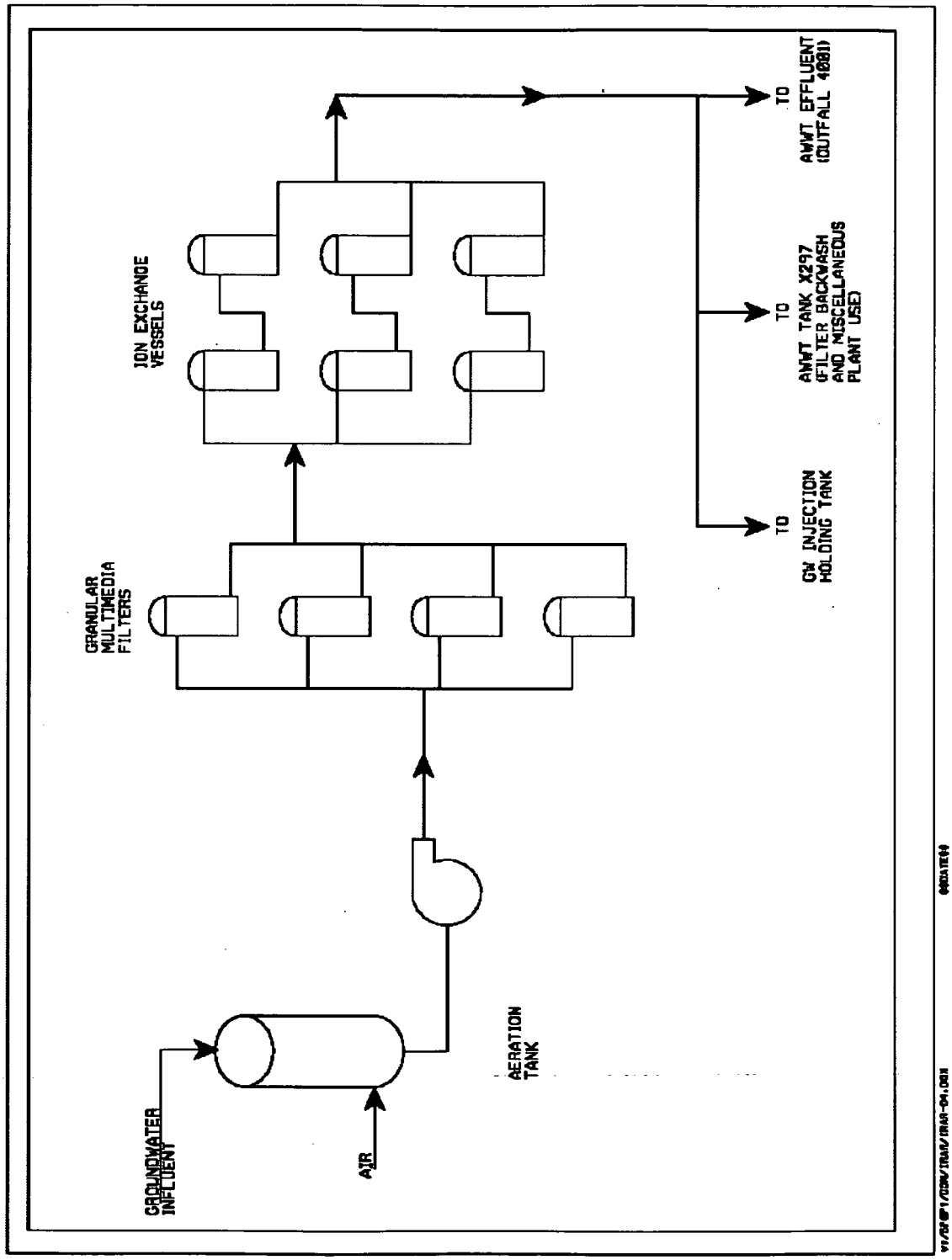


Figure B-4. Advanced Wastewater