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REVISED PROPOSED PLAN

FOR REMEDIAL ACTIONS

AT SILOS 1 AND 2

40700-PL-0001

U.S. Department of Energy
Fernald Environmental Management Project

Rev. 0
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Prepared Under DOE Contract No. DE-AC24-92OR21972
By Fluor Fernald, Inc.

FERNALD
Environmental Management Project

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ACRONYMS & ABBREVIATIONS

ACA	Amended Consent Agreement
AEA	Atomic Energy Act
ARAR	applicable or relevant and appropriate requirement
AWWT	Advanced Wastewater Treatment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CAT	Critical Analysis Team
COC	constituent of concern
D&D	decontamination and demolition
DOE	U.S. Department of Energy
DOE-FEMP	U.S. Department of Energy-Fernald Environmental Management Project
DOE-NV	U.S. Department of Energy–Nevada
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
ESD	explanation of significant differences
FCAB	Fernald Citizens Advisory Board
FEMP	Fernald Environmental Management Project
FMPC	Feed Materials Production Center
FS	Feasibility Study
FS/PP-EIS	Feasibility Study/Proposed Plan – Environmental Impact Statement
ILCR	incremental lifetime cancer risk
IRT	Silos Project Independent Review Team
ISO	International Shipping Organization
LSA	low specific activity
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NPL	National Priorities List
NTS	Nevada Test Site
OEPA	Ohio Environmental Protection Agency
O&M	operations and maintenance
OSDF	On-site Disposal Facility
OU	operable unit
Pb	lead
PEIC	Public Environmental Information Center
Po	polonium
POP	Proof of Principle
PP	Proposed Plan
PRL	preliminary remediation levels

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ACRONYMS & ABBREVIATIONS

Ra	radium
RA	remedial action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act, as amended
RCS	Radon Control System
RD/RA	remedial design/remedial action
RI	Remedial Investigation
Rn	radon
ROD	Record of Decision
RTS	Radon Treatment System
Sr	strontium
TBC	to be considered
TBD	ton per day
Tc	technetium
TCLP	Toxicity Characteristic Leaching Procedure
Th	thorium
TTA	Transfer Tank Area
U	uranium
VITPP	Vitrification Pilot Plant
WAC	waste acceptance criteria

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1.0 INTRODUCTION

DOE is issuing this Revised Proposed Plan for Remedial Actions at Silos 1 and 2 [hereinafter called the Proposed Plan (PP)] as part of its public participation responsibilities under Section 117(a) of the *Comprehensive Environmental Response Compensation and Liability Act* (CERCLA 1980), as amended, and 40 Code of Federal Regulations (CFR) 300.430(f)(2) of the NCP. The intent of this PP is to inform and solicit views of the public on the recommended preferred treatment alternative for the Silos 1 and 2 material.

The purpose of the PP is to facilitate public participation in the remedy selection process by:

- Recommending a preferred treatment alternative for the Silos 1 and 2 material and presenting the rationale for DOE's preference.
- Describing the alternatives that were considered in detail within the *Revised Feasibility Study Report for Silos 1 and 2.*
- Soliciting public review and comment on the alternatives described in **Section 6.0** of this PP and the preferred alternative recommendation documented in **Section 8.0**.
- Providing information on how the public can be involved in the remedy selection process.

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This PP addresses the reevaluation of the selected treatment remedy for the remediation of the *Operable Unit 4* (OU4) Silos 1 and 2 material at the U.S. Department of Energy's (DOE) Fernald Environmental Management Project (FEMP), formerly known as the Feed Materials Production Center (FMPC). The FEMP site is included on the National Priorities List (NPL) of the U. S. Environmental Protection Agency (EPA). Inclusion on the NPL reflects the relative importance placed by the federal government on ensuring the expedient completion of cleanup operations at the FEMP. DOE owns the facility and is conducting cleanup activities at the site under its Environmental Restoration and Waste Management Program with the support of the EPA and the Ohio Environmental Protection Agency (OEPA). Together, the three agencies actively promote local community and public involvement in the decision making process regarding the remediation of the FEMP site.

In July 1997, the U.S. Department of Energy-Fernald Environmental Management Project (DOE-FEMP) and the EPA formally entered an agreement resolving disputes concerning the schedule and the path forward for the remediation of the OU4 Silos 1, 2 and 3 materials. The EPA directed the DOE-FEMP to proceed with the development of a supplemental Feasibility Study/Proposed Plan (FS/PP) and subsequent Record of Decision (ROD) amendment for the Silos 1 and 2 material and explanation of significant differences (ESD) for the Silo 3 material.

Consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the DOE-FEMP prepared a revised Feasibility Study (FS[1]) which developed and evaluated a range of treatment alternatives for safely and effectively remediating the OU4 Silos 1 and 2 material. The results of the detailed and comparative analyses presented in the revised FS have been used to develop the technical and regulatory basis for recommending a preferred remedy for the Silos 1 and 2 material in this PP.

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[1] *Revised Feasibility Study for Silos 1 and 2*, 1999, is available for review in the Administrative Record at the PEIC (refer to **Section 9.0** of this PP).

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This PP summarizes key information that can be found in greater detail in the original Remedial Investigation (RI) and FS Reports for OU4 (FEMP 1993a, 1994a), and the *Revised Feasibility Study Report for Silos 1 and 2*. Information relevant to the remedial selection process is in the Administrative Record. The Administrative Record is located at the Public Environmental Information Center (PEIC), just south of the FEMP site. The PEIC's address and business hours are as follows:

10995 Hamilton-Cleves Highway
Harrison, Ohio 45030
Monday, 7:30 a.m. to 8:00 p.m.
Tuesday – Thursday, 7:30 a.m. to 5:00 p.m.
Friday, 7:30 a.m. to 4:30 p.m.
Phone: (513) 648-7480

This PP, along with the revised FS, will become part of the Administrative Record pursuant to 40 CFR Part 300.825(a)(2) and will be available at the PEIC.

It is DOE policy to integrate the National Environmental Protection Act of 1969 (NEPA) into the procedural and documentation requirements of CERCLA wherever practicable. The incorporation of NEPA values into the original OU4 FS and PP (FEMP 1994b) resulted in a broader and more detailed analysis of the potential environmental impacts associated with implementing the alternatives. The original OU4 FS and PP also included a broad evaluation of cumulative impacts of all FEMP site remediation activities. The resulting integrated process and documentation package for OU4 was termed a *Feasibility Study/Proposed Plan – Environmental Impact Statement* (FS/PP-EIS) (FEMP 1993b).

Integrated CERCLA/NEPA documents (i.e., FS and PP) were then prepared for each of the four ensuing operable units (OUs) at the FEMP. These documents were "tiered" from the original OU4 FS/PP-EIS. Tiering is a process allowed for in the NEPA regulations in which a project that will be accomplished in a series of steps (e.g., remediation of the Fernald Site) can be evaluated in stages. Since the OU4 FS/PP-EIS provided the OU4 NEPA evaluation and resulted in a decision for OU4 only, cumulative impacts were evaluated and updated as each remaining OU (i.e., 1, 2, 3, and 5) prepared its FS/PP documents.

The development of the revised FS and this PP for Silos 1 and 2 has incorporated the same CERCLA/NEPA strategy successfully by integrating the RI/FS documentation previously completed by all five operable units at the FEMP. This includes the original OU4 FS, PP, and ROD (EPA 1994). As documented in the NEPA Supplement Analysis incorporated into the revised FS for Silos 1 and 2, the alternatives evaluated in the revised FS were previously evaluated in the original OU4 FS. No additional impacts were identified as a result of their reevaluation.

In accordance with both CERCLA and 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 remedial selection for the Silos 1 and 2 material, which will be presented in a ROD amendment. Applying the integrated approach for CERCLA and NEPA, DOE plans to prepare and issue a single ROD amendment for OU4, which will 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.

The identification of the preferred alternative in the PP is only an initial recommendation. Changes to the preferred alternative or selection 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 PP (refer to **Section 6.0**). The EPA will make the final decision regarding the selected remedy and will document it in a ROD amendment after all comments from the public and OEPA have been taken into consideration. A summary of DOE's responses to these comments (called a Responsiveness Summary) will be included in the ROD amendment document and made available in the Administrative Record.

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2.0 SITE BACKGROUND

This section provides a brief summary of the history of the FEMP and description of OU4. A more detailed discussion can be found in Section 1, Section 2, and Appendix F of the revised FS.

The FEMP is a 425-hectare (1,050 acre) former uranium processing facility located in southwestern Ohio approximately 18 miles northwest of the city of Cincinnati (see **Figure 2.1-1**). It is located just north of Fernald, Ohio a small farming community, and lies on the boundary between Hamilton and Butler Counties.

The FEMP site was constructed from 1950 to 1951 under the authority of the Atomic Energy Commission, eventually known as the DOE. Between 1952 and 1989, the DOE-FEMP facility (then called the *FMPC*) produced high purity uranium metal products for the nation's defense programs. Production ceased in the summer of 1989 due to a declining demand for uranium feed product; and, plant activities turned their focus to environmental cleanup. In June 1991, the site was officially closed for production by an act of Congress. To reflect a new mission focused on environmental restoration, the name of the facility was changed to the FEMP in August 1991.

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 FEMP site. Large quantities of liquid and solid materials were generated during production operations. Before 1984, solid and slurried materials from uranium processing were stored or disposed in the on-property 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 a total of 8,012 yd^3 of K-65 material and 878 yd^3 of BentoGrout™ clay (Silos 1 and 2); one concrete silo containing 5,088 yd^3 of cold metal oxides (Silo 3); one unused concrete silo (Silo 4); two lime sludge ponds; a burn pit; a clearwell; and a solid waste landfill (see **Figure 2.1-2**).

