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PROPOSED PLAN FOR REMEDIAL ACTIONS AT OPERABLE UNIT 4 DECEMBER 1993 DRAFT FINAL

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PROPOSED PLAN FOR REMEDIAL ACTIONS AT OPERABLE UNIT 4 DOE/EIS-0195D

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

DECEMBER 1993

U.S. DEPARTMENT OF ENERGY
FERNALD FIELD OFFICE

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Documents Comprising the Draft Feasibility Study/Proposed Plan-Environmental Impact Statement for Remedial Actions at Operable Unit 4, the Fernald Environmental Management Project

DOE/EIS-0195D

Feasibility Study for Operable Unit 4, Fernald Environmental Management Project, Volumes I-IV, Department of Energy, Fernald Field Office, Fernald, Ohio, December 1993.

Proposed Plan for Remedial Actions at Operable Unit 4, Fernald Environmental Management Project, Department of Energy, Fernald Field Office, Fernald, Ohio, December 1993.

Incorporated by reference:
Remedial Investigation Report for Operable Unit 4, Fernald Environmental Management Project, Volumes I-III, Department of Energy, Fernald Field Office, Fernald, Ohio, November 1993.

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FERNALD, OHIO

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(Offer expires April 20, 1994, at the conclusion of the Public Review Period)

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1.0 INTRODUCTION 5042

This Proposed Plan for Remedial Actions at Operable Unit 4 (hereinafter called Proposed Plan) addresses the management of contaminated material in the area designated as Operable Unit 4 of the Fernald Environmental Management Project (FEMP), formerly known as the Feed Materials Production Center. The FEMP site is a government-owned facility located about 17 miles (27 kilometers) northwest of Cincinnati, Ohio. From 1952 until 1989, the FEMP site provided high-purity uranium metal products to support United States defense programs. Production was stopped due to declining demand and a recognized need to commit available resources to remediation. The FEMP site is included on the National Priorities List of the U. S. Environmental Protection Agency (EPA). Inclusion on the National Priorities List reflects the relative importance placed by the federal government on ensuring the expedient completion of cleanup operations at the FEMP. The facility is owned by the U.S. Department of Energy (DOE), which as the lead agency is conducting cleanup activities at the site under its Environmental Restoration and Waste Management Program. The EPA and the Ohio Environmental Protection Agency (OEPA) are the support agencies. Together, the three agencies actively promote local community and public involvement in the decision making process regarding the remediation of the FEMP site.

The purpose of this Proposed Plan is to facilitate public participation in the remedy selection process by:

- Identifying the initially preferred alternative for Operable Unit 4 and presenting the rationale for DOE's preference.

- Describing the other alternatives that were considered in detail within the Feasibility Study Report for Operable Unit 4.

- Soliciting public review and comment on all of the alternatives described in Section 5.0 of this Proposed Plan.

- Providing information on how the public can be involved in the remedy selection process.

DOE is issuing this Proposed Plan as part of its public participation responsibilities under section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). This Proposed Plan summarizes key information that can be found in greater detail in the Remedial Investigation and Feasibility Study Reports for Operable Unit 4. See the "Proposed Plan/Other Document Cross Reference Matrix" located on the last page of this Proposed Plan for specific cross reference information. The Remedial Investigation and Feasibility Study Reports for Operable Unit 4 are contained in the Administrative Record file for the FEMP site, located at the Public Environmental Information Center, 10845 Hamilton-Cleves Highway in Harrison, Ohio (see Section 7.0).

In accordance with both CERCLA and the National Environmental Policy Act of 1969 (NEPA) processes, these documents are made available to the public for comment. Public involvement is an important factor in the decision-making process for site remediation. Public comments will be considered in the remedy selection for each operable unit, which will be presented in a Record of Decision. Applying the integrated approach for CERCLA and NEPA, DOE plans to prepare and issue a single Record of Decision for each operable unit to be signed by both DOE and EPA. The contents of the documents prepared for the remedial actions at the FEMP site are not intended to represent a statement on the legal applicability of NEPA to remedial actions conducted under CERCLA.

In addition, it is DOE policy to integrate NEPA into the procedural and documentation requirements of CERCLA wherever practicable. On May 15, 1990, a Notice of Intent was published in the Federal Register indicating that DOE planned to prepare an Environmental Impact Statement (EIS) consistent with NEPA to evaluate the environmental impacts associated with the cleanup actions for each of the five FEMP operable units. Consistent with the Notice of Intent, the resulting integrated process and documentation package are termed a Feasibility Study/Proposed Plan-Environmental Impact Statement (FS/PP-EIS).

Currently, the five FEMP operable units are at different stages for evaluating cleanup alternatives; however, each operable unit has identified a leading remedial alternative (see Appendix K of the FS Report for Operable Unit 4). As the cleanup process moves ahead, the leading remedial alternatives may be modified based on new information or on public and support agency (EPA and OEPA) comments. Functioning as the lead CERCLA/NEPA integrated document, the Operable Unit 4 FS/PP-EIS addresses cumulative environmental impacts for implementing the leading remedial alternatives for each FEMP operable unit. The NEPA cumulative analysis focuses on the potential impacts to human health and the environment as the result of implementing one or all of the leading remedial alternatives for the five FEMP operable units. The CERCLA/NEPA integrated documents prepared subsequent to Operable Unit 4 will be derived from, or be fully encompassed by, the impact analysis presented in the Operable Unit 4 FS/PP-EIS. If the leading remedial alternatives for any of the operable units change, additional NEPA review will be performed and documented as appropriate to evaluate the impacts to human health and the environment. This additional analysis will be presented in the integrated CERCLA/NEPA documents for the remaining operable units where appropriate.

The identification of the preferred alternative in the Proposed Plan is only an initial recommendation. Changes to the preferred alternative or use of another alternative may result if public and agency comments or additional data indicate such a change would result in a more appropriate selection. Therefore, all interested individuals are encouraged to provide comments on the alternatives presented in this Proposed Plan (refer to Section 7.0). The final decision regarding the selected remedy will be documented in a Record of Decision after all comments from the public and OEPA are taken into consideration. A summary of DOE's responses to these comments (called a Responsiveness Summary) will be included in the Record of Decision document and made available in the Administrative Record.

The Proposed Plan includes the following:

- Section 2.0 presents the history and description of the site.
- Section 3.0 defines the concept of the operable unit, subunits, and components of Operable Unit 4.
- Section 4.0 summarizes the nature and extent of contamination in Operable Unit 4 and risks to human health and the environment if no action is taken.
- Section 5.0 summarizes the remedial alternatives being considered for Operable Unit 4.
- Section 6.0 summarizes the evaluation of remedial alternatives and summarizes DOE's initially preferred alternative.
- Section 7.0 describes the opportunities for public involvement.
- A glossary defining key terms and acronyms.
- A reference list which serves as a bibliography.
- A cross reference matrix which provides information on where expanded discussion relative to text in Proposed Plan Sections can be located.

2.0 DESCRIPTION AND HISTORY OF THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

2.1 SITE HISTORY

2.1.1 Overview of the FEMP Site's Production Activities

During its 37 years of operation, the FEMP site's primary mission was to process uranium into metallic "feed" materials which were shipped, or "fed," to other DOE facilities for use in the nation's atomic weapons program. The principal products were variously sized, highly purified uranium metal forms of assorted standard isotopic assays. The production process at the FEMP site began with the purification of uranium contained in materials that were recycled from production and that were received from other sites. Scrap metals generated on site or received from other sources were also refined for production. The materials were then heated in a furnace which upgraded them to chemical processing requirements.

2.1.2 Operating History of the FEMP Site

The FEMP site was constructed in 1950 and 1951 under the authority of the Atomic Energy Commission, eventually known as the DOE. In 1951, National Lead of Ohio, Inc., entered into contract with the Atomic Energy Commission as the Management and Operations Contractor for the facility. Operations began in 1951 upon completion of the Pilot Plant, the site's first operational facility. In 1960, production reached its peak. Beginning in 1964, reduced demand led to production declines. In 1981, the FEMP site began planning to accommodate increased activity due to the government's decision to increase uranium metal production for weapon and other programs.

On January 1, 1986, Westinghouse Materials Company of Ohio, a wholly-owned subsidiary of Westinghouse Electric Corporation, assumed management and operations responsibility for the site. Production ceased in the summer of 1989 due to a declining demand for uranium feed product, and plant activities were focused on environmental cleanup. In June 1991, the site was officially closed for production by an act of Congress and the site was renamed the Fernald Environmental Management Project. On December 1, 1992, Fernald Environmental Restoration Management Corporation (FERMCO), a wholly-owned subsidiary of Fluor Daniel Inc., assumed responsibility for managing the restoration.

2.2 SITE DESCRIPTION

The FEMP site is a 425 hectare (1050 acre) facility 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, 345 hectares (850 acres) are in Crosby township of Hamilton County, and 80 hectares (200 acres) are in Ross and Morgan Townships of Butler County. Other nearby communities include Shandon, New Baltimore, Ross, and Harrison (See Figure 2-1).

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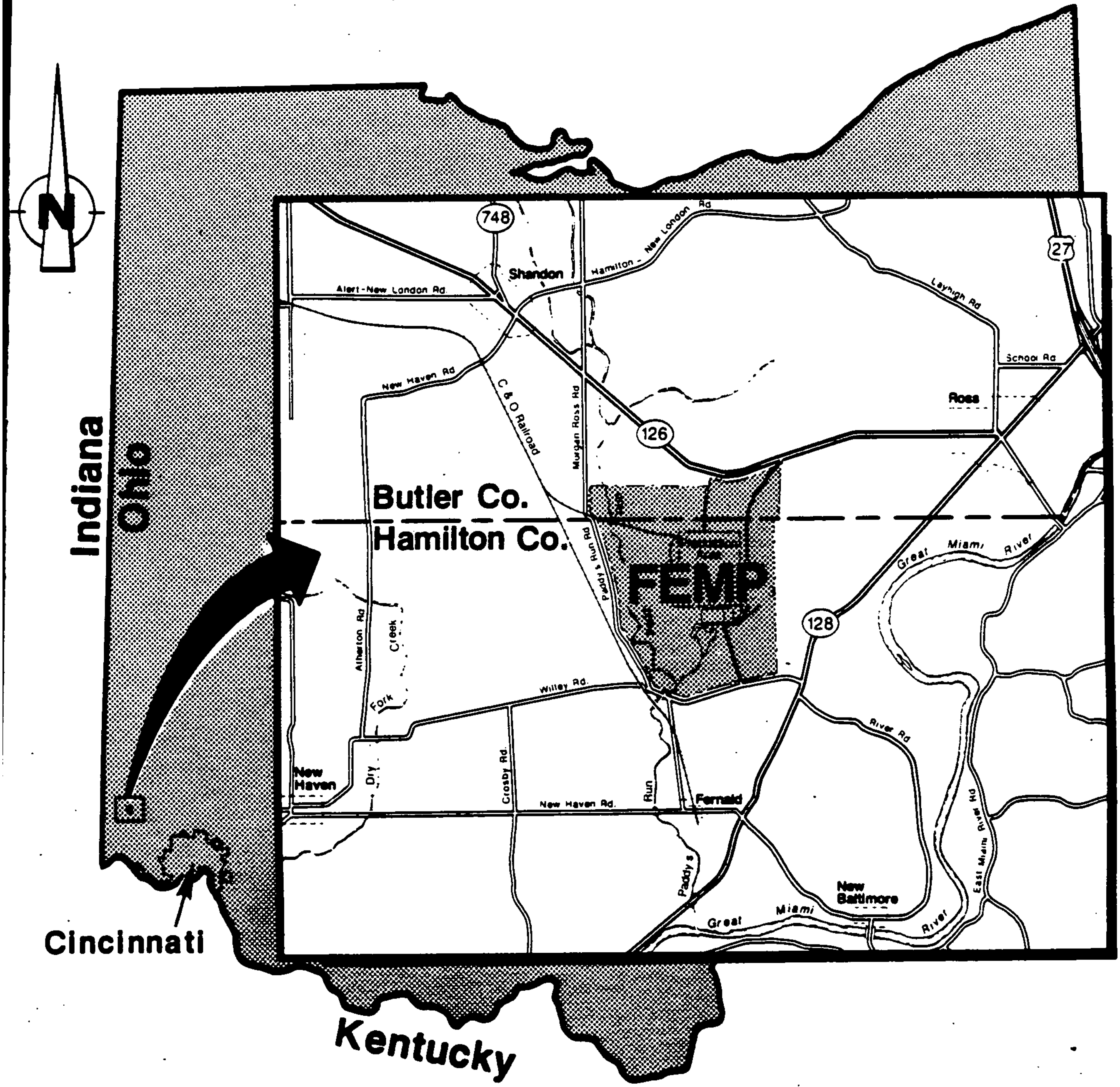
FIGURE 2-1
FEMP AND VICINITY



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

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2.3 HISTORY OF WASTE GENERATION AND DISPOSAL

Production operations at the facility were limited to a fenced 55-hectare (136-acre) tract of land, now known as the former Production Area, located near the center of the site. Large quantities of liquid and solid materials were generated during production operations. Prior to 1984, solid and slurried materials from uranium processing were stored or disposed in the on-site Waste Storage Area. This area, located west of the former Production Area, includes six low-level radioactive waste storage pits; two earthen-bermed, concrete silos containing K-65 residues; one concrete silo containing cold metal oxides; one unused concrete silo; two lime sludge ponds; a burn pit; a clearwell; and a solid waste landfill (see Figure 2-2).

Operable Unit 4 is located within this on-site Waste Storage Area and by definition includes the four concrete silos, ancillary facilities and surface and subsurface soils within the units boundaries. Since the focus of this Proposed Plan is specific to Operable Unit 4, no information on sitewide contamination is described in this document. Sitewide information is provided in the Sitewide Characterization Report (DOE 1993b) which is available in the Administrative Record at the Public Environmental Information Center (refer to Section 7.0 for additional information).

Silos 1 and 2, known as the K-65 Silos, contain the residues generated from the processing of high grade uranium ores. This processing was completed to extract the uranium compounds from the natural ores. These ores, termed pitchblende, were shipped to the United States from a mine in the Belgian Congo (now known as Zaire). The K-65 residues contain high activity concentrations of radionuclides, including radium and thorium, and are classified as by-product materials, consistent with Section 11(e)2 of the Atomic Energy Act (AEA), generated consequential to the processing of natural uranium ores.

Silo 3 contains residues, known as cold metal oxides, which were generated at the FEMP site during uranium extraction operations in the 1950s involving the previously mentioned Belgian Congo ores and uranium concentrates received from a variety of uranium mills in the United States and abroad. The residues within Silo 3 also contain significant activity concentrations of radionuclides but lower than the K-65 residues. The residues within Silo 3 are similarly classified as by-product materials pursuant to Section 11(e)2 of the AEA. Silo 4 was never used for waste storage; however, rain water has infiltrated into the silo and has been previously removed whenever necessary.

2.4 CONTAMINANTS PRESENT IN RESIDUES AND WASTE MATERIAL

The significant concerns associated with the Silos 1 and 2 include:

- High concentrations of radionuclides, including radium and thorium, that are present in the residues;
- An elevated, direct-penetrating radiation field in the vicinity of the silos due to the material in the silos;

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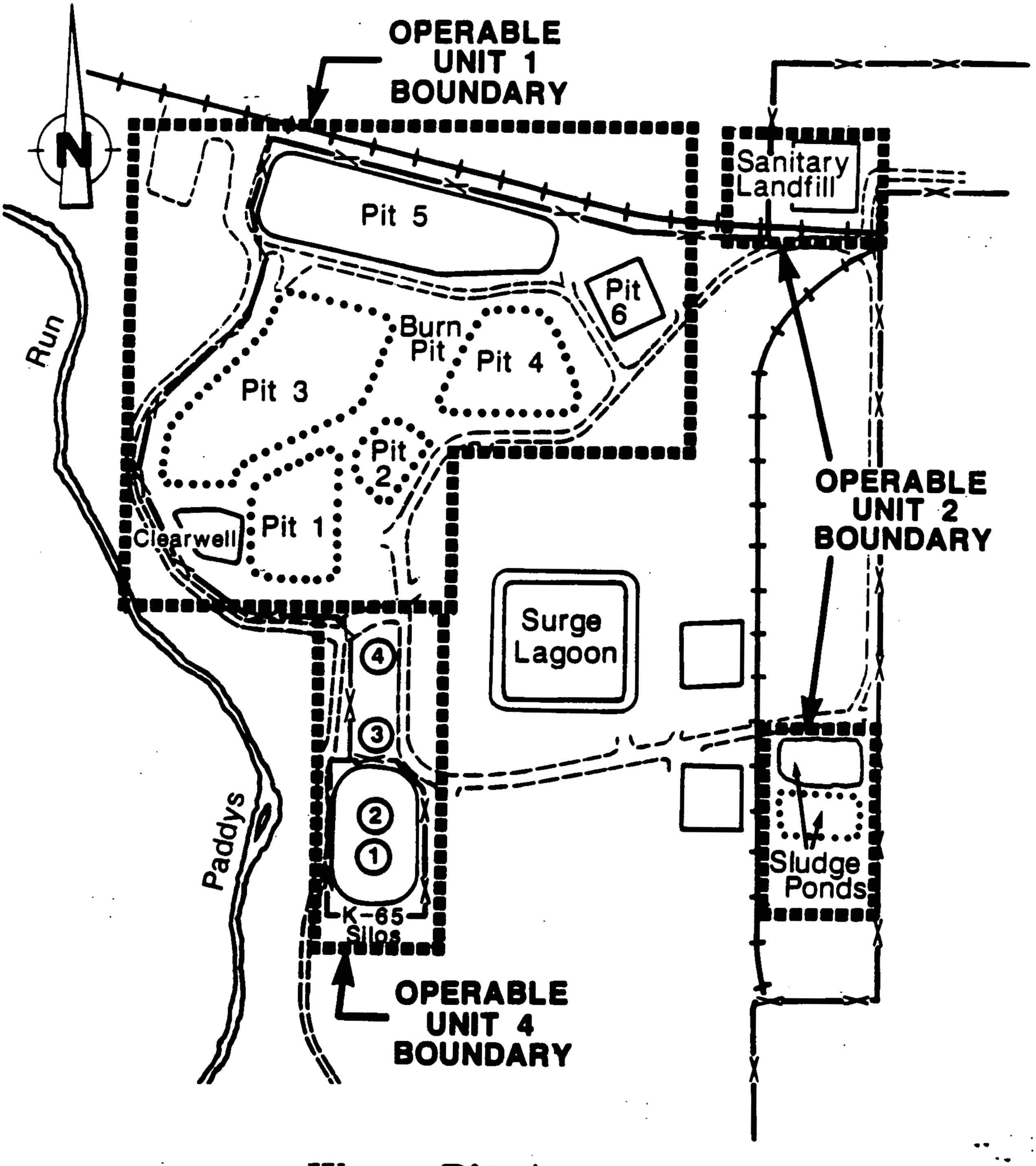
FIGURE 2-2
WASTE STORAGE AREA



Waste Pit Area

Scale in Feet
0 250 500

LEGEND

Covered Pits
Railroad
Fenceline
Roadway

GRAPHICS # 2158

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- Chronic emissions of radon gas (a radioactive gas from the decay of radium) from Silos 1 and 2 into the atmosphere;
- The structural instability of the silo domes and the age of the remaining portions of the structures;
- The potential threat of the contaminated residues leaching into the underlying sole-source aquifer.

The contents of Silo 3 also contain significant concentrations of radionuclides. The cold metal oxides in Silo 3 have a significantly lower direct radiation field and radon emanation rate than the K-65 residues in Silos 1 and 2; however, there is concern that dust particles would escape in the event of the silo structure collapsing.

Silo 4 was never used for material storage and remains empty today, except for some rainwater that has accumulated in the silo through the leaky silo dome. It is not considered a current or potential threat to the environment.

2.4.1 Characteristics of the Operable Unit 4 Stored Residue Inventories

This section summarizes available characterization data obtained during the RI on the nature of the radiological and chemical constituents of the residues presently stored within Silos 1, 2, and 3 in the Operable Unit 4 Study Area. Also included is a brief description of the contents of the decant sump tank located under Silos 1 and 2, the contents of Silo 4, and the radon treatment system. More detailed discussions on the nature of these stored materials and facilities can be found in Chapter 4.0 of the RI Report for Operable Unit 4.

Contents of Silos 1 and 2

Silos 1 and 2 contain K-65 residues and bentonite clay. The bentonite clay layer was added in 1991 within the K-65 Silos to reduce radon emanation. Radionuclides at significant activity levels within these silos are actinium, radium, thorium, polonium, and a radioactive isotope of lead-210. Each of these radionuclides are naturally occurring elements found in the original ores processed at the FEMP and Mallinckrodt. It is estimated that the silos contain approximately 27 metric tons (30 tons) of uranium.

Non-radiological constituents detected in significant concentrations in Silos 1 and 2 residues include sodium, magnesium, molybdenum, nickel, barium, lead, calcium, and iron, PCBs, and tributyl phosphate (a solvent used in the former uranium extraction process at FEMP). Tests performed on samples of stored residues identified that lead can leach from the untreated residues in concentrations which exceed federal guidelines typically applied to hazardous wastes.

Decant Sump Tank

Samples taken from the water within the decant sump tank during 1991 revealed elevated concentrations of lead-210, polonium, radium, and uranium. Analytical results also revealed the presence of above background concentrations of strontium and technetium. With the exception of these latter two constituents, radiological contaminants present in the decant sump tank are consistent with the relative concentrations of constituents found in Silos 1 and 2. This result confirms that the decant sump tank is continuing to collect leachate from the underdrains in Silos 1 and 2, as it was designed to do. Strontium and technetium are by-products of nuclear fission and are not present in Silos 1 and 2. Strontium and technetium were present in trace quantities in incoming process streams from other DOE facilities. They are also present in the environment due to fallout from past world-wide nuclear weapons testing. Their presence in the decant sump tank indicates that some surface water probably leached into the decant sump tank.

The metals found in liquid samples from the decant sump tank included aluminum, antimony, arsenic, chromium, copper, lead, molybdenum, selenium, silver, vanadium, and zinc. In addition, eighteen organic compounds were detected in the decant sump tank liquids at very low concentrations. With the exception of toluene, all volatile compounds detected were at or below concentrations which represent the laboratories' ability to accurately quantify the level of the constituents.

Radon Treatment System

The predominant contaminant present is lead-210 and its associated decay products. Periodic surveys for direct radiation and removable fixed radioactive contamination reveal that only isolated contamination is present in accessible portions of the Radon Treatment System.

Silo 3

During the 1989 sampling of Silo 3 contents, 12 radionuclides were identified, including actinium, lead-210, and the major isotopes of radium, thorium, and uranium. Thorium-230 had the highest activity concentration. These sample results are consistent with process knowledge. Present within the silo residue is approximately 40 metric tons (44 tons) of uranium.

Of the 23 inorganic constituents detected, those which represent the highest relative hazard include arsenic and vanadium. Results from sampling in 1989 indicated that the Silo 3 residues leach arsenic, chromium, and selenium at levels exceeding comparable limits applied to hazardous wastes. It has also been concluded that organics are not present in Silo 3 residues due to high material processing temperatures prior to residue transport for storage in the silos.

Silo 4

Silo 4 was never employed for the storage of wastes or in-process materials and remains empty. Inspections completed on Silo 4 during the RI/FS site investigations confirmed that no waste materials were present within the silo. Site records indicate that rain water has been periodically removed from Silo 4 and treated through the FEMP wastewater treatment system.

2.5 CONTAMINATED ENVIRONMENTAL MEDIA

In addition to the waste areas described in Section 2.4, contamination is present in environmental media within the Operable Unit 4 area, such as surface and subsurface soil, soils within the earthen berm surrounding Silos 1 and 2, groundwater, surface water, and perched water.

2.6 OVERVIEW OF THE NATURE AND EXTENT OF CONTAMINATION

This section summarizes the nature and extent of contamination within environmental media in the Operable Unit 4 Study Area. Also included in this section is an overview of the levels of direct radiation associated with the current conditions within Operable Unit 4. Additional detail on these conditions is provided in Section 4.0 of the RI Report for Operable Unit 4.

Surface Soils

Sampling performed as part of the RI/FS and other site programs in the vicinity of Operable Unit 4 indicates the occurrence of above background concentrations of uranium, and to a lesser degree other radionuclides, in the surface soils within and adjacent to the Operable Unit 4 Study Area. Activity concentrations observed during the RI for the surface soils in the vicinity of Operable Unit 4 were as much as 20.8 pCi/g for U-238, or 16 times natural background, and 4.8 pCi/g for Th-230, or two times background. These above background concentrations appear to be generally limited to the upper six inches of soil. Available survey data and process knowledge indicate no direct relationship between the surface soil contamination in the Operable Unit 4 Study Area and the silo contents. Further, more than 70 percent of the surface soil samples indicate that the uranium contamination in surface soils is depleted uranium (i.e., the uranium contains depleted percentages of U-235). This result is inconsistent with the silo residues that consist of natural uranium. Thus, the existence of these activity concentrations in the surface soils are attributed to air deposition resulting from the former Production Area and past plant production operations and/or waste handling practices in the waste pit area.

Soil samples were also collected from the soils contained in the earthen embankment (berm) surrounding Silos 1 and 2. The analytical data from the berm fill show only slightly elevated radionuclide activity concentrations. Uranium was the predominant contaminant with activity concentrations less than 4 picoCuries per gram (pCi/g), or approximately three times background. In addition to U-238, activity concentrations of polonium (Po)-210 and lead (Pb)-210 ranging up to 10 and 6 times background, respectively, were identified in the berm fill. These radionuclides are produced from the natural radioactive decay of Rn-222. Their presence in the berm fill is a direct result of radon escaping the silos by passing through the silo wall. Once outside the silo and in the soil, the radon decays to Pb-210 and then Po-210.