Treatment Slurry Dewatering - Simplified Process

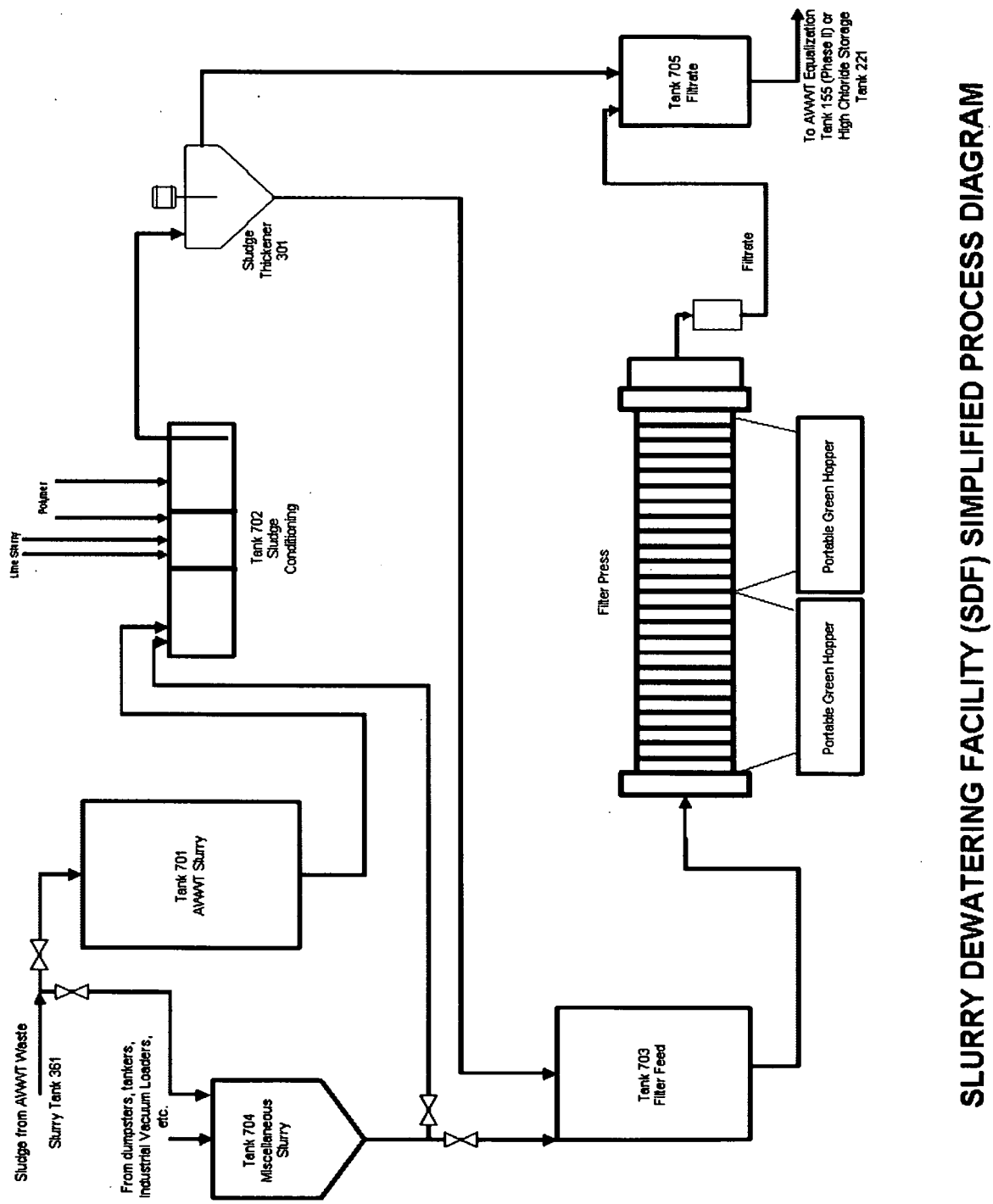
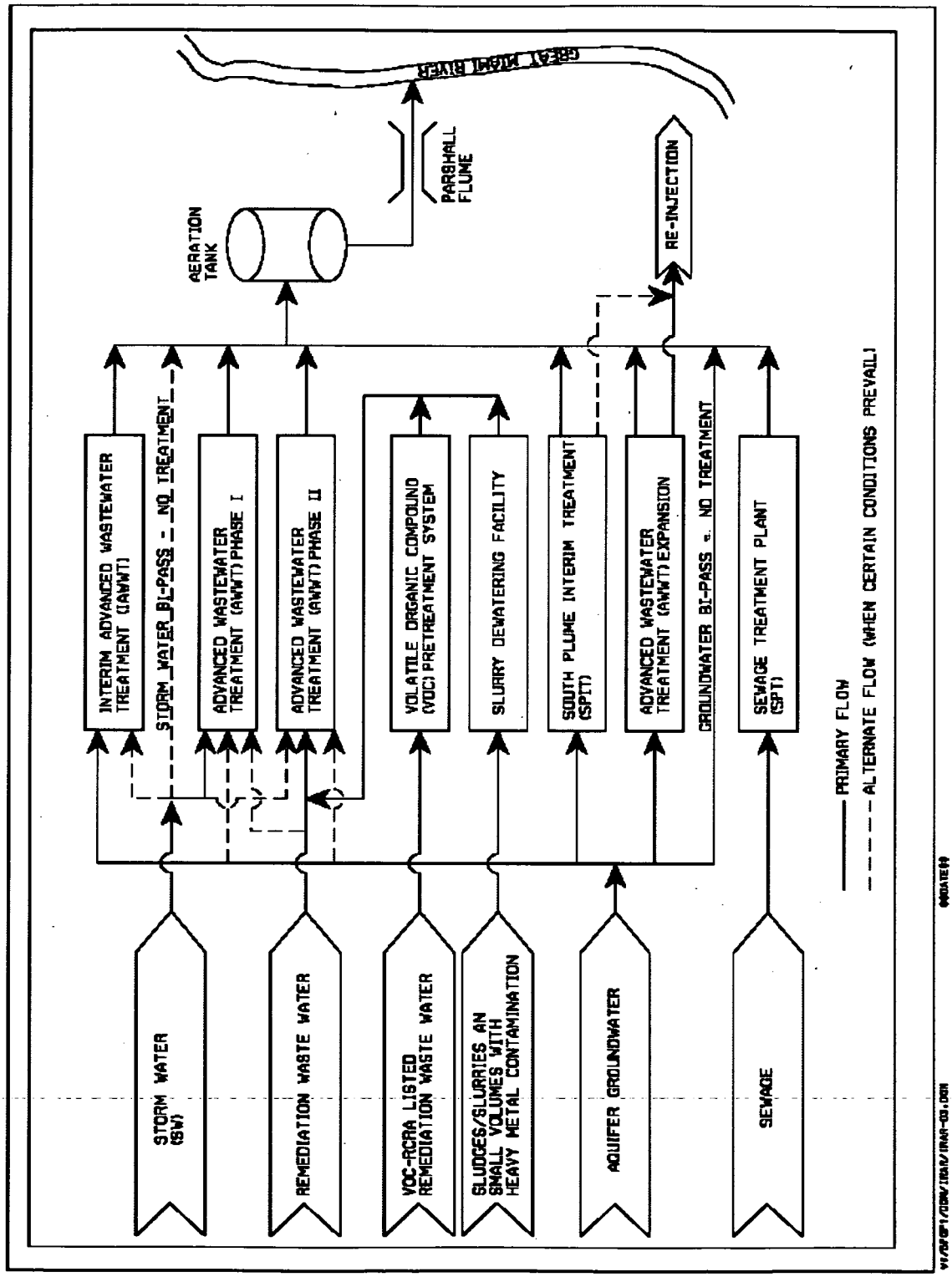