Figure 2.1-1

FEMP Facility Location Map

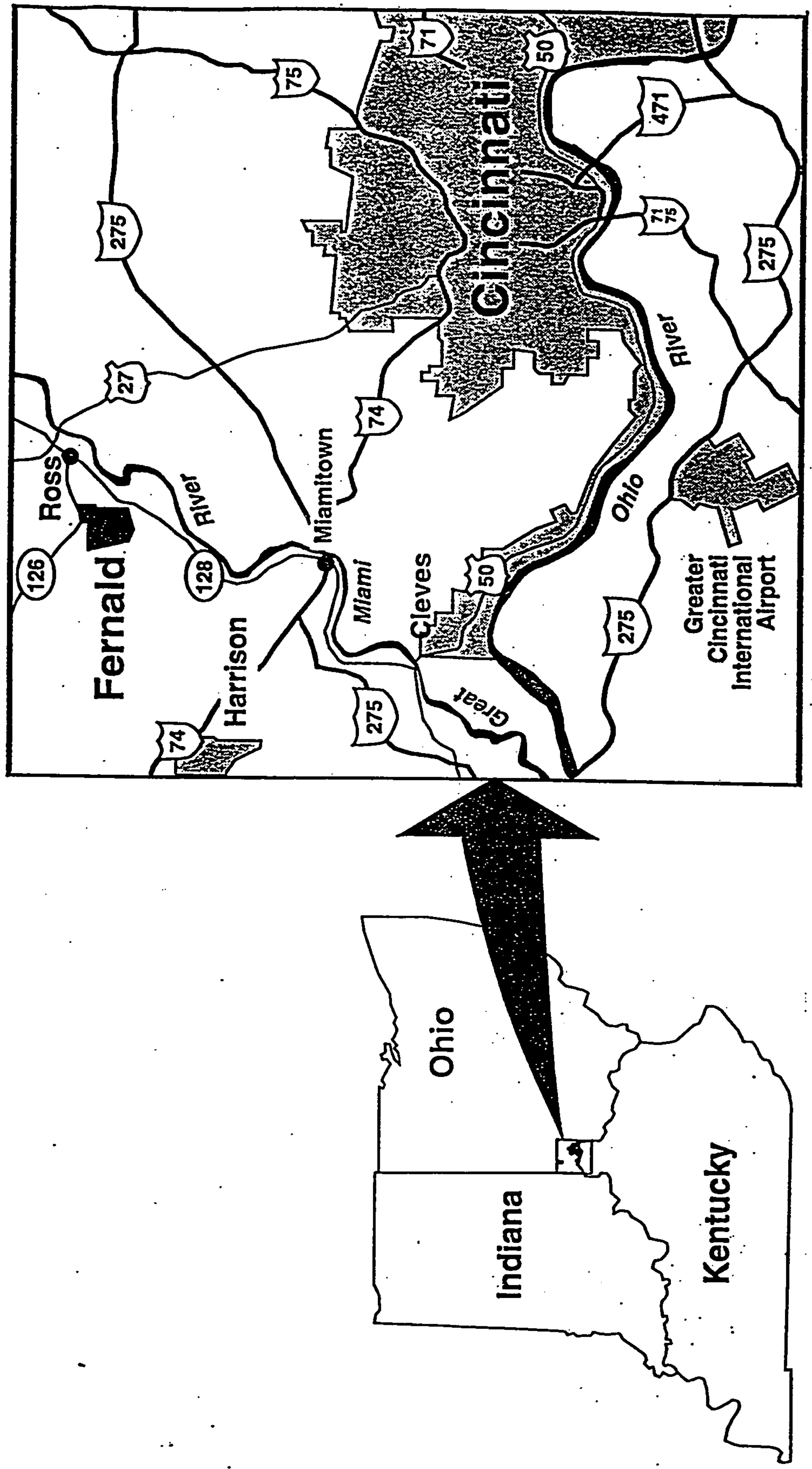

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Figure 2.1-2

Waste Storage Area

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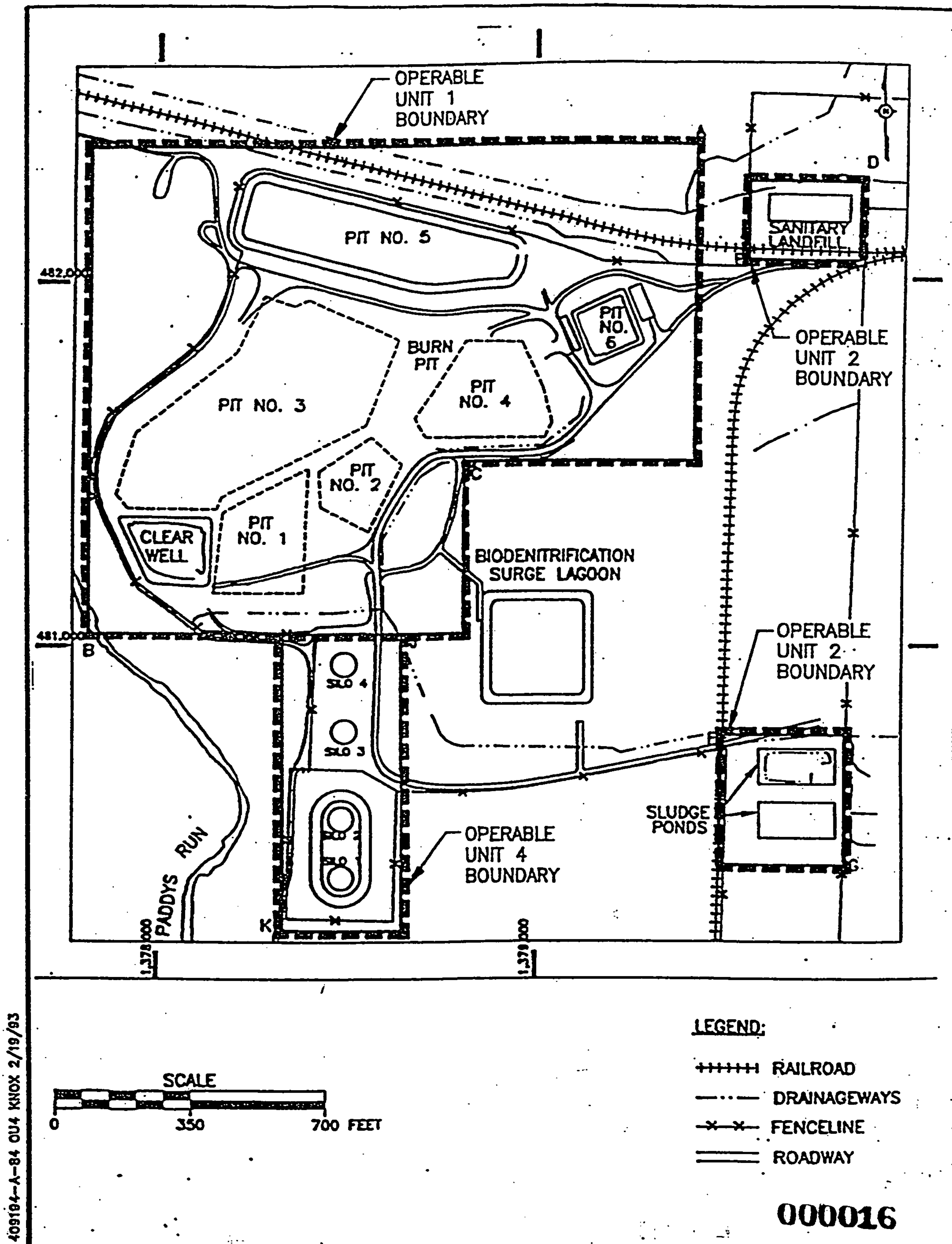

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To establish the legal framework by which to address the releases and threats of hazardous substances from containers and facilities at the FEMP, the DOE-FEMP as the lead agency for the remediation of the FEMP site, and the EPA entered into a Consent Agreement in 1990, as amended in 1991. The Consent Agreement as Amended Under CERCLA Sections 120 and 106(a) (ACA) is the legal basis that administratively governs the proper management and restoration of the FEMP site.

To promote a more structured and expeditious cleanup, the facility and associated environmental issues of the FEMP site are being managed as five OUs. An OU is a term employed under federal environmental regulation to represent a logical grouping of environmental issues at a cleanup site. Separate RI/FS documentation was prepared and issued for the five OUs at the FEMP. The five OUs, for which RI/FS documents have been compiled, are defined within the ACA as:

- OU1: Waste Pits 1 through 6, the Clearwell, burn pit, berms, liners, and soil to a determined depth (estimated to be approximately 3 feet) beneath the waste pits.

- OU2: Other waste units including the flyash piles, other South Field disposal areas, lime sludge ponds, solid waste landfills, berms, liners, and soil within the OU boundary.

- OU3: Former production area and production-associated facilities and equipment (includes all above- and below-grade improvements) including, but not limited to: all structures, equipment, utilities, drums, tanks, solid waste, waste product, thorium (Th), effluent lines, a portion of the Silos 1 and 2 material transfer line, wastewater treatment facilities, fire training facilities, scrap metal piles, feedstocks, and the coal pile.

- OU4: Silos 1, 2, 3, and 4, their contents, berms, and Decant Sump Tank System; Radon Treatment System (RTS); a portion of concrete trench and Silos 1 and 2 material transfer line within the boundary of OU4; miscellaneous pads and concrete structures; soils beneath and immediately surrounding Silos 1 through 4; and, perched groundwater in the vicinity of the silos that may be encountered during the implementation of cleanup activities.

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- OU5: Environmental media including groundwater (both perched and the Great Miami Aquifer), surface water, soil not included in the definitions of OUs 1 through 4, sediment, flora, and fauna.

All five OUs (including OU4) completed the RI/FS process and initiated conducting remedial actions in accordance with their respective EPA-approved final RODs. The original selected remedy for Silos 1 and 2 within OU4 is being reevaluated through a revised FS.

2.1 Regulatory Classification of Silos 1 and Material

Silos 1 and 2, known as the "K-65 Silos," contain the material generated from the processing of high grade uranium ores termed pitchblende. This processing was performed to extract the uranium compounds from the natural ores. The Silos 1 and 2 material contains high activity concentrations of radionuclides, including radium (Ra) and Th. The Silos 1 and 2 material was generated consequential to the processing of natural uranium ores and is therefore classified as by-product material, as defined in Section 11(e)(2) of the Atomic Energy Act (AEA), as amended.

The Silos 1 and 2 material is a complex wasteform from a regulatory perspective. Applicable or relevant and appropriate requirements (ARARs) for its remediation is provided in Appendix A of the revised FS.

2.1.1 Regulatory Classification of Silos 1 and 2 Material

The material contained in Silos 1 and 2 is 11(e)(2) by-product material resulting from the processing of uranium ore concentrates. It is specifically exempt, as defined, from regulation as solid waste under the Resource Conservation and Recovery Act, as amended (RCRA) 40 CFR Part 261.4(a)(4). The referenced exclusion applies to "... source, special nuclear or by-product material as defined in the Atomic Energy Act of 1954 as amended, 42 U.S.C. 2011 *et seq.*" Since a material must first be a solid waste in order to be a hazardous waste, and since the silos material is excluded from regulation as solid waste, the Silos 1 and 2 material cannot be regulated as hazardous waste under RCRA.

Silos 1 and 2 only contain material from the chemical extraction (beneficiation) of uranium from ores. Neither solid nor hazardous wastes nor hazardous constituents (metals) were added to the silos nor mixed with the Silos 1 and 2 residues. The metals found in the material were present in the natural ore and were unintentionally extracted from the parent ore along with the uranium during the process of beneficiation, becoming more concentrated in the residue after the uranium was removed. The presence of natural metals is expected in by-product material and neither invalidates the definition nor the exclusion. Also, no hazardous waste or waste constituents were created at any time during the beneficiation process. Although the leachability of lead in the Silos 1 and 2 material exceeds the RCRA toxicity characteristic level, this does not cause the material to become subject to RCRA regulation, due to a hazardous waste characteristic, because the metals are not from an external source, they are associated with the parent material [whose residues, including any ancillary metals, are excluded from the definition of solid waste pursuant to 40 CFR 261.4(a)(4)].

2.1.2 Packaging and Transportation

For purposes of proper transportation, the material is governed by the U.S. Department of Transportation (DOT) regulations under 49 CFR Subtitle B Chapter I Subchapter C, *Hazardous Materials Regulations*.

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Federal regulations promulgated by the DOT on September 28, 1995 (60 Federal Register 50292) categorize low specific activity (LSA) material into three classifications: LSA-I, LSA-II, and LSA-III. Evaluation of the radionuclide content for Silos 1 and 2 material indicates that this material meets one of the criteria for LSA-II material. Specifically, Silos 1 and 2 material is classified as LSA-II material because the "Class 7 (radioactive) material is essentially uniformly distributed and the average specific activity does not exceed $10^{-4}A_2$/g for solids" (49 CFR Part 173.403)[2]. Therefore, the OU4 Silos 1 and 2 material is classified as LSA-II material for proper transportation.

2.1.3 Disposal

As discussed in **Section 6**, all alternatives evaluated in the FS will dispose the treated Silos 1 and 2 material at the Nevada Test Site (NTS). The NTS is a DOE-owned and managed facility utilized for disposal of selected low-level radioactive wastes from other DOE sites.

DOE derives authority from the AEA to manage small quantities of 11(e)(2) by-product material as "low-level waste" so that it may dispose of such small waste quantities at DOE low-level waste disposal facilities (NTS). Such quantities must not be "too large for acceptance at DOE low-level waste disposal sites," and such wastes must meet the requirements for low-level waste in accordance with DOE Order 435.1 Chapter IV(B)(4).

The treated Silos 1 and 2 material is 11(e)(2) by-product material and may be managed as a low-level waste pursuant to DOE Order 435.1. As a low-level waste, it must meet the NTS waste acceptance criteria (WAC) and, therefore, may not contain a RCRA listed waste, or exhibit a RCRA characteristic, regardless of the exclusion defined for by-product material at 40 CFR Part 261.4(a)(4).

[2] The A_2 value is the maximum activity, in curies, of radioactive material, other than special form, low specific activity (LSA), or surface contaminated objects permitted in a Type A package. To be classified as LSA-II material, the average specific activity must be less than one ten thousandth (10^{-4}) of the calculated A_2 value per gram of material. As an example, if a material has a calculated A_2 value of 10,000 Ci, the average specific activity must be less than 1 Ci/g.

DOE-FEMP will be responsible for demonstrating compliance with the NTS WAC. Specifically, DOE-FEMP will document the absence of the hazardous characteristics defined at 40 CFR Subpart C, especially those toxic constituents identified in Table 1 of 40 CFR Part 261.24 that may have been used in a process, regardless of the waste's regulatory status. Official approval of the wastestream will be documented under separate cover after a successful review by the Department of Energy-Nevada (DOE-NV) Radioactive Waste Acceptance Program.

2.2 Remediation Under CERCLA

The FEMP site was placed on the NPL pursuant to the NCP in 1989. Therefore, contamination at the FEMP site is undergoing remediation pursuant with CERCLA. The materials in Silos 1 and 2 are considered "pollutants or contaminants," as that term is defined under CERCLA and the NCP. The term includes but is not limited to:

> "any element, substance, compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring .... For purposes of the NCP, the term pollutant or contaminant means any pollutant or contaminant that may present an imminent and substantial danger to public health or welfare."

CERCLA provides guidance on the specific cleanup standards that should be applied to a remedial action, or to the criteria for choosing among remedial alternatives when implementing regulations for CERCLA under 40 CFR Part 300 (which is the NCP). The EPA has established nine evaluation criteria for choosing among remedial actions in Subpart E - *Hazardous Substance Response*, 40 CFR Part 300.430(e)(9).