One sample collected as part of the berm investigations was retrieved from an interval that closely reflected the original ground surface prior to berm installation. Analytical results from this sample showed distinctly higher concentrations of radionuclides than other samples taken within the berm soils. Uranium and radium concentrations in the sample were 19 and 580 times background, respectively. This sample clearly indicates the occurrence of some spillage or seepage from the silo onto the original surface soils adjacent to the silo at that location.

Subsurface Soils

As part of the RI, samples were collected from the subsurface soils located under and adjacent to the K-65 silos. Analytical results reveal elevated concentrations of radionuclides from the uranium decay series in the soils at the interface between the berm and the original ground level. Elevated concentrations (up to 53 pCi/g for U-238, about 40 times background) were also noted in slant boreholes, which passed in close proximity to the silo underdrains.

The occurrence of these above background concentrations in soils near the silo underdrains are attributed to vertical migration of leakage from the silo underdrains or decanting system. Elevated readings at the interface between the silo berms and the native soils are attributed to historical air deposition or past spillage from the silos during filling operations in the 1950s, prior to installation of the berms.

Surface Water and Sediment

Extensive sampling was conducted on the sediment and surface water present in Paddys Run and on key drainage swales leading to Paddys Run, as part of the RI and other site programs. Results of the surface water sampling indicate the occurrence of above background concentrations of U-238, up to 1500 times background, in the drainage swales in the vicinity of the Silos 1 through 4. The highest readings were recorded in a drainage ditch, which flows from east to west, located approximately 250 feet south of Silo 1. The most probable source of the contamination in Paddys Run and the drainage swales is the resuspension of contaminated particles from surface soils within the Operable Units 4 and 1 Study Areas into storm water.

Groundwater

Groundwater samples were collected from wells within the Operable Unit 4 Study Area during the RI. Groundwater occurs not only in the Great Miami Aquifer underlying the FEMP site, but also in discrete zones of fine-grained sands located in the soils above the lower aquifer. The water contained in these sand pockets in the clay-rich glacial soils are termed perched water zones. Samples were collected from slant borings placed adjacent to and under Silos 1 and 2; 1000-series wells screened in the glacial overburden; 2000-series wells screened at the water table in the Great Miami Aquifer; and 3000-series wells screened at approximately the central part of the Great Miami Aquifer, just above the clay interbed.

Background concentrations of naturally occurring inorganics and radionuclides in groundwater in the vicinity of FEMP site were being established under the site-wide RI/FS during the completion of the RI for Operable Unit 4. The background concentration of total uranium in groundwater was assumed to be less than 3 micrograms per liter (μg/L) or 3 parts per billion (ppb).

Perched Water

Elevated concentrations of total uranium were detected in the slant boreholes under and around Silos 1 and 2. Slant Boring 1617, immediately southwest of Silo 1, contained the highest concentration of total uranium (9240 μg/L).

Uranium concentrations were also elevated in samples collected from the 1000-series wells. The highest observed total uranium concentrations obtained from 1000-series wells were in samples collected from Well No. 1032, located 150 feet due west of Silo 2. The range of the concentrations was 196 to 276 μg/L.

Considering both the slant borings and 1000-series wells, U-238 was found in the range of 1.1 to 1313 pCi/L. Overall, well measurements and analytical results confirmed that the perched groundwater in the vicinity of Operable Unit 4 flows from east to west. Further, Operable Unit 4 is contributing to contamination of perched groundwater in this region of the site.

Great Miami Aquifer

The concentration of total uranium in the upper portion of the Great Miami Aquifer, based on analysis of samples from the 2000-series wells, ranged from less than 1 μg/L to 40.3 μg/L. These data do not necessarily suggest that the silos are the source of the observed contamination because both upgradient and downgradient wells contain above background concentrations of total uranium. Well No. 2032, located 150 feet west of Silos 1 and 2, exhibited a concentration of total uranium at 39.0 μg/L. Well No. 2033, located 150 feet east of Silos 1 and 2, exhibited a concentration of total uranium at 40.3 μg/L. Because groundwater flow in this region of the Great Miami Aquifer is from west to east, these two wells are located upgradient and downgradient of Operable Unit 4, respectively. The above data, as well as measurements taken from other vicinity wells, demonstrate that there is no apparent link between contamination in the Great Miami Aquifer and Operable Unit 4.

The concentration of total uranium measured at deeper levels in the Great Miami Aquifer (3000-series wells) ranged from less than 1 to 4 μg/L, with the exception of 1 sample out of 16, which contained 15 μg/L. Like the 2000-series wells, no conclusion could be drawn to link this contamination to the silos.

3.0 SCOPE AND ROLE OF OPERABLE UNITS

3.1 THE OPERABLE UNIT CONCEPT

The EPA issued a Notice of Noncompliance to the DOE in 1985, identifying major concerns over potential environmental contamination caused by the FEMP site's production operations. In 1986, a series of conferences and negotiations between the DOE and the EPA resulted in the Federal Facilities Compliance Agreement. A major component of this agreement was the Remedial Investigation/ Feasibility Study (RI/FS). The RI/FS Work Plan (DOE 1988) identified 39 site areas for investigation.

These 39 areas were grouped into five "operable units" to make the RI/FS process more manageable. The operable unit concept at the FEMP site involves grouping waste areas or related environmental concerns in a manner so as to permit the more expedient completion of the RI/FS process. The operable unit concept became a condition of the April 1990 Consent Agreement between the EPA and the DOE.

The Record of Decision is the final step in the RI/FS process; it establishes the selected remedial alternative and provides a time frame by which remediation efforts can begin. A summary description of the five operable units and the dates on which the Draft Record of Decision for each is scheduled to be submitted to the EPA are listed below:

Operable Unit 1: Six waste pits, a burn pit, and a clearwell
Draft Record of Decision: November 6, 1994

Operable Unit 2: Two lime sludge ponds, two flyash piles, a disposal area containing construction rubble, and a solid waste landfill
Draft Record of Decision: January 5, 1995

Operable Unit 3: The former Production Area, consisting of plant buildings, scrap metals, equipment, and drummed inventories
Draft Record of Decision: April 2, 1997

Operable Unit 4: Four concrete storage silos and associated structures, and equipment
Draft Record of Decision: June 10, 1994

Operable Unit 5: Environmental media (air, water, groundwater, and soils) not associated with other operable units
Draft Record of Decision: July 3, 1995

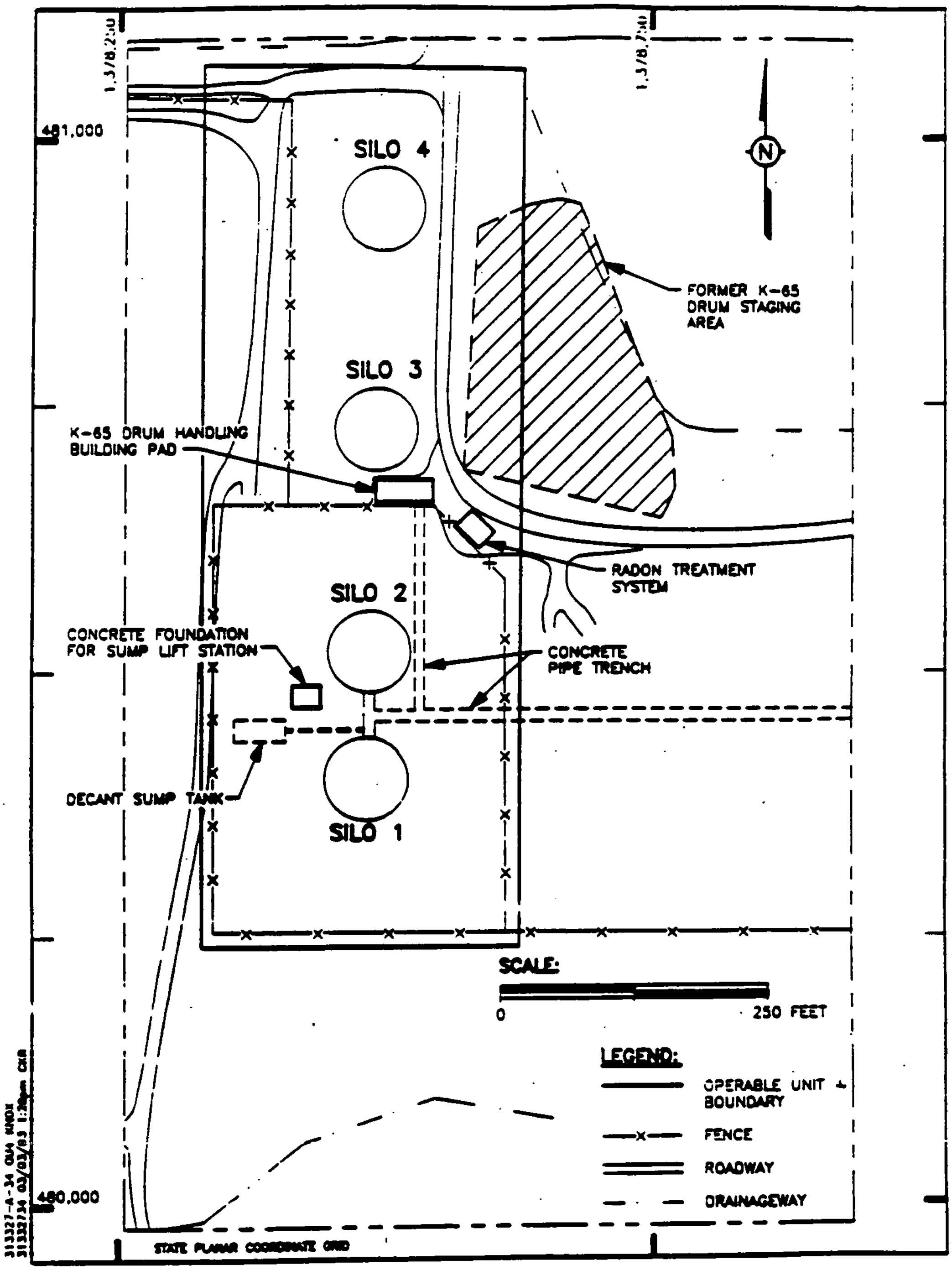
A sixth operable unit, known as the Comprehensive Sitewide Operable Unit, was added as a provision of the Amended Consent Agreement (signed in 1991). This is not a specific site area; rather, it was created to enable DOE, the EPA, and the public to make a final assessment from a sitewide perspective that ongoing planned remedial actions identified in the Records of Decision for the five operable units will provide a comprehensive remedy which is protective of human health and the environment.

3.2 COMPONENTS OF OPERABLE UNIT 4

Operable Unit 4 consists of the following site facilities and associated environmental media (see Figure 3-1):

- Silos 1 and 2 (commonly known as the K-65 Silos) and their contents
- Silo 3 and its contents (cold metal oxides silo)
- Silo 4 (empty, except for rainwater infiltration)
- K-65 decant sump tank and its contents
- A radon treatment system
- A portion of a concrete pipe trench and other concrete structures
- An earthen berm surrounding Silos 1 and 2
- Soils beneath and immediately surrounding Silos 1, 2, 3, and 4
- Perched groundwater encountered in the vicinity of the silos during the implementation of cleanup activities

FIGURE 3-1
OPERABLE UNIT 4 AREA



4.0 SUMMARY OF CONTAMINATION AND RISKS

This section provides an overview of the contaminated media, properties of the residues remaining in inventory within Operable Unit 4, and the nature and extent of the contaminants of concern associated with these stored residues. This section describes exposure pathways and provides a summary of the potential risks to human health posed by the continued storage of these materials within Operable Unit 4 and an overview of the potential risks posed by the FEMP to ecological receptors.

4.1 CONTAMINATED MEDIA

Section 2 of the Proposed Plan identified contaminated materials and environmental media associated with Operable Unit 4. These materials include:

- K-65 residues, also known as "hot raffinates," contained in Silos 1 and 2; metal oxides, also known as "cold metal oxide," contained in Silo 3; and sludge in the decant sump tank.

- Structural material and equipment, including concrete and metal structural materials used in the construction of Silos 1, 2, 3, and 4, and contaminated equipment, including the decant sump tank, process piping, process piping trench material, and radon treatment system.

- Soil within the Operable Unit 4 boundaries including surface soil around the silos, subsurface soil beneath the silos and around pipe trenches, and berm soil around Silos 1 and 2.

- Residual water contained in Silo 4 and perched groundwater that may be encountered during potential remedial actions within the Operable Unit 4 boundaries.

With the exception of perched groundwater encountered during potential remedial actions, surface water and groundwater are not addressed as source media within the Feasibility Study Report for Operable Unit 4. With regard to surface water, there are no surface water impoundments within Operable Unit 4. Potential remediation of groundwater contamination for the entire FEMP site is being addressed as part of Operable Unit 5. Thus, within the Operable Unit 4 baseline risk assessment, groundwater is considered as an environmental receptor medium but not as a source term for which remedial actions are addressed. On the basis of available site characterization data, estimates were made for the volume of wastes and contaminated environmental media requiring remedial action, and are presented in Table 4-1.

4.2 CONSTITUENTS OF CONCERN

4.2.1 Determination of Constituents of Concern

The chemical and radiological constituents present within the stored waste inventories and environmental media within the Operable Unit 4 Study Area present certain risks to human and environmental receptors. The type and degree of this risk has been estimated for existing or baseline conditions using EPA risk assessment methodology. A baseline risk assessment estimates the risks

TABLE 4-1

MATERIAL VOLUME ESTIMATES
OPERABLE UNIT 4

Media	Volume		
Waste Material	Waste Residue	Bentonite Clay	Total Waste
Silo 1 contents[a]	3,282 m^3 (4,293 yd^3)	357 m^3 (467 yd^3)	3,639 m^3 (4,760 yd^3)
Silo 2 contents[a]	2,843 m^3 (3,719 yd^3)	314 m^3 (411 yd^3)	3,157 m^3 (4,130 yd^3)
Silo 3 contents[b]	3,890 m^3 (5,088 yd^3)		3,890 m^3 (5,088 yd^3)
Decant sump tank sludge[b]			3,785 L (1,000 gallons)
Structural Material and Equipment[c]			
Silo 1, 2, and 3 structures			1,530 m^3 (2,000 yd^3)
Silo 4 structure			510 m^3 (670 yd^3)
Decant sump tank, process piping, process piping trenches, radon treatment system			280 m^3 (370 yd^3)
Drum handling building pad, sump lift station concrete			20 m^3 (30 yd^3)
Soil			
Berm soil[d]			8,060 m^3 (10,540 yd^3)
Surface soil[e]			3,400 m^3 (4,440 yd^3)
Subsoil[f]			11,200 m^3 (14,650 yd^3)
Residual Water			
Decant sump tank water[g]			30,280 L (8,000 gallons)
Residual water (Silo 4)[h]			49,210 L (13,000 gallons)
Water encountered during remedial actions			Unknown

[a] Volume estimate based on silo surface mapping results
[b] Volume estimate based on visual observations during sampling operations
[c] Volume estimate based on available construction drawings. Note that Silo 4 structure considered non-contaminated by process knowledge.
[d] Volume estimate based on quantity of soils comprising berms
[e] Volume estimate based on soil depth of 6 inches across entire OU4 area
[f] Volume estimate based on soil depth of 5 feet extending beneath Silos 1 and 2 to toe of berm, includes 5 foot soil depth beneath decant sump tank
[g] Assumes refilling of decant sump tank by infiltrating liquid after the most recent pumping of the decant sump tank which was completed as a maintenance action in January, 1993.
[h] Volume assumed to collect based on historical in-leakage of rainwater through silo dome.

that could occur in and around the FEMP site in the event no further cleanup actions are taken. These risks are evaluated for the situation as it presently exists and for how it could exist up to 1,000 years in the future.

Risks to human health that might result from various hypothetical exposures to site contaminants were estimated with standard methods that have been developed by the EPA and other agencies. Two types of health effects can result from exposures to radionuclides and chemicals: carcinogenic, (e.g., lung cancer caused by inhalation of radon) and noncarcinogenic diseases (e.g., nephritis of the kidney caused by ingestion of uranium). To limit the likelihood of someone getting cancer from contamination at a CERCLA site, the EPA has established a range of from one in one million ($1x10^{-6}$) to one in ten thousand ($1x10^{-4}$) for the incremental lifetime risk of cancer associated with possible exposures (EPA 1990). Cancer risk is defined as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to a potential carcinogen (EPA 1991a). This range is referred to as the "target range" to provide a point of reference for the risk estimates presented in this section. It represents the increased probability (over the background cancer rate) that someone could get cancer during their lifetime if they were repeatedly exposed to contaminants at the FEMP site.

To put this risk range in the context of the background cancer rate, it is estimated that about one in three Americans will develop cancer during their lifetime from all causes (American Cancer Society 1992) and that the risk from exposure to radiation naturally occurring in the environment is about one in one hundred ($1x10^{-2}$), primarily from radon (EPA 1989d). Thus, the EPA target range for CERCLA cleanup sites is a very small percentage of the normal cancer risk expected in the general United States population from everyday exposures and other causes. For example, the incremental risk targeted by the upper end of EPA's range means that if all persons in a population of 10,000 were assumed to be repeatedly exposed to a site's contaminants, one person might get cancer as a result of those exposures in addition to the estimated 3,000 cancer cases expected from all other causes.

To address the possibility that someone could incur a disease other than cancer from contamination at a CERCLA site, the EPA has developed a measure called a hazard quotient. This quotient is determined by comparing the amount of a specific contaminant that someone might intake during exposures at a site with the dose that the scientific community considers safe or acceptable for that contaminant. Exposures to more than one contaminant can result in multiple hazard quotients. The sum of these hazard quotients equals the hazard index. If the hazard index exceeds one, a noncarcinogenic health effect might result from the estimated exposure. This value is used as the point of reference for the results presented in this discussion.

For someone to be at risk for an adverse health effect from a contaminated site, the individual must be exposed to the waste at that site. To help establish the need to undertake cleanup at a CERCLA site, the EPA evaluates the risk an individual site possesses, utilizing an assumption that no institutional controls are in place and no cleanup action is taken. By this approach, the primary hazards can be identified, and it can be determined whether someone who might enter the site could be at risk.

4.2.2 <u>Identified Constituents of Concern</u>

The Remedial Investigation Report for Operable Unit 4 identified many different radiological and chemical constituents that were present within the contaminated media. However, not all of them pose significant health risks, because they are either naturally-occurring or present at levels which pose no additional risk. The Baseline Risk Assessment for Operable Unit 4 evaluated constituents and exposure pathways to ascertain their potential present and future impacts on human health. Constituents that resulted in risks to a receptor of greater than one in one million ($1x10^{-6}$) or which yielded a Hazard Index greater than 0.2 were designated as constituents of concern (see Tables 4-2 and 4-3). Radiological constituents of concern, by media, are shown in Table 4-2. Chemical constituents of concern, by media, are shown in Table 4-3.

TABLE 4-2

OPERABLE UNIT 4 RADIOLOGICAL CONSTITUENTS OF CONCERN

Radionuclide	Silos 1 & 2	Silo 3	Structure/ Equipment	Soil	Residual Water
Actinium-227	X	X	X		X
Lead-210	X	X	X	X	X
Polonium-210	X		X	X	X
Protactinium-231	X	X	X		X
Radium-224		X	X		X
Radium-226	X	X	X	X	X
Radium-228		X	X		X
Strontium-90				X	X
Technetium-99				X	X
Thorium-228	X	X	X		X
Thorium-230	X	X	X	X	X
Thorium-232	X	X	X		X
Uranium-234	X	X	X	X	X
Uranium-235/236	X	X	X		X
Uranium-238	X	X	X	X	X

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TABLE 4-3

CHEMICAL CONSTITUENTS OF CONCERN
OPERABLE UNIT 4

Chemical	Silos 1 & 2	Silo 3	Structure/ Equipment[a]	Soil	Residual Water[b]
Inorganics					
Antimony	X		X	X	X
Arsenic	X	X	X	X	X
Barium	X	X	X	X	X
Beryllium	X	X	X	X	X
Boron	X		X		X
Cadmium	X	X	X	X	X
Chromium	X	X	X	X	X
Cobalt	X	X	X		X
Copper	X	X	X	X	X
Cyanide	X		X	X	X
Lead	X	X	X		X
Manganese		X	X		X
Mercury	X	X	X		X
Molybdenum	X		X	X	X
Nickel	X	X	X	X	X
Selenium	X	X	X		X
Silver	X	X	X	X	X
Thallium	X	X	X	X	X
Uranium	X[c]	X[c]	X	X[c]	X
Vanadium	X	X	X	X	X
Zinc	X	X	X	X	X
Organics					
2-Butanone	X		X	X	X
2-Hexanone	X		X		X
2-Nitrophenol		X	X		X
4-Methyl-2-pentanone	X		X		X
4-Nitrophenol		X	X		X
Acenaphthylene				X	X
Acetone	X		X	X	X
Aldrin	X		X		X
Anthracene				X	X
Aroclor-1248	X		X		X
Aroclor-1254	X		X	X	X
Aroclor-1260	X		X		X
Benzo(a)anthracene				X	X
Benzo(a)pyrene				X	X
Benzo(b)fluoranthene				X	X
Benzo(g,h,i)perylene				X	X
Benzoic acid	X		X	X	X
Bis(2-ethylhexyl)phthalate	X		X	X	X
Carbon tetrachloride	X		X		X
Chrysene				X	X

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TABLE 4-3
(Continued)

Chemical	Silos 1 & 2	Silo 3	Structure/ Equipment[a]	Soil	Residual Water[b]
Organics (Continued)					
4,4'-DDE	X		X		X
4,4'-DDT	X		X		X
Di-n-butyl phthalate	X		X	X	X
Di-n-octyl phthalate	X		X		X
Dibenzo(a,h)anthracene				X	X
Dieldrin	X		X		X
Diethyl phthalate	X		X		X
Dimethyl phthalate	X		X		X
Endosulfan I	X		X		X
Endosulfan II	X		X		X
Endrin	X		X		X
Fluoranthene	X		X	X	X
Heptachlor epoxide	X		X		X
Indeno(1,2,3-cd)pyrene				X	X
Methylene chloride	X		X	X	X
N-nitroso-di-n-propylamine	X		X		X
Phenanthrene				X	X
Phenol	X		X	X	X
Pyrene	X		X	X	X
Tetrachloroethene	X		X		X
Toluene	X		X	X	X
Tributyl phosphate	X		X		X
Xylenes (total)	X		X	X	X

[a] No samples collected from structures/equipment; however, it is assumed that constituents present in silos have permeated into the concrete structure.

[b] Constituents are primarily based on results of decant sump tank sampling. In addition, constituents detected in silos and soils are assumed to be present in residual water.

[c] Analysis for uranium by inductively coupled argon plasma was not performed, analysis by radiological methods.

4.3 OVERVIEW OF THE BASELINE RISK ASSESSMENT

4.3.1 Exposure Scenarios for the Baseline Risk Assessment

Exposure scenarios are developed to support completion of a baseline risk assessment to depict what might happen in and around the FEMP site if no further cleanup or restoration action is taken. The scenarios are used in determining the need for additional cleanup activities at the site. Five scenarios were modeled to estimate the potential risks to human and ecological receptors resulting from conditions within Operable Unit 4. In each of the five scenarios presented, the term "receptor" refers to a person whose health conditions may be affected by Operable Unit 4 contaminants. Depending on the land use, different risks to human health and the environment could occur.

The Operable Unit 4 baseline risk assessment utilized two "source terms" as a way to predict future risk. The current source term assumed the silos remain in much the same condition as they are today. In the future source term, it was assumed that the Silos 1 and 2 domes collapse and the Silo 3 structure collapses entirely. This would cause the Silo 3 contents to be exposed to the environment whereas the contents of Silos 1 and 2 would be somewhat contained by the surrounding berms and the bentonite cover over the K-65 residues.

It is important to consider that the DOE and the EPA have already decided that the FEMP site will undergo cleanup and remediation. The baseline exposure scenarios are used to show why cleanup is necessary and to identify the sources of contamination and the potential routes (term and pathways) by which humans or the environment could be exposed to these contaminants. Table 4-4 and Table 4-5 present the exposure pathways for each land use scenario. These scenarios are discussed in the following sections.

4.3.1.1 Current Land Use With Access Restrictions (Current Source Term)

In this scenario, the FEMP site is assumed to continue to be operated by DOE as an industrial facility. The current facility access restrictions are assumed to remain in place. Access restrictions (i.e., fencing, signs, security forces, etc.) are intended to keep people from entering contaminated site areas, such as Operable Unit 4, and thereby reduce the risk of exposure to contamination. Their presence promotes the safety of site workers and visitors.

This scenario assumes that DOE maintains a site-specific health and safety program to ensure that non-remediation workers and visitors on property are protected. Therefore, the risk assessment addresses workers subjected to short exposure durations under controlled conditions. These controls include personnel protective equipment and emission control equipment.