Figure B-5. Remediation Wastewater Management (1996 – 2005) - Simplified Process



APPENDIX C – HWMU CLOSURES

There were no Hazardous Waste Management Units (HWMUs) associated with Operable Unit 5 groundwater or treatment facilities. However, small quantities of wastewater that were known to contain one or more Resource Conservation and Recovery Act (RCRA) listed hazardous waste constituents have been treated in the on-site wastewater treatment system. The DOE and Ohio EPA negotiated a regulatory mechanism under the Mixture Rule Exclusion found at Ohio Administrative Code 3745-51-03(A)(2)(e) allowing that wastewaters containing listed constituents could be appropriately managed through existing FCP wastewater treatment systems and exempt from associated RCRA listing. This exclusion eliminated the need for pre-treatment of wastewaters containing listed constituents and eliminated the associated listing that would have otherwise been applied to treatment plant residuals (e.g., sludges). This policy was articulated in DOE letter DOE-0678-98 dated April 15, 1998 and approved by Ohio EPA on May 14, 1998.

Other small quantities of wastewater, particularly those related to waste management activities and building decontamination wastewater, contained concentrations of certain heavy metals above RCRA toxicity characteristic levels. These wastewaters were processed through the Slurry Dewatering Facility for specific treatment for these metals.

APPENDIX D – REMOVAL ACTIONS

Under CERCLA, a removal action is defined as a "short-term cleanup often completed prior to a more formal ROD process." As discussed in Section 2.2, there were four removal actions associated with Operable Unit 5 that were conducted as an effort to minimize the release or threat of release of contaminants and to accelerate cleanup activities. These four removal actions are summarized below.

- Removal Action No. 1: Contaminated Water Beneath FMPC Buildings
  This removal action involved the installation of several small extraction wells in former production Plants 2/3, 6, 8, and 9 for the purposes of removing perched groundwater beneath these plants contaminated with VOCs. The original configuration involved the pumping of these wells to holding tanks which then discharged this water, via tanker truck, to a small VOC treatment system (10 gpm hydraulic capacity) located in Plant 8. This treatment system implemented Granular Activated Carbon absorption for removing these VOC's. This removal action was closed in September 1995.
- Removal Action No. 3: South Groundwater Contamination Plume (Five Parts). This removal action was closed and moved to the post-ROD File in May 1997. The five parts included:
  - Part 1 – Alternate Water Supply – this action was taken to provide an alternate water supply to two affected industrial users.
  - Part 2 – South Plume Groundwater Recovery Well System – this action involved the installation of five groundwater extraction wells located at the leading edge of the South Groundwater Contamination Plume and discharged this groundwater directly to the Great Miami River. These well established the hydraulic boundary to prevent further migration of the plume of contamination. Appurtenant facilities included a new outfall line with a new monitoring station, new valve house, and aeration tank.
  - Part 3 – An Interim Treatment System to Remove Uranium – this action involved the installation of two, interim ion exchange based treatment systems. One system was located at the Storm Water Retention Basin to remove uranium from collected storm water. The second system was located at the Biodenitrification Facility for uranium removal from the BDN effluent.
  - Part 4 – Groundwater Monitoring and Institutional Controls – this action was focused on the continuation of the groundwater monitoring program already in place at the time as well as preventing the use of contaminated groundwater.
  - Part 5 – Additional Investigation to Identify the Leading Edge and Extent of the South Plume – as the title indicates this part involved confirming that there was no uranium contamination above the original 20 μg/L level beyond the south plume wells as well as attempting to identify the leading edge of the plume exceeding the 20 μg/L level.
- Removal Action No. 16: Collect Uncontrolled Production Area Runoff
  This action extended the storm water collection system for the former production area to collect those areas previously uncollected. This additional drainage collected flowed by gravity to the Storm Water Retention Basin. This action was completed May 22, 1997.
- Removal Action No. 30: KC-2 Warehouse/Well 67
  This action involved the plugging of groundwater monitoring well no. 67 to prevent the migration of contamination within the warehouse to the underlying groundwater.

APPENDIX E – LEGAL AGREEMENTS

The DOE has conducted operations at the Fernald Site under several legal agreements beginning with the 1986 Federal Facility Compliance Agreement. This includes the Consent Agreement and Amended Consent Agreement under CERCLA 121 and other agreements such as Ohio EPA Directors Findings and Orders, and Consent Decrees. This appendix, however, describes the legal agreements specific to Operable Unit 5 Aquifer Restoration.

Agreement Resolving Dispute Concerning Denial of Request for Extension of Time to Submit Operable Unit 2 Documents – April 1993

On October 17, 1992, DOE submitted the Operable Unit 2 Remedial Investigation to EPA, which was subsequently disapproved by EPA on December 17, 1992. Having a direct bearing on the other documents and respective schedules, DOE requested an extension of time under Section XVIII of the Amended Consent Agreement (ACA). EPA did not concur with the request for an extension and on February 16, 1993 DOE invoked the dispute resolution process under Section XIV of the ACA. Later, DOE invoked the dispute resolution process when, on March 16, 1993, EPA notified DOE that it intended to assess stipulated penalties relative to missing Operable Unit 2 document milestones.