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The NCP under 40 CFR Part 300.430(f)(1)(ii)(E) requires that "each remedial action shall utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable." Preference shall be given to alternatives that provide treatment as a principle element and bias against off-site land disposal of untreated waste. The selected alternative shall provide long-term protectiveness of human health and the environment, meet all ARARs that are identified in the ROD, and provide the best balance of trade-offs among alternatives in terms of the five balancing criteria.

The CERCLA off-site rule (found in CERCLA Section 121(d)(3) and promulgated at 40 CFR Part 300.440) requires that waste from a remedial action that is shipped off-site for treatment and/or disposal be transferred only to those units at a facility that (1) are operating in compliance with RCRA and other applicable federal and state requirements, and (2) do not have any uncontrolled releases of hazardous waste or constituents. The rule applies to any remedial action involving the transfer of hazardous substances, pollutants, or contaminants as defined under CERCLA Sections 101(14) and (33) pursuant to any CERCLA authority, including cleanups at federal facilities [40 CFR Part 300.440(a)(1)].

In a letter dated July 7, 1998, the EPA Region 9 granted approval to the NTS to dispose of CERCLA waste from DOE facilities in waste management units 3 and 5 in accordance with the Off-site Rule (40 CFR Part 300.440). As clarification, the EPA Region 9, in a letter dated December 4, 1998, stated that the CERCLA Off-site Rule approval for the NTS waste management units 3 and 5 includes management of small volumes of 11(e)(2) by-product materials from Fernald OU4 as low-level waste under the provisions of Chapters III and IV of DOE Order 435.1 or any subsequent applicable DOE directive.

2.2.1 Purpose and Need for Decision

Facilities and environmental media at the FEMP site, including OU4, contain radioactive and chemical constituents at levels that exceed certain federal and state standards, and guidelines for protecting human health and the environment. Currently, DOE-FEMP maintains custody of the property and restricts access with fences and security forces, precluding a member of the public from being exposed to site areas that have contamination.

A formalized risk assessment process was established by the EPA to determine the necessity for implementation of cleanup actions. Under this process, several hypothetical scenarios that could expose members of the public to site contamination were examined. One of these scenarios assumed that site access was not controlled (i.e., unrestricted) and a member of the public could be exposed to the higher contamination areas. Results of the risk assessment performed for this hypothetical, unrestricted access scenario indicated that an individual establishing residence within the highly contaminated portions of the OU4 area, under existing conditions, would be subjected to an increased risk of incurring an adverse health effect. Risk assessment calculations performed for OU4 indicate the projected level of increased risk exceeds established federal regulatory guidelines. Based on the results of the baseline risk assessment, the DOE-FEMP concluded in the *Remedial Investigation Report for Operable Unit 4* (FEMP 1993a) that existing site conditions warrant remedial action. A summary of the original assessment results can be found in Appendix F of the revised FS.

2.2.2 Original OU4 Record of Decision

The decision documented by the original OU4 ROD (EPA 1994) was based on the information available in the Administrative Record for OU4 and maintained in accordance with CERCLA. The major documents prepared through the CERLCA process include the RI, the FS, and the PP for OU4.

The original OU4 ROD and the supporting CERCLA documentation [e.g., FS and PP (FEMP 1994 a,b)] prepared for remediation of the FEMP site (including OU4) also includes the appropriate NEPA evaluations. These integrated CERCLA/NEPA evaluations considered the potential impacts from remediation activities at the FEMP. The OU4 FS/PP-EIS (FEMP 1993b) was the lead CERCLA/NEPA document for remediation of the FEMP. Therefore, it was intended that the original OU4 ROD serve as DOE-FEMP's ROD for OU4 under both CERCLA and NEPA; however, it was not the intent of the DOE-FEMP to make a statement on the legal applicability of NEPA to CERCLA actions.

The original selected remedy of vitrification was selected (after the original FS/PP-Draft EIS was issued) with consideration of input received from public hearings held on March 21, 1994, in Harrison, Ohio and on May 11, 1994, in Las Vegas, Nevada. In preparation of the original OU4 ROD, DOE-FEMP considered the comments received both during the public comment period for the original FS/PP-Draft EIS and following issuance of the final EIS. The original OU4 ROD was approved by the EPA in December 1994.

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2.2.3 Description of the Original Selected Remedy

On the basis of the evaluation of remedial alternatives conducted in the original FS/PP, the major components of the selected remedy documented in the original OU4 ROD (EPA 1994) are as follows:

- Removal of the contents of the Silos 1, 2, 3 and the decant sump tank sludge.

- Treatment of the Silos 1, 2, and 3 material and sludges removed from the silos and the decant sump tank by vitrification to meet disposal facility WAC.

- Off-site shipment of the vitrified contents of Silos 1, 2, 3 and the decant sump tank for disposal at the NTS.

- Demolition of Silos 1, 2, 3 and 4 and decontamination, to the extent practicable, of the concrete rubble, piping, and other generated construction debris.

- Removal of the earthen berms and excavation of the contaminated soils within the boundary of OU4, to achieve remediation levels. Placement of clean backfill to original grade following excavation.

- Demolition of the remediation and support facilities after use. Decontamination or recycling of debris before disposition.

- On-property interim storage of excavated contaminated soils and contaminated debris in a manner consistent with the approved *Work Plan for FEMP Removal Action No. 17 - Improved Storage of Soil and Debris* (DOE 1996)[3], pending final disposition of soil and debris in accordance with the RODs of OUs 5 and 3, respectively.

- Continued access controls and maintenance and monitoring of the stored waste inventories.

- Institutional controls of the OU4 area such as deed and land-use restrictions.

- Potential, additional treatment of stored OU4 soil and debris using OU5 and OU3 waste treatment systems.

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[3] This component of the selected remedy was documented in the original Operable Unit 4 Record of Decision in 1994. However, for purposes of this revised Proposed Plan, the reference has been updated to the most recent revision.

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- Pumping and treating, as required, of any contaminated perched groundwater encountered during remedial activities.

- Disposal of the OU4 FEMP contaminated debris and soils consistent with the RODs for OUs 3 and 5, respectively.

Although the selected remedy documented in the original OU4 ROD specifies on-site disposal for the OU4 soil and debris, the final decision regarding the final disposition of the OU4 debris and soils was placed in abeyance, until the OU3 and OU5 RODs were completed. This approach allowed DOE to take full advantage of planned waste management and treatment strategies by these OUs and enabled the integration of disposal decisions for contaminated soils and debris on a site-wide basis.

2.2.4 Need for Modifying the Record of Decision

Following final approval and upon the effective date of the original OU4 ROD, the DOE-FEMP prepared and submitted the *Work Plan for the Operable Unit 4 Remedial Design* (RDWP) that identified the approach for the implementation of the selected remedy (FEMP 1995a). The RDWP was approved by the EPA in June 1995. As part of the OU4 remedial design process, a treatability study program was initiated in May 1996 to collect quantitative performance data to support full-scale application of the joule-heated vitrification technology to the silos material.

The joule-heated Vitrification Pilot Plant (VITPP) treatability study program involved processing non-radioactive surrogate material with selected chemical and physical properties of the combined Silos 1, 2, and 3 materials. The joule-heated VITPP testing program consisted of three campaigns with the following objectives: (1) to determine (using surrogates) whether it was more economical to vitrify the Silos 1, 2, and 3 materials together or separately; (2) to gain experience vitrifying silos material and handling high-sulfate, barium and lead concentrations and BentoGrout™; and (3) and to determine maximum production rates through induced agitation (via bubbling tubes) in a molten glass bath to increase production.

During the joule-heated VITPP testing program, many technical and operational difficulties were encountered which resulted in documented schedule delays and cost increases. The DOE-FEMP recognized that the technical path forward for remediation of the Silos 1, 2, and 3 materials needed to be reassessed in order to address the issues experienced. In September 1996, DOE formally requested extension of enforceable milestones associated with implementing the OU4 remedy.

In October 1996, EPA denied DOE's request for extension of the milestones. EPA and DOE then initiated informal dispute resolution and began reevaluation of the technical path forward for the remediation of the silos material. The DOE-FEMP determined that additional independent technical expertise would prove beneficial to reevaluation of the path forward for remediation of the silo material. In November 1996, the DOE-FEMP convened the Silos Project Independent Review Team (IRT) as a technical resource to assist the DOE-FEMP in this reevaluation. The IRT was comprised of technical representatives, from throughout the DOE complex and private industry, with expertise in various aspects of chemical stabilization, vitrification, and other treatment technologies. VITPP technical and operational difficulties culminated with suspension of VITPP testing following a melter hardware failure in December 1996. The recommendations of the IRT and other evaluations on the part of the DOE-FEMP and FEMP stakeholders (Silos Project IRT 1997) - along with the evaluation of the December 26, 1996, melter hardware failure (FEMP 1997) - supported a decision that vitrification of the Silo 3 material (although possible) would not be practical because of its significant cost and extension to the cleanup schedule. Also, the concentrations of hazardous and radiological constituents in Silo 3 material are low compared to the levels present in the Silos 1 and 2 material; this is an additional key factor for deciding to treat the Silo 3 material separately from the Silos 1 and 2 material.

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In addition, the evaluations concluded that separating the Silos 1 and 2 material from Silo 3 material would significantly reduce the technical uncertainties and programmatic risks of developing an effective treatment process for the separate wastestreams. Together DOE-FEMP and stakeholders decided that an alternate remedy should be considered for treatment and disposal of the Silo 3 material. On July 22, 1997, the DOE-FEMP and the EPA formally entered an "Agreement Resolving Dispute Concerning Denial of Request for Extension of Time for Certain OU4 Milestones," hereinafter referred to as the *Settlement* between the EPA and DOE-FEMP (EPA 1997), resolving disputes concerning the schedule and path forward for the remediation of the Silos 1, 2, and 3 materials. In the Settlement, the EPA directed DOE-FEMP to proceed with the development of a revised FS, PP, and ROD amendment to reevaluate the treatment remedy for Silos 1 and 2 material, and ESD documenting the change in remedy for Silo 3 material. The EPA's basis for directing DOE to proceed with the ROD amendment is discussed in **Section 2.2.5.**

Consistent with the Settlement and in support of the technical basis for the alternatives being evaluated in the revised FS, the DOE-FEMP performed the Proof of Principle (POP) Testing Program. This testing was scoped and implemented to address agency and stakeholder concerns that the detailed evaluation of the alternatives and comparative analysis would be supported by commercial data provided by pilot-scale testing of the alternative remedial technologies.

An ESD was completed by DOE-FEMP and approved by the EPA in March 1998 to document the change in remedy for treatment of the Silo 3 material to chemical stabilization and off-site disposal (FEMP 1998b).

Similarly, DOE-FEMP has prepared a revised FS and this revised PP to recommend the final treatment technology for the Silos 1 and 2 material. The Settlement specified an enforceable milestone of February 1, 2000 for submittal of a draft supplemental FS and PP to the EPA for review and approval. The revised FS will be available for stakeholder inspection and comment and the revised PP will be formally issued for stakeholder review. These revised documents will provide the basis for selection of the final treatment remedy, which will be documented and approved in an amendment to the original OU4 ROD for the Silos 1 and 2 material.

2.2.5 Basis for Path Forward

Pursuant with Section 117 of CERCLA and the NCP at 40 CFR Part 300.435(c)(2)(ii), a ROD amendment should be processed when "differences in the remedial or enforcement action, settlement, or consent decree fundamentally alter the basic features of the selected remedy [in the ROD] with respect to scope, performance, or cost."

The EPA's position requiring a ROD amendment for the Silos 1 and 2 material was based upon the specific circumstances surrounding this situation. The EPA noted that some increase in remedial cost can be reasonably expected; but, whether the cost increase is considered *not significant, significant and requires an ESD,* or *fundamentally alters the selected remedy and must be addressed by a ROD amendment,* has to be determined on a case-by-case basis. The EPA emphasized that, in this specific case where the final remedial cost estimated by DOE-FEMP for the Silos 1 and 2 material increased significantly [i.e., approximately 5 times greater than the original estimate], a ROD amendment was required. Therefore, it was EPA's position that the anticipated increase in the cost of implementing joule-heated vitrification for treatment of the Silos 1 and 2 material constituted a fundamental change to the selected remedy and therefore requires a re-examination of the selected remedy and a ROD amendment (EPA 1997).

As part of the path forward, a service contract was entered into to remove material from Silos 1 and 2 and place the material into a Transfer Tank Area (TTA). This will allow for storage of the material in a more controllable and safer configuration pending remediation by the selected treatment alternative. In conjunction with the TTA, a Radon Control System (RCS) is being constructed to collect and control radon emissions from the TTA and the remediation facility.