Under the scenario with access restrictions, members of the public are assumed to not be permitted to establish residence on the Operable Unit 4 Study Area. A trespassing child receptor is considered

TABLE 4-4

BASELINE EXPOSURE SCENARIOS
CURRENT LAND USE

CURRENT LAND USE WITHOUT ACCESS CONTROLS CURRENT LAND USE WITH ACCESS CONTROLS		
Receptor	**Exposure Pathways (Current Source Term - silos intact)**	**Exposure Pathways* (Future Source Term - silos collapsed)**
On-Property Worker/Groundskeeper	• Breathing airborne contaminants • Touching contaminants in soil • External radiation exposure from contaminated soil and silos • Incidental ingestion of soil	• Breathing airborne contaminants • Touching contaminants in soil • Touching silo contents • External radiation exposure from contaminated soil and silos • Incidental ingestion of soil and silo contents
Trespassing Child	• Breathing airborne contaminants • Touching contaminants in soil and water • External radiation exposure from contaminated soil and silos • Incidental ingestion of soil and water	• Breathing airborne contaminants • Touching contaminants in soil and water • Touching silo contents • External radiation exposure from contaminated soil and silos • Incidental ingestion of soil, water, sediment and silo contents
Off-Property Farmer (assumes the farmer lives on a property right next to the site)	• Breathing airborne contaminants • Eating/drinking farm-produced vegetables/meat/milk	• Breathing airborne contaminants • Drinking groundwater • Eating/drinking farm-produced vegetables/meat/milk • Skin contact with groundwater while bathing
Off-Property Surface Water User (assumes the person gets all home water from the Great Miami River--no groundwater)	• Ingesting surface water • Skin contact with surface water • Eating/drinking farm-produced vegetables/meat/milk or fish from the river	• Ingesting surface water • Skin contact with surface water • Eating/drinking farm-produced vegetables/meat/milk or fish from the river

*Silos are not assumed to collapse for the current land use with access controls scenario

TABLE 4-5

BASELINE EXPOSURE SCENARIOS
FUTURE LAND USE

FUTURE LAND USE WITHOUT ACCESS CONTROLS		
Receptor	**Exposure Pathways (Current Source Term - silos intact)**	**Exposure Pathways (Future Source Term - silos collapsed)**
On-Property Resident Farmer (assumes the farmer lives on the property and conducts agricultural activities)	• Breathing airborne contaminants • Eating/drinking farm-produced vegetables/meat/milk • External radiation exposure from contaminated soil and silos	• Breathing airborne contaminants • Drinking groundwater • Skin contact with groundwater while bathing • Eating/drinking farm-produced vegetables/meat/milk • External radiation exposure from contaminated soil and silos • Skin contact with silo waste
On-Property Resident Child	• Breathing airborne contaminants • Eating/drinking farm-produced vegetables/meat/milk • External radiation exposure from contaminated soil and silos • Touching sediments and surface water	• Breathing airborne contaminants • Drinking groundwater • Skin contact with groundwater while bathing • Eating/drinking farm-produced vegetables/meat/milk • External radiation exposure from contaminated soil and silos • Touching sediments and surface water • Skin contact with silo waste
Off-Property Farmer (assumes the farmer lives on a property right next to the site)	• Breathing airborne contaminants	• Drinking groundwater • Breathing airborne contaminants • Eating/drinking farm-produced vegetables/meat/milk • Skin contact with groundwater while bathing
Off-Property Surface Water User (assumes the person gets all home water from the Great Miami River--no groundwater)	• Drinking surface water • Skin contact with surface water • Eating/drinking farm-produced vegetables/meat/milk or fish from the river	• Drinking surface water • Skin contact with surface water • Eating/drinking farm-produced vegetables/meat/milk or fish from the river

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under this scenario in accordance with EPA's conventional practice. Also, off-property residential receptors are evaluated for this scenario. The following receptors are evaluated under this exposure scenario:

- Off-Property Farmer Receptor - Potential exposures are evaluated to a hypothetical farm family living immediately adjacent to the FEMP property boundary.

- Trespassing Child Receptor - Potential exposures to a hypothetical child who trespasses on FEMP property in the Operable Unit 4 Study Area are evaluated.

- Off-Property User of Surface Water from the Great Miami River - Potential exposures to a hypothetical user of surface water from the river are evaluated.

4.3.1.2 Current Land Use Without Access Restrictions (Current Source Term)

In this scenario, the access restrictions provided by the DOE are assumed to be discontinued, and the site continues to be used as an industrial facility, not owned by the federal government. No further cleanup or remediation is assumed to have been performed other than that which the DOE has already accomplished.

The risk assessment under the scenario without access restrictions also assumes that members of the public would not establish residence on the Operable Unit 4 Study Area. A trespassing child receptor and a worker receptor are considered under this scenario. These hypothetical receptors are assumed to be exposed to contaminants at locations on the existing property of the FEMP. Also, off-site residential receptors are evaluated. The hypothetical receptors evaluated under the exposure scenarios included the same receptors as for the Current Land Use with Access Restrictions and the following additional receptor:

- Groundskeeper Worker Receptor - Potential exposures are evaluated to a non-DOE worker who is present on the property. The worker conducts activities in the Operable Unit 4 Study Area including groundskeeping and maintenance. No groundwater from the Operable Unit 4 Study Area would be used.

4.3.1.3 Current Land Use Without Access Restrictions (Future Source Term)

This scenario is identical to the previous scenario except that it assumes structural failure of the silos would occur while an industrial concern is operating on property. This structural failure scenario assumes collapse of the entire Silo 3 structure and collapse of the domes in Silos 1 and 2. Under this scenario, Silo 3 residues are assumed to be spread over an enlarged area. K-65 residues are assumed to remain within the Silos 1 and 2 walls due to the surrounding berm fill. The principal on-property receptors evaluated under this scenario are workers and a hypothetical trespassing child, since people would not be permitted to live inside the property boundaries. Off-site farmers in the immediate vicinity and nearby residents using surface water from the Great Miami River would also be considered potential receptors. The on-property worker, the trespassing child, and the off-site farmer would be most at risk under this hypothetical exposure scenario due to exposure to chemical hazards and radiological contaminants.

4.3.1.4 Future Land Use Without Access Restrictions (Current Source Term)

The future land use scenario evaluated under the Baseline Risk Assessment assumes that existing access controls are discontinued and the FEMP property reverts to predominant land use in the area - a family farm. The hypothetical receptors considered under this exposure scenarios included the off-property farmer and off-property user of surface water from the Great Miami River previously described, as well as the following:

- The Reasonable Maximum Exposure On-Property Resident Farmer Receptor - Potential exposures are evaluated to a hypothetical farmer who resides on the FEMP property and conducts agricultural activities. Typical activities may include food and feed production, livestock production, and general farm work.

- The Central Tendency On-Property Resident Farmer Receptor - Potential exposures are evaluated to a farmer who resides on the property and conducts agricultural activities. This exposure is similar to the reasonable maximum exposure resident farmer with modifications of exposure parameter values to more closely reflect values typical of actual living conditions.

- On-Property Resident Child Receptor - This receptor is similar to the reasonable maximum exposure resident farmer with modifications of exposure parameter values to reflect values typical of a child.

4.3.1.5 Future Land Use Without Access Restrictions (Future Source Term)

This scenario is identical to the previous one in that access restrictions are assumed to be discontinued, and the facility reverts to a family farming land use. It differs from the previous scenario in that it assumes that Silo 3 eventually collapses and its contents spill, contaminating the surface soil in the Operable Unit 4 Study Area. It also assumes that the Silos 1 and 2 domes also collapse, however, the K-65 residues would be contained within the silo walls due to the surrounding berm fill. Over time, the silo contents would begin leaching to groundwater through the infiltration of rainwater. The main receptors considered under this scenario include the hypothetical on-property resident farmer (reasonable maximum exposure and central tendency), the on-property resident child, and the off-site resident.

4.3.2 Current and Potential Site Risks

Table 4-6 presents the results of the Baseline Risk Assessment for each of the identified exposure scenarios. To assist in evaluating the potential risks to each of the identified receptors, a number of mathematical models were employed to estimate the concentration of contaminants through the environment from the Operable Unit 4 area. The models assist in predicting the affects that the physical processes of nature will have on the movement of contaminants through the environment.

TABLE 4-6
SUMMARY OF BASELINE RISKS

Land Use/ Source Term	Type of Risk	Trespassing Child	Groundskeeper	Off-Site Resident Farmer	Off-Site User of Surface Water	CT On-Property Resident Farmer	RME On-Property Resident Farmer	On-Property Resident Child
Current Land Use Without Access Controls/Silos Intact	Lifetime Cancer Risk Dominant: Pathway Source Constituent Secondary: Pathway Source Constituent	$5.0x10^{-3}$ external radiation soils Ra-226 dermal contact soils beryllium	$2.0x10^{-4}$ external radiation soils Ra-226 dermal contact soils beryllium	$1.0x10^{-4}$ milk consumption air indeno()pyrene	$2.0x10^{-7}$ fish ingestion surface water benzo(b)fluoranthene	NA	NA	NA
	Chemical Hazard Index Dominant: Pathway Source Constituent	3.0 dermal contact surface water uranium	0.1 dermal contact soils antimony	0.05 veg/fruit deposition air uranium	0.0004 veg/fruit ingestion surface water acetone	NA	NA	NA
Current Land Use Without Access Controls/Silos Collapsed	Lifetime Cancer Risk Dominant: Pathway Source Constituent Secondary: Pathway Source Constituent	$1.0x10^{-2}$ external radiation soils Ra-226 external radiation soils Th-228	$2.0x10^{-2}$ external radiation soils Ra-226 external radiation soils Th-228	$2.0x10^{-4}$ veg/fruit deposition air arsenic Milk ingestion air indeno (1,2,3-cd) pyrene	$2.0x10^{-6}$ drinking water surface water U-238 fish ingestion surface water arsenic	NA	NA	NA
0035	Chemical Hazard Index Dominant: Pathway Source Constituent Secondary: Pathway Source Constituent	80.0 dermal contact soils uranium inhalation air cobalt	20.0 inhalation air cobalt	5.0 inhalation air cobalt	0.002 drinking water surface water uranium	NA	NA	NA

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TABLE 4-6
SUMMARY OF BASELINE RISKS
(CONTINUED)

Land Use/ Source Term	Type of Risk	Trespassing Child	Groundskeeper	Off-Site Resident Farmer	Off-Site User of Surface Water	CT On-Property Resident Farmer	RME On-Property Resident Farmer	On-Property Resident Child
Current Land Use With Access Controls/Silos Intact.	Lifetime Cancer Risk	$5.0x10^{-5}$	NA	$1.0x10^{-4}$	$2.0x10^{-7}$	NA	NA	NA
	Dominant: Pathway Source Constituent	dermal contact soils beryllium		milk consumption air indeno()pyrene	fish ingestion surface water benzo(b)fluoranthene			
	Secondary: Pathway Source Constituent	external radiation soils Ra-226						
	Chemical Hazard Index	3.0	NA	0.05	0.0004	NA	NA	NA
	Dominant: Pathway Source Constituent	dermal contact soils antimony		veg/fruit deposition air uranium	veg/fruit ingestion surface water acetone			
Future Land Use/ Silos Intact	Lifetime Cancer Risk	NA	NA	$1.0x10^{-4}$	$2.0x10^{-7}$	$5.0x10^{-3}$	$1x10^{-1}$	$6.0x10^{-2}$
	Dominant: Pathway Source Constituent			milk consumption air indeno()pyrene	fish ingestion surface water benzo(b)fluoranthene	milk ingestion soil indeno()pyrene	milk ingestion soil indeno()pyrene	milk ingestion soil indeno()pyrene
	Secondary: Pathway Source Constituent					meat ingestion soil indeno()pyrene	meat ingestion soil indeno()pyrene	milk ingestion soil benzo(6)floranthene
	Chemical Hazard Index	NA	NA	0.05	0.0004	8.0	20.0	100.0
	Dominant: Pathway Source Constituent			veg/fruit deposition air uranium	veg/fruit ingestion surface water acetone	veg/fruit ingestion soils antimony	veg/fruit ingestion soils antimony	milk ingestion soils silver

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SUMMARY OF BASELINE RISKS
(CONTINUED)

Land Use/ Source Term	Type of Risk	Trespassing Child	Groundskeeper	Off-Site Resident Farmer	Off-Site User of Surface Water	CT On-Property Resident Farmer	RME On-Property Resident Farmer	On-Property Resident Child
Future Land Use/ Silos Collapsed	Lifetime Cancer Risk	NA	NA	2.0×10^{-4}	2.0×10^{-6}	1.0×10^{-1}	>1.0	2.0×10^{-1}
	Dominant:							
	Pathway			veg/fruit deposition	drinking water	external radiation	external radiation	external radiation
	Source			air	surface water	soils	soils	soils
	Constituent			arsenic	U-238	Ra-226	Ra-226	Ra-226
	Secondary:							
	Pathway			inhalation	fish ingestion	external radiation	external radiation	external radiation
	Source			air	surface water	soils	soils	soils
	Constituent			arsenic	arsenic	Th-228	Th-228	Th-228
	Pathway					veg/fruit ingestion	veg/fruit ingestion	veg/fruit ingestion
	Source					soils	soils	soils
	Constituent					Pb-210	Pb-210	arsenic
	Chemical Hazard Index	NA	NA	5.0	0.002	300	500	2000
	Dominant:							
	Pathway			inhalation	drinking water	veg/fruit ingestion	veg/fruit ingestion	veg/fruit ingestion
	Source			air	surface water	soil	soil	soil
	Constituent			cobalt	uranium	arsenic	arsenic	arsenic

Note: Shaded pathway/receptor combinations indicate an incremental increase in lifetime cancer risk of greater than 1 in 1 million, or a chemical hazard index greater than 1.

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Following application of these models, assumptions were made, based upon EPA guidance, as to the quantity of contaminants which a hypothetical receptor could be exposed to through ingestion, inhalation, direct contact, and direct radiation. Conservative assumptions are employed in the models and for the parameters which estimate exposure to provide an upper bound estimate of the risk each of the receptors could reasonably be expected to receive up to 1000 years into the future. For example, for the trespassing child under the current land use with access controls and current source term scenario, the child is assumed to play in Paddys Run immediately adjacent to the silos for four hours per day, for 52 days per year, for 12 years of his/her life. This hypothetical trespassing child is assumed to ingest 0.1 gram of sediment per day from a location which represents the highest measured concentration of contaminants. Similar conservative assumptions are used for potential exposure to this receptor through incidental ingestion of surface water, external radiation, and other pathways. As identified in Table 4-6, the calculated incremental lifetime cancer risk to the hypothetical trespassing child is 5.0×10^{-3} (probability of 5 in one thousand) under the current land use with access controls/current source term scenario. This risk is greater than the generally accepted allowable incremental lifetime cancer risk range in CERCLA of between 10^{-6} and 10^{-4}.

Similar conservative assumptions were employed to calculate the potential reasonable maximum exposures the hypothetical off-site farmer could receive as a result of the existing conditions in Operable Unit 4. For the current land use with access controls/current source term scenario, the off-site farmer is assumed to be present at a hypothetical point which exhibits both the maximum modeled air and groundwater concentrations of contaminants for 350 days per year. At this point the farmer is assumed to ingest 2 liters of groundwater per day, ingest all foodstuffs which were contaminated by air deposition of contaminants, and inhale air containing these maximum levels of contaminants. Other pathways of exposure to this receptor were also considered. On the basis of these and other assumptions, the maximum calculated incremental lifetime cancer risk to the off-site farmer is approximately 1×10^{-4} (probability of 1 in ten thousand). This level is within the generally accepted allowable risk range.

The highest Hazard Index under this same exposure scenario would be 3.0 to the trespassing child, due primarily to antimony, chromium, and uranium in soil.

Of the remaining scenarios, the future land use/future source-term scenario represents the most conservative scenario considered under the Baseline Risk Assessment. Within this scenario, a family is assumed to have established a residence within the Operable Unit 4 boundaries. Additionally, the domes of Silos 1 and 2 are assumed to have failed, and Silo 3 is assumed to have suffered total structural failure, spreading its contents to the surface soil of Operable Unit 4. The dominant radiological cancer risk under this scenario approaches unity (1). The highest risk would be to the on-property resident farmer due to external radiation exposure to concentrations of radium and thorium in soils. The dominant chemical cancer risk (1.0×10^{-1}) would also be to the on-property resident farmer due primarily to ingestion of arsenic and indeno (1,2,3-cd) pyrene through the meat and milk ingestion exposure routes. The total risk to the on-property resident farmer exceeds unity due primarily to the previously described radiological risk. The highest chemical hazard index equals 2000 under this scenario . This would be applicable to the on-property resident child due primarily to ingestion of soil and foodstuffs along with dermal contact with soil materials containing arsenic. These heightened risk levels clearly illustrate and emphasize the need for cleanup and remediation of Operable Unit 4.

4.3.3 Uncertainties

Uncertainties are associated with the information and data used in each phase of the Baseline Risk Assessment for Operable Unit 4. These uncertainties are due to a number of factors, including the conservative bias of parameters, parameter variability (random errors or natural variations), and the necessity of using computer models to predict complex environmental interactions. Uncertainties also arise from the use of animal data to predict the toxic effects and the toxic potency in humans. As EPA has pointed out in their guidance for human health risk assessments, "It is more important to identify the key site-related variables and assumptions that contribute most to the uncertainty than to precisely quantify the degree of uncertainty in the risk assessment" (EPA 1991a). Table 4-7 presents uncertainties in the Operable Unit 4 risk assessment. The potential impact on estimated risks in Table 4-7 gives a quantitative indicator of the extent to which the source of uncertainty may impact the estimates of risk presented in the scenarios. The direction of bias in Table 4-7 provides an indicator of the degree to which the source of uncertainty results in an overstatement of risk (increased conservation from a health protectiveness standpoint) or an understatement of risk (decreased conservation from a health protectiveness standpoint).

4.4 BASELINE ECOLOGICAL RISK ASSESSMENT

A Site-Wide Baseline Ecological Risk Assessment was completed and included in the Site-Wide Characterization Report (DOE 1993b). The purpose of this risk assessment was to estimate the potential and future risks of FEMP site contaminants to ecological receptors (e.g., plants and animals) if no remediation is implemented. The Amended Consent Agreement between EPA and DOE stipulates that Operable Unit 5 is responsible for "Environmental Media" at the FEMP site, and therefore is designated to prepare a Sitewide Ecological Risk Assessment as part of the Remedial Investigation Report for Operable Unit 5. Supplementary discussion on ecological risk assessment issues specific to Operable Unit 4 can be found in Section 6.3.4 of this Proposed Plan. The following section provides a summary of the Baseline Ecological Risk Assessment found in the Sitewide Characterization Report.

4.4.1 Summary of the Baseline Ecological Risk Assessment

The receptors evaluated in the Baseline Ecological Risk Assessment include all organisms, exclusive of humans and domestic animals, potentially exposed to FEMP site contaminants. The ecological risk assessment focuses on a group of indicator species selected to represent a variety of exposure pathways and trophic positions (i.e., location in the food chain). The species evaluated were the

TABLE 4-7

UNCERTAINTIES ASSOCIATED WITH ESTIMATED RISKS FOR OPERABLE UNIT 4

SOURCE OF UNCERTAINTY	POTENTIAL IMPACT ON ESTIMATED RISKS	DIRECTION OF BIAS
The applicability of the future resident farmer scenario	high	increases conservatism
Bias in silo waste sampling	high for radionuclides	increases conservatism
Assumptions in geochemical, groundwater, and air transport modeling	moderate to high	increases conservatism
Impact of sand lens beneath Operable Unit 4 on groundwater model	moderate to high	increases conservatism
Estimated volume of air released from silo headspaces	moderate to high	increases conservatism
Environmental transfer factors for contaminants	moderate to high	increases conservatism
Contaminant toxicity information	moderate to high	increases conservatism
The applicability of the trespassing child scenario under current land use	moderate	increases conservatism
Determination of the Operable Unit 4 RME from all media and exposure routes simultaneously	moderate	increases conservatism
Silo headspace radon concentration measurement data	low	neutral
High sample quantitation limits for some radiological analytical results in silo waste samples	low	decreases conservatism
Heterogeneity of waste form	moderate	increases conservatism
Assumption that concentration is uniformly distributed in contaminated medium	moderate	increases conservatism
Assumption that receptor is continuously at the point of highest air concentration	moderate to high	increases conservatism

white-tailed deer, white-footed mouse, raccoon, red fox, muskrat, American robin, and red-tailed hawk. The species were selected based on species abundance on the FEMP site, trophic position, and habitat requirements.

The assessment examined risks to terrestrial (i.e., land-dwelling) organisms associated with contaminants in two environmental media: surface soils and surface water in Paddys Run. Risks to aquatic (i.e., water-dwelling) organisms were evaluated for exposure to contaminants in Paddys Run, the Great Miami River, and in runoff into the storm sewer outfall ditch.

All nonradioactive and radioactive constituents of greatest human health risk were considered to be of concern for the ecological risk assessment. Estimated ecological risks associated with exposure to site constituents of concern are primarily due to nonradioactive inorganic chemicals in soils rather than to organic chemicals or radionuclides. This is true for both terrestrial and aquatic organisms and for plants as well as wildlife. The relative hazards to individual species varied, but the white-footed mouse consistently had the highest indices of these chemicals. This can be attributed to the assumed intake of insects by the mouse.

Estimated hazards from exposure of terrestrial organisms to constituents of concern in site surface waters were relatively low. Estimated doses to terrestrial organisms at the FEMP site, originating from soil uptake by plants and earthworms, were below levels expected to cause detectable effects. However, as with inorganic chemicals, this conclusion is sensitive to assumptions about muscle to muscle (i.e., prey to predator) transfer of radionuclides. Radiation doses due to water intake were insignificant.

Exposure to radiological contaminants at the measured concentrations in the surface waters and sediments impacted by the FEMP site does not appear to pose a risk to aquatic organisms. However, radionuclides in runoff from the site into surface water would predict estimated exposures to exceed the suggested upper limit of one rad per day (NCRP, 1991). Under this calculation, the most affected organisms would be aquatic plants, receiving a total dose from internal and external exposure of about 140 rad per day. The total dose to fish would be minimally over the limit, at 1.6 rad per day, and the total dose to benthic macroinvertebrates (e.g., crayfish) would be about 14 rad per day. Although the maximum concentrations at low flow were used in source runoff calculations, the minimum values in the storm sewer outfall ditch and Paddys Run are within the same magnitude of values. Doses to aquatic organisms in the Great Miami River would be well below one rad per day. The actual measured concentrations of cadmium, copper, mercury, and silver in surface water exceeded chronic toxicity criteria for the protection of fresh-water organisms.

Actual field studies on the impact of the FEMP site on terrestrial and aquatic communities do not indicate any effects of contaminant impacts in RI/FS plant samples from arsenic and mercury exceeding background levels (i.e., levels of a chemical or radionuclide found in uncontaminated areas near the FEMP site). In addition, although potential impacts at the individual level were predicted for wildlife species, detrimental or adverse impacts have not been observed in the field. This indicates that the predicted potential effects have not occurred. A comparison of the concentrations of inorganic chemical concentrations in site soils to regional background values indicate the average site concentrations are similar to background values. This indication suggests that ecological risks estimated using background values of inorganics would be comparable to those estimated for the FEMP site, and emphasizes the conservative nature of the modeling method used.

4.4.2 Conclusions of the Baseline Ecological Risk Assessment

In summary, although radionuclides are the most pervasive contaminants at the FEMP site, estimated ecological risks to both terrestrial and aquatic organisms are primarily associated with nonradioactive inorganic chemicals (e.g., mercury, zinc, and calcium). Although estimated potential risks utilizing computer models are substantial in some instances, they are based on soil inorganic chemical concentrations comparable to background levels, and damaging effects have not been observed in the field. This suggests that current site-specific ecological risks are low and are essentially the same as for background concentrations of these constituents. In addition, the remediation proposed by DOE will substantially reduce any future potential risks. These risks will be quantified in the Operable Unit 5 Remedial Investigation and Feasibility Study.

In conclusion, actual or threatened releases of hazardous substances from the site, if not addressed by the preferred alternative or one of the other active measures considered, may present a current or potential threat to public health, welfare, or the environment.

5.0 SUMMARY OF ALTERNATIVES

Remedial alternatives were developed by examining available technologies for cleanup that were potentially applicable to the contaminated materials within Operable Unit 4. These alternatives were screened to eliminate those that were impractical to implement or ineffective at addressing the hazards associated with the specific materials. The alternatives which passed this screening process were subjected to a detailed analysis to examine the merits of each at addressing the concerns associated with the operable unit. The results of this detailed review are compared for each of the alternatives in Section 6.0. This section provides a description of each of the remedial action alternatives which passed the screening process and underwent detailed analysis. For more in-depth information on remedial alternatives, refer to the Feasibility Study Report for Operable Unit 4, available for review in the Administrative Record at the Public Environmental Information Center (refer to Section 7.0 of this Proposed Plan).

As previously discussed, the materials within Operable Unit 4 exhibit a wide range of properties. Most notable would be the elevated direct radiation associated with the K-65 residues versus the much lower direct radiation associated with cold metal oxides in Silo 3. Even more significant would be the much lower levels of contamination associated with the soils and building materials, like concrete, within the Operable Unit 4 Study Area. To account for these differences and for the varied cleanup alternatives applying to each waste type, Operable Unit 4 was segmented into three subunits. These subunits, which are listed below, are used through the detailed evaluation of alternatives and the identification of the preferred alternative in Section 6.0.

Subunit A: Silos 1 and 2 contents (K-65 residues and bentonite clay) and the sludge in the decant sump tank

Subunit B: Silo 3 contents (cold metal oxides)

Subunit C: Silos 1, 2, 3, and 4 structures; contaminated soils with the Operable Unit 4 boundary, including surface and subsurface soils and the earthen berm around Silos 1 and 2; the decant sump tank; the radon treatment system; the concrete pipe trench and the miscellaneous concrete structures with Operable Unit 4, and any debris (i.e., concrete, piping, etc.,) generated through implementing cleanup for Subunits A and B.

Table 5-1 presents a brief description of remedial alternatives which were selected for detailed evaluation for each Operable Unit 4 subunit. Sections 5.1 through 5.4 provide a description of each of the Operable Unit 4 remedial alternatives which underwent a detailed analysis. Included within each alternative description is an estimate of the time to implement, the quantities of wastes handled, and the estimated total costs of the alternative. The No-Action Alternative (Section 5.1) is presented as a baseline for comparison purposes. Incorporated within each alternative involving remedial actions is the initiation of on-site cleanup activities within 15 months after the Record of Decision for Operable Unit 4 is approved by the EPA.