The negotiations conducted throughout this process resulted in an agreement with a direct impact on Operable Unit 5 treatment facilities and water management. The DOE agreed to spend not less than $2.0 million dollars on a supplemental environmental project that consisted of:

- Procurement and installation of one additional Interim Advanced Wastewater Treatment trailer unit (this additional unit was later named the South Plume Interim Treatment System)
- Extend the life of the existing Interim Advanced Wastewater Treatment trailer unit
- Utilize off-peak capacity in Advanced Wastewater Treatment Facility, Phase I, for treatment of South Plume Groundwater
- Eliminate low uranium streams from Advanced Wastewater Treatment Facility, Phase II, and use the resulting additional capacity for treatment of South Plume Groundwater

Ohio Environmental Protection Agency Directors Findings and Orders: Groundwater Monitoring – September 2000

Under the Resource Conservation and Recovery Act (RCRA), facilities with land-based units that store or manage hazardous waste (as defined under RCRA) are required to implement a groundwater monitoring program. Because of the ongoing groundwater remediation and groundwater monitoring activities conducted at the site, the Department of Energy petitioned the State of Ohio to use the Integrated Environmental Monitoring Plan as an alternate groundwater monitoring program to that previously implemented beginning in 1993. Through these Directors Findings and Orders, the State of Ohio granted the Department of Energy and exemption from several state regulations provided the IEMP was implemented and was subject to State of Ohio approval when revised. (The issuance of these orders officially terminated the Director's Findings and Orders of September 10, 1993 concerning the same matter)

Ohio Environmental Protection Agency (Ohio EPA), 1987a, Permit to Install, Application Number 05-1043, "Storm Water/Spill Retention Facility," November 1987.

Ohio Environmental Protection Agency (Ohio EPA), 1987b, Permit to Install, Application Number 05-2872, "Changes to Biosurge Lagoon," December 1987.

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APPENDIX G – GROUNDWATER REMEDY PHOTOS

Figure G-1 - Advanced Wastewater Treatment Facilities

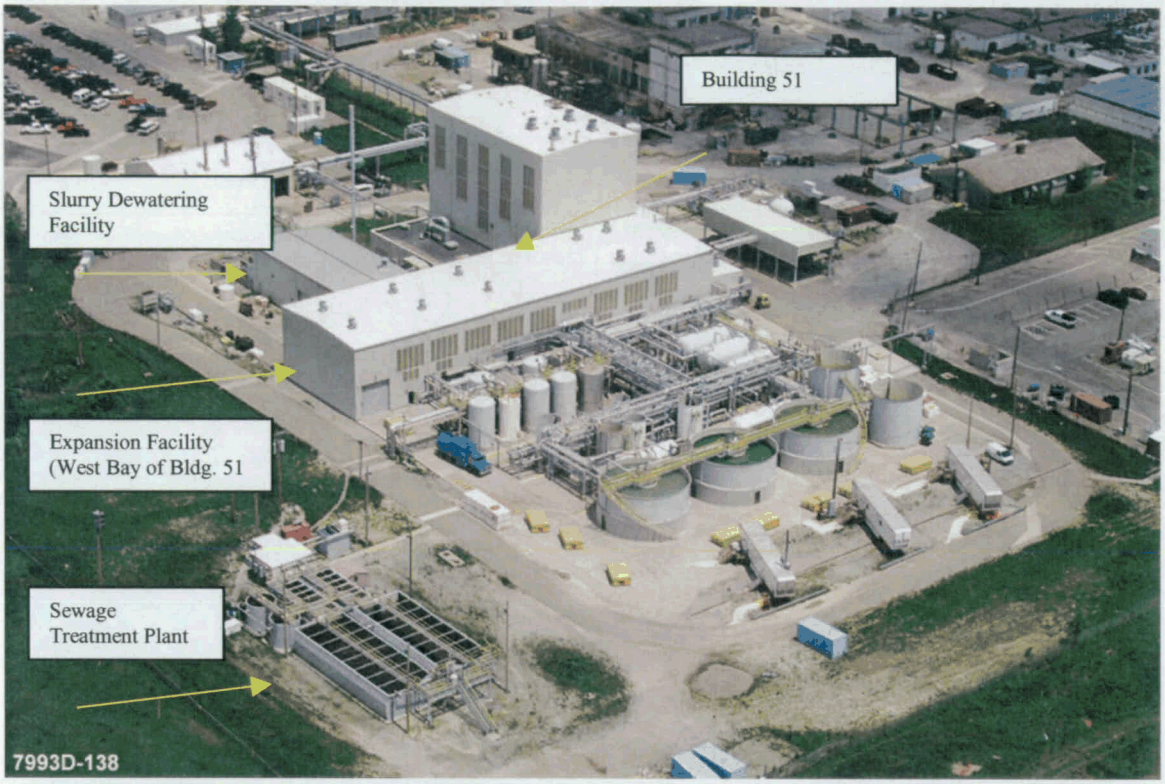

Figure G-2 - South Plume Interim Treatment and Interim Advanced Wastewater Treatment Facilities