2.2.6 Scope of the Revised FS Evaluation

The scope of the revised FS for Silos 1 and 2 is more specific than a traditional FS. Based upon the Settlement with the DOE-FEMP and the EPA (EPA 1997), the scope of the revised FS is to supplement the original FS/PP to evaluate vitrification and other potential alternatives for remediation of Silos 1 and 2. Other portions of the selected remedy (removal, off-site disposal, and disposition of the silos structures, soil, and debris) for OU4 are not being re-evaluated. New components are not being added to the remedy identified in the approved ROD. Therefore, the general RAs and remedial action objectives (RAOs), and the performance objectives for Silos 1 and 2 material identified in the original OU4 FS and ROD remain the basis for the revised FS.

In addition to removal, treatment and disposal, general response actions evaluated in the original OU4 FS included: no action, containment, and institutional control. Based upon these general response actions, potential remedial technologies and process options were evaluated and combined into remedial alternatives. A wide range of alternatives were originally evaluated for the remediation of the Silos 1 and 2 material, including several removal/treatment with off-site disposal alternatives, removal/disposal without treatment, removal/treatment with on-site disposal, and no action. Based upon detailed and comparative analyses of these alternatives, removal of the Silos 1 and 2 material followed by remediation through vitrification, and off-site disposal at the NTS was selected as the remedy.

The revised FS was prepared to reevaluate the implementation of the treatment technology selected in the original OU4 ROD using data compiled for the original OU4 RI and FS reports, as well as updated information (i.e., cost, implementability, etc.) from post-ROD treatability studies. The portions of the original RI/FS that determined that the remedial action for Silos 1 and 2 material was to include retrieval from the silos, treatment, and off-site disposal were not reevaluated. Alternatives to the selected remedy that were evaluated in the original FS, such as no action, on-site disposal, or disposal without treatment for the COCs, were not reevaluated in the revised FS.

Therefore, the methodology and approach adopted by the revised FS has been tailored to address the specific circumstances (e.g., regulatory, technical, administrative) surrounding the revised decision-making process for the *treatment* of the Silos 1 and 2 material. The revised FS has been prepared consistent with the requirements of the CERLCA, the ACA, DOE orders and guidance, and EPA guidance. Consistent with the NCP and EPA guidance (EPA 1988), the FS examines an appropriate range of treatment alternatives.

As required by the NCP, each treatment alternative has been developed to the extent necessary to facilitate the fair comparison of the alternatives against established regulatory-based evaluation criteria. To establish a basis for the development of alternatives, the revised FS relies upon the data compiled for the original OU4 RI and FS reports, post-ROD treatability testing, commercial and DOE-complex experience, POP testing of alternative treatment technologies, and lessons learned involving the technologies being evaluated. The best available assumptions have been employed in the revised FS to define the basis of the development and evaluation of the alternatives.

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The NCP requires that nine criteria be used in evaluating the remedial alternatives to the extent necessary to support the balanced and objective comparison of these alternatives against established criteria in the revised FS. The nine criteria are subdivided into two threshold criteria (overall protection of human health and the environment and compliance with ARARs), five primary balancing criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost), and two modifying criteria (state acceptance and community acceptance). These nine criteria help in evaluating the alternatives against each other in order to select the preferred alternative.

For evaluating cost, remedial alternatives are typically developed to the extent necessary to produce cost estimates with a range of accuracy of +50% to -30%. The conceptual design level of information presented in the FS will be refined for the selected alternative following closer examination during the remedial design process.

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3.0 SITE CHARACTERISTICS

This section summarizes available characterization data obtained during the original RI (FEMP 1993a) on the nature of the radiological and chemical constituents of the material presently stored within Silos 1 and 2 in the OU4 study area. Also included is a brief description of the contents of the Decant Sump Tank System located under Silos 1 and 2 and the RTS. More detailed discussions on the nature of these stored materials and facilities can be found in Chapter 4.0 of the RI or Appendix F, Section 2 of the revised FS.

3.1 Contents of Silos 1 and 2

Silos 1 and 2 contain a total of 8,012 yd^3 of 11(e)(2) by-product material and a total of 878 yd^3 of BentoGrout™ clay for a total volume of 8,890 yd^3. The BentoGrout™ clay layer was added in 1991 to the Silos 1 and 2 material in order to reduce radon (Rn) emanation. Radionuclides at significant activity levels within these silos are actinium (Ac), Ra, Th, polonium (Po), and a radioactive isotope of lead (Pb-210). These radionuclides are naturally occurring elements found in the original ores processed at the FEMP and Mallinckrodt.

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

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

- High concentrations of radionuclides, including Ra-226 and Th-230, that are present in the material.
- An elevated, gamma radiation field in the vicinity of the silos due to the material in the silos.
- Chronic emissions of Rn-222 (a radioactive gas from the decay of Ra-226) from Silos 1 and 2 material into the atmosphere.
- The structural instability of the silos domes and the age of the remaining portions of the structures.
- The potential threat of the silos material leaching RCRA metals and radionuclides into the underlying sole-source aquifer.

3.2 Decant Sump Tank System

The decant sump tank was an integral part of the former operations associated with Silos 1 and 2 and continues to collect groundwater beneath the two silos. Samples from the water within the decant sump tank during 1991 revealed elevated concentrations of Pb-210, Po-210, Ra-226, and U. Analytical results also revealed the presence of above background concentrations of strontium (Sr)-90 and technetium (Tc)-99. With the exception of these latter two constituents, radiological contaminants present in the Decant Sump Tank System are consistent with the relative concentrations of constituents found in Silos 1 and 2. This result confirms that the Decant Sump Tank System is continuing to collect leachate from the underdrains in Silos 1 and 2, as it was designed to do. Sr-90 and Tc-99 were only detected in one decant sump tank sample and the concentrations detected were only slightly above the contract required detection limits. Sr-90 and Tc-99 are fission products and would not be present in the decant sump tank if the liquids consisted solely of leachate from Silos 1 and 2 collected via the silo underdrains. The presence of these radionuclides may have come from a number of sources other than leaching of radionuclides from the silo contents. These sources include: carry-over of other beta emitters during the laboratory chemical separation process (most probable source); infiltration of meteoric water into the decant sump tank; cross-contamination of

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the sample within the transport tanker prior to sample collection; or infiltration of perched groundwater into the decant sump tank.

The metals found in liquid samples from the Decant Sump Tank System include aluminum, antimony, arsenic, chromium, copper, lead, molybdenum, selenium, silver, vanadium, and zinc. In addition, 18 organic compounds were detected in the Decant Sump Tank System liquids at low concentrations. With the exception of toluene, all volatile compounds detected were at or below concentrations that allow a laboratory to accurately quantify the level of the constituents.

3.3 Radon Treatment System

The RTS was installed in November 1987, to reduce the radon inventory within the headspace of Silos 1 and 2. Following RI/FS sampling of Silos 1 and 2 material in 1989, the RTS was abandoned in place. The RTS was sampled during a removal site evaluation in January 1992. The predominant contaminant present is Pb-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 RTS.

3.4 Contaminated Environmental Media

In addition to the waste areas described, contamination is present in environmental media within the OU4 area, such as surface and subsurface soil, soils within the earthen berm surrounding Silos 1 and 2, groundwater, surface water, and perched water.

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Principal Threats

The NCP describes principal threats as those involving liquids, areas contaminated with high concentrations of toxic compounds, and highly mobile materials. Consistent with the NCP, the original OU4 RI provided a detailed characterization of the source term within OU4 and identified those contaminants that contributed to an incremental lifetime cancer risk (ILCR) value greater than the CERCLA criterion of 1×10^{-6} and a hazard quotient greater than the CERCLA criterion of 1.0. The original OU4 RI identified that the principal threats to human health and the environment posed by the Silos 1 and 2 material are from the following contaminant/transport pathways:

- Direct radiation
  - Direct exposure to gamma radiation from radioactive constituents within the silos.
  - Direct exposure to gamma radiation from radioactive constituents in surface soil.

- Air emissions
  - Dispersion of radon that escapes from the silos into the atmosphere.
  - Dispersion of volatile organic compounds or fugitive dust generated from soil.

- Surface water runoff
  - Erosion of contaminated soils into Paddys Run from the vicinity of the silos.

- Groundwater transport
  - Leaching of contaminants from the silos contents via soils to underlying groundwater.
  - Leaching of contaminants from the silos contents via soil to a sand silty/clay lens in the glacial till, which could carry contaminants to surface water and sediment in Paddys Run.

Potential remedial alternatives for OU4 were developed in order to: mitigate the short-term and long-term exposure and associated risks from gamma radiation; reduce radon emanation rates from the Silos 1 and 2 material; minimize the leachability of contaminants from the waste material; eliminate potential of air dispersion from a silo collapse; eliminate the dispersion of fugitive dust generated from the soil; and, eliminate contaminated surface water runoff from contaminated soils into Paddys Run.

3.5 Overview of the Nature and Extent of Contamination

This section summarizes the nature and extent of contamination within environmental media in the OU4 study area. Also included in this section is an overview of the levels of direct radiation associated with the current conditions within OU4. Additional detail on these conditions is provided in Section 4.0 of the original OU4 RI.

Surface Soils

Sampling performed as part of the RI/FS and other site programs in the vicinity of OU4 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 OU4 study area. These above background concentrations appear to be generally limited to the upper six inches of soil. Available survey data and process knowledge do not indicate a direct relationship between the surface soil contamination in the OU4 study area and the silos contents.

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.

Subsurface Soils

As part of the original OU4 RI, samples were collected from the subsurface soils located under and adjacent to Silos 1 and 2. Analytical results revealed 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 silos underdrains.

Groundwater

With the exception of perched groundwater encountered during potential remedial action, groundwater within the Great Miami Aquifer underlying the silos area is not within the scope of OU4. Groundwater in the Great Miami Aquifer underlying the entire FEMP site is being addressed as part of OU5.

Uranium was the major radionuclide contaminant found in the perched water. Elevated concentrations of total uranium were detected in the slant boreholes under and around Silos 1 and 2.

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. Both upgradient and downgradient wells contain above background concentrations of total uranium. Therefore, other sources of contamination must exist besides Silos 1 and 2.

3.6 Overview of the Baseline Risk Assessment

Baseline Risk Assessments were performed in 1994 to determine the potential human health effects and ecological risks that could result from exposure to the contaminants present in OU4.

The baseline assessment of human health risks quantified the health risks to hypothetical human receptors due to exposure from radioactive and chemical sources in OU4, under the no-action alternative. The process analyzed the potential, human health consequences under different scenarios if no remedial actions were taken to address identified environmental concerns.

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The major constituents of concern (COCs) related to the silos material are heavy metals such as, arsenic, cadmium, chromium, and lead, and radionuclides in the U-238, U-235, and Th-232 decay chains such as, Ra-226, Th-230, and Pb-210. [Appendix E of the *RI Report for OU4* (FEMP 1993a) provides full details of the process for selecting COCs.] COCs were detected in Silos 1 and 2, the surrounding surface soil and subsurface soil, and the silos berm soils. Baseline Risk Assessment source term concentrations were determined for the COCs in these media. Fate and transport modeling were then conducted to estimate the exposure point concentrations of contaminants in environmental media (e.g., groundwater, air, and surface water).

Results of the risk assessment performed for this hypothetical, unrestricted access scenario indicated that an individual establishing residence within the highly contaminated portions of the OU4 area, under existing conditions, would be subjected to an increased risk of incurring an adverse health effect. Risk assessment calculations performed for OU4 indicate that the projected level of increased risk exceeds established federal regulatory guidelines. On the basis of the results of the baseline risk assessment, the DOE-FEMP concluded in the OU4 RI that existing site conditions warrant remedial action.

Appendix D and Section 6.0 of the OU4 RI provide detailed information on the baseline assessment of human health risks.

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3.7 Overview of the Baseline Ecological Risk Assessment

A Sitewide Baseline Ecological Risk Assessment was completed and included in the *Site-wide Characterization Report* (FEMP 1993c). Its purpose was to estimate the potential and future risks of FEMP contaminants to ecological receptors if no remediation was implemented. The following is a summary of the Baseline Ecological Risk Assessment found in the Sitewide Characterization Report.

The EPA and DOE agreed in the September 1991 ACA that the Site-wide Ecological Risk Assessment would be performed as part of the *Remedial Investigation Report for Operable Unit 5* (FEMP 1994c). The Site-wide Ecological Risk Assessment in the RI for OU5 quantifies and assesses the possible risks from current concentrations of site contaminants to ecological receptors inhabiting on-property and off-site areas not presently targeted for remediation based on human-health concerns.

Although radionuclides are the most ubiquitous contaminants at the FEMP, estimated ecological risks to both terrestrial and aquatic organisms are primarily associated with nonradioactive inorganic chemicals. Although estimated risks are substantial in some instances, they are based on soil inorganic chemical concentrations comparable to background levels; and, deleterious effects have not been observed in the field. This suggests that FEMP site-specific ecological risks are low. However, remedial actions are appropriate to address contaminants that have potential to cause harm in the future.

More discussion on the Risk Assessment and Ecological Risk issues specific to OU4 can be found in Appendix F of the revised FS for Silos 1 and 2 and in the original *Proposed Plan for Remedial Actions at Operable Unit 4* (FEMP 1994b).