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TABLE 5-1

SUMMARY OF OPERABLE UNIT 4 SUBUNIT ALTERNATIVES

OPERABLE UNIT 4 SUBUNIT	ALTERNATIVE	DESCRIPTION
Subunit A Silos 1 and 2 contents and decant tank sludge	0A 2A/VIT 2A/CEM 3A.1/VIT 3A.1/CEM	No action Removal, vitrification, on-property disposal Removal, cement stabilization, on-property disposal Removal, vitrification, off-site disposal at NTS Removal, cement stabilization, off-site disposal at NTS
Subunit B Silo 3 contents (cold metal oxides)	0B 2B/VIT 2B/CEM 3B.1/VIT 3B.1/CEM 4B	No action Removal, vitrification, on-property disposal Removal, cement stabilization, on-property disposal Removal, vitrification, off-site disposal at NTS Removal, cement stabilization, off-site disposal at NTS Removal and on-property disposal
Subunit C Silos 1, 2, 3, and 4 structures, soils, debris	0C 2C 3C.1 3C.2	No action Demolition, removal, on-property disposal Demolition, removal, off-site disposal at NTS Demolition, removal, off-site disposal at Permitted Commercial Facility

The cost estimates include the costs associated with designing the remedy, purchasing equipment, constructing facilities, and decontaminating and demolishing these same facilities when cleanup is completed. These types of costs are termed capital costs. Also included in the costs estimates are operation and maintenance costs for items such as operating or maintaining any treatment equipment and providing any monitoring during or following remedial activities. In order to ensure the ability to compare cost estimates between various alternatives which could require varied time periods to complete, all costs are reported in terms of present worth.

Present worth allows the estimator to account for the effects of inflation and the varied schedules for completing the remedial actions for each alternative by converting future costs to current dollars. The total present worth cost estimate for each alternative represents the amount of money that, if invested in the first year of cleanup and paid out at the assumed discount rate, would be sufficient to cover all capital, operating, and maintenance costs over the duration of the remedial action. Each of the cost estimates assumes an annual inflation rate of seven percent and are accurate within a range of +50 to -30 percent. Additional detailed cost estimates are presented in Appendix E of the Feasibility Study-Environmental Impact Statement (FS-EIS) Operable Unit 4.

Section 121 of CERCLA requires that remedial actions achieve a standard or level of control that is consistent with environmental laws or regulations, which are termed applicable or relevant and appropriate requirements (ARARs). ARARs pertain to all aspects of a remedial action, including the establishment of cleanup levels, the operation and performance of treatment systems, and the design of disposal facilities.

ARARs consist of two sets of requirements, those that are applicable and those that are relevant and appropriate. Applicable requirements are those substantive standards or requirements that specifically address a situation at a CERCLA site. Relevant and appropriate requirements are standards or requirements that address problems sufficiently similar to the situation at a CERCLA site that their use is well suited to the site. In certain cases standards may not exist in the promulgated regulation that address the proposed action or the constituents of concern. In these cases, nonpromulgated advisories, criteria, or guidance that were developed by the EPA, other federal agencies, or states are to be considered (TBC) in establishing remedial action objectives that are protective of human health and the environment.

A detailed discussion of all ARARs and TBC criteria associated with the remedial alternatives being evaluated for Operable Unit 4 is presented in Appendix F of the Feasibility Study Report for Operable Unit 4. From these detailed lists, certain major ARARs and TBCs were selected based on their importance in protecting human health and the environment. These include those associated with the protection of drinking water sources, the control of radionuclide emissions, the design and siting of a solid waste disposal facility, the management of Resource Conservation and Recovery Act (RCRA) hazardous waste, and compliance with NEPA.

The major ARARs associated with the remedial alternatives evaluated in this section, with the exception of the no action alternatives, are presented in Tables A-1 through A-3 in Appendix A of this Proposed Plan. These major ARARs are segregated into three types:

(a) Chemical-specific ARARs are usually health- or risk-derived numerical values that establish an acceptable level or concentration of chemical or radionuclide that may remain in specific environmental media after remediation is complete. These levels are deemed to be protective of human health and are used to help establish remedial cleanup goals.

(b) Location-specific ARARs generally restrict certain activities, or dictate where certain activities may be conducted, solely because of geographical, hydrologic, hydrogeologic, or land use concerns.

(c) Action-specific ARARs are usually restrictions on the conduct of certain activities or the operation of certain technologies at the site.

The tables identify all remedial alternatives associated with the major regulatory requirement, the rationale for designation of the regulatory requirement as an ARAR/TBC, and the mechanism by which the remedial alternative will comply with the requirement. All of the alternatives discussed in Sections 5.2 through 5.4, would meet all pertinent ARARs identified for these alternatives.

5.1 NO-ACTION ALTERNATIVE FOR ALL SUBUNITS

The No-Action Alternative for Subunits A, B, and C is presented to provide a baseline for comparison with the other alternatives per the President's Council on Environmental Quality and the National Oil and Hazardous Substances Pollution Contingency Plan regulations. Under the No-Action Alternatives, designated as 0A, 0B, and 0C for each of the three subunits, the contaminated and/or uncontaminated materials within each subunit would remain unchanged without any further removal, treatment, or containment activities.

Alternatives 0A, 0B, and 0C do not provide for monitoring of soil, groundwater, or radon emissions from the Operable Unit 4 facilities or soils, and do not provide for access controls (e.g., physical barriers and deed restrictions) taken to reduce the potential for exposure to any human or ecological receptors. The No-Action Alternatives would not decrease the toxicity, mobility, or volume of contaminants or reduce public health or environmental risks. Also, goals for protecting the underlying groundwater aquifer would not be met. No costs are associated with the No-Action Alternative.

ARAR Compliance for No-Action Alternatives

Alternatives 0A, 0B, and 0C would not comply with a number of chemical-specific, location-specific, or action-specific applicable or relevant and appropriate requirements (ARARs). Under the no-action alternatives, Silos 1, 2, and 3 would eventually fail, resulting in the release of silo contents to the air, soil, groundwater, and surface water. Fate and transport modeling indicate that uranium and gross alpha and beta radiation would exceed safe drinking water limits under 40 CFR § 141. In addition, residual, localized "hot spots" (e.g., radium contaminated soils) could exceed the limits established in 40 CFR § 192.12.

5.2 SUBUNIT A - CONTENTS OF SILOS 1 AND 2

This section presents the alternatives which were evaluated for Subunit A during the detailed analysis of alternatives phase of the Operable Unit 4 feasibility study. These alternatives focus on the remediation of the K-65 residues contained in Silos 1 and 2.

5.2.1 Alternative 2A/Vit - Removal, Vitrification, and On-Property Disposal

Capital Cost:	*$36.5 million (M)*
O&M Costs:	
During Remediation:	*$11.7 M*
Post-Remediation:	*$3.4 M*
Present Worth:	*$43.6 M*

Years to Implement: 6

This alternative requires the removal of Silos 1 and 2 contents along with the sludge in the decant sump tank, stabilization of these materials by vitrification, and on-property disposal of the treated materials. Under Alternative 2A/Vit, approximately 6,790 m^3 (8,890 yd^3) of untreated materials would be removed from Silos 1 and 2. The silo contents would be combined with approximately 3785 L (1000 gallons) of sludge from the decant sump tank and treated. Following treatment, approximately 2770 m^3 (3645 yd^3) of vitrified material would be packaged in DOT specification 7A Type A containers and placed in an on-property above-grade reinforced concrete disposal vault. Disposal of contaminated materials from the berms, Silos 1 and 2 structures, the material removal equipment, and the vitrification system would be managed under the alternatives for Subunit C. In accordance with CERCLA requirements for on-property disposal of the treated materials, a review would be performed every five years by EPA to ensure the continued protection of human health and the environment.

Material Removal

Silos 1 and 2 residues and decant sump tank sludge would be slurried and pumped to the vitrification plant for processing. During the material removal phase, Silos 1 and 2 and the decant sump tank would be equipped with an off-gas handling system to treat radon and other potential airborne contaminants. This off-gas handling system would be operational during material removal, and before personnel enter the area above the silo domes to reposition material removal equipment and conduct repairs or maintenance. The off-gas handling system and operating procedures would be designed as necessary to minimize exposure to personnel located over the work areas and to prevent the escape of radon and radioactive particulates from the silos and the decant sump tank to the atmosphere.

Material Stabilization

Silos 1 and 2 residues and decant sump tank sludge would be combined with glass forming agents and processed in a high temperature furnace and converted into a stable vitrified glass form exhibiting excellent durability and constituent leaching characteristics. It should be noted that current planning focuses upon pouring the molten glass directly into DOT specification 7A Type A containers capable of withstanding the high temperature of the vitrified waste form. The final waste form would continue to be optimized in pilot plant treatability studies and a final decision regarding the final waste form would be reached during the pilot plant treatability studies. Process tanks/vessels and piping containing slurried K-65 residues would be designed to minimize potential radon and particulate emissions to the atmosphere during treatment. The direct radiation associated with the treated residues would remain relatively unchanged from the untreated form of the K-65 residues.

Disposal of Treated Material

Studies completed on a small scale as part of the Remedial Investigation/Feasibility Study (RI/FS) project that the volume of material requiring disposal can be reduced by over 50 percent as a result of applying the vitrification process. The vitrified material would be containerized and disposed in an above-grade reinforced concrete disposal vault located on property. The vault would be constructed on a reinforced concrete mat and equipped with a leachate collection/detection system to facilitate the collection of any contaminated leachate after final closure.

The proposed disposal facility would be located on the northeast portion of the site, north of the former Production Area. This location is subject to change based upon the results of the detailed design process. The location was selected on the basis of the limited prior use of the area and the favorable geologic conditions present at the area. Investigations in this area have identified a significant thickness of low permeability clay. Isolated silt and sand lenses within the clay in this area may be excavated or grouted in place to minimize the potential for vertical or horizontal movement of groundwater underlying the disposal facility. The specific scope of the required engineering controls would be determined as part of detailed design.

Final closure would be completed by the construction of a multimedia cap over the vault. The capping system would be composed of alternating composite soil liners and drainage layers to minimize the potential release of contaminated leachate to the underlying Great Miami Aquifer. This cap would include a clay cover to eliminate radon emanation from the disposed materials and a barrier to preclude intrusion by burrowing animals and hypothetical future residents of the area. Upon completion of the multimedia cap, access controls such as fencing would be installed. Monitoring wells would be appropriately located to evaluate the effectiveness of the above-grade disposal vault in ensuring long-term protection of human health and the environment. To provide added assurance against any future activities by man to inadvertently intrude into the disposal vault, permanent markers would be installed to identify the vault and restrictions would be placed in the site deed. Additionally, the affected disposal areas at the FEMP would be placed under the perpetual ownership of the federal government. While the disposal vault would be designed to not require any continued active operations or maintenance, perpetual ownership would permit the government to continue to exercise its right to preclude any development or drilling in areas where contaminated materials are disposed.

All facilities and equipment installed and used by this alternative would be disassembled and decontaminated during the post-remediation phase. Contaminated materials would be disposition in accordance with Subunit C alternatives.

Implementation Time and Costs

Remedial action activities under Alternative 2A/Vit could be completed in approximately six years. Construction, testing, and start-up of the material processing facility would require about three years. The treatment facility, which would operate concurrently with residue removal operations, would require about three years to complete the vitrification of the silo residues. Capital costs for alternative 2A/Vit are estimated to be 36.5 million dollars. Operation and maintenance (O&M) costs during remediation are estimated at 11.7 million dollars over three years while post-remediation O&M costs are estimated at 3.4 million dollars over a thirty year period. The total present worth cost for this alternative is estimated at 43.6 million dollars.

5.2.2 Alternative 2A/Cem - Removal, Cement Stabilization, and On-Property Disposal

Capital Cost:	*$71.2 M*
O&M Costs:	
During Remediation:	*$11.7 M*
Post-Remediation:	*$ 3.6 M*
Present Worth:	*$74 M*
Years to Implement:	*6*

Alternative 2A/Cem would require the removal of Silos 1 and 2 contents along with the decant sump tank sludge using removal methods identical to those identified in Alternative 2A/Vit, followed by cement stabilization of this material, and on-property disposal of the treated material. Under Alternative 2A/Cem, approximately 6,790 m^3 (8,890 yd^3) of untreated materials would be removed from Silos 1 and 2. The silo contents would be combined with approximately 3,785 L (1,000 gallons) of sludge from the decant sump tank and treated. Following treatment, approximately 18,166 m^3 (23,903 yd^3) of cement stabilized material would be packaged in DOT specification 7A Type A containers and placed in an on-property above-grade reinforced concrete disposal vault using methods identical to those used in Alternative 2A/Vit. Disposal of contaminated materials from the berms, Silos 1 and 2 structures, the material removal equipment and the cement stabilization systems would be managed under the alternatives for Subunit C. In accordance with CERCLA requirements for on-property disposal of the treated materials, a review would be performed every five years by EPA to ensure the continued protection of human health and the environment. The components of this alternative not previously described are as follows:

Material Stabilization

Silo 1 and 2 residues and the decant sump tank sludge would be combined with cement and other additives necessary for stabilizing the materials into a cement form. Similar to Alternative 2A/Vit, process tanks/vessels and piping containing slurried K-65 residues would be designed to minimize potential radon and radionuclide particulate emissions to the atmosphere during treatment. Studies conducted on a small scale in a laboratory, as part of the Operable Unit 4 RI/FS, indicate that an estimated 150 percent increase can be expected in the volume of waste requiring disposal following stabilization. This increase is a result of the large volume of additives needed to effectively stabilize the silo residues and decant sump tank sludge in cement. These studies have also concluded that the cement stabilization of the wastes effectively reduces the radon emission rate from the waste and the tendency of the waste to leach contaminants into groundwater. The direct radiation associated with the untreated residues would be slightly reduced due to the effects of mixing the additives with the residues. The solidified materials would be packaged in containers for disposal.

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Implementation Time and Costs

Remedial action activities under Alternative 2A/Cem could be completed in approximately six years. Approximately three years are projected for completion of site preparation, facilities construction, equipment installation, testing, and start-up of the material processing facility. Material removal and treatment activities would require about three years. Capital costs for Alternative 2A/Cem are estimated to be 71.2 million dollars. Operation and maintenance (O&M) costs during remediation are estimated at 11.7 million dollars over three years, while post-remediation O&M costs are estimated at 3.6 million dollars over a thirty year period. The total present worth cost for this alternative is estimated at 74 million dollars.

5.2.3 Alternative 3A.1/Vit - Removal, Vitrification, and Off-Site Disposal - Nevada Test Site

Capital Cost:	*$38 M*
O&M Costs:	
During Remediation:	*$11.7 M*
Post-Remediation:	*$0*
Present Worth:	*$43.5 M*
Years to Implement:	*6*

This alternative involves the removal, vitrification, and off-site disposal of the treated Silos 1 and 2 contents and decant sump tank sludge. This alternative is identical to Alternative 2A/Vit except that the on-property disposal, monitoring, and institutional controls have been replaced by transportation of the treated material to an off-site location for disposal. Treated material would be transported by rail, then truck, to the Nevada Test Site (NTS), a DOE-owned facility that currently accepts low-level radioactive material from DOE facilities for disposal. Under Alternative 3A.1/Vit, approximately 6,790 m^3 (8,890 yd^3) of untreated residues would be removed from Silos 1 and 2 and combined with approximately 3,785 L (1,000 gallons) of sludge from the decant sump tank and treated. Approximately 2,770 m^3 (3,645 yd^3) of vitrified material would be packaged in DOT specification 7A Type A containers and transported to NTS for disposal. Disposal of contaminated materials from the berms, Silos 1 and 2 structures, the material removal equipment, and the vitrification system would be managed under the alternatives for Subunit C. The components of this alternative not previously described are as follows:

Disposal of Treated Material

Off-site disposal for this alternative involves the packaging, loading, and shipping of the treated material, in accordance with all required Department of Transportation (DOT) regulations, to the low-level radioactive disposal site at NTS. Shipment of the treated material to NTS would be performed by rail transportation from the FEMP site. Currently, there are no direct rail lines into the NTS. The treated material would be transported by rail to either a point near Las Vegas, Nevada, or one of the areas north of Las Vegas. From either location, the containers carrying the treated material would be transferred to trucks for transportation over roads to NTS.

NTS is located approximately 3219 kilometers (km) [2000 miles (mi)] from the FEMP site. It is currently in operation and it is assumed that NTS has both the resources and the capacity to accept any of the stabilized Operable Unit 4 material. Disposal at the NTS would be very effective at precluding human contact with and contaminant migration from the treated residues from Subunit A. The FEMP site has an approved NTS waste shipment and certification program that is periodically audited by NTS. Efforts have been initiated to amend the current program to include Operable Unit 4 treated material. All NTS waste acceptance requirements would need to be satisfied.

Implementation Time and Costs

Remedial action activities under Alternative 3A.1/Vit could be completed in approximately six years. Approximately three years is projected for completion of site preparation, facilities construction, and equipment installation. Material removal and treatment activities would require about three years. Transportation and off-site disposal would conclude shortly after the completion of material processing. Capital costs for Alternative 3A.1/Vit are estimated to be 38.0 million dollars. Operation and maintenance (O&M) costs during remediation are estimated at 11.7 million dollars over three years. Due to the off-site disposal option, there are no post-remediation O&M costs associated with this alternative. The total present worth cost for this alternative is estimated at 43.5 million dollars.

5.2.4 Alternative 3A.1/Cem - Removal, Cement Stabilization, and Off-Site Disposal - NTS

Capital Cost:	*$69.9 M*
O&M Costs:	
During Remediation:	*$11.7 M*
Post-Remediation	*$0*
Present Worth:	*$71.4 M*
Years to Implement:	*6*

This alternative is identical to Alternative 2A/Cem except that the on-property disposal, monitoring, and institutional controls have been replaced by transportation of the treated material off site. Treated material and debris would be transported by rail or truck to the NTS, a DOE-owned facility that currently accepts low-level radioactive material from DOE facilities for disposal. Under Alternative 3A.1/Cem, approximately 6,790 m^3 (8,890 yd^3) of untreated materials would be removed from Silos 1 and 2 and combined with approximately 3785 L (1000 gallons) of sludge from the decant sump tank and treated. Approximately 18,166 m^3 (23,903 yd^3) of cement stabilized product would be packaged in DOT specification 7A Type A containers and transported to NTS for disposal. Disposal of contaminated materials from the berms, Silos 1 and 2 structures, the material removal equipment, and the cement stabilization system would be managed under the alternatives for Subunit C.

Implementation Time and Costs

Remedial action activities under Alternative 3A.1/Cem could be completed in about six years. Approximately three years are projected for completion of site preparation, facilities construction, and

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equipment installation. Material removal and treatment activities would require about three years. Transportation and off-site disposal would conclude shortly after the completion of material processing. Capital costs for Alternative 3A.1/Cem are estimated to be 69.9 million dollars. Operation and maintenance (O&M) costs during remediation are estimated at 11.7 million dollars over three years. Due to the off-site disposal option, there are no post-remediation O&M costs associated with this alternative. The total present worth cost of this alternative is estimated at 71.4 million dollars.

5.3 SUBUNIT B - CONTENTS OF SILO 3

This section presents the alternatives which were evaluated for Subunit B during the detailed analysis of alternatives phase of the Operable Unit 4 feasibility study. These alternatives focus on the remediation of the cold metal oxides contained in Silos 3.

5.3.1 Alternative 2B/Vit - Removal, Vitrification, and On-Property Disposal

Capital Cost:	*$25.2 M*
O&M Costs:	
During Remediation:	*$4.9 M*
Post-Remediation:	*$3.2 M*
Present Worth:	*$28.0 M*
Years to Implement:	*4*

This alternative requires the removal, vitrification, and on-property disposal of the Silo 3 contents. Under Alternative 2B/Vit, approximately 3,890 m^3 (5,088 yd^3) of untreated materials would be removed from Silo 3 and stabilized in a vitrified glass form. Following treatment, approximately 1,471 m^3 (1,935 yd^3) of vitrified material would be packaged in containers and placed in an on-property above-grade reinforced concrete disposal vault. The Silo 3 structural materials and associated soils would be managed under Subunit C alternatives. In accordance with CERCLA requirements for on-property disposal of the treated materials, a review would be performed every five years by the EPA to ensure the continued protection of human health and the environment. The components of this alternative not previously described are as follows:

Material Removal

Due to the powder-like characteristics of Silo 3 cold metal oxide residues, Alternative 2B/Vit would utilize a pneumatic removal process to transport Silo 3 contents to the material processing facility. The pneumatic removal system consists of a compressed air-driven pump that displaces and removes the dry wastes. Air entrained in the cold metal oxides, suctioned from Silo 3, would be separated using filter/receiver systems allowing the cold metal oxides to be pneumatically "pushed" to the vitrification facility. A glove box system would be used at the interface of the pneumatic removal system and the silo dome to function as secondary containment. This arrangement, along with appropriate operations procedures, would be designed to prevent releases to the atmosphere during operations.

Material Stabilization

The vitrification process is identical to that described in Section 5.2.1 for Alternative 2B/Vit. Studies conducted as part of the RI/FS on a small scale in a laboratory indicate that vitrification can effectively reduce the tendency of the Silo 3 residues to leach inorganics and radionuclides to groundwater. This testing also demonstrated that over a 50 percent reduction in the volume of material requiring disposal could be achieved through the application of vitrification technology to the Silo 3 residues. The vitrified residues would be packaged in containers for disposal.

Implementation Time and Costs

Remedial action activities under Alternative 2B/Vit could be completed in about four years. Site preparation and construction activities would take approximately three years. Removal and material processing activities would require about one year. Capital costs for Alternative 2B/Vit are estimated to be 25.2 million dollars. Operation and maintenance (O&M) costs during remediation are estimated at 4.9 million dollars over one year, while post-remediation O&M costs are estimated at 3.2 million dollars over a thirty year period. The total present worth cost for this alternative is estimated at 28.0 million dollars.

5.3.2 Alternative 2B/Cem - Removal, Cement Stabilization, and On-Property Disposal

Capital Cost:	*$35.9 M*
O&M Costs:	
During Remediation:	*$4.9 M*
Post-Remediation:	*$3.2 M*
Present Worth:	*$37.4 M*
Years to Implement:	*4*

This alternative uses the material removal methodology presented in Alternative 2B/Vit, followed by treatment of the Silo 3 contents by cement stabilization, and on-property disposal of the stabilized material. Under Alternative 2B/Cem, approximately 3,895 m^3 (5,088 yd^3) of untreated materials would be removed from Silo 3 and stabilized in a cement form. Approximately 5,999 m^3 (7,894 yd^3) of stabilized material would be packaged in DOT specification 7A Type A containers and placed in an on-property above-grade reinforced concrete disposal vault. The Silo 3 structural materials and associated soils would be managed under Subunit C alternatives. In accordance with CERCLA requirements for on-property disposal of the treated materials, a review would be performed every five years by the EPA to ensure the continued protection of human health and the environment. The components of this alternative not previously discussed are as follows:

Material Stabilization

The cement stabilization process is identical to that described in Section 5.2.2 for Alternative 2A/Cem with the exception of differences in the cement formulations required to accommodate physical and chemical differences between K-65 residues and Silo 3 cold metal oxides. Treatability studies have indicated that cementation of the Silo 3 metal oxides would result in an approximately 50 percent increase in the volume of treated material, requiring disposal, over the untreated material.

Implementation Time and Costs

Remedial action activities under Alternative 2B/Cem could be completed in about four years. Site preparation and construction activities would take approximately three years. Removal and material processing activities would require about one year. Capital costs for Alternative 2B/Cem are estimated to be 35.9 million dollars. O&M costs during remediation are estimated at 4.9 million dollars over one year, while post-remediation O&M costs are estimated at 3.2 million dollars over a thirty year period. The total present worth cost for this alternative is estimated at 37.4 million dollars.

5.3.3 Alternative 3B.1/Vit - Removal, Vitrification, and Off-Site Disposal - NTS

Capital Cost:	*$26.6 M*
O&M Costs:	
During Remediation:	*$4.9 M*
Post-Remediation:	*$0*
Present Worth:	*$27.9 M*
Years to Implement:	*4*

This alternative involves the removal, stabilization, and off-site disposal of the Silo 3 contents. This alternative is identical to Alternative 2B/Vit, except that the on-property disposal, monitoring, and institutional controls have been replaced by the transportation of the treated material by rail and/or truck to the NTS for disposal. Under Alternative 3B.1/Vit, approximately 3,895 m^3 (5,088 yd^3) of untreated materials would be removed from the silo. Approximately 1,471 m^3 (1,935 yd^3) of vitrified material would be packaged in DOT specification 7A Type A containers and transported to NTS for disposal. Alternative 3B.1/Vit would have to meet applicable off-site requirements which include the NTS material acceptance criteria and the U. S. Department of Transportation regulations pertaining to the transport of hazardous and radioactive materials.

Implementation Time and Costs

Remedial action activities under Alternative 3B.1/Vit could to be completed in about four years. Site preparation and construction activities would take approximately three years. Removal activities would require about one year. Transportation and off-site disposal would conclude shortly after the completion of material processing. Capital costs for Alternative 3B.1/Vit are estimated to be 26.6 million dollars. O&M costs during remediation are estimated at 4.9 million dollars over one year. Due to the off-site disposal option, there are no post-remediation O&M costs associated with this alternative. The total present worth cost of this alternative is estimated at 27.9 million dollars.