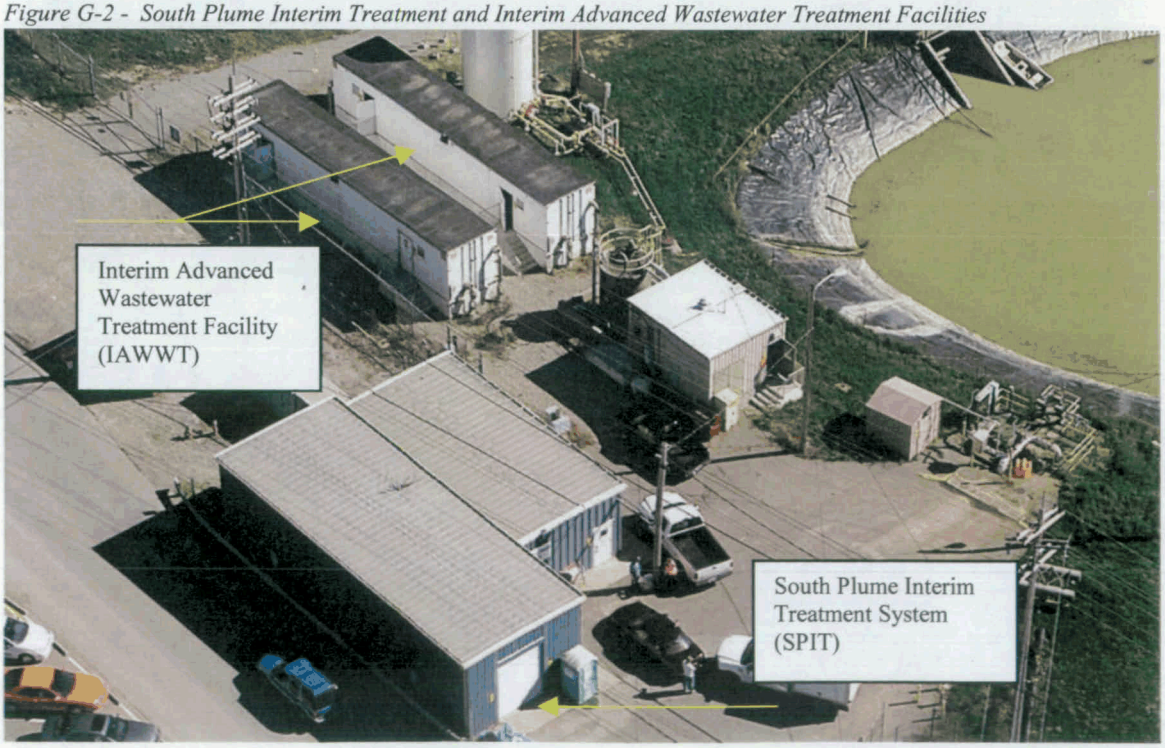

Figure G-3 - Converted Advanced Wastewater Treatment Facility

FigureG-4 - Typical Ion Exchange Vessels

Figure G-5 - Dowex 21K Ion Exchange Resin