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4.0 SCOPE AND ROLE

4.1 Scope of OU4

OU4 is commonly referred to as the "Silos Project," as distinguished by the four concrete silos, three of which contain low-level waste. OU4, as depicted in **Figure 4.1-1**, consists of the following FEMP facilities and associated environmental media:

- Silos 1 and 2 and their contents (also termed *K-65 Silos*).
- Silo 3 and its contents (also termed *cold metal oxide silo*).
- Silo 4 (empty).
- Silos 1 and 2 decant sump tank, its contents, and associated silo underdrain system.
- The RTS.
- The portion of a concrete pipe trench within the boundaries of OU4, and other concrete structures.
- An earthen berm surrounding Silos 1 and 2.
- Soils beneath and immediately adjacent to Silos 1, 2, 3 and 4.
- Perched groundwater in the vicinity of the silos that may be encountered during the implementation of cleanup activities.

The goal of the OU4 remedial action is to safely remediate the OU4 components in a timely, efficient, and cost-effective manner, that ensures compliance with all ARARs and that would be protective of human health and the environment. After the OU4 remedial actions are complete, the former waste storage area will be restored to a natural habitat in accordance with the *Natural Resource Restoration Plan, Draft* (FEMP 1998a). The complete remediation of the OU4 area will eliminate the FEMP's most significant inventory of contaminated (activity) material and chronic source term of radon emissions at the FEMP site.

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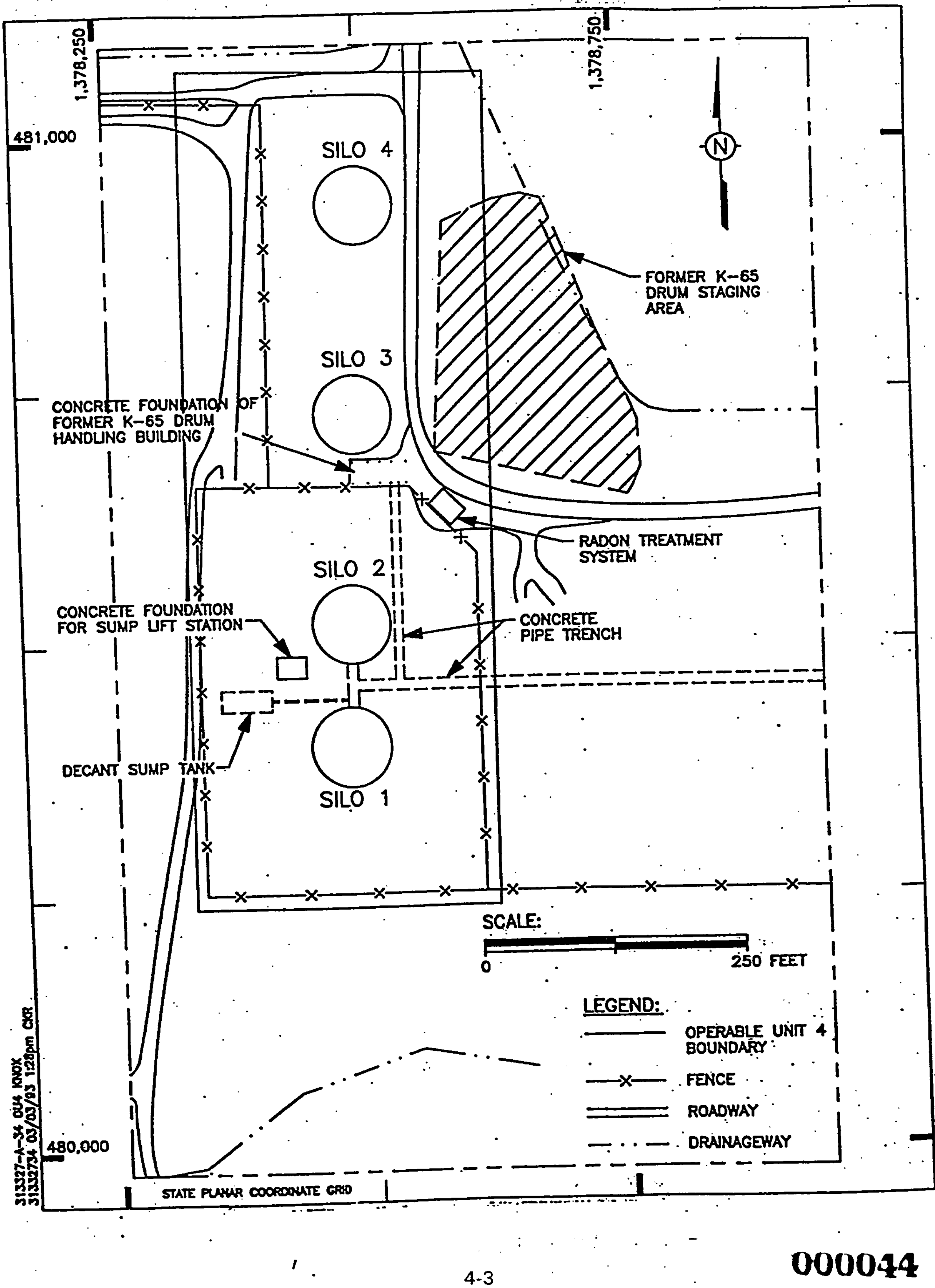
Figure 4.1-1 8116

Operable Unit 4



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The objective of the revised FS is to gather and present information to support an informed risk management decision regarding which technology appears to be the most appropriate for the treatment of the Silos 1 and 2 material.

This PP recommends a preferred technology for treating Silos 1 and 2 material based on the information presented in the revised FS. In addition, this PP presents a preferred alternative for remediating the structures associated with treating Silos 1 and 2 material, including the TTA and the RCS, and for remediating OU4 soils within Area 7.

The remedial actions proposed in the revised FS are similar to those evaluated in the detailed analysis of the original OU4 FS. Because these proposed remedial actions identify off-site disposal as the remedy for treated Silos 1 and 2 material, the FEMP on-site residual risk from Silos 1 and 2 material is virtually nonexistent.

Integration with OU3

The decontamination and demolition (D&D) of the OU4 silos and the above-grade remediation facilities will be planned and performed in accordance with the FEMP OU3 ROD (FEMP 1996a) and the OU3 implementing remedial action documents (i.e., the Facility Closure and Demolition Project's "Project Execution Plan"). The hierarchy of regulatory and site requirements that govern the performance of OU4 D&D activities, flow down directly from the OU3 regulatory process by the OU3 Integrated Remedial Design/Remedial Action (RD/RA) Work Plan and the OU3 Project-specific Implementation Plan.

Integration with OU5

Discrete data points were collected as part of the OU5 RI (FEMP 1994c) to characterize the nature and extent of contamination in environmental media at the site; the results of the data analyses are summarized in the OU5 FS (FEMP 1995b) and are discussed below.

The OU5 RI/FS examined soil on a site-wide basis. All soil at the FEMP, not contemplated to be exhumed as part of a remedy for OUs 1 through 4, is considered within the scope of OU5. This approach has been adopted to examine soil on a site-wide basis to formulate and evaluate comprehensive remedial alternatives that are consistent with presentations in the FS reports for OUs 1, 2, and 4. The ROD for OU4 established OU-specific soil preliminary remediation levels (PRLs) that were revisited by OU5. The OU5 ROD (FEMP 1996b) established final remediation levels for the site-wide soils, including OU4, based on a future land-use scenario. The OU5 ROD modified the OU4 soil remediation levels, which are in some cases more restrictive that the original OU4 PRLs. A more detailed discussion is provided in Appendix F of the revised FS.

The OU5 RI/FS process examined perched groundwater on a site-wide basis. It should be noted, however, that the ACA provides that each OU address perched groundwater envisioned to be encountered as a consequence of conducting RAs. Perched groundwater collected as a result of remediation activities will be directed to OU5 wastewater treatment systems.

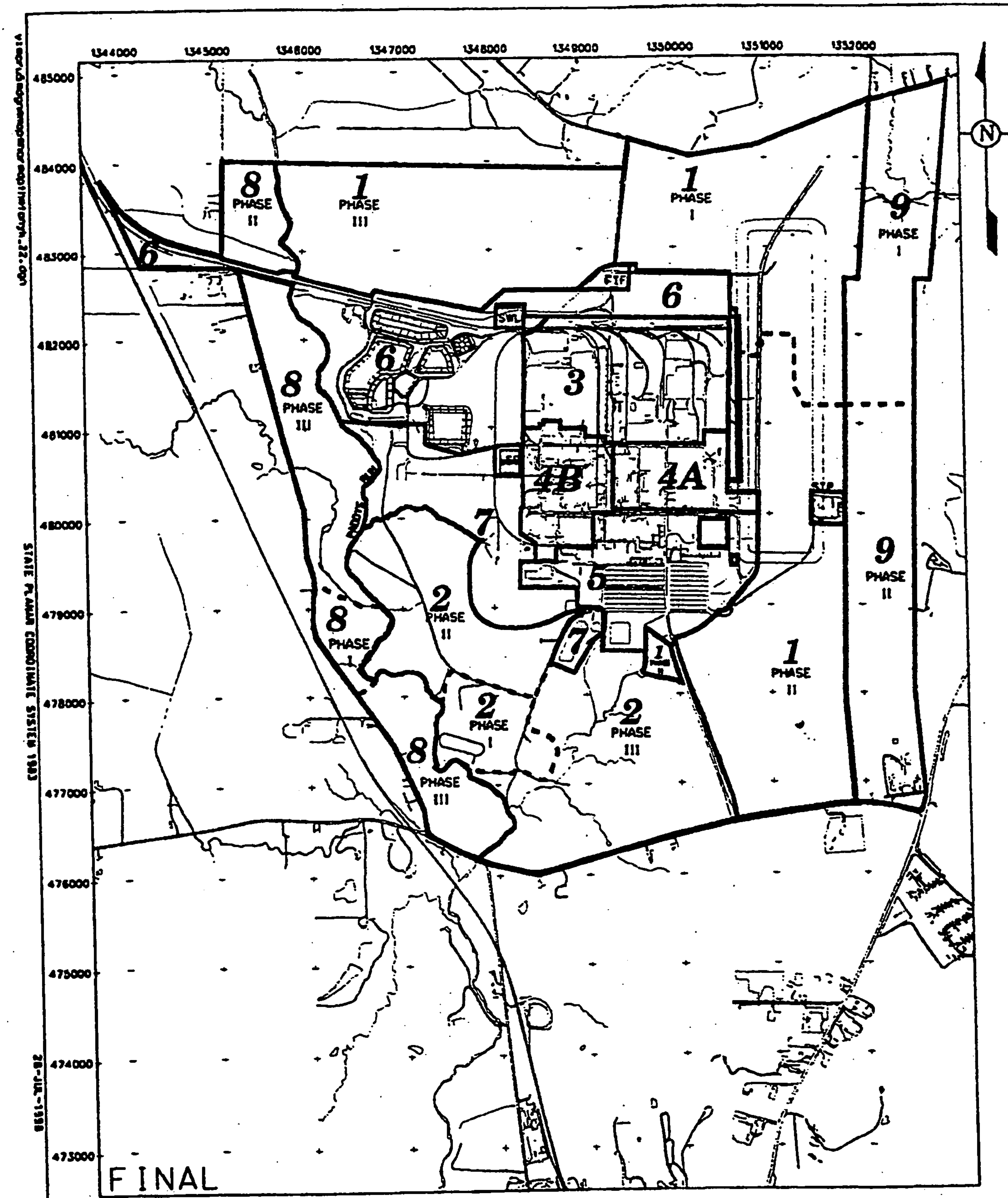
Process wastewaters generated during RAs conducted by all OUs will be directed to OU5 treatment systems [i.e., Advanced Wastewater Treatment (AWWT) Facility]. OU5 has established pretreatment requirements to ensure that available treatment capabilities will not be exceeded by incoming wastewater streams. These requirements have been included in the Design Basis and Description for the alternatives (Appendix G of the revised FS). These projected process wastewater streams have been factored into each of the OU4 remedial alternatives presented in this report.

Integration with OU2

The FEMP On-site Disposal Facility (OSDF) has a WAC for soils and debris that ensures that materials disposed within its confines are protective of human health and the environment. The OSDF will be available for disposal of the existing Silos 3 and 4 structures and associated facilities (i.e., treatment facilities, superstructures, RTS). Soil and debris from D&D activities associated with these facilities will be disposed in the OSDF if they meet the WAC for disposal. Any soils and debris that do not satisfy the OSDF WAC will be disposed at the NTS or an appropriately licensed commercial facility.