5.3.4 Alternative 3B.1/Cem - Removal, Cement Stabilization, and Off-Site Disposal - NTS

Capital Cost:	*$36.1 M*
O&M Costs:	

During Remediation: *$4.1 M*
Post-Remediation: *$0*
Present Worth: *$35.4 M*
Years to Implement: *4*

This alternative is identical to Alternative 3B.1/Vit (Section 5.3.3), except that Silo 3 contents would be stabilized in cement prior to off-site disposal at NTS as described for Alternative 2B/Cem (Section 5.3.2). Under Alternative 3B.1/Cem, approximately 3,895 m^3 (5,088 yd^3) of contaminated materials would be removed from Silo 3. Approximately 5,999 m^3 (7,894 yd^3) of stabilized material would be transported to NTS for disposal.

Implementation Time and Costs

Remedial action activities under Alternative 3B.1/Cem could be completed in about four years. Site preparation and construction activities would take approximately three years. Removal activities would require about one year. Transportation and off-site disposal would conclude shortly after the completion of material processing. Capital costs for Alternative 3B.1/Cem are estimated to be 36.1 million dollars. O&M costs during remediation are estimated at 4.1 million dollars over one year. Due to the off-site disposal option, there are no post-remediation O&M costs associated with this alternative. The total present worth cost of this alternative is estimated at 35.4 million dollars.

5.3.5 Alternative 4B - Removal and On-Property Disposal

Capital Cost: *$21.8 M*
O&M Costs:
During Remediation: *$1.1 M*
Post-Remediation: *$3.2 M*
Present Worth: *$22.0 M*
Years to Implement: 2

This alternative requires removal of the Silo 3 contents, packaging, and on-property disposal of the untreated material. This alternative is identical to Alternative 2B, with the exception that it does not include treatment. Under Alternative 4B, approximately 3,895 m^3 (5,088 yd^3) of contaminated materials would be removed from Silo 3 and packaged in containers for disposal in an on-property above-grade reinforced concrete disposal vault. The Silo 3 structural materials and associated soils would be managed under the Subunit C alternative. In accordance with CERCLA requirements for on-property disposal of the treated materials, a review would be performed every five years by the EPA to ensure the continued protection of human health and the environment.

Implementation Time and Costs

Remedial action activities under Alternative 4B could be completed in about two years. Site preparation and construction activities would take approximately one year. Removal and packaging activities would require about one year. Capital costs for Alternative 4B are estimated to be 21.8 million dollars. O&M costs during remediation are estimated at 1.1 million dollars over one year.

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Post-remediation O&M costs are estimated to be 3.2 million dollars. The total present worth cost of this alternative is estimated at 22 million dollars.

5.4 SUBUNIT C - SILOS 1, 2, 3, AND 4 STRUCTURES, SOILS, AND DEBRIS

This section presents the alternatives which were evaluated for Subunit C during the detailed analysis of alternatives phase of the Operable Unit 4 Feasibility Study. These alternatives focus on the remediation of Silos 1, 2, 3, and 4 structures, contaminated soils within the Operable Unit 4 boundary including surface and subsurface soils and the earthen berms around Silos 1 and 2, the existing Radon Treatment System (RTS), the K-65 Drum Handling Building pad, standing water within Silo 4 (if any), the decant sump tank, the process piping and trenches, and any rubble or debris (i.e., decontamination and decommissioning (D&D) of the treatment facility) generated consequential to the implementation of remedial actions for all Operable Unit 4 subunits.

It should be recognized that the volume of contaminated soils and rubble being addressed under Subunit C is less than one percent of the volumes of similar contaminated materials anticipated to be generated and handled on a sitewide basis under the five FEMP operable units. In the development of all remedial alternatives for Subunit C materials, this PP has considered the integration of several treatment programs currently under development, which potentially can offer waste minimization opportunities in the near future. Operable Unit 3 is currently developing pilot plant programs which focus upon the treatment of rubble and debris prior to disposal. Likewise, because Operable Unit 5 contains the majority of the sitewide soils to be considered for remediation, it is currently evaluating technologies and alternatives which have the potential to treat the Operable Unit 4 contaminated soils.

To ensure the proper integration of sitewide cleanup strategies, activities and the responsible expenditure of available resources, interim storage of Operable Unit 4 Subunit C generated soils, rubble, and debris may be necessary for a period of time. Interim storage would be provided to enable full utilization of projected treatment systems (e.g., Operable Unit 5 soil washing) and to provide for consistency in FEMP waste management strategies. Interim storage facilities and practices would be consistent with approved removal action procedures, identified ARARs and other direction provided by EPA. In addition, the management of the Operable Unit 4 contaminated soil and debris during interim storage would include measures, consistent with the work plan for Removal Action Number 17 - Improved Storage of Soil and Debris, to ensure future identification and retrivability of these wastes for final disposition.

Preliminary information indicates that to reduce uranium-238 and its two progeny to essentially background concentrations, necessary to reduce the risk to the on-property farmer to an ILCR of 10^{-6}, is not feasible. Operable Unit 5 Treatability Study results to date indicate that soil washing technology is limited to significantly higher concentrations of radiological contamination. Therefore, the proposed final remediation levels for Operable Unit 4 reflect a future land use consistent with the Site-Wide Characterization Report and the Comprehensive Response Action Risk Evaluation.

However, additional input from the Fernald Citizen Task Force and the public is essential before making final recommendations on land use from a site-wide perspective. The Operable Unit 4 soil final remediation levels will be re-examined by the Operable Unit 5 Feasibility Study Report and Record of Decision based upon available Operable Unit 5 Feasibility Study conclusions, recommendations from the Fernald Citizen Task Force, and further public comment. If found to be necessary, the Operable Unit 5 Record of Decision will modify the Operable Unit 4 final remediation levels downward to ensure protectiveness of human health and the environment.

5.4.1 Alternative 2C - Demolition, Removal, and On-Property Disposal

Capital Cost:	*$36.3*
O&M Costs:	
During Remediation:	*$0*
Post-Remediation:	*$3.6 M*
Present Worth:	*$34.3 M*
Years to Implement:	*2*

Alternative 2C involves the demolition of the Silos 1, 2, 3, and 4 structures and disposal of the materials from the removal of the earthen berm, decant sump tank, process piping, and trenches. Alternative 2C further addresses the excavation of contaminated subsurface soils within the operable unit boundary and disposal of the debris generated as a result of implementing remedial actions for Subunits A and B. Contaminated material would be placed in an above-grade disposal vault at the FEMP site. Under Alternative 2C, approximately 25,000 m^3 (32,700 yd^3) of material would be placed in an on-property above-grade disposal vault. Since material would remain on property under Alternative 2C, a review would be performed every five years by EPA in accordance with CERCLA to ensure the continued protection of human health and the environment.

Demolition and Decontamination of the Silo Structures

Before Silos 1, 2, 3, and 4 are demolished, loose interior materials and concrete would be removed from the silo surfaces. Silo demolition would consist of the systematic removal, dismantling, and disposal of the Silos 1, 2, 3, and 4 domes, walls, floor slabs and footers. Removal would involve cutting each of the silo structures into manageable pieces after appropriate bracing has been installed. The demolition would begin with the dismantling of the Silo 4, as this silo has never been used, making it an ideal full-scale model to test and confirm demolition methodologies with minimal risk of radiological release to the environment. Based on experience obtained through the dismantling of Silo 4, demolition of Silos 1, 2, and 3 would proceed according to the sequencing and procedures established during the remedial design and remedial action phases.

Demolition and Decontamination of Other Operable Unit 4 Structures

The existing RTS, Drum Handling Building pad, sump lift station foundation, concrete pipe trench, and the decant sump tank would also be removed and decontaminated. It is estimated that approximately 790 m (2600 ft) of process piping in the process piping trenches would be cut into manageable sections and disposed. It is estimated that 280 m^3 (365 yd^3) of concrete from the trench, decant sump tank process piping, and existing radon treatment system would be disposed. Additionally, all facilities constructed and equipment installed and utilized to implement the selected alternatives for Subunits A and B would be disassembled, decontaminated (if necessary), and disposed.

Non-porous materials, such as steel fencing and structural steel, attaining the unrestricted use, free release criteria defined in DOE Order 5400.5 would be released from the site as uncontaminated. The criteria within DOE Order 5400.5 are equivalent to criteria currently being employed by the Nuclear Regulatory Commission. Materials not attaining these levels would be retained for disposal as contaminated.

Remediation of Soil

After the silos are demolished, the surface soils within the boundary of Operable Unit 4 would be excavated to attain proposed remediation levels for each of the constituents of concern. These cleanup levels consist of incremental concentration levels above background. The concentration of each of these constituents which naturally occurs in local soils would be added to the incremental constituent concentration levels (both listed in Table 5-2) to yield the proposed final remediation levels of the soil excavation process. Evaluation of the attainment of cleanup standards would take into considering all appropriate EPA guidance available at the time the remedial actions are performed. The cleanup levels would be protective of future land uses with continued government ownership and control of the site. Section 6.3.1.1 describes the basis for the proposed continuation of government control of the site and the development of remediation goals. The cleanup levels would be protective of the hypothetical off-property resident and expanded trespasser. Soils beneath the silos, decant sump tank, concrete pipe trench, or other locations below this depth would be removed as necessary to attain these cleanup goals.

All soils exhibiting highly elevated direct radiation levels (i.e., potentially contaminated soils beneath Silos 1 and 2) would be segregated from other Subunit C wastes and dispositioned as part of the selected remedy for Subunit A. Following excavation, the affected areas would be returned to original grade with the placement of clean backfill and revegetated.

Water Treatment

Wastewater generated as a result of this remedial action, along with water removed from the decant sump tank, Silo 4 (if any), and perched water would be sent to the FEMP Advanced Wastewater Treatment facility for treatment prior to discharge to the Great Miami River. In accordance with the Amended Consent Agreement, groundwater cleanup will be handled by Operable Unit 5. Operable Unit 4 would only handle the cleanup of perched water encountered during remedial action activities.

TABLE 5-2

PROPOSED REMEDIATION LEVELS IN SOILS

CONSTITUENTS	BACKGROUND CONCENTRATION	PROPOSED REMEDIATION LEVEL
Lead - 210[1]	1.33 pCi/g	78 pCi/g
Radium - 226[2]	1.45 pCi/g	2 pCi/g
Radium - 228[3]	1.19 pCi/g	2 pCi/g
Thorium - 228	1.43 pCi/g	2 pCi/g
Uranium - 238[1]	1.22 pCi/g	60 pCi/g
Antimony	7.7 mg/kg	NR
Arsenic	8.45 mg/kg	NR
Barium	91.3 mg/kg	NR
Cadmium	0.82 mg/kg	NR
Chromium (III)	15.5 mg/kg	NR
Molybdenum	2.6 mg/kg	NR
Nickel	20.9 mg/kg	NR
Silver	2.6 mg/kg	NR
Thallium	0.58 mg/kg	NR
Vanadium	30.4 mg/kg	NR
Zinc	62.2 mg/kg	NR

[1]Includes two daughter products
[2]Includes five daughter products
[3]Includes one daughter product
NR-No Remediation Required

Disposal of Soil, Debris and Rubble

Under this alternative, Operable Unit 4 soil, debris, and rubble would be disposed of in an on-property disposal vault. The on-property disposal facility would be similar in design and location to that previously discussed for Alternatives 2A/Vit and 2B/Vit except for one feature. Due to the nature of Subunit C material, intruder and radon barriers would not be required as part of the disposal vault design.

The volume of contaminated soil, rubble, and debris to be addressed under Operable Unit 4 represents a small fraction (less than one percent) of the total volume of similar wastes to be addressed under Operables Unit 5 and 3. Operable Unit 3 is currently in the process of conducting a RI/FS aimed at gaining additional insight into the effectiveness of various decontamination technologies for building materials. Additionally, the Operable Unit 3 RI/FS is evaluating the appropriate type and location of disposal for contaminated rubble and debris. The decision on the Operable Unit 3 RI/FS is presently scheduled at a time which coincides with the implementation of remedial actions for Operable Unit 4. Similarly, Operable Unit 5, which contains the vast majority of the sites' contaminated soils, is in the process of evaluating alternatives for treating and disposal of site soils.

In order to take full advantage of opportunities to integrate treatment and disposal options for soils and debris from Operable Unit 4 with Operable Units 5 and 3 respectively, the Operable Units 5 and 3 RI/FS reports will revisit the Operable Unit 4 remediation levels and disposal options for soils and debris. The treatment and disposal of Operable Unit 4 soils and debris would be able to take advantage of any applicable waste minimization initiatives developed for soil and debris by Operable Units 5 and 3. The Operable Unit 4 soil clean up levels would be adjusted lower if found to be necessary, to insure protectiveness of human health and the environment. No increase in cleanup levels would be implemented just to be consistent with Operable Unit 5.

Implementation Time and Costs

Approximately 3 months would be required for site preparation; 15 months would be required to demolish and decontaminate the silo structures as well as the surface soil, berm soils, subsurface soils, process piping, and decant sump tank. Demobilization activities would extend the duration of the alternative to two years. During this time frame, the above-grade disposal facility would also be constructed and capped. Capital costs for Alternative 2C are estimated to be 36.3 million dollars. Post-remediation O&M costs are estimated to be 3.6 million dollars. The total present worth cost of this alternative is estimated at 34.3 million dollars.

5.4.2 Alternative 3C.1 - Demolition, Removal, and Off-Site Disposal - NTS

Capital Cost:	*$76.2 M*
O&M Costs:	*$0*
Present Worth:	*$68.9 M*
Years to Implement:	*2*

This alternative is identical to Alternative 2C, except that the on-property disposal, monitoring, and institutional controls have been replaced by packaging and off-site transportation of the material by rail or truck to the NTS for disposal. The off-site disposal option for Alternative 3C.1 involves the packaging, loading, and shipping of the material generated by this alternative to NTS.

Implementation Time and Costs

Remedial actions for Alternative 3C.1 could require about two years to complete, including the transportation of the packaged materials to NTS. Capital costs for Alternative 3C.1 are estimated to be 76.2 million dollars. Due to the off-site disposal aspect of this alternative there are no O&M costs anticipated. The total present worth cost of this alternative is estimated at 68.9 million dollars.

5.4.3 Alternative 3C.2 - Demolition, Removal, and Off-Site Disposal (Permitted Commercial Disposal Site)

Capital Cost:	*$48.6 M*
O&M Costs:	*$0*
Present Worth:	*$44.0 M*
Years to Implement:	2

This alternative is identical to Alternative 3C.1, except that the off-site disposal at NTS has been replaced by the off-site disposal at a permitted commercial disposal site. One such site is located near Clive, Utah, approximately 3058 km (1900 mi) from the FEMP site. The facility has been permitted by the State of Utah to accept mixed hazardous waste and naturally occurring by-product materials such as those in Subunit C.

Disposal

Due to its relatively long distance from the FEMP site, it would require coordination with several states for its transportation. Additionally, an exemption from DOE Order 5280.2A prohibiting disposal of DOE wastes at a commercial facility would be needed before waste could be transported to the disposal site.

Implementation Time and Costs

Remedial actions for Alternative 3C.2 could require about two years to complete, including the transportation of the packaged materials to a permitted commercial disposal site. Capital costs are estimated to be 48.6 million dollars. Due to the off-site disposal option, no O&M costs are anticipated for Alternative 3C.2. The total present worth cost of this alternative is estimated at 44.0 million dollars.

6.0 EVALUATION OF ALTERNATIVES

This section identifies the preferred remedial action alternative for each of the three Operable Unit 4 subunits, discusses the nine criteria used to evaluate alternatives, and presents a summary of the comparative analysis of the evaluation of the preferred alternatives and the other alternatives against the nine criteria that EPA uses to evaluate alternatives. The alternatives comparison for each subunit is summarized in Table 6-1. The preferred remedial action alternative for each subunit is shown in boldface type. Only the no-action alternatives do not pass the threshold criteria.

6.1 IDENTIFICATION OF THE PREFERRED REMEDIAL ALTERNATIVE FOR OPERABLE UNIT 4

Based on the detailed analysis of the alternatives performed during the Feasibility Study, the preferred alternative identified for each of the subunits is as follows:

- Subunit A: Alternative 3A.1/Vit - Removal, Vitrification, Off-site Disposal - Nevada Test Site
- Subunit B: Alternative 3B.1/Vit - Removal, Vitrification, Off-site Disposal - Nevada Test Site
- Subunit C: Alternative 2C - Demolition, Removal, On-Property Disposal

Based on existing information, these alternatives would provide the best performance when compared with the other alternatives, with respect to the nine evaluation criteria.

Because Subunit C involves the management of soils and debris, DOE has considered other FEMP sitewide factors in assembling an overall preferred remedial alternative for Operable Unit 4. Of particular significance is the fact that the volumes of soil and debris in Subunit C are only a small fraction of the volumes of soil and debris that must be addressed as part of the entire FEMP site cleanup.

DOE believes that the disposition of the Subunit C materials should be integrated with the larger volumes of similar soil and debris. As described in Section 5 of the Proposed Plan, the initially preferred alternative for Subunit C (Alternative 2C) incorporates an integration strategy. Figure 6-1 illustrates the combination of the subunit alternatives into the overall preferred remedial alternative for Operable Unit 4. Section 6.1.1 presents the considerations and strategy for integrating the Subunit C materials with sitewide waste management activities. Section 6.1.2 describes the overall preferred remedial alternative for Operable Unit 4, incorporating the integration strategy for Subunit C materials.

TABLE 6-1

COMPARISON OF REMEDIAL ALTERNATIVES

SUBUNIT A - SILOS 1 AND 2 CONTENTS

Alternative	Overall Protection of Human Health and Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume through treatment	Short-Term Effectiveness	Implementability	Total Present Worth Cost
0A - No Action	Not protective	Does not comply with all ARARs	Not effective or permanent	No treatment; therefore, no reduction	High	Reliable technology, Easy	-0-
2A/Vit - Removal, Vitrification, On-Property Disposal	Protective[1]	Complies with all ARARs[2]	Effective and reliable	Reduces toxicity, mobility, and volume	Medium	Innovative technology, Moderately difficult	$43.6M
2A/Cem - Removal, Cement Stabilization, On-Property Disposal	Protective[1]	Complies with all ARARs[2]	Effective and reliable	Reduction of mobility	Medium	Reliable technology, Easy	$74.0M
3A.1/Vit - Removal, Vitrification, Off-Site Disposal - Nevada Test Site	**Protective**	**Complies with all ARARs**	**Effective and most reliable**	**Reduces toxicity, mobility, and volume**	**Medium**	**Innovative technology, Difficult**	**$43.5M**
3A.1/Cem - Removal, Cement Stabilization, Off-Site Disposal - Nevada Test Site	Protective	Complies with all ARARs	Effective and most reliable	Reduces mobility	Medium	Reliable technology, Difficult	$71.4M

[1] – Assessment of protectiveness adopts the use of continued federal goverment ownership and evaluates risk to expanded trespassers and the off-property farmer.
[2] – Assumes substantive technical requirements for Ohio disposal facility siting are met.
Bold – Preferred Remedial Action Alternative
Shaded areas – Did not meet threshold criteria (Overall Protection or Compliance with ARARs), therefore, not compared.
Protective – Risk is within the one in ten thousand to one in a million USEPA target risk range

TABLE 6-1
(Continued)

SUBUNIT B - SILO 3 CONTENTS

Alternative	Overall Protection of Human Health and Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume through treatment	Short-Term Effectiveness	Implementability	Total Present Worth Cost
0B - No-Action	Not protective	Does not comply with all ARARs	Not effective or permanent	No treatment; therefore, no reduction	High	Reliable technology, Easy	-0-
2B/Vit - Removal, Vitrification, On-Property Disposal	Protective[1]	Complies with all ARARs[2]	Effective and reliable	Reduces mobility and volume	Medium	Innovative technology, Moderately Difficult	$28.0M
2B/Cem - Removal, Cement Stabilization, On-Property Disposal	Protective[1]	Complies with all ARARs[2]	Effective and reliable	Reduces mobility	Medium	Reliable technology, Easy	$37.4M
3B.1/Vit - Removal, Vitrification, Off-Site Disposal - NEVADA TEST SITE	**Protective**	**Complies with all ARARs**	**Effective and most reliable**	**Reduces mobility and volume**	**Medium**	**Innovative technology, Difficult**	**$27.9M**
3B.1/Cem - Removal, Cement Stabilization, Off-Site Disposal - NEVADA TEST SITE	Protective	Complies with all ARARs	Effective and most reliable	Reduces mobility	Medium	Reliable technology, Difficult	$35.4M
4B - Removal and On-Property Disposal	Protective[1]	Complies with all ARARs[2]	Effective but reliable	No treatment; therefore, no reduction	High	Reliable technology, Easy	$22.0M

[1] -- Assessment of protectiveness adopts the use of continued federal goverment ownership and evaluates risk to expanded trespassers and the off-property farmer.
[2] -- Assumes substantive technical requirements for Ohio disposal facility siting are met.
Bold -- Preferred Remedial Action Alternative
Shaded areas -- Did not meet threshold criteria (Overall Protection or Compliance with ARARs), therefore, not compared.
Protective -- Risk is within the one in ten thousand to one in a million USEPA target risk range

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TABLE 6-1
(Continued)

SUBUNIT C - SILOS 1, 2, 3, AND 4 STRUCTURES, SOILS, AND DEBRIS

Alternative	Overall Protection of Human Health and Environment	Compliance	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume through treatment	Short-Term Effectiveness	Implementability	Total Present Worth Cost
0C - No-Action	Not protective	Does not comply with all ARARs	Not effective or permanent	No treatment; therefore, no reduction	High	Reliable technology, Easy	-0-
2C - Demolition, Removal, On-Property Disposal	**Protective[1]**	**Complies with all ARARs[2]**	**Effective and reliable**	**No treatment; therefore, no reduction**	**Medium**	**Reliable technology, Easy**	**$34.3M**
3C.1 - Demolition, Removal, Off-Site Disposal - Nevada Test Site	Protective	Complies with all ARARs	Effective and most reliable	No treatment; therefore, no reduction	Medium	Reliable technology, Moderately difficult	$68.9M
3C.2 - Demolition, Removal, Off-Site Disposal - Permitted commercial facility	Protective	Complies with all ARARs	Effective and most reliable	No treatment; therefore, no reduction	Medium	Reliable technology, Moderately difficult	$44.0M

[1] -- Assessment of protectiveness adopts the use of continued federal goverment ownership and evaluates risk to expanded trespassers and the off-property farmer.
[2] -- Assumes substantive technical requirements for Ohio disposal facility siting are met.
Bold -- Preferred Remedial Action Alternative
Shaded areas -- Did not meet threshold criteria (Overall Protection or Compliance with ARARs), therefore, not compared.
Protective -- Risk is within the one in ten thousand to one in a million USEPA target risk range

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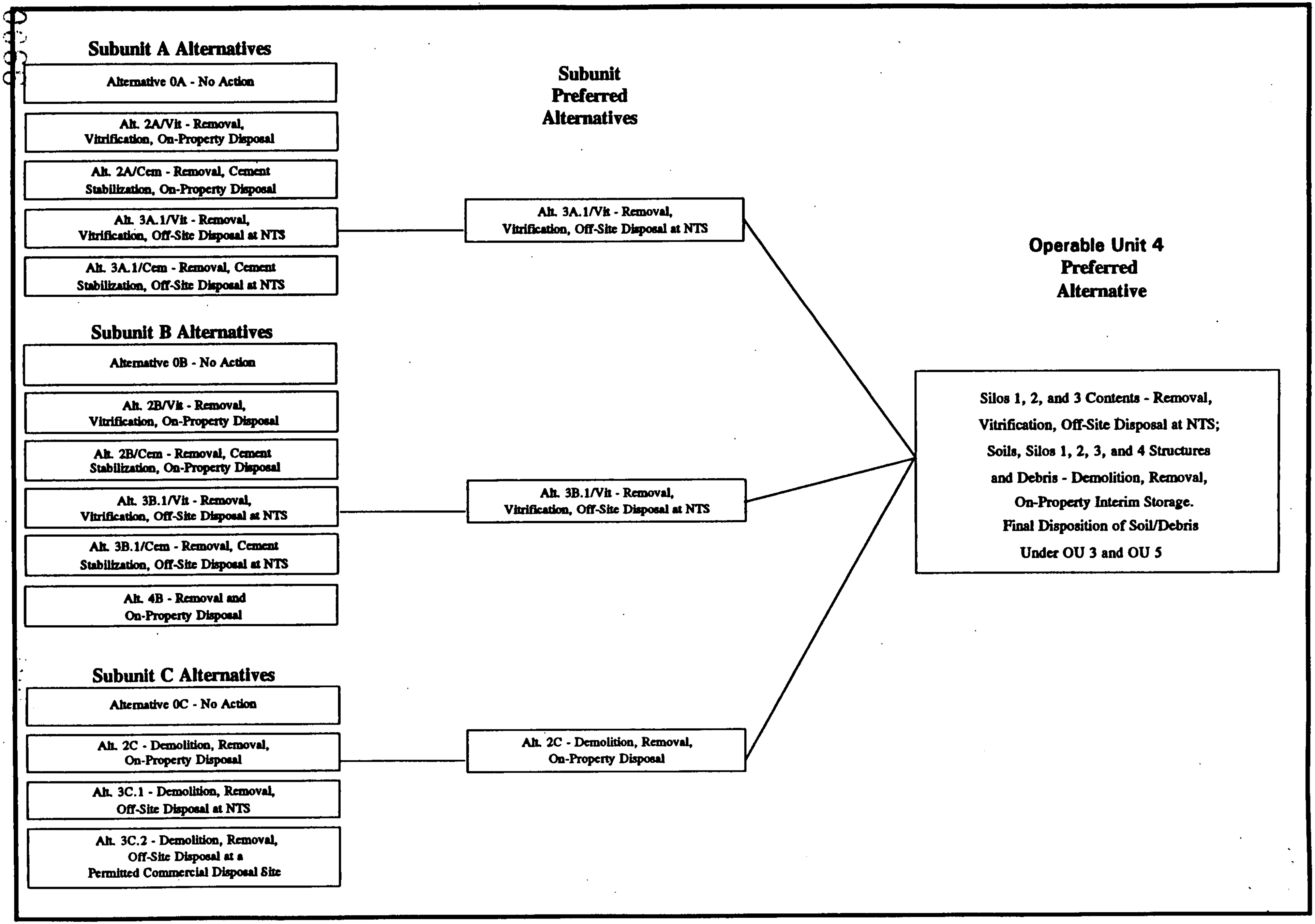

FIGURE 6-1
OPERABLE UNIT 4 PREFERRED ALTERNATIVE FLOWCHART

Sections 6.1.3 and 6.1.4 summarize environmental and ecological risk factors associated with implementing the preferred alternative.