Figure G-6 - Slurry Dewatering Facility Filter Press

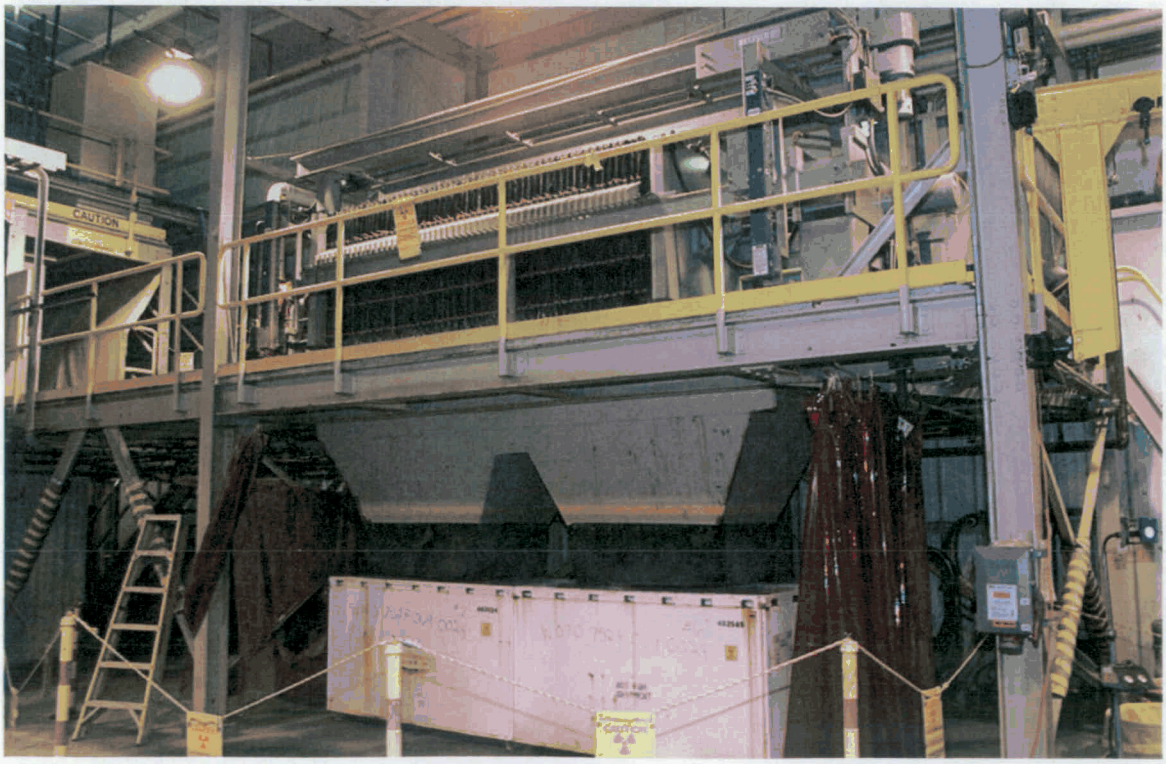

Figure G-7 - Biosurge Lagoon & Storm Water Retention Basin

Figure G-8 - Typical Extraction Well House (exterior)