Due to prolonged contact of the Silos 1 and 2 concrete with the Silos 1 and 2 material, the likelihood of contaminant migration to the interior of the concrete, and the uncertainty in the cost and effort required to adequately decontaminate it, the concrete from Silos 1 and 2 is more appropriately managed in the same manner as "Category C, Processed-related Metals" as defined in the OU3 ROD. Therefore, concrete from Silos 1 and 2 will be administratively excluded from disposal at the FEMP OSDF. The interior surface of Silos 1 and 2 will be gross decontaminated to remove visible Silos 1 and 2 material before the structures are demolished, size reduced, and packaged for off-site disposal.

Based on the current operating schedule, the FEMP OSDF will not be available for disposal of soil and debris generated from D&D of the OU4 remediation facilities, which include the Decant Sump Tank System, other below-grade appurtenances, and OU4 Area 7 soils. Therefore, the revised FS and PP assumed for costing purposes that all soil and debris from D&D of the OU4 remediation facilities, including treatment facilities, the TTA, RCS, and Pilot Plant, will be disposed at the NTS. However, should programmatic changes occur and the OSDF become available, soil and debris meeting the OSDF WAC will be disposed in the OSDF.



Legend:

—— Remediation Area Boundary
------ Phase Boundary Within A Remediation Area

Figure 4.1-2
Generalized Sitewide Remediating Areas - Sitewide Characterization and Excavation Project

4.2 Integration of OU4 with the National Environmental Policy Act

As previously stated, it is DOE policy to integrate NEPA requirements into the procedural and documentation requirements of CERCLA, wherever practicable. This policy is embodied within DOE Order 5400.4 defining the roles and responsibilities of the DOE regarding compliance with CERCLA and the integration of the remedial process with NEPA.

The revised FS contains the NEPA environmental impact analysis as part of the detailed analysis of each remedial alternative. The evaluation of environmental impacts includes a discussion of the impacts to biotic resources, socioeconomics, cultural resources, wetlands, and floodplains. The NEPA impact analysis is factored into the detailed and comparative analysis of alternatives presented in Sections 3 and 4 of the revised FS and the identification of the preferred alternative in this PP. Additionally, the revised FS has been supplemented to incorporate the results of a NEPA Supplement Analysis (Appendix D of the revised FS) that assesses the potential environmental impacts associated with the alternatives being considered in the revised FS against the results of the original OU4 FS/PP-EIS.

5.0 REMEDIAL ACTION OBJECTIVES

The remedy approved in the OU4 ROD (EPA 1994) consisted of the following components:

- Removal of the contents from the Silos 1, 2, and 3 structures, on-site vitrification of the silos materials, and disposal at the NTS.
- Decontamination and demolition of all silos structures and the vitrification facility in accordance with the approved OU3 ROD (FEMP 1996a).
- Excavation and treatment of contaminated soils, and treatment of perched water encountered during RA, in accordance with the approved OU5 ROD (FEMP 1996b).

The OU4 ROD identifies that the treatment portion of the remedy for the Silos 1 and 2 material will "significantly reduce the leachability of metal contaminants of concern to levels that are below RCRA regulatory thresholds." This treatment requirement is still relevant and serves as the basis for screening and selecting alternatives for evaluation in the revised FS.

As discussed in Section 1.0 of the revised FS, DOE performed, in accordance with the ACA, a RI/FS for OU4 that was approved by the EPA in August 1994. The initial phase of evaluating alternatives for the remediation of Silos 1 and 2 involved the development of RAOs and ARARs for each portion of the RA. As discussed in **Section 2.1.6**, the RAOs and performance objectives for treatment of the silos material, as identified in the original OU4 FS, remain the basis for the treatment remedy proposed in this PP and were not reevaluated as part of the revised FS. The RAOs are presented below:

- Prevent direct contact with or ingestion of Silos 1 and 2 material.

- Prevent release or migration of waste materials to soil, groundwater, surface water or sediment.

- Prevent exposures to Silos 1 and 2 material that may cause an individual to exceed applicable dose limits.

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6.0 SUMMARY OF ALTERNATIVES

Potential treatment technologies were examined for their capability to treat Silos 1 and 2 material. These technologies were screened to eliminate those that were impractical to implement or ineffective at addressing the hazards associated with the silos material. Based upon the screening of potential treatment technologies, vitrification and chemical stabilization were identified for further evaluation (i.e., for a detailed analysis to examine the merits of each at addressing the concerns associated with the silos material). To provide a comprehensive and thorough evaluation, each of these two technologies were evaluated in the Detailed Analysis of Alternatives and Comparative Analysis of Alternatives (Sections 3 and 4 of the revised FS) based upon two representative processes, resulting in four alternatives as follows:

- Vitrification – Joule-heated;
- Vitrification – Other;
- Chemical Stabilization — Cement-based; and
- Chemical Stabilization — Other.

The results of this detailed analysis were used for a comparative analysis of the technologies, summarized in **Section 7.0**. Included within each technology process description is an estimate of the volumes of treated and secondary waste that would require disposal from the treatment process, the number of shipments to the NTS, and the estimated total costs for the treatment process. For more in-depth information on the representative process, refer to the revised FS (available for review in the Administrative Record at the PEIC, refer to **Section 9.0** of this PP).

The cost estimates in the revised FS were prepared in accordance with the Design Basis and Description (Appendix G of the revised FS), which incorporated technology-specific data generated during the POP Testing Project. The estimates employ a wide variety of cost-estimating methods and techniques such as generic unit costs, contractor-supplied information, DOE guidance, conventional cost-estimating guides, commercial remedial costs, and cost information based on actual FEMP operation and maintenance (O&M) experience on jobs of similar magnitude and complexity. The cost elements were developed for: (1) capital costs; (2) engineering costs; (3) O&M costs; (4) D&D costs; (5) project management costs; (6) waste disposal costs; and (7) cost of money. A more detailed discussion of the cost-estimating methods, basis, and assumptions for these cost components is presented in Appendix C of the revised FS.

Section 121 of CERCLA requires that RAs achieve a standard or level of control that is consistent with environmental laws or regulations, which are termed ARARs. ARARs pertain to all aspects of a RA, including the establishment of cleanup levels and the operation and performance of treatment systems.

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 COCs. 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 RAOs 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 Silos 1 and 2 material is presented in Appendix A of the revised FS. From these detailed lists, certain key ARARs and TBCs were identified to have significant impact on evaluating the alternatives. These include those associated with the control of radionuclide emissions, the management of RCRA hazardous waste, and compliance with NEPA.

These key ARARs associated with the remedial alternatives evaluated in this section are presented in **Tables A-1 through A-3 in Appendix A** of this PP. A complete identification of all ARARs associated with remediation of the Silos 1 and 2 material is found in Appendix A of the revised FS.

The tables identify the remedial alternatives associated with the major regulatory requirements, 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 6.1 through 6.4**, would meet all pertinent ARARs identified for these alternatives.

6.1 On-site Joule-heated Vitrification, Off-site Disposal at the NTS (VIT1)

Figure 6.1-1 presents a simplified process flow diagram of a proposed VIT1 process. A detailed discussion of this alternative is available in Section 3.2.1 of the revised FS.

The treatment system described in this section is based upon data and other information compiled from POP testing and has been developed as a viable way to implement this alternative. Equivalent systems may exist and are not precluded from consideration, consistent with the final selected remedy, during remedial design.

This alternative (VIT1) involves the removal, on-site treatment through joule-heated vitrification, and off-site disposal of the treated silos material at the NTS. The Silos 1 and 2 material is removed from the TTA as a slurry containing approximately 10 wt% solids for the VIT1 process. The VIT1 process involves dewatering of the Silos 1 and 2 material slurry to minimize the volume of material to be vitrified. The process used to demonstrate this alternative during POP testing produced a solid, stabilized wasteform that has a waste loading of approximately 90 wt% Silos 1 and 2 material. The treated material is packaged in shielded shipping and disposal containers designed to meet the requirements under DOT for shipping LSA-II solid material.

Data from the POP testing of the VIT1 alternative on surrogate Silos 1 and 2 material indicate that the original 6,797 m^3 (8,890 yd^3) of material in Silos 1 and 2 could be reduced to a monolithic wasteform with a volume of approximately 3,274 m^3 (4,283 yd^3).

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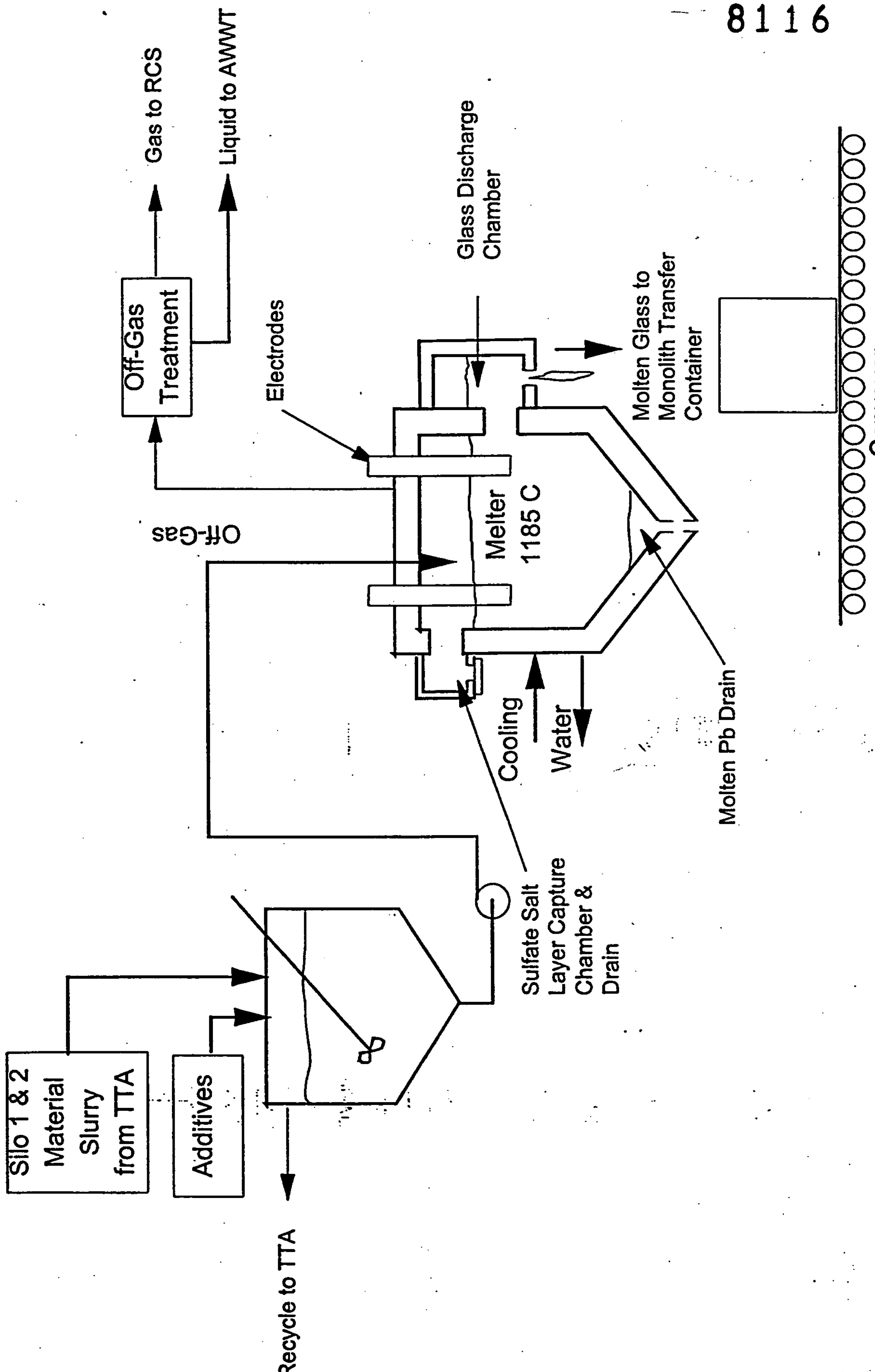