6.1.1 <u>Considerations for FEMP Sitewide Waste Management Integration</u>

As previously discussed in Section 3.0 of this Proposed Plan, the operable unit concept has been adopted at the FEMP site to address the management of similar types of wastes using similar approaches to remedial action. The identification of Operable Unit 4 as a discrete waste management area of the FEMP site resulted primarily from the nature and configuration of the materials in Silos 1, 2, and 3.

The preferred alternative for Operable Unit 4 would utilize vitrification to treat the materials of Subunits A and B (contents of Silos 1, 2, and 3) for final disposal off site. The remaining Operable Unit 4 materials, Subunit C, include residual soils which have been contaminated by the contents of Subunits A and B. They also include the structural debris which would result from the demolition of the silos, associated structures, and vitrification processing facility once treatment has been completed. The Operable Unit 4 Feasibility Study Report addresses the Subunit C materials as a remaining source of contamination. The previously identified preferred alternative incorporates final disposition of the soils and debris in an on-property above-grade disposal facility, as described above.

Currently, two other FEMP site operable units are in the process of evaluating remedial alternatives for contaminated soils and debris. By definition, Operable Unit 5 will develop, evaluate, and propose a final remedial alternative to address, on a sitewide basis, contaminated environmental media, including soils. Similarly, Operable Unit 3 will propose a final remedial alternative for the debris, including structural concrete, steel, and process piping, which will result from the decontamination and dismantling of the former Production Area facilities.

Operable Unit 5 has already initiated pilot-scale soil washing operations on the basis of earlier bench-scale tests which yielded promising results for this technology. The soil washing process involves treating contaminated soils with a reagent (e.g., sulfuric acid and sodium carbonate systems are being tested) which extracts soil contaminants in solution and reduces contaminant concentration in the soils. The extract is recovered and reduced in volume for appropriate disposal. Based on the efficiency of the process, the washed soils (which represent the largest fraction of the treated material) may be suitable for disposal in a less restrictive manner, based on estimated residual risk. The approach is designed to minimize the volume of waste eventually requiring more restrictive and expensive containment or disposal. The total volume of soil which might be treated by Operable Unit 5 is estimated to be up to two million cubic yards. A large-scale soil washing facility is currently in the preliminary design stage. Based on current schedules for remedial actions for Operable Unit 5, this facility is scheduled to be operational by September, 1997.

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Likewise, Operable Unit 3 has initiated a removal action (Removal Action 17) to manage debris resulting from decontamination and dismantling activities. An engineered Central Storage Facility, to contain contaminated debris from production facility dismantling prior to disposition, is nearing final design. A Remedial Investigation and Feasibility Study is underway to evaluate various alternatives for decontamination, disposal, or recycling of contaminated structural debris. The total volume of material to be managed by Operable Unit 3 is estimated to be several million cubic yards.

The estimated volume of contaminated soils and structural debris comprising Operable Unit 4 Subunit C materials is less than one percent of the Operable Unit 5 soil volume and less than one percent of the Operable Unit 3 debris volume.

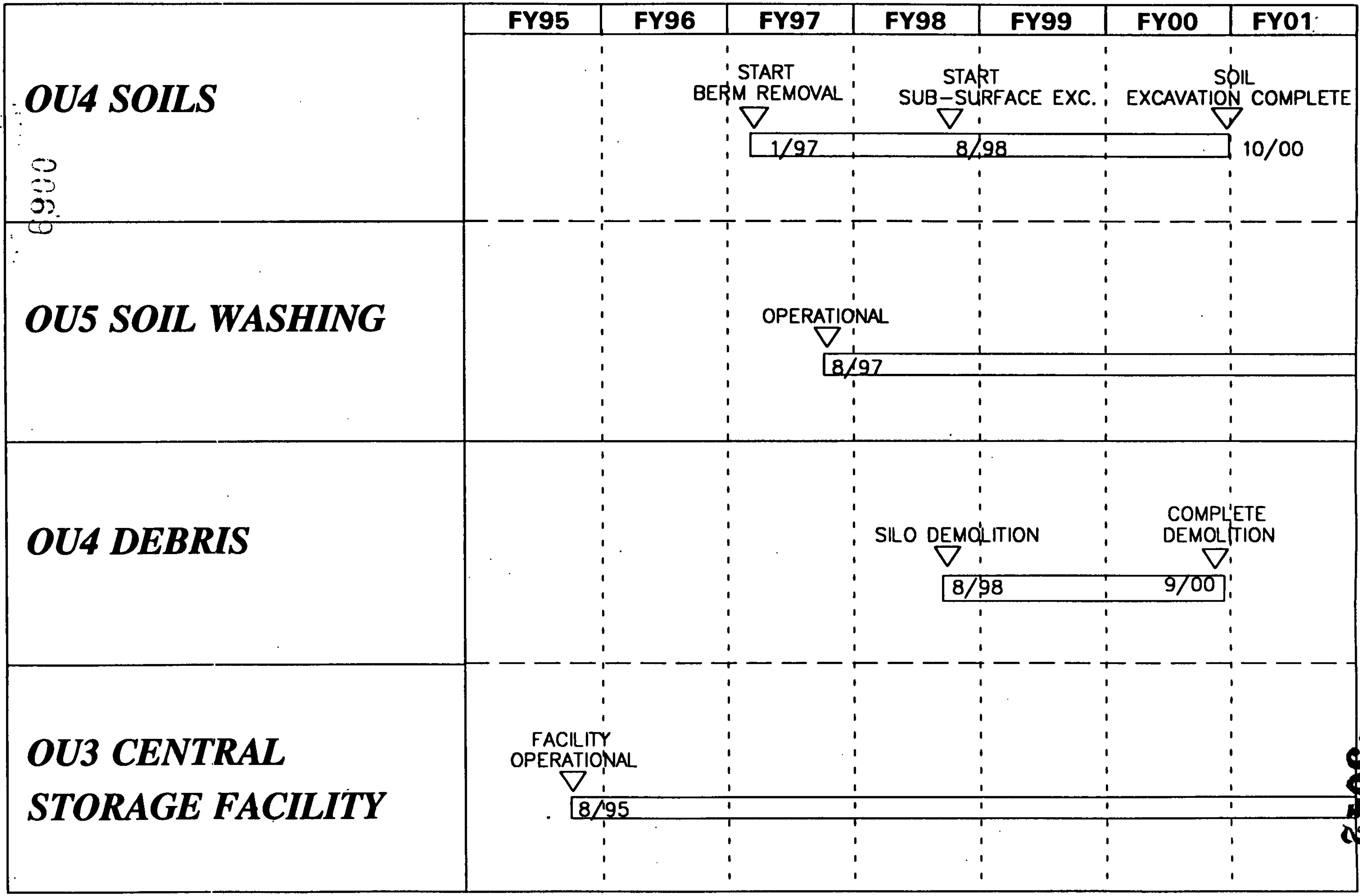
In the interest of coordinating sitewide cleanup efforts at the FEMP and to fulfill the statutory preference of CERCLA for waste treatment and volume reduction, it is proposed that the decision regarding the type and location of the final disposition of the Operable Unit 4 soil and debris be placed in abeyance to facilitate the proper integration of this decision with forthcoming decisions for Operable Units 5 and 3 respectively. The integration would be achieved by placing in interim storage the soils and debris resulting from the implementation of the Operable Unit 4 preferred alternative. Interim storage would be conducted in accordance with the EPA-approved Work Plan for Removal Action 17. The final disposition of the Operable Unit 4 materials would occur coincidental to the implementation of the Records of Decision for Operable Units 5 and 3. This strategy would promote cost-savings through reduction of volumes requiring disposal and would realize economies-of-scale through treatment by processes developed for larger volumes of soil and debris as well as disposal.

The current remedial action implementation schedules for Operable Units 3, 4, and 5 would favor this proposed approach. Figure 6-2 shows the key milestones for coordination. Operable Unit 4 soil excavation would be initiated in January, 1997, approximately six months before the Operable Unit 5 soil washing plant is scheduled to go on line. The duration of Operable Unit 4 soil excavation extends to the year 2000 due to the required sequence for removal and treatment of the silo contents. Thus, there would be ample time for Operable Unit 5 to optimize the washing process to accommodate Operable Unit 4 soils. The Operable Unit 3 Central Storage Facility will be operational nearly five years before the Operable Unit 4 remedial action sequence indicates completion of silo and processing facility decontamination and dismantling. By then, it is expected that Operable Unit 3 would have made significant progress in decontamination and recycling technology.

The overlapping remedial action schedules for Operable Units 3, 4, and 5 provide an excellent opportunity to integrate FEMP sitewide cleanup activities in a manner consistent with CERCLA preferences for treatment, minimization of land disposal, and cost-effectiveness.

In the unlikely event unforeseen circumstances preclude the integration of Operable Unit 4 rubble and debris with the Operable Unit 3 Record of Decision and the Operable Unit 4 soils with the Operable

FIGURE 6-2
OPERABLE UNITS 3, 4, AND 5 COORDINATION SCHEDULE



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Unit 5 Record of Decision, a disposal decision for Operable Unit 4 rubble, debris, and soils would be documented in an Explanation of Significant Differences (ESD) or a ROD amendment for Operable Unit 4 in accordance with Section 117(c) of CERCLA and EPA guidance. The ESD or ROD amendment would provide the public and the EPA further opportunity to review and comment on the selected disposal option for Operable Unit 4 rubble and debris.

6.1.2 Description of Preferred Remedial Alternative for Operable Unit 4

To address the overall remediation of Operable Unit 4, the preferred alternatives for each of the subunits are combined to form the preferred remedial alternative for Operable Unit 4. The alternative initially preferred by DOE and identified in Figure 6-1, consists of the following major components:

- Removal of the contents of Silos 1, 2, and 3 (K-65 residues and cold metal oxides) and the decant sump tank sludge.
- Vitrification (glassification) of the residues and sludges removed from the silos and decant sump tank.
- Off-site shipment for disposal at the NTS of the vitrified contents of Silos 1, 2, 3, and the decant sump tank.
- Demolition of Silos 1-4 and decontamination, to the extent practical, of the concrete rubble, piping, and other generated construction debris.
- Removal of the earthen berms and excavation of contaminated soils within the boundary of Operable Unit 4, to achieve proposed remediation levels. Placement of clean backfill following excavation.
- Demolition of the vitrification treatment unit and associated facilities after use. Decontamination or recycling of debris prior to disposition.
- On-property interim storage of excavated contaminated soils and remaining contaminated debris in a manner consistent with the approved Work Plan for Removal Action 17 (improved storage of soil and debris).
- Continued access controls and maintenance and monitoring of the stored wastes inventories.
- Potential additional treatment of stored Operable Unit 4 soil and debris inventories using Operable Unit 5 and 3 waste treatment systems.

- Place in abeyance the final decision regarding the final treatment and disposal of remaining Operable Unit 4 contaminated soils and debris

- Disposal of remaining Operable Unit 4 contaminated soils and debris consistent with the selected remedies for Operable Units 5 and 3.

Under this alternative, the K-65 residues and cold metal oxides would be removed from Silos 1, 2, and 3 and treated in a newly constructed on-property vitrification facility. The sludges from the decant sump tank would also be removed and treated in the vitrification facility. Following treatment, the vitrified residues would be containerized and transported off site for disposal at the NTS.

Following removal of the residues, the concrete silo structures would be demolished. Additionally, the existing radon treatment system and other miscellaneous structures within the Operable Unit 4 area would be demolished. Further, following completion of treatment, the newly constructed vitrification facility would be disassembled. Surface scabbling, acid washing, and other standard decontamination technologies would be applied to the extent practical to minimize the volume of waste requiring disposal. Opportunities for recycling of generated materials would also be explored.

Contaminated soils within the boundary of the Operable Unit 4 area would be excavated to the extent necessary to attain the proposed remediation levels previously defined in Table 5-2. To achieve these clean-up levels, a minimum six inches of soils would be removed from the entire Operable Unit 4 area. Excavated areas would be backfilled with clean fill to original grade and revegetated.

Contaminated soil and debris would either be processed through the selected OU5 and OU3 remedy identified by OU5 and OU3 ROD or placed in an interim storage facility located in the northern portion of the site (see Figure 6-3) to await the finalization of the disposal decisions for soils and debris under OU5 and OU3. The interim storage would be managed pursuant to the approved work plan for Removal Action 17 - (Improved Storage of Soil and Debris).

The decision regarding the final disposition of the remaining Operable Unit 4 contaminated soil and debris would be placed in abeyance to take full advantage of planned and in progress waste minimization treatment processes. Further, this strategy enables the proper integration of disposal decisions on a sitewide basis. As planned treatment facilities become available under Operable Units 5 and 3 remedial actions, full consideration would be given to applying these systems to the inventoried contaminated materials from Operable Unit 4. Following the application of available waste minimization processes, the remaining Operable Unit 4 contaminated soil and debris would be disposed consistent with the selected remedies for Operable Units 5 and 3.

The total estimated present worth cost for the preferred alternative is 91.3 million dollars. Table 6-2 summarizes the capital and operating and maintenance costs. The total estimated present worth cost is

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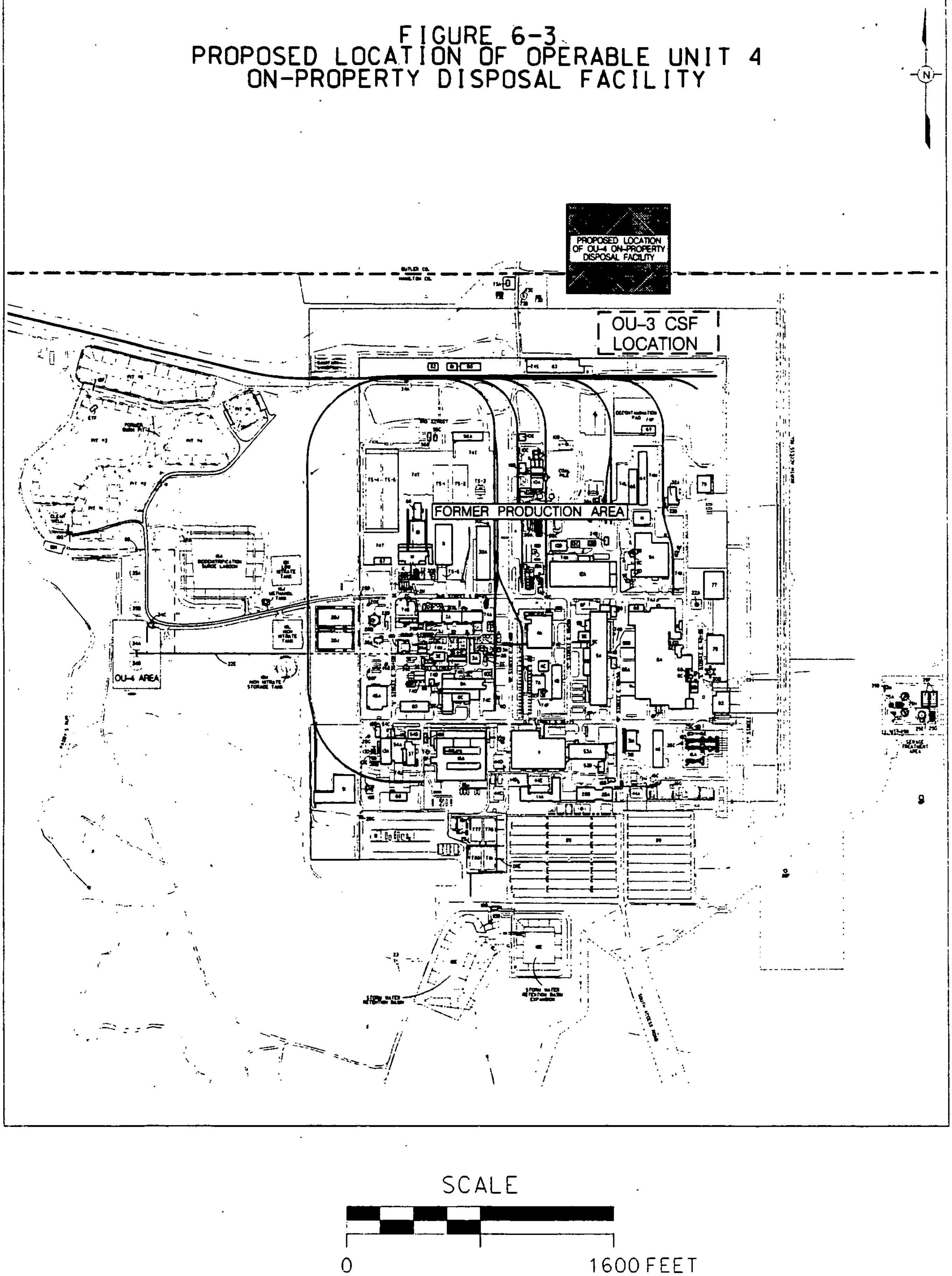
FIGURE 6-3
PROPOSED LOCATION OF OPERABLE UNIT 4 ON-PROPERTY DISPOSAL FACILITY



<PROJECT*>-<8.5x11>-</res2227/fig6-3.dgn>-<OPER. UNIT 4>

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TABLE 6-2

SUMMARY OF COSTS
OPERABLE UNIT 4 PREFERRED ALTERNATIVE (Million $)

Capital Cost	86.0
Operations & Maintenance Costs	
During Remediation	16.6
Post-Remediation	3.6
Total Present Worth Cost	91.3

Note:
- The accuracy of the cost estimates are between +50% and -30%.
- Estimates of Capital and Operations & Maintenance costs are expressed in terms of total costs. The total present worth cost is calculated from the total costs applying a discount rate of 7 percent and an Operations & Maintenance period of 30 years.

less than the sum of the total costs of the preferred alternatives for Subunit A, B, and C. This is due to the fact that Subunits A and B would share common costs associated with site preparation, construction of the silo contents removal work platform and processing facilities, and packaging and transportation. Further, the capital costs associated with construction of the on-property disposal facility have been removed.

On the basis of currently available information, the preferred alternative provides the best performance when compared with the other alternatives, with respect to the evaluation criteria. This alternative would achieve substantial risk reduction by removing the sources of contamination, treating the material for which exposures result in the highest risk, shipping the treated residues off site for disposal, and managing the remaining contaminated soils and debris consistent with the sitewide strategy. The proposed treatment alternative both reduces the mobility of the hazardous constituents and results in significant a reduction in the volume of materials requiring disposal. DOE believes the preferred alternative would be protective of human health and the environment; comply with ARARs; be cost-effective; utilize permanent solutions to the maximum extent practical; and utilize treatment as a principal element of the response.

6.1.3 Summary of Preferred Alternative Impacts

As part of the comparative evaluation in Section 6.3, short-term and long-term environmental impacts are presented for each alternative. Section 4.0 and Appendix I of the Feasibility Study Report contain further details. The cumulative impacts of the preferred alternative for Operable Unit 4 are adequately represented by the discussions presented for the preferred alternative in each Subunit.

Short-term environmental impacts associated with removal, vitrification, and transportation of treated Subunits A and B materials to the NTS would be minimized through engineered operations designed to control releases to the air, soil, surface water, and groundwater caused by remedial activities. No wetlands or floodplains will be impacted by short-term or long-term operations, either at the FEMP site or NTS. Long-term environmental impacts associated with the permanent disposal of Subunits A and B treated residues at NTS are minor. There may be minor short-term impacts to biota at the FEMP site during implementation of the preferred alternative. Long-term effects would be favorable to biota at the FEMP site due to cleanup actions; and no long-term impacts of biota are expected from disposal activities at NTS.

6.1.4 Ecological Risk Assessment

A qualitative evaluation has been conducted on residual contaminants of concern that will remain after completion of the Operable Unit 4 Remedial Action. The primary pathways of concern associated with ecological receptors coming in contact with Operable Unit 4 include surface soil (e.g., ingestion and plant uptake) and runoff of surface soil to surface water bodies (e.g., exposures to aquatic habitat and ingestion of surface water). The preferred alternative for Operable Unit 4 includes the removal of the surface soil from the entire Operable Unit 4 Study Area and the replacement of this soil with clean fill material, so ecological receptors will have very minimal contact with residual contaminants.

The pathways of concern associated with uranium in the subsurface soil is groundwater (e.g., ingestion of drinking water and normal contact). Refer to Appendix D of the Feasibility Study for Operable Unit 4 for more quantitative risk information related to human health. From an ecological risk standpoint, ecological receptors will have very minimal contact with the groundwater pathway. Therefore, residual contaminants (i.e., uranium) will not pose a risk to ecological receptors within Operable Unit 4 due to its limited availability to enter the surface soil and surface water pathway involving ecological receptors.

The Amended Consent Agreement between EPA and DOE stipulates that Operable Unit 5 is responsible for "Environmental Media" at the FEMP site, and therefore, is designated to prepare a Sitewide Ecological Risk Assessment as part of the Remedial Investigation Report for Operable Unit 5. During a February 17, 1993, meeting at the FEMP site, an agreement was reached between Operable Unit 5 representatives and the chief representative of the EPA - Region V's Biological Technical Group, stating that the possible risks from current concentrations of site contaminants to ecological receptors inhabiting on-site and off-site areas not presently targeted for remediation must meet criteria to protect human health. Therefore, Operable Units 1 - 4 will not be evaluated in the Sitewide Ecological Risk Assessment. Only those contaminants present in detectable quantities in the physical area of Operable Unit 5 and recorded in the RI/FS database will be evaluated in the Sitewide Ecological Risk Assessment. However, it is the policy at the FEMP site to qualitatively address ecological risks related to residual contaminants of concern in the Feasibility Study reports for Operable Units 1 - 4.

6.2 EVALUATION CRITERIA

Specific legal requirements for remedial actions are specified under CERCLA Section 121, as amended. These requirements include protection of human health and the environment, compliance with ARARs, a preference for permanent solutions which use treatment as a principal element (to the maximum extent possible), and cost-effectiveness. To determine whether alternatives meet the requirements, EPA has identified nine criteria in the National Contingency Plan (EPA 1990) that must be evaluated for each alternative selected for detailed analysis.

The first two criteria are called threshold criteria because they relate directly to legal findings that must be made in the Record of Decision. Alternatives must meet these two criteria to be considered as final solutions. The factors reviewed under each of these two criteria are summarized below.

1. **Overall protection of human health and the environment:** Examines whether a remedy would provide adequate overall protection to human health and the environment. Evaluates how risks would be eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls included in the alternative.

2. **Compliance with ARARs:** Determines if a remedy would meet all pertinent environmental laws and requirements.

The next five criteria are grouped together as the primary balancing criteria under which the alternatives are evaluated. The factors reviewed under each of these five criteria are summarized below.

3. **Long-term effectiveness and permanence:** Evaluates the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met.

4. **Reduction of toxicity, mobility, or volume through treatment:** Reviews the anticipated performance of the proposed treatment technologies for their abilities to reduce the hazards of, prevent the movement of, or reduce the quantity of waste materials.

5. **Short-term effectiveness:** Evaluates the ability of a remedy to achieve protection of workers, the public, and the environment during construction and implementation.

6. **Implementability:** Examines the practicality of carrying out a remedy, including the availability of materials and services needed during construction and operation.

7. **Cost:** Reviews both estimated capital and operation and maintenance costs of the remedy. Costs are presented as present worth costs. "Present worth" is defined as the amount of money that, if invested in the first year of implementing a remedy and paid out as needed, would be sufficient to cover all costs associated with the remedy over its planned life. Present worth costs allow remedies that would occur over different time periods to be compared on an even basis.

The final two criteria, **State Acceptance** and **Community Acceptance**, are called modifying criteria and will be considered following receipt of public comments on the Feasibility Study/Proposed Plan-Environmental Impact Statement (FS/PP-EIS). These comments will be addressed in the Responsiveness Summary of the Record of Decision document.

8. **State Acceptance:** Evaluates the technical and administrative issues and concerns the State of Ohio may have regarding each of the alternatives.

9. **Community Acceptance:** Evaluates the issues and concerns the public may have regarding each of the alternatives.

6.3 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

The following sections summarize the information presented in Section 5.0 of the Feasibility Study Report for Operable Unit 4 and rely upon the detailed analysis of alternatives presented in Section 4.0 of the same report.

6.3.1 Analysis for Subunit A

Overall Protection of Human Health and the Environment. As part of the Feasibility Study, two potential future land uses of the FEMP were evaluated to assess the ability of the individual alternative to adequately protect human health and the environment. These land uses consider potential exposures to contaminants released during or following the implementation of the alternatives were evaluated for a range of viable receptors. These scenarios included future land use with and without the assumption of continued federal ownership and control. With continued government ownership, the FEMP land would not be available for residential or farming use. Access to the site would be limited by fencing and physical markers, but it would be reasonable to assume that an expanded trespasser would visit the site occasionally. It is also assumed that the land surrounding the FEMP site would continue to be used for family farms. For a cleanup remedy to be considered protective, it should not result in any unacceptable risks to an expanded trespasser or an off-site farmer as discussed in Section 6.3.3. The evaluation also considers the future possibility that the federal government might lose control of the FEMP site. In that case, a farm might be established on the FEMP property. The remedial alternatives were evaluated as to what risks might exist for a hypothetical on-property farmer if government control of the site is lost. The basis for and detailed results of these evaluations are in Appendix D of the Feasibility Study Report for Operable Unit 4.