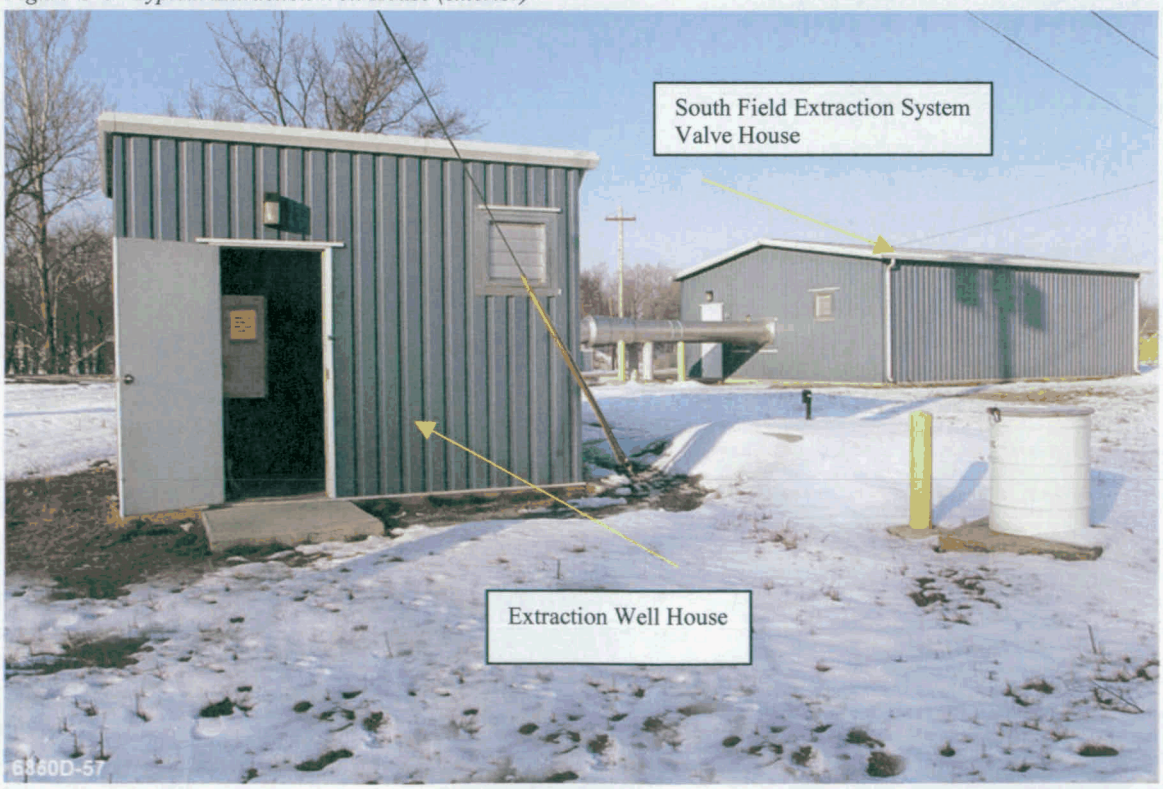

Figure G-9 - Extraction Well House (interior)

APPENDIX H – LIST OF ACRONYMS

ACA	Amended Consent Agreement
ACM	asbestos containing material
AEC	Atomic Energy Commission
ANSI	American National Standards Institute
ARAR	applicable or relevant and appropriate requirements
ASQC	American Society of Quality Control
ASME	American Society of Mechanical Engineers
AWWT	Advanced Wastewater Treatment
BSL	bio surge lagoon
CAWWT	converted Advanced Wastewater Treatment facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMT	continuous multi-tube sampler
D&D	decontamination & dismantlement
DF&O	Director's Findings & Orders
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
ERDA	U.S. Energy Research & Development Administration
ESD	explanation of significant differences
FCP	Fernald Closure Project
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Company
FFCA	Federal Facilities Compliance Agreement
FMPC	Feed Materials Production Center
FRL	final remediation levels
HQ	hazard quotient
HWMU	Hazardous Waste Management Unit
IAWWT	Interim Advanced Wastewater Treatment facility

IEMP	Integrated Environmental Management Plan
ILCR	incremental lifetime cancer risk
IRDP	integrated remedial design plan
Kd	distribution coefficient (modeling parameter)
LMICP	Legacy Management and Institutional Controls Plan
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/l	milligrams/liter
NLO	National Lead of Ohio
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NQA	National Quality Assurance
NTS	Nevada Test Site
O&M	operations and maintenance
OFFO	Office Federal Facilities Oversight (Ohio EPA)
Ohio EPA	Ohio Environmental Protection Agency
O&MMP	operations and maintenance master plan
OSDF	On-site Disposal Facility
OSWER	Office of Solid Waste and Emergency Response (U.S. EPA)
OU	Operable Unit
PLC	programmable logic controller
QA/QC	quality assurance/quality control
QAJSP	Quality Assurance Job Specific Plan
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RM	Requirements Manual
RSE	Removal Site Evaluation
SARA	Superfund Amendments and Reauthorization Act
SCQ	Site-wide CERCLA Quality Assurance Plan

SDWA	Safe Drinking Water Act
SEP	Site-wide Excavation Plan
SP	stockpile (soil stockpile)
SPIT	South Plume Interim Treatment
SWIFT	Sandia Waste Isolation Flow and Transport model
SWRB	storm water retention basin
TCLP	toxicity characteristic leaching procedure
µg/L	micrograms per liter
VOC	volatile organic compound
WAC	waste acceptance criteria
WAO	Waste Acceptance Organization
WEMCO	Westinghouse Environmental Management Company of Ohio
WMCO	Westinghouse Materials Company of Ohio
WPRAP	Waste Pits Remedial Action Project

APPENDIX I – SIGNATURE PAGE

I certify that the remedial actions as described within this report have been completed and the ground water remedy is operational and functional.

_____

Johnny W. Reising, Director
United States Department of Energy
Fernald Closure Project