Figure 6.1-1

Simplified Process Diagram
Vitrification - Joule-heated

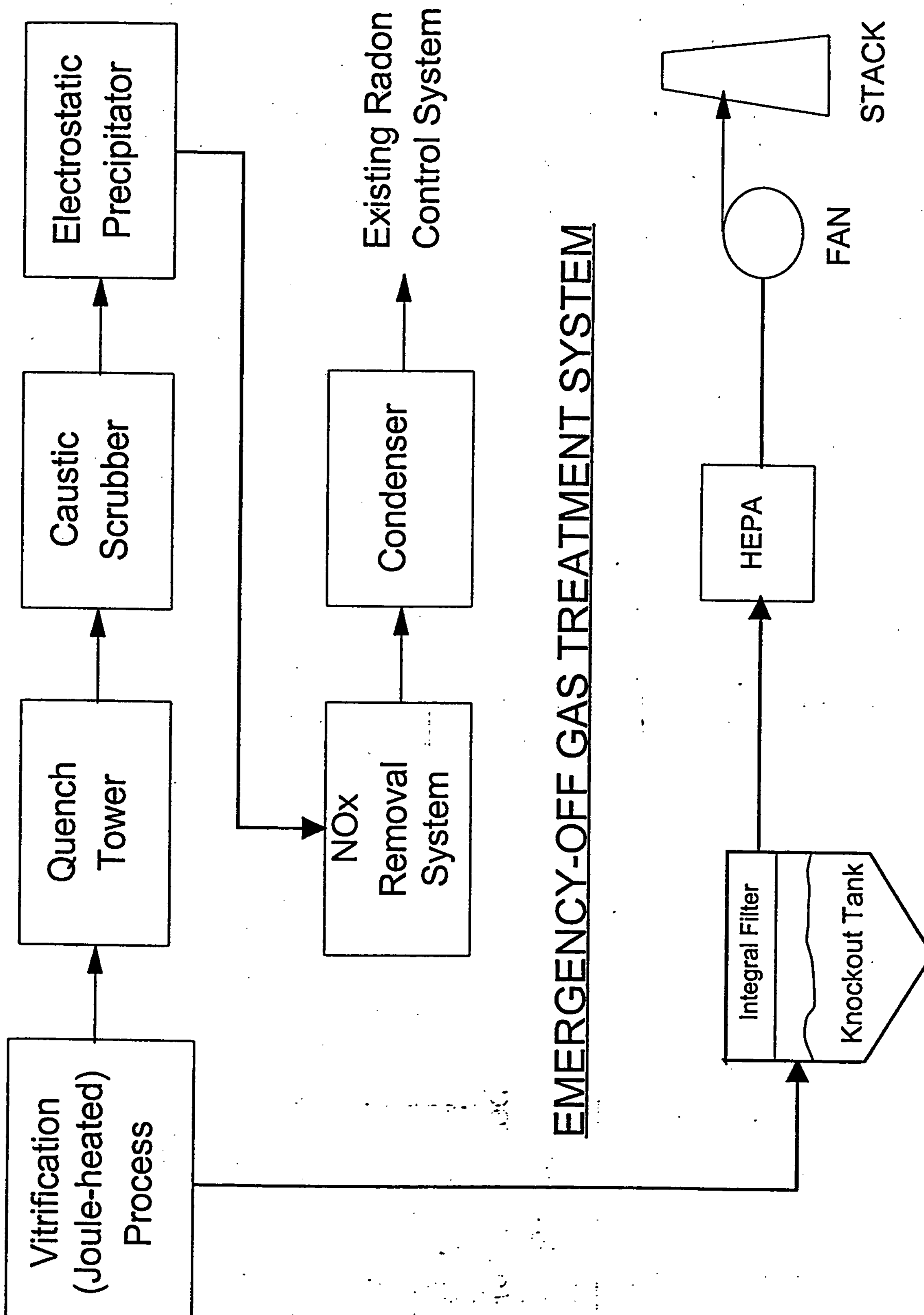

Figure 6.1-1a

Off-Gas Treatment System

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However, due to the shielding necessary for protection of workers and the general public and for meeting DOT requirements, containerization of the treated material results in an overall disposal volume of approximately 8,895 m^3 (11,635 yd^3). In addition, the VIT1 process O&M activities will generate approximately 1,430 m^3 (1,870 yd^3) of solid secondary waste. The total estimated disposal volume of the treated Silos 1 and 2 material and all secondary wastestreams is 10,325 m^3 (13,505 yd^3), equating to an overall volume increase of 52%, compared to the original volume of material in Silos 1 and 2.

This alternative involves construction of a feed preparation system to prepare and deliver a feed slurry containing both silos material and glass-formers to the melter, a nominal 15-ton per day (TPD) joule-heated melter, and a melter off-gas system to provide necessary treatment of effluent gases. The full-scale treatment facility also includes many support systems such as product cooling, wastewater treatment, off-specification material rework, building ventilation, and personnel support facilities. Additionally, the remediation facility includes an interim storage facility capable of handling 45 days of production capacity in order to accommodate the waste verification process and intermittent disruptions in the FEMP shipping program.

This alternative involves the packaging, loading, and shipping (via truck or intermodal transportation) of vitrified material for disposal at the NTS. Approximately 2,398 shipping and disposal containers would be shipped to the NTS. If two containers were placed on one truck per shipment, approximately 1,199 direct truck shipments to the NTS would be required. For intermodal transport, two containers would be placed in an International Shipping Organization (ISO) container. One ISO container would be placed on a truck and two ISO containers would be placed on a railcar. This would result in 1,199 truck shipments from the FEMP to an intermodal facility, 600 railcar shipments by regular freight from an intermodal facility in the east to an intermodal facility in the west, and 1,199 truck shipments from the intermodal facility to the NTS.

The estimated cost for this alternative is summarized below:

Capital Cost	$69 million (M)
Engineering Cost	$25 M
O&M Cost	$134 M
D&D Cost	$35 M
Project Management Cost	$22 M
Waste Disposal Cost	$25 M
Cost of Money	$46 M
Summary Cost	$356 M

6.2 On-site Vitrification other than Joule-heated, Off-site Disposal at the NTS (VIT2)

Figure 6.2-1 presents a simplified process flow diagram of the proposed VIT2 process. A detailed discussion of this alternative is available in Section 3.3.1 of the revised FS.

The treatment system described in this section is based upon data and other information compiled from POP testing and has been developed as a viable way to implement this alternative. Equivalent systems may exist and are not precluded from consideration, consistent with the final selected remedy, during remedial design.

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This alternative (VIT2) involves the removal, on-site treatment through vitrification by a process other than joule-heated (combustion melter), and off-site disposal of the treated silos material at the NTS. The Silos 1 and 2 material is removed from the TTA as a slurry containing approximately 10 wt% solids for the VIT2 process. The VIT2 process involves dewatering and drying of the Silos 1 and 2 material slurry to minimize the volume of material to be vitrified. The process used to demonstrate this alternative during POP testing produced a solid stabilized wasteform that has a waste loading of approximately 87 wt% Silos 1 and 2 material. The treated material is packaged in shielded shipping and disposal containers designed to meet the requirements under DOT for shipping LSA-II solid material.

Data from the POP testing of the VIT2 alternative on surrogate Silos 1 and 2 material indicate that the original 6,797 m^3 (8,890 yd^3) of material in Silos 1 and 2 could be reduced to a frit wasteform with a volume of approximately 6,643 m^3 (8,689 yd^3). However, due to the shielding necessary for protection of workers and the general public and for meeting DOT requirements, containerization of the treated material results in an overall disposal volume of approximately 12,756 m^3 (16,450 yd^3). In addition, the VIT2 process O&M activities will generate approximately 1,644 m^3 (2,150 yd^3) of solid secondary waste.

The total estimated disposal volume of the treated Silos 1 and 2 material and all secondary wastestreams is 14,220 m^3 (18,600 yd^3), equating to an overall volume increase of 109%, compared to the original volume of material in Silos 1 and 2.

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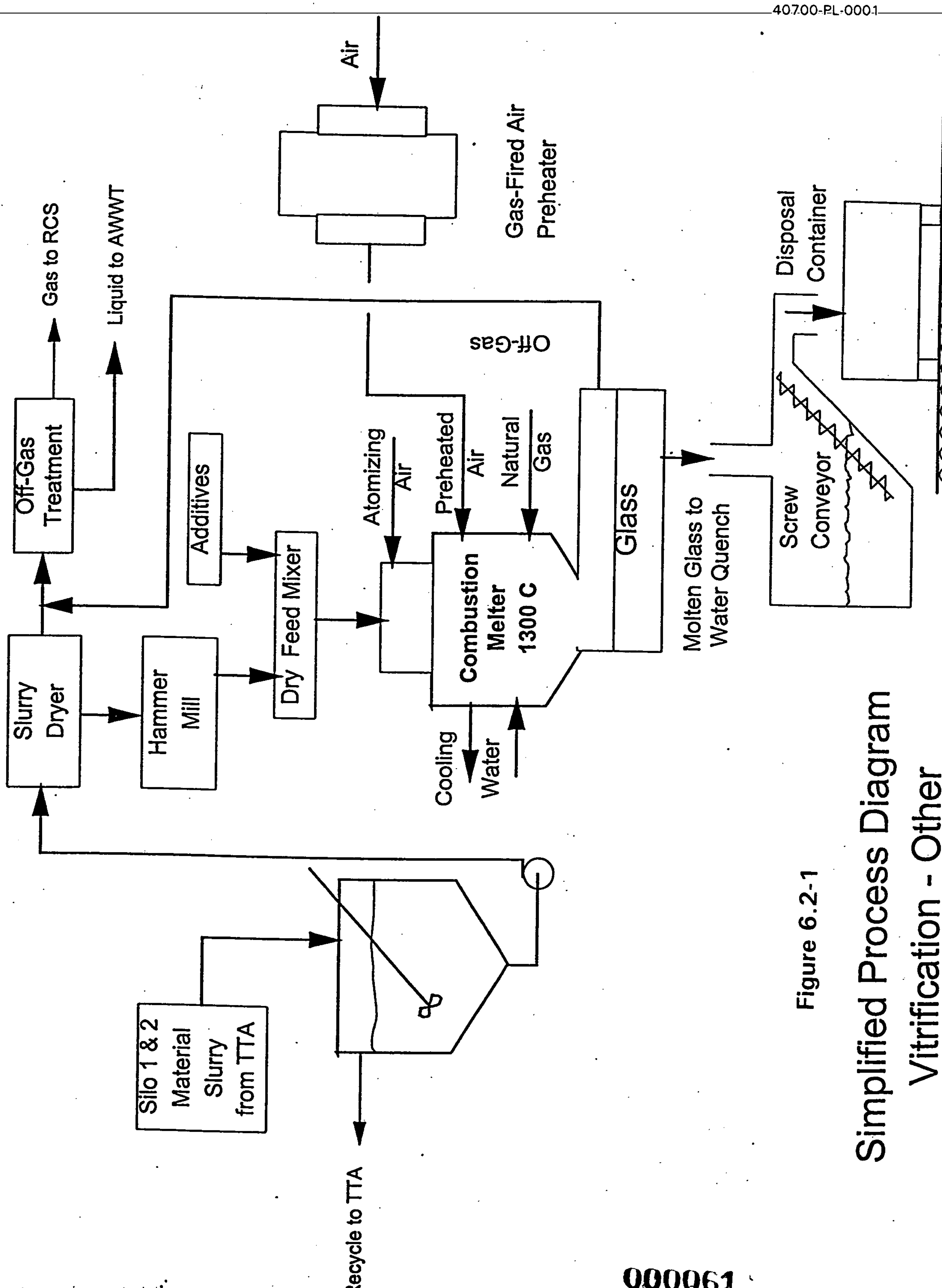