All of the alternatives, with the exception of the no-action alternative (Alternative 0A), would provide overall protection of human health (assuming continued federal government control) and the environment by eliminating, reducing, or controlling risk through treatment, engineering controls, or institutional controls. The preferred alternative (3A.1/Vit) would provide the greatest overall protection because the Subunit A residues would be treated and removed to the NTS. The source of unacceptable risks to the expanded trespasser and off-site farmer would be eliminated, and in the event that the government lost control of the FEMP site, there would be no risk from Subunit A residues to an on-property farmer. Overall protection at the NTS would be maintained because the vitrified residues resist leaching and the NTS is located in a sparsely populated, arid region, where depths to groundwater range up to 600 m (2000 ft).

Compliance with ARARs. CERCLA requires that remedial actions achieve a standard or level of control that is consistent with environmental regulations, which are termed applicable or relevant and appropriate requirements (ARARs). ARARs apply to all aspects of remedial action, including the establishment of cleanup levels, the operation and performance of treatment systems, and the design of disposal facilities. In addition to meeting ARARs, operations at DOE-owned facilities must be conducted according to DOE Orders. Although DOE Orders are not promulgated laws, the technical requirements may be adopted as TBCs for the alternative if they cover areas not addressed by promulgated requirements, or if they improve protection of human health and the environment because they are more stringent than existing regulatory requirements. Detailed discussion of compliance with ARARs is provided in Appendix F of the Feasibility Study Report for Operable Unit 4.

All of the Subunit A alternatives, with the exception of the no-action alternative, would meet all pertinent ARARs identified for these alternatives. Since the preferred alternative, Alternative 3A.1/Vit, includes off-site disposal at NTS, there would be no long-term compliance issues associated with the FEMP site. For example, off-site disposal would eliminate the need to demonstrate that drinking water maximum contamination levels (MCLs) are attained for Subunit A residues. In the short-term, the on-property remediation activities during removal and treatment would address the operational requirements for airborne emissions, soil pathways, and penetrating radiation by engineered controls.

For Alternative 3A.1/Vit, the packaging and transportation of the treated waste would be accomplished with the requirements for the protection of worker and public safety from the radiological hazards (49 CFR § 171-173, 177-178). This alternative would also comply with other off-site requirements, such as the waste acceptance criteria specified by NTS, to meet their disposal requirements. The probability of an inadvertent intruder coming in contact with the Subunit A residues at NTS is less than that for the FEMP site, based on the demographic characteristics of both locations.

Long-Term Effectiveness and Permanence. All Subunit A alternatives would ensure long-term protectiveness to human health and the environment because residual risks to viable receptors would be less than a 10^{-6} incremental lifetime cancer risk, and no non-carcinogenic effects (hazard index less than 0.2) would be indicated for either receptor.

All alternatives involve the removal and treatment of Subunit A residues by either vitrification or cement stabilization. The preferred alternative would be most effective based on treatability studies conducted on the Subunit A materials which demonstrated that vitrification would be effective in reducing radon emanation and in minimizing the leaching of constituents. Tests using cement stabilization demonstrated that this process would also be effective in preventing the movement of constituents from the stabilized form. The vitrified material is expected to have greater durability over the long term, because the vitrification process is essentially irreversible. Tests on the cement-stabilized form indicated that this process is not irreversible.

The characteristics of the NTS would provide greater certainty than on-property disposal over the long term that the treated residues would not affect human health and the environment.

Reduction of Toxicity, Mobility, or Volume through Treatment. Alternatives 2A/Vit and 3A.1/Vit would use the vitrification process to treat the Subunit A material. This technology would physically bind the contaminants in a glass-like matrix which would significantly reduce contaminant mobility and material volume. Mobility would be reduced because the contaminants would be bound in the matrix and the volume of the treated material would be less than 50 percent of the untreated material volume. Vitrification would also destroy organic contaminants in the treated material. Although most contaminants in the treated material would be incorporated into the vitrified product to reduce mobility over the long term, some contaminants would be released during the vitrification process and must be treated through an off-gas treatment system. The material generated through the off-gas treatment system may require stabilization to limit subsequent contaminant mobility.

Alternatives 2A/Cem and 3A.1/Cem would use the cement stabilization process to treat contaminated material. This technology will physically and chemically bind the constituents in a cement-like matrix, so the mobility of constituents via leaching from this treated material would be greatly reduced. However, organic constituents would not be destroyed. The total volume of material would increase by approximately 150 percent as a result of adding the cement stabilizing and setting agents.

Alternatives 2A/Vit and 3A.1/Vit are favored over Alternatives 2A/Cem and 3A.1/Cem because they would: reduce the toxicity of organic contaminants; generate a treated form which has greater resistance to leaching; and reduce the volume of Subunit A materials.

Short-Term Effectiveness. For all Subunit A alternatives, the various removal, treatment, and disposal activities will result in increased short-term risks for exposures (compared to no action). The short-term effectiveness of the removal operations is expected to be the same among all alternatives for Subunit A. There is some uncertainty associated with controlling and treating the off-gases generated by the vitrification process. For the on-property alternatives (2A/Vit and 2A/Cem), short-term disruption of land for the disposal vault construction would result in minor impacts to biota and wetlands. Proper engineering controls would minimize these impacts. For the off-site alternatives

(3A.1/Vit and 3A.1/Cem), there would be increased risks from transportation accidents because the increased volume of the treated material would increase the number of trips. Short-term impacts at NTS associated with the transportation and off-loading of treated residues would be minor.

In summary, Alternatives 2A/Cem and 3A.1/Cem are favored over Alternatives 2A/Vit and 3A.1/Vit because of the uncertainty associated with off-gas control and treatment for the vitrification process.

<u>Implementability</u>. The removal and treatment activities in Alternatives 2A/Cem and 3A.1/Cem could be implemented using standard equipment, procedures, and readily available resources. Hydraulic removal is a standard mining technology that is normally reliable and uses readily available equipment. The cement stabilization technology has been applied successfully at a number of remedial sites. EPA considers cement stabilization a demonstrated treatment technology and has approved its use in the final remedy for many National Priorities List sites. This technology has also been applied at other sites that are radioactively contaminated. The cement stabilization process would require large quantities of cement, flyash, and blast furnace slag, which are available.

Although removal and disposal are the same for Alternative 2A/Vit as for Alternative 2A/Cem and Alternative 3A.1/Vit as for Alternative 3A.1/Cem, the vitrification process is more difficult to implement than the cement stabilization process. The vitrification process would require fewer chemical reagents than the cement stabilization process, but larger amounts of energy (electricity). Vitrification would facilitate the re-processing of off-specification treated materials compared to cement stabilization. In addition, the vitrification process equipment would be more complex to construct and operate than that of the cement stabilization process. There is limited experience available for the types and quantities of the material from the silos and decant sump tank on which to base an assessment of the likely performance of the vitrification technology. The vitrification technology is not as widely available as the cement stabilization technology. Off-gas treatment is also an additional complexity with vitrification where delays could occur. However, operational experience is being gained as part of the structured RI/FS treatability studies and planned vitrification pilot studies currently in progress.

Alternatives 2A/Vit and 2A/Cem would require an on-property, above-grade disposal vault. Construction of the disposal vault would be readily implemented using standard construction procedures and materials. Alternatives 3A.1/Vit and 3A.1/Cem involve off-site transportation and disposal at the NTS. While technically straightforward, off-site transportation would require coordination efforts with a number of states located along the transportation route, as well as the State of Nevada. The waste acceptance criteria requirements, specific to the NTS would be required prior to shipping the Subunit A materials . In summary, Alternatives 2A/Cem and 3A.1/Cem would be favored over Alternatives 2A/Vit and 3A.1/Vit, based on relative overall implementation.

<u>Cost</u>. The estimated total present worth costs for Subunit A alternatives are provided on Table 6-3,

TABLE 6-3
OPERABLE UNIT 4 REMEDIAL ALTERNATIVE COST SUMMARY (MILLION$)

ALTERNATIVE	CAPITAL	OPERATING & MAINTENANCE		TOTAL PRESENT WORTH COST
		SHORT-TERM (During Remediation)	LONG-TERM (Post Remediation)	
Subunit A - Silos 1 and 2 Contents				
OA - No Action	0	0	0	0
2A/Vit - Removal, Vitrification, On-Property Disposal	36.5	11.7	3.4	43.6
2A/Cem - Removal, cement Stabilization, On-Property Disposal	71.2	11.7	3.6	74.0
3A.1/Vit - Removal, Vitrification, Off-Site disposal - Nevada Test Site	38.0	11.7	0	43.5
3A.1/Cem - Removal, Cement Stabilization, Off-Site Disposal - Nevada Test Site	69.9	11.7	0	71.4
Subunit B - Silo 3 Contents				
OB - No Action	0	0	0	0
2B/Vit - Removal, Vitrification, On-Property Disposal	25.2	4.9	3.2	28.0
2B/Cem - Removal, Cement Stabilization, On-Property Disposal	35.9	4.9	3.2	37.4
3B.1/Vit - Removal, Vitrification, Off-Site Disposal - Nevada Test Site	26.6	4.9	0	27.9
3B.1/Cem - Removal, Cement Stabilization, Off-Site Disposal - Nevada Test Site	36.1	4.1	0	35.4
4B - Removal, On-Property Disposal	21.8	1.1	3.2	22.0
Subunit C - Silos 1, 2, 3, and 4 Structures, Soils, and Debris				
0C - No Action	0	0	0	0
2C - Demolition, Removal, On-Property Disposal	36.3	0	3.6	34.3
3C.1 - Demolition, Removal, Off-Site Disposal - Nevada Test Site	76.2	0	0	68.9
3C.2 - Demolition, Removal, Off-Site Disposal - Permitted commercial facility	48.7	0	0	44.0

The accuracy of the cost estimates are between +50% and -30%.
Estimates of capital and operations & Maintenance Costs are expressed in terms of total costs. The total present worth costs are calculated from the total cost figures applying a discount rate of 7.0% and an Operating & Maintenance period of 30 years.

and include a breakdown of capital and operating and maintenance costs.

Alternative 3A.1/Vit is the least expensive action alternative. The present worth cost of Alternative 2A/Vit is approximately $0.2 million higher than that of Alternative 3A.1/Vit. This is due to the higher cost of construction of an on-property above-grade disposal vault as compared to off-site transportation and disposal at NTS. Alternatives 3A.1/Cem and 2A/Cem are approximately 64 percent and 70 percent more expensive, respectively, than Alternative 3A.1/Vit. The alternatives that include cement stabilization are more expensive than vitrification alternatives, primarily due to the additional packaging, transportation, and disposal for the larger volume of cement-stabilized material.

State Acceptance. State acceptance of the preferred alternative will be addressed after the public comment period ends and will be included in the Responsiveness Summary of the Record of Decision document.

Community Acceptance. Community acceptance of the preferred alternative will be addressed after the public comment period ends and will be included in the Responsiveness Summary of the Record of Decision document.

Subunit A Comparative Analysis Summary

Alternative 3A.1/Vit is identified as the preferred alternative because it is cost-effective and would result in the permanent treatment and volume reduction of Subunit A materials. It would provide overall protection of human health and the environment with fewer uncertainties over the long-term.

6.3.2 SUBUNIT B

Subunit B alternatives would employ the same removal, treatment, and disposal options as those for Subunit A materials. Many of the factors considered and discussed under the Subunit A analysis are identical for Subunit B. Therefore, frequent references will be made to the information presented previously in Section 6.3.1. Only those factors unique to remediation of the Subunit B materials will be emphasized. This approach will be applied to the discussions under the primary balancing criteria as well.

The comparison of the Subunit B alternatives against the threshold criteria of overall protection of human health and the environment and compliance with ARARs is summarized below.

Overall Protection of Human Health and the Environment. As discussed in Section 6.3.1.1, this evaluation assumes that the federal government would continue to own the FEMP site. For a cleanup remedy to be considered protective, it should not result in any unacceptable risks to a expanded trespasser or an off-site farmer.

All alternatives, with the exception of the no-action alternative (0B), would provide overall protection of human health and the environment. These alternatives will eliminate, reduce, or control the health or environmental risks resulting from constituents in Subunit B materials. These alternatives would limit exposure to contaminants by removing the material, treating the material by either vitrification or cement stabilization, and then disposing the treated material in an on-property above-grade disposal vault (Alternatives 2B) or off site at NTS (Alternatives 3B.1). Alternative 4B's protection is based on removal and disposal in an on-property above-grade vault, and by retaining institutional controls. Long-term effectiveness would be attained for each of these alternatives.

Off-site disposal would provide a greater degree of protectiveness than on-property disposal for the same reasons discussed under this criterion for Subunit A. For Subunit B residues the inadvertent intruder to the on-property, above-grade disposal vault would not be exposed to levels of direct radiation as high as those for Subunit A residues.

In summary, Alternatives 3B.1/Vit and 3B.1/Cem would provide the greatest overall protection because they would remove the Subunit B residues from the FEMP site.

Compliance with ARARs. With the exception of the no-action alternative, Subunit B alternatives would comply with all pertinent ARARs identified for these alternatives. Under the no-action alternative, Silo 3 would eventually fail, resulting in the release of cold metal oxides to the environment. This scenario would likely result in radiological releases to the air, soil, groundwater, and surface water (via storm water runoff). For example, fate and transport modeling for this scenario indicates that the safe drinking water limits (MCLs in 40 CFR § 141) would be exceeded for uranium, and gross alpha and beta radiation.

For those alternatives that include on-property disposal, an Alternative 4B is the least favorable on-property alternative because the material is not treated.

In summary, Alternatives 2B/Vit, 2B/Cem, 3B.1/Vit, and 3B.1/Cem would meet all pertinent ARARs identified for these alternatives. Because the uncertainty associated with demonstrating that the FEMP on-site disposal vault would provide for the long-term protection of inadvertent intruders, Alternatives 3B.1/Vit and 3B.1/Cem are favored over 2B/Vit, 2B/Cem, and 4B.

Long-Term Effectiveness and Permanence. All Subunit B alternatives would ensure long-term protectiveness to human health and the environment. For all alternatives, projected FEMP site residual risks to viable receptors would be less than 10^{-6} incremental lifetime cancer risk, and no non-carcinogenic effects (hazard index less than 0.2) would be indicated for either receptor.

The characteristics of the treated residue form (vitrification or cement stabilization) and the disposal options (on site or off site at NTS) are similar to those discussed under long-term effectiveness for

Subunit A materials. Long-term environmental impacts are also the same as those considered for Subunit A.

Alternatives 3B.1/Vit and 3B.1/Cem provide a greater long-term effectiveness than Alternatives 2B/Vit, 2B/Cem, and 4B.

Reduction of Toxicity, Mobility, or Volume through Treatment. Alternatives 2B/Vit and 3B.1/Vit would use the vitrification process to treat the Subunit B material. This technology would physically bind the contaminants in a glass-like matrix, which would significantly reduce contaminant mobility and material volume. Mobility would be reduced since the contaminants would be bound in the matrix and the volume of the treated material would be approximately 62 percent of the untreated material volume.

Alternatives 2B/Cem and 3B.1/Cem would use the cement stabilization process to treat the Subunit B material. This technology will physically and chemically bind the constituents in a cement-like matrix, so the mobility of constituents (via leaching from) in this treated material would be greatly reduced. However, the total volume of material will increase by 55 percent as a result of adding the cement stabilizing and setting agents.

Alternative 4B does not reduce toxicity, mobility, or volume because it does not include the treatment. In summary, Alternatives 2B/Vit and 3B.1/Vit are favored over Alternatives 2B/Cem, 3B.1/Cem, and 4B because they would generate a treated form which has greater resistance to leaching and would reduce the volume of the Subunit B materials.

Short-Term Effectiveness. For the Subunit B action alternatives, the various removal, treatment, and disposal activities would result in increased short-term risks (compared to no action). The short-term effectiveness of removal operations is expected to be the same among all alternatives for Subunit B. There is some degree of uncertainty associated with controlling and treating the off-gases generated by the vitrification process.

The increased risks due to off-site transportation of the treated residues to NTS and the short-term environmental impacts associated with removal, treatment, and disposal are similar to those described in Section 6.3.1. Alternative 4B provides the highest short-term effectiveness because no treatment is provided.

In summary, Alternative 4B is the favored alternative, and alternatives 2B/Cem and 3B.1/Cem are favored over Alternatives 2B/Vit and 3B.1/Vit because of the uncertainty associated with off-gas control and treatment for the vitrification process.

Implementability. The removal and treatment activities for all Subunit B action alternatives could be implemented with standard equipment, procedures, and readily available resources. Pneumatic removal would be employed for the Subunit B materials and it is a standard technology that is typically reliable and uses readily available equipment. All other aspects of implementing the action alternatives for Subunit B are identical to those discussed for Subunit A under the implementability criterion in Section 6.3.1.

In summary, Alternative 4B would be favored and Alternatives 2B/Vit and 3B.1/Vit would be the least favored, based on relative overall implementability.

Cost. The estimated total present worth costs for Subunit B Alternatives are provided in Table 6-2 and include a breakdown of capital and operating and maintenance costs.

Alternative 4B is the least expensive action alternative. The present worth costs of Alternatives 2B/Vit and 3B.1/Vit are approximately the same, and are about 5.5 - 6 million dollars higher than that of Alternative 4B. This is due to the treatment component of those alternatives not included in Alternative 4B. Alternatives 3B.1/Cem and 2B/Cem are approximately 27 percent and 34 percent more expensive, respectively, than Alternatives 3B.1/Vit and 2B/Vit, respectively. Alternative 3B.1/Cem is more expensive than Alternative 3B.1/Vit primarily due to the additional packaging, transportation, and disposal of the larger volume of cement-stabilized material.

State Acceptance. State acceptance of the preferred alternative will be addressed after the public comment period ends and will be included in the Responsiveness Summary of the Record of Decision document.

Community Acceptance. Community acceptance of the preferred alternative will be addressed after the public comment period ends and will be included in the Responsiveness Summary of the Record of Decision document.

Subunit B Comparative Analysis Summary

Alternative 3B.1/Vit is the preferred alternative because it is cost-effective and would result in the permanent treatment and volume reduction of Subunit B materials. Alternative 3B.1/Vit would provide overall protection of human health and the environment with fewer uncertainties over the long-term.

6.3.3 Subunit C

Overall Protection of Human Health and the Environment. Alternative 0C would not provide adequate protection of human health and the environment. As discussed in Section 6.3.1, evaluations were conducted for future land uses with and without continued federal ownership. For a cleanup remedy to be considered protective, it would not result in any unacceptable risks to an expanded trespasser or an off-site farmer under the future land use with continued federal ownership scenario.

All of the action alternatives (Alternatives 2C, 3C.1, and 3C.2) would limit exposure to constituents by decontaminating, demolishing, and removing the material to either an on-property above-grade disposal facility or off-site disposal facility, and then excavating contaminated soils and placing clean fill over residual contaminated subsurface soils. The placement of the clean fill was not used as a measure to limit exposures but rather to restore the natural drainage patterns and promote revegetation. Table 5-2 summarizes the proposed soil cleanup levels, all of which would be protective to the expanded trespasser, trespassing child and off-site resident over the long term. Short-term risks would be higher for off-site disposal due to the increased risk of transportation accidents. These action alternatives would be protective of all anticipated receptors assuming continued federal government ownership and control of the area; this includes the off-site farmer and the expanded trespasser receptors.

The basic difference among the action alternatives is the disposal option. On-property disposal (Alternative 2C) would be in an above-grade disposal facility. Off-site disposal options include NTS (Alternative 3C.1) and a permitted commercial disposal site (Alternative 3C.2).

The on-property, above-grade disposal facility would be designed for a 1000 year life with no active maintenance. Fate and transport modeling using conservative assumptions concludes that protectiveness would be maintained over the long term.

NTS and the permitted commercial disposal facility would incorporate engineering controls to ensure protectiveness. Both are located in a climatic, demographic, and hydrogeologic setting which favors minimization of constituent migration to human or environmental receptors.

Alternatives 3C.1 and 3C.2 would provide the greatest overall protection because they would remove the Subunit C excavated soils and debris from the FEMP site.

Compliance with ARARs. All alternatives, other than Alternative 0C (No Action) would meet all pertinent ARARs identified for these alternatives. Under the no-action alternative, it would be likely that constituents would continue to be released to the air, groundwater, and surface water. There would also be a risk for direct contact with contaminated soil and exposure to direct radiation.

For Alternative 2C, an exemption to the Ohio solid waste facility location requirements may be granted on the basis of meeting certain technical requirements of OAC 3745-27-07(B)(5) for the proposed location of the disposal facility on the FEMP site. Since the on-site disposal operations would involve consolidation of materials, rather than new facility construction, the state requirement is relevant and appropriate to this alternative.

The material associated with Subunit C poses fewer hazards than the material in Subunits A and B. Therefore, the on-property, above-grade disposal facility would require less stringent engineering design requirements to meet the provisions of 40 CFR § 192.

Alternatives 2C, 3C.1, and 3C.2 would meet all pertinent ARARs identified for these alternatives.

Long-Term Effectiveness and Permanence. All Subunit C alternatives, which maintain federal government control of land use, would ensure long-term protectiveness to human health and the environment. For all alternatives, projected FEMP site residual risks to viable receptors (off-site farmer, trespassing child and expanded trespasser) would be less than 10^{-6} incremental lifetime cancer risk and no non-carcinogenic effects (hazard index less than 0.3) would be indicated for either receptor. Although residual contamination would remain in the Operable Unit 4 Study Area, the level of risk from the contaminated soil would be controlled by excavating soil that exceeds proposed cleanup levels and by placing clean soil over the excavated areas.

Alternative 2C would employ an on-site disposal facility designed to minimize leachate generation from water infiltration and contact with contaminated soil and debris. Fate and transport modeling using conservative assumptions demonstrates that both risk- and ARAR-based protective levels would be maintained for the Great Miami Aquifer over the long term.

Alternatives 3C.1 (NTS) and 3C.2 (permitted commercial disposal facility) would provide long-term protectiveness because the residual soils and debris would be removed from the FEMP site. The institutional controls and adequate facility maintenance are likely to be more reliable at NTS, as it is a DOE-owned facility.

Following completion of remedial operations, impacted areas would be restored; long-term environmental impacts are expected to be minor. Alternative 2C would result in permanent dedication of approximately 4.7 hectares (11.6 acres) of land for the disposal facility. Alternatives 3C.1 and 3C.2 would provide a greater long-term effectiveness than Alternative 2C.

Reduction of Toxicity, Mobility, or Volume through Treatment. Alternatives 2C, 3C.1, and 3C.2 will isolate the material from the environment by containment. Treatment of the contaminated silo structures, berm material, or soils is not included in any of the alternatives, so no reduction in toxicity, mobility, or volume would be achieved.

Short-Term Effectiveness. For all alternatives, the various demolition and removal activities would result in increased short-term exposures compared to no action. Alternatives 3C.1 and 3C.2 would pose additional risks to the public and workers associated with off-site shipment to NTS or the permitted commercial disposal facility.

During the implementation of any of the action alternatives, the general public is not likely to be exposed to contaminants because of the distance from the work area, the very low levels of contamination, and the methods proposed to control dust during demolition. Potential short-term environmental impacts resulting from the implementation of Alternatives 2C, 3C.1, and 3C.2 include generation of fugitive dust, increased sediment in surface runoff, and disturbance and/or displacement of wildlife as a result of noise, dust, and human activity. Engineering controls would be used to minimize these potential short-term impacts.

In summary, Alternative 2C is favored over Alternatives 3C.1 and 3C.2. The short-term risks to the public and workers for constructing the on-site disposal facility would offset the increased risks to the public and workers associated with off-site transportation of the contaminated soils and debris.

Implementability. Alternatives 2C, 3C.1, and 3C.2 would all employ the same decontamination, demolition, and excavation operations. With the exception of the remotely controlled operations proposed for decontaminating Silos 1, 2, and 3, all operations are standard construction activities which would be easily implemented. The remote silo decontamination operations would be used on the uncontaminated Silo 4 first to improve worker familiarity and identify any potential operational difficulties.

Alternative 2C involves on-site disposal facility construction, which would employ standard construction services and materials. The off-site disposal alternatives (3C.1 and 3C.2) would involve standard transportation practices. Alternatives 3C.1 and 3C.2 would be more difficult to implement than Alternative 2C from an administrative perspective due to the coordination required with those states through which shipment would pass to the off-site locations. Additional efforts would be required to ensure that the Subunit C materials complied with criteria established by either NTS or the permitted commercial disposal facility. Alternative 2C would require coordination with the State of Ohio to ensure that all technical requirements for the on-site disposal facility were met. Alternative 2C is favored over Alternatives 3C.1 and 3C.2 based on relative overall implementability.

Cost. The estimated total present worth costs for Subunit C alternatives are provided in Table 6-2, and include a breakdown of capital and operating and maintenance cost.

There are no capital or O&M costs associated with Alternative 0C-No Action. Alternative 2C, which includes an on-property disposal, is the least expensive action alternative. Transportation to NTS (Alternative 3C.1) or to a permitted commercial disposal facility (Alternative 3C.2) are both more expensive than constructing an on-property vault. However, the overall cost of disposal at a permitted commercial disposal facility is anticipated to be approximately 64 percent lower than the cost of disposal at a DOE-owned facility. This is primarily due to the packaging requirements of the DOE-owned facility. The commercial disposal facility accepts bulk shipment of material.

State Acceptance. State acceptance of the preferred alternative will be addressed after the public comment period ends and will be included in the Responsiveness Summary of the Record of Decision document.

Community Acceptance. Community acceptance of the preferred alternative will be addressed after the public comment period ends and will be included in the Responsiveness Summary of the Record of Decision document.

Subunit C Comparative Analysis Summary

Alternative 2C is identified as the preferred alternative because it is cost-effective, would provide overall protection of human health and the environment over the long-term, and would eliminate the increased risks and costs associated with off-site transportation and disposal. As previously discussed in Section 6.1.2, the decision regarding the final disposition of the Operable Unit 4 Subunit C contaminated soil and debris would be placed in abeyance to take full advantage of planned and in progress waste minimization treatment processes. The contaminated soil and debris would either be processed through the selected OU5 and OU3 remedy identified by the respective OU5 and OU3 ROD or placed in interim storage to await the finalization of the disposal decisions for soils and debris under OU5 and OU3.

7.0 COMMUNITY PARTICIPATION

Input from the public is an important element of the decision-making process for cleanup actions at the FEMP site. Comments on the proposed remedial action at the FEMP site will be received during a public review period following issuance of the Draft Feasibility Study/Proposed Plan-Environmental Impact Statement (FS/PP-EIS) for Operable Unit 4 documents. Oral comments may be presented at a formal public meeting that will be conducted March 21, 1994, 7:00 p.m., at the Plantation, 9660 Dry Fork Road, Harrison, Ohio. Written comments may be submitted at that public meeting or mailed to the following addresses before the close of the public comment period. The public comment period will be conducted from March 7 through April 24, 1994.

Mr. Ken Morgan
Director, Public Information
U.S. Department of Energy Fernald Field Office
P.O. Box 398705
Cincinnati, OH 45239-8705
513-648-3131

Mr. Jim Saric
U.S. Environmental Protection Agency
77 West Jackson Boulevard
5HRE 8J
Chicago, IL 60604
312-886-0992

Information relevant to the proposed remedial actions, including the Remedial Investigation Report for Operable Unit 4, Baseline Risk Assessment, Feasibility Study Report, Proposed Plan, and supporting technical reports is in the Administrative Record. The Administrative Record is located at the Public Environmental Information Center, just south of the FEMP site. For information regarding the Public Environmental Information Center, call 513-738-0164.

PUBLIC ENVIRONMENTAL INFORMATION CENTER HOURS

10845 Hamilton-Cleves Highway
Harrison, OH 45030
Monday and Thursday, 9 a.m. to 8 p.m.
Tuesday, Wednesday and Friday, 9 a.m. to 4:30 p.m.
Saturday, 9 a.m. to 1 p.m.

GLOSSARY

Administrative Record: Documentation of Remedial Investigation/Feasibility Study activities for each operable unit. The documents in the Administrative Record are used to make decisions for the Fernald Environmental Management Project (FEMP) remediation program, as well as for short-term protective measures (removal actions) implemented until a final remediation plan can be put into effect. The Administrative Record is made available for public review so that community members have the opportunity to provide comments to the DOE on proposed cleanup activities at the FEMP site. The Administrative Record for the FEMP site is located at the Public Environmental Information Center (see below).

Amended Consent Agreement: The modified Consent Agreement signed in September, 1991, which includes the renegotiation framework and schedules for developing, implementing, and monitoring appropriate response actions at the Fernald Environmental Management Project (FEMP) and to facilitate cooperation, exchange of information, and participation of EPA and DOE in such actions.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): A federal law, passed in 1980 and modified in 1986 (see SARA), that created a special tax to be placed in a trust fund. This trust fund, generally referred to as Superfund, is used to investigate and remedy abandoned or uncontrolled hazardous waste sites. Under this legislation, the US EPA can carry out one of two possible actions:

1. Pay for site remediation if those responsible for generating the waste cannot be located or are unwilling or unable to perform the work.

2. Use legal action to force those responsible for generating the waste to remediate the site or pay the government for the cost of remediation.

For the FEMP, the DOE is the lead agency, and is remediating the site with oversight from the US EPA in accordance with the Amended Consent Agreement.

Hazardous Waste: Those wastes that are designated hazardous by EPA Regulation 40 CFR § 261.

Note:

By-product material as defined in Section 11(e)(2) of the Atomic Energy Act (AEA) is specifically exempted from regulation as a hazardous waste in 40 CFR § 261 (a)(4). However, this material may exhibit a characteristic of hazardous waste which can pose a substantial or potential hazard to human health or the environment when improperly managed, thereby making certain hazardous waste provisions of RCRA relevant and appropriate to the management of this material.

Isotope: A variation of an element that has the same atomic number of protons but a different weight because of the number of neutrons. Various isotopes of the same element may have different radioactive behaviors, some are highly unstable.

National Priorities List (NPL): EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. A site must be on the NPL to receive money from the Trust Fund for remedial action. The list is based primarily on the score a site receives from the Hazard Ranking System. EPA is required to update the NPL at least once a year. The FEMP (formerly the Feed Materials Production Center) is on this list.

Nevada Test Site (NTS): A DOE owned facility that currently accepts low-level radioactive material from DOE facilities. This sparsely populated area is located 88 km (55 mi) north of Las Vegas, Nevada in a dry climate.

Operable Unit: Term for each of a number of separate activities undertaken as part of a National Priorities List (NPL) site cleanup. A typical operable unit would be removing drums and tanks from the surface of a site. The FEMP has been divided into five operable units.

Picocurie (pCi): Measurement of radioactivity. A picocurie is a trillionth of a curie, representing about 2.2 radioactive particle disintegrations per minute. A curie is the basic unit used to describe the amount of radioactivity in a sample of material. It is based upon the approximate decay rate of 1 gram of radium which is 37 billion disintegrations of radioactive particles per second. Picocuries are often expressed in units related to a liquid volume unit such as picocuries per liter (pCi/L) or related to a solid mass unit such as picocuries per gram (pCi/g).

Public Environmental Information Center (PEIC): An information repository located approximately 2.5 km (1.5 mi) south of the FEMP site. In addition to the Administrative Record, the PEIC contains additional materials to help the public understand cleanup activities at the site, such as the Annual Environmental Report, news clippings, fact sheets and textbooks. For additional information about the PEIC, call (513) 738-0164 during normal operating hours (Refer to Section 7.0).

Rad: Unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs per gram or 0.01 joules per kilogram . Dose is the amount of energy deposited in body tissue due to radiation exposure.

Radionuclide: Radioactive element characterized according to its atomic mass and atomic number which can be man-made or naturally occurring. Radioisotopes can have a long life as soil or water pollutants, and are believed to have potentially mutagenic effects on the human body.

Record of Decision (ROD): A public document that explains which cleanup alternative(s) will be used at National Priorities List sites, where under CERCLA, trust funds pay for the cleanup.

Remedial Action (RA): The actual construction or implementation phase of an National Priorities List (NPL) site cleanup that follows remedial design.

Remedial Investigation/Feasibility Study (RI/FS): Two distinct but closely related studies that are usually conducted at the same time. The Remedial Investigation/Feasibility Study is intended to:

1. Collect the data needed to determine the nature and extent of contamination at an NPL site;

2. Establish criteria for site remediation;

3. Identify and screen alternatives for remedial action;

4. Analyze the available technology and cost (e.g., feasibility) of each alternative.

At the FEMP, five Remedial Investigation/Feasibility Study documents will be prepared, one for each operable unit. Similar documents may also be prepared for a Comprehensive Sitewide Operable Unit. The Remedial Investigation and Feasibility Study Reports for Operable Unit 4 are contained in the Administrative Record file for the FEMP site, located at the Public Environmental Information Center.

Removal Action: Short-term immediate actions taken to address releases of hazardous substances that require expedited response.

Resource Conservation and Recovery Act (RCRA): (1976) An act which enabled the EPA to issue regulations for a national hazardous waste management program. The regulations govern hazardous waste from the time it is created to the time of its disposal. RCRA requires strict "cradle to grave" control, documentation, and proper management of hazardous wastes.

Superfund Amendments and Reauthorization Act (SARA): The 1986 law that reauthorized CERCLA. SARA Title III, a free-standing provision of the law, is of particular relevance to the FEMP site, since, among other functions, it provides for the establishment of the National Contingency Plan. This plan contains provisions for setting up the Administrative Record as a vehicle for public involvement in cleanup activities.

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PROPOSED PLAN/OTHER DOCUMENT CROSS REFERENCE MATRIX

Proposed Plan Section	Other FEMP Document *
2.1 Site History	RI Section 1.1
2.2 Site Description	RI Section 1.1
2.3 History of Waste Generation and Disposal	FS Section 1.4
2.4 Contaminant present in Residues and Waste Material	FS Section 1.4
2.5 Contaminated Environmental Media	FS Section 1.5
2.6 Overview of the Nature and Extent of Contamination	FS Section 1.5
3.1 The Operable Unit Concept	FS Appendix K, Section K.1.4
3.2 Components of Operable Unit 4	FS Section 1.0
4.1 Overview of the Baseline Risk Assessment	RI Appendix D and FS Section 1.6
4.2 Ecological Impacts	FS Appendix I
5.1 No-Action Alternative for All Subunits	FS Section 4.2
5.2 Subunit A - Silo 1 and 2 Contents	FS Section 4.2, 4.3, 4.4
5.3 Subunit B - Silo Contents	FS Section 4.3
5.4 Subunit C - Silos 1, 2, 3, and 4 Structures, Soils and Debris	FS Section 4.4
6.1 Identification of the Preferred Remedial Alternative for Operable Unit 4	N/A
6.2 Evaluation Criteria	FS Section 4.1.2
6.3 Summary of the Comparative Analysis of Alternatives	FS Sections 5.2, 5.3, and 5.4

* "FS" refers to the Draft Final Feasibility Study Report for Operable Unit 4 (December, 1993) and "RI" refers to the Final Remedial Investigation Report for Operable Unit 4 (November, 1993).

APPENDIX A

SUMMARY OF MAJOR ARARs FOR OPERABLE UNIT 4 REMEDIAL ACTION ALTERNATIVES

INTRODUCTION

This appendix presents a summary of the key ARARs and TBCs which pertain to the remedial alternatives which were retained in the Detailed Analysis of Alternatives (Section 4) of the Feasibility Study for OU4, and described in Section 5 of the Proposed Plan. This table includes both applicable or relevant and appropriate requirements (ARARs) established under federal and state environmental laws, and to be considered (TBC) criteria which were determined to be necessary to ensure protection of human health and the environment.

The appendix has three tables in accordance with the three types of ARARs: Chemical-Specific, Location-Specific, and Action-Specific. The layout of the tables is as follows: the retained alternatives are listed in the first column, followed by the regulatory citation and classification as applicable, relevant and appropriate, or TBC. Next the basis for selection and determination of the class of ARAR is described, followed finally by the strategy for compliance with the ARAR during implementation of the alternative. This format and contained information is consistent with the EPA Interim Final Guidance on Preparing Superfund Decision Documents: the Proposed Plan, Record of Decision, Explanation of Significant Differences, and Record of Decision Amendment (OERR; EPA/540/G-89/007, July 1989).

A detailed listing, and discussion of compliance with ARARs is provided in Appendix F of the Feasibility Study Report for Operable Unit 4. A list of acronyms presented in the tables are defined below.

LIST OF ACRONYMS

ARAR	- Applicable or Relevant and Appropriate Requirements
AWWT	- Advanced Waste Water Treatment Facility
CAMU	- Corrective Action Management Unit
CFR	- Code of Federal Regulation
FEMP	- Fernald Environmenal Management Project
HEPA	- High-Efficiency Particulate Air (filter)
HLRW	- High Level Radioactive Waste
MCL	- Maximum contaminant level
MCLG	- Maximum contaminant level goal
NEPA	- National Environmental Policy Act
NESHAPS	- National Emission Standards for Hazardous Air Pollutants
OAC	- Ohio Administrative Code
ORC	- Ohio Revised Code
OU4	- Operable Unit 4
pCi	- picocuries
SWMU	- Solid Waste Management Unit
TBC	- to be considered
TRU	- Transuranic
TSD	- Treatment, Storage, or Disposal Facility
TU	- Temporary Unit
UMTRCA	- Uranium Mill Tailings Radiation Control Act
WWTS	- Waste Water Treatment System

SUMMARY OF MAJOR ARARs FOR OPERABLE UNIT 4 REMEDIAL ACTION ALTERNATIVES

Chemical-Specific

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Determination as ARAR/TBC	Basis for Compliance
2A 2B, 4B 2C	Inorganic Chemicals in Drinking Water 40 CFR 141.11, 40 CFR 141.15, 40 CFR 141.16, 40 CFR 141.51, and 40 CFR 141.62 and 143.3 (OAC 3745-81-11, 3745-81-15, and 3745-81-16)	Relevant and Appropriate	These requirements are not applicable since no public water system (as defined in 40 CFR 141) is involved. They are relevant and appropriate to protect drinking water sources from the same contaminants found in the operable unit. These contaminants might migrate or leach into the underlying aquifer as a consequence of various alternatives.	Fate and transport modeling, for the proposed disposal facility, predicts that potential future releases to the aquifer from the facility will not exceed MCLs or MCLGs. This is primarily due to the presence of approximately 30 feet of low hydraulic conductivity glacial till, that has no significant hydrologic connections with the underlying aquifer, beneath the proposed disposal facility.
2A 2B, 4B 2C	Organic Chemicals in Drinking Water 40 CFR 141.61 (OAC 3745-81-12)	Relevant and Appropriate	The requirement is not applicable since no public water system (as defined in 40 CFR 141) is involved. It is relevant and appropriate to protect drinking water sources from the same contaminants found in the operable unit. These contaminants might migrate or leach into the underlying aquifer as a consequence of remedial actions.	Fate and transport modeling, for the proposed disposal facility, predicts that potential future releases to the aquifer from the facility will not exceed MCLs. This is primarily due to the presence of approximately 30 feet of low hydraulic conductivity glacial till, that has no significant hydrologic connections with the underlying aquifer, beneath the proposed disposal facility.
2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2	Radionuclide Emissions (Except Airborne Radon-222) 40 CFR 61, Subpart H	Applicable	Radioactive materials within this operable unit might contribute to the dose to members of the public from the air pathway during implementation of remedial actions. This requirement is applicable to remedial actions implemented in OU4, since NESHAPS applies to operating units.	The pollution control equipment for the silos and treatment system for off-gas emissions will be designed to limit the discharge of radionuclides to acceptable levels.

TABLE A-1
(Continued)

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Determination as ARAR/TBC	Basis for Compliance
2A, 3A.1 2B, 3B.1, 4B 2C	Radon-222 Emissions 40 CFR 61 Subpart Q	Applicable	Facilities such as the silos within this operable unit might qualify as sources since they might contain radium-226 in sufficient concentrations to emit radon-222. This requirement is applicable only to storage and disposal of radium-bearing material.	The radon-222 flux rate standard of 20 pCi/m^2/s would be met during storage and/or disposal. This is due to the presence of a bentonite layer in the silos (prior to treatment), and the stabilized nature of the treated waste.
2A 2B, 4B 2C	Standards for Control of Residual Radioactive Material 40 CFR 192, Subpart A 40 CFR 192.02(b)	Relevant and Appropriate	Radioactive materials in this operable unit are residual radioactive material from uranium processing. However, the FEMP site is not an ore processing site designated under the UMTRCA; therefore, management of these residues is relevant and appropriate under this regulation.	Radon-222 emissions would comply with the 20 pCi/m^2/s release flux rate and the 0.5 pCi/L concentration above background at the disposal site boundary. This is due to the presence of a bentonite layer in the disposal cell, and the stabilized nature of the treated waste.

SUMMARY OF MAJOR ARARs FOR OPERABLE UNIT 4 REMEDIAL ACTION ALTERNATIVES

Location-Specific

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Determination as ARAR/TBC	Basis for Compliance
2A 2B, 4B 2C	Solid, Nonhazardous Waste Disposal Facility Design Considerations OAC 3745-27-07	Relevant and Appropriate	The State of Ohio solid waste rules are relevant and appropriate to the disposal of silo residues, demolition debris, and other solid wastes generated by the implementation of a remedial alternative within a CAMU. Creation of a solid waste landfill requires that the technical location requirements of the State of Ohio be satisfied. On-site disposal alternatives might trigger this part of the Ohio requirements, which are more stringent than the federal counterparts. The FEMP site is over a sole source aquifer as defined in OAC 3745-27-07. An exemption to this prohibition by demonstration of compliance with the technical criteria in this rule is permitted under ORC 3734.02(G).	The proposed disposal vault meets the technical considerations used to grant exemptions: approximately 30 feet of low hydraulic conductivity glacial till lies beneath the proposed liner, saturated zones in the glacial till have no significant hydrologic connections with the underlying aquifer, and fate and transport modeling predicts that potential future releases to the aquifer from the facility will not adversely impact human health or safety or the environment.
2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2	Compliance with Floodplain/Wetlands Environmental Review Requirements 10 CFR 1022 (Executive Order 11990)	Applicable	This requirement is applicable because the FEMP is a DOE facility subject to the NEPA requirements for environmental activities at federal facilities. Several alternatives might result in destruction or modification of wetland areas.	These alternatives would comply with all NEPA evaluation and documentation requirements. NEPA documentation will also specify public notice requirements, wetland assessments, and any mitigative measures that may be required.

TABLE A-3

SUMMARY OF MAJOR ARARs FOR OPERABLE UNIT 4 REMEDIAL ACTION ALTERNATIVES

Action-Specific

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Determination as ARAR/TBC	Basis for Compliance
2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2	Treatment, Storage, or Disposal Facility (General Standards) 40 CFR 264, Subpart B (OAC 3745-54-13 through 16)	Relevant and Appropriate	Residues, which exhibit a characteristic similar to RCRA hazardous waste, removed from this operable unit might be treated, stored, and disposed in accordance with TSD facility standards.	These alternatives would undertake actions to comply with the TSD Facility general standards.
2A 2B, 4B 2C	Releases from Solid Waste Management Units 40 CFR 264, Subpart F OAC 3745-54-91 through 99; and OAC 3745-55-01 through 011)	Relevant and Appropriate	This requirement is relevant and appropriate because the residues stored in the silos are sufficiently similar to hazardous waste.	These alternatives would install monitoring wells to comply with the groundwater monitoring requirements.
2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2	Closure 40 CFR 264, Subpart G 40 CFR 264.111, .114, and .116 (OAC 3745-55-11, -14, and -16)	Relevant and Appropriate	These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste and the remedial alternatives might require closure of units used to manage waste materials.	These alternatives would design, construct, operate, and monitor the disposal facility to meet the closure performance standard; decontaminate all equipment used in closure, and file a survey plot showing location of disposal facility.
2A 2B, 4B 2C	Post-Closure 40 CFR 264.117 (OAC 3745-55-17) 40 CFR 264.119 (OAC 3745-55-19)	Relevant and Appropriate	These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste and some remedial alternatives might leave residues in place.	These alternatives would comply with the post-closure requirements for units involved in disposal, including continued monitoring, access controls, and deed restrictions.
2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2	Container Storage 40 CFR 264.171 - 178 Subpart I (OAC 3745-55-71 through -78)	Relevant and Appropriate	These requirements pertain to alternatives utilizing containers for storage, or treatment of hazardous waste in containment buildings. The requirements are relevant and appropriate because the residues in the silos are sufficiently similar to hazardous waste.	These alternatives would take measures to comply with the hazardous waste container requirements.

(Continued)

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Determination as ARAR/TBC	Basis for Compliance
2A, 3A.1 2B, 3B.1	Tank Systems 40 CFR 264, Subpart J (OAC 3745-55-91 through 96)	Relevant and Appropriate	These requirements pertain to alternatives utilizing treatment or storage in a tank. These requirements are relevant and appropriate because the residues in the silos are sufficiently similar to hazardous waste.	All process tanks will be constructed with durable material that is compatible with the waste and treatment process for which the tank is designed. The tank design will include secondary containment capable of detecting and collecting releases. Approved inspection and maintenance procedures, which include scheduled visual inspection of all tanks will be established prior to management of waste in the tanks.
2A 2B, 4B 2C	Landfill Capping 40 CFR 264.310 (OAC 3745-57-10)	Relevant and Appropriate	Land disposal of hazardous waste constitutes closure as a landfill, which requires a cap to prevent migration of waste constituents due to leaching. This requirement is relevant and appropriate because the residues are sufficiently similar to hazardous wastes.	Compliance would be achieved through proper design, construction, and implementation of institutional controls at the disposal vault. These controls would include continued inspection, monitoring, and maintenance of the disposal facility and surveyed benchmarks.

TABLE A-3
(Continued)

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Determination as ARAR/TBC	Basis for Compliance
2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2	Corrective Action for SWMUs (CAMU and TU) 40 CFR, Subpart S 40 CFR 264.552-.553	Relevant and Appropriate	During the process of remediation, waste materials might require management in or consolidation in land based units for the purpose of staging, treating or disposing the material. All of the materials generated from remediation of OU4 are considered remediation wastes, amenable to management under this requirement. Some of the waste material might exhibit a RCRA characteristic, or otherwise be sufficiently similar to hazardous waste to make this requirement relevant and appropriate.	These alternatives would demonstrate they can meet the seven criteria required for use of a CAMU, and would use only tanks or containers as temporary units.
2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2	Radiation Dose Limit (All Pathways) DOE Order 5400.5, Chapter II, Section 1.a (proposed 10 CFR 834)	To be considered	Radiation sources within this operable unit might contribute to the total dose to members of the public from this DOE facility. This requirement establishes limits for allowable exposure of the public to radiation sources from all pathways as a result of routine DOE activities. It is included as TBC to ensure adequate protection of human health and the environment from sources of radioactivity.	Where appropriate, the treatment facility design will include HEPA filters to control radioactive particulate emissions. Excavations, excavated soil, and other sources of particulate emissions will be controlled, as appropriate, through good construction practices. Releases to water will be controlled by design and operation of secondary containment features and treatment in the FEMP WWTS and AWWT. Treatment of the waste source will reduce contributions to dose from radon gas, and reduce the likelihood of migration of radionuclides.
2A	Land Disposal of Radioactive Waste 10 CFR 61, Subpart A 10 CFR 61.7(b)(5), 61.42, 61.52 (a)(2), and 61.56(b)	Relevant and Appropriate	The prescriptive intruder protection requirements in 10 CFR 61 have been adopted for the on-site disposal of the K-65 residues to provide reasonable assurance of the long-term protection of the inadvertent intruder. These intruder protection measures were deemed relevant and appropriate due to the characteristics of the K-65 wastes and the specific land use and demographics in the areas surrounding the FEMP.	Design of the disposal unit will include a minimum cover thickness of 5m (15 feet) above the wastes or the use of specially designed intruder barriers to preclude inadvertent intrusion for at least 500 years.

TABLE A-3
(Continued)

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Determination as ARAR/TBC	Basis for Compliance
2A, 3A.1	Environmental Radiation Protection Standards for Mgt. and Disposal of HLRW, Spent Nuclear Fuel, and TRU Wastes 40 CFR 191, Subpart A 40 CFR 191.03(b)	Relevant and Appropriate	As directed by the U.S. EPA letter, "OU4 Screening Dispute Resolution U.S. DOE Fernald," Catherine McCord, EPA, to Andy Avel, DOE, dated October 18, 1990.	This requirement would be met through the use of treatment for waste stabilization, followed by disposal in an engineered vault with design features that would prevent inadvertant exposures, or the uncontrolled release of radioactive material. Institutional control measures would also be implemented for on-site disposal.
2A	Environmental Radiation Protection Standards for Mgt. and Disposal of HLRW, Spent Nuclear Fuel, and TRU Wastes 40 CFR 191, Subpart B	To be considered	As directed by the U.S. EPA letter, "OU4 Screening Dispute Resolution U.S. DOE Fernald," Catherine McCord, EPA, to Andy Avel, DOE, dated October 18, 1990.	This alternative would comply with these requirements through design considerations of the disposal facility. In addition, fate and transport modeling results indicate compliance with individual and groundwater protection requirements will be met.
2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2	NEPA Implementation 10 CFR 1021.2	Applicable	This requirement is applicable because the FEMP is a DOE facility, subject to NEPA evaluation for specific actions at DOE facilities.	NEPA evaluations and documentation will be prepared for the selected remedial alternatives in accordance with established site procedures.

TABLE A-3
(Continued)

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Determination as ARAR/TBC	Basis for Compliance
2A 2B, 4B 2C	Standards for Control of Residual Radioactive Material 40 CFR 192, Subpart A 40 CFR 192.02(a)	Relevant and Appropriate	Radioactive materials in this operable unit are residual radioactive material from uranium processing. However, the FEMP site is not on ore processing site designated under the UMTRCA; therefore, management of these residues is relevant and appropriate under this regulation.	Treatment of the waste and disposal in a properly designed disposal facility will control residuals for 200-1000 years.
2C, 3C.1, 3C.2	Standards for Cleanup of Lands Contaminated with Residual Radioactive Materials 40 CFR 192, Subpart B 40 CFR 192.12(a)	Relevant and Appropriate	*	This requirement would be met by removing contaminated soil down to required levels, and disposal of the residues in an engineered vault with a 3 m (10 ft.) thick multimedia cover.
2A, 3A.1, 2B, 3B.1, 4B, 2C, 3C.1, 3C.2	Implementation of Health and Environmental Protection Standards for Uranium Mill Tailings 40 CFR 192, Subpart C	Relevant and Appropriate	*	These alternatives would use this guidance during implementation.

* [Use same language in Rationale for all 3 sites]

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