Figure 6.2-1
Simplified Process Diagram
Vitrification - Other

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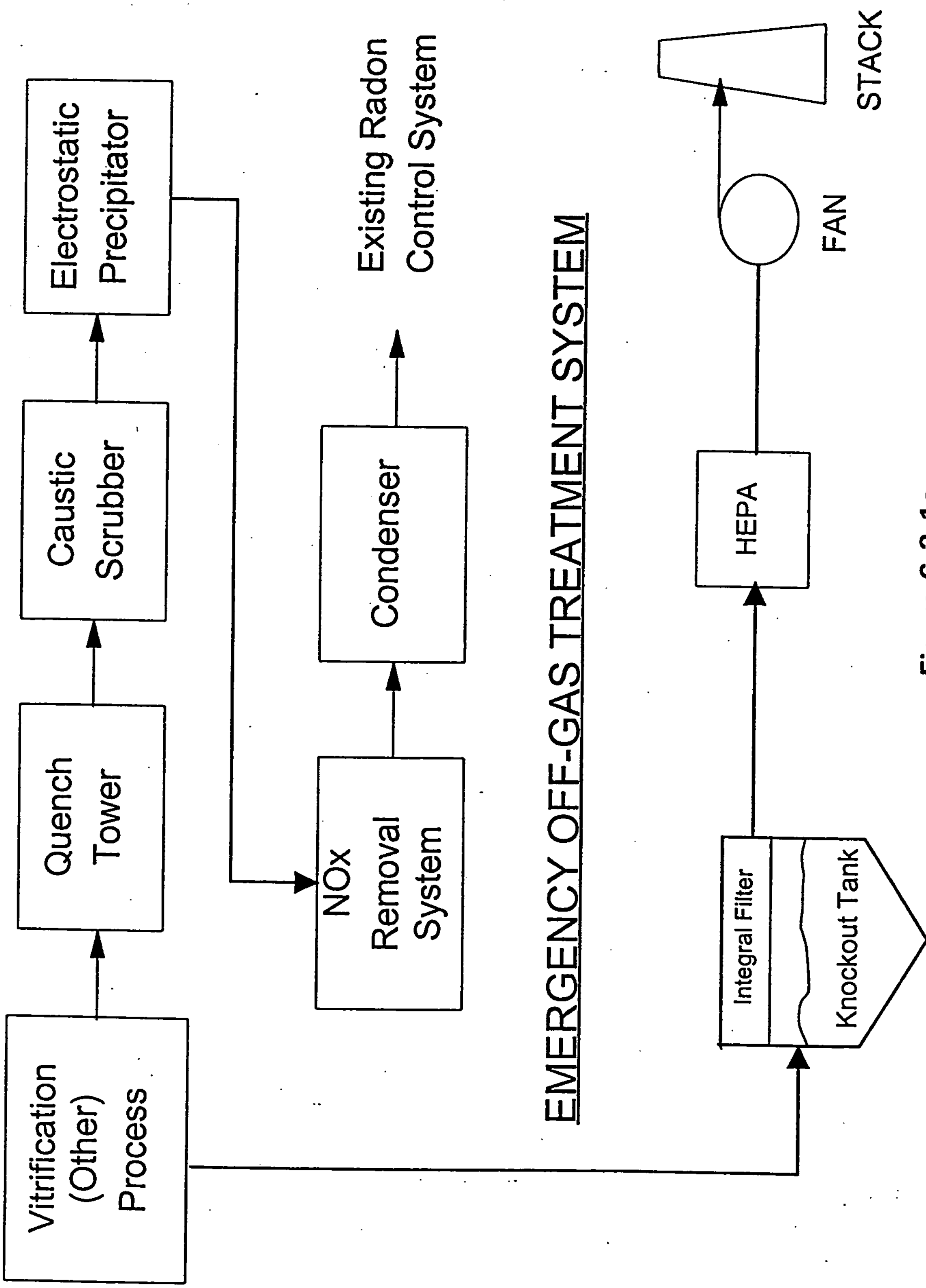

Figure 6.2-1a

Off-Gas Treatment System
Vitrification - Other

This alternative involves construction of a feed preparation system to prepare and deliver a dry feed containing both silos material and glass-formers to the melter, a nominal 15-TPD combustion-heated melter, and a melter off-gas system to provide necessary treatment of effluent gases. The full-scale treatment facility also includes many support systems such as product forming, wastewater treatment, off-specification material rework, building ventilation, and personnel support facilities. Additionally, the remediation facility includes an interim storage facility capable of handling 45 days of production capacity in order to accommodate the waste verification process and intermittent disruptions in the FEMP waste shipping program.

This alternative involves the packaging, loading, and shipping (via truck or intermodal transportation) of vitrified material for disposal at the NTS. Approximately 2,162 shipping and disposal containers would be shipped to the NTS. If two containers were placed on one truck per shipment, approximately 1,081 direct truck shipments to the NTS would be required. For intermodal transport, two containers would be placed in an ISO container. One ISO container would be placed on a truck and two ISO containers would be placed on a railcar. This would result in 1,081 truck shipments from the FEMP to an intermodal facility, 541 railcar shipments by regular freight from an intermodal facility in the east to an intermodal facility in the west, and 1,081 truck shipments from the intermodal facility to the NTS.

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The estimated cost for this alternative is summarized below:

Capital Cost	$67 M
Engineering Cost	$25 M
O&M Cost	$133 M
D&D Cost	$38 M
Project Management Cost	$22 M
Waste Disposal Cost	$20 M
Cost of Money	$37 M
Summary Cost	$342 M

6.3 On-site Chemical Stabilization Cement-based, Off-site Disposal at the NTS (CHEM1)

Figure 6.3-1 presents a simplified process flow diagram of the proposed CHEM1 process. A detailed discussion of this alternative is available in Section 3.4.1 of the revised FS.

The treatment system described in this section is based upon data and other information compiled from POP testing and has been developed as a viable way to implement this alternative. Equivalent systems may exist and are not precluded from consideration, consistent with the final selected remedy, during remedial design.

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This alternative (CHEM1) involves the removal, on-site treatment through chemical stabilization by a cementation process, and off-site disposal of the treated silos material at the NTS. The Silos 1 and 2 material is removed from the TTA as a slurry containing approximately 10 wt% solids for the CHEM1 process. The CHEM1 process involves dewatering of the Silos 1 and 2 material slurry to minimize the volume of material to be stabilized. The process used to demonstrate this alternative during POP testing produces a solid stabilized wasteform that has a waste loading of approximately 40 wt% Silos 1 and 2 material. However, a 30 wt% waste loading was used for the evaluation of the CHEM1 alternative to enhance the ease of operability. The treated material is packaged in shielded shipping and disposal containers designed to meet the requirements under DOT for shipping LSA-II solid material.

Data from the POP testing of the CHEM1 alternative on surrogate Silos 1 and 2 material indicate that the original 6,797 m^3 (8,890 yd^3) of material in Silos 1 and 2 would be increased to a wasteform with a volume of approximately 20,836 m^3 (27,254 yd^3). However, due to the shielding necessary for protection of workers and the general public and for meeting DOT requirements, containerization of the treated material results in an overall disposal volume of approximately 36,431 m^3 (47,652 yd^3). In addition, the CHEM1 process O&M activities will generate approximately 1,388 m^3 (1,815 yd^3) of solid secondary waste. The total estimated disposal volume of the treated Silos 1 and 2 material and all secondary wastestreams is 37,819 m^3 (49,500 yd^3), equating to an overall volume increase of 456%, compared to the original volume of material in Silos 1 and 2.

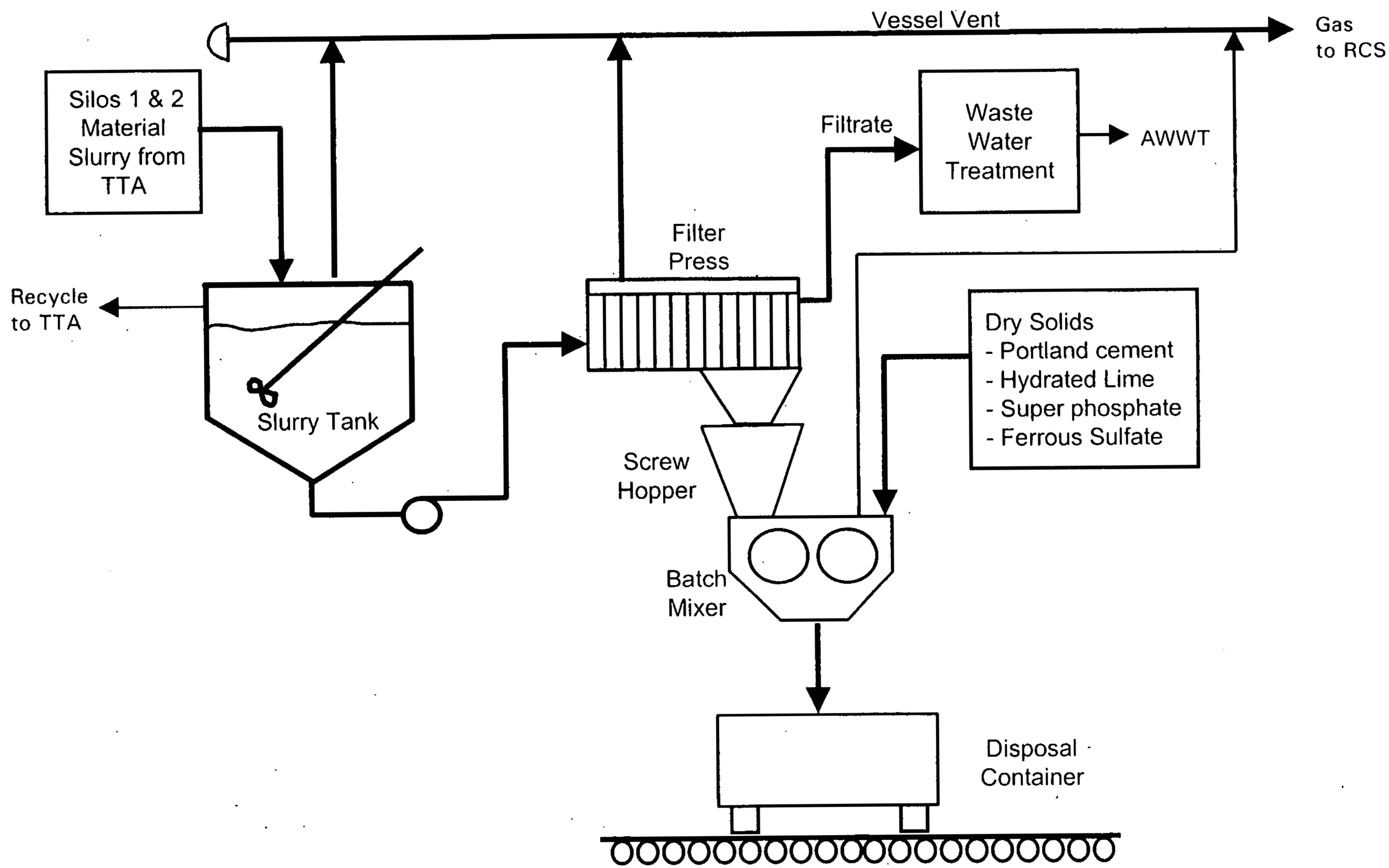

Figure 6.3-1

Simplified Process Diagram
Chemical Stabilization - Cement-based

This alternative involves construction of a feed preparation system to prepare and deliver a feed slurry containing both silos material and cement-based additives to the mixer, a nominal 80-TPD mixer, and an air emissions system to provide necessary treatment of radionuclide particulate. The full-scale treatment facility also includes many support systems such as product curing, off-specification material rework, building ventilation, and personnel support systems. Additionally, the remediation facility includes an interim storage facility capable of handling 45 days of production capacity in order to accommodate the waste verification process and intermittent disruptions in the FEMP waste shipping program.

This alternative involves the packaging, loading, and shipping (via truck or intermodal transportation) of stabilized material for disposal at the NTS. Approximately 6,078 shipping and disposal containers would be shipped to the NTS. If two containers were placed on one truck per shipment, approximately 3,039 direct truck shipments to the NTS would be required. For intermodal transport, two containers would be placed in an ISO container. One ISO container would be placed on a truck and two ISO containers would be placed on a railcar. This would result in 3,039 truck shipments from the FEMP to an intermodal facility, 1,520 railcar shipments by regular freight from an intermodal facility in the east to an intermodal facility in the west, and 3,039 truck shipments from the intermodal facility to the NTS.

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The estimated cost for this alternative is summarized below:

Capital Cost	$55 M
Engineering Cost	$24 M
O&M Cost	$77 M
D&D Cost	$34 M
Project Management Cost	$21 M
Waste Disposal Cost	$58 M
Cost of Money	$28 M
Summary Cost	$297 M

6.4 On-site Chemical Stabilization other than Cement-based, Off-site Disposal at the NTS (CHEM2)

Figure 6.4-1 presents a simplified process flow diagram of the proposed CHEM2 process. A detailed discussion of this alternative is available in Section 3.5.1 of the revised FS.

The treatment system described in this section is based upon data and other information compiled from POP testing and has been developed as a viable way to implement this alternative. Equivalent systems may exist and are not precluded from consideration, consistent with the final selected remedy, during remedial design.

This alternative (CHEM2) involves the removal, on-site treatment through chemical stabilization by a process that is not cement-based, and off-site disposal of the treated silos material at the NTS. The Silos 1 and 2 material is removed from the TTA as a slurry containing approximately 10 wt% solids for the CHEM2 process. The CHEM2 process involves combining the Silos 1 and 2 material as a liquid slurry with a binder and other chemical additives in a carbon steel cylindrical shipping and disposal container with a built-in agitator. The process used to demonstrate this alternative during POP testing produced a solid stabilized wasteform that has a waste loading of approximately 24 wt% Silos 1 and 2 material. The treated material is packaged in shielded shipping and disposal containers designed to meet the requirements under DOT for shipping LSA-II solid material.

Data from the POP testing of CHEM2 alternative on surrogate Silos 1 and 2 material indicate that the original 6,797 m^3 (8,890 yd^3) of material in Silos 1 and 2 would be increased to a wasteform with a volume of approximately 22,855 m^3 (29,895 yd^3). However, due to the shielding necessary for protection of workers and the general public and for meeting DOT requirements, containerization of the treated material results in an overall disposal volume of approximately 33,144 m^3 (43,352 yd^3). In addition, the CHEM2 process O&M activities will generate approximately 1,300 m^3 (1,700 yd^3) of solid secondary waste. The total estimated disposal volume of the treated Silos 1 and 2 material and all secondary wastestreams is 34,444 m^3 (45,050 yd^3), equating to an overall volume increase of 407%, compared to the original volume of material in Silos 1 and 2.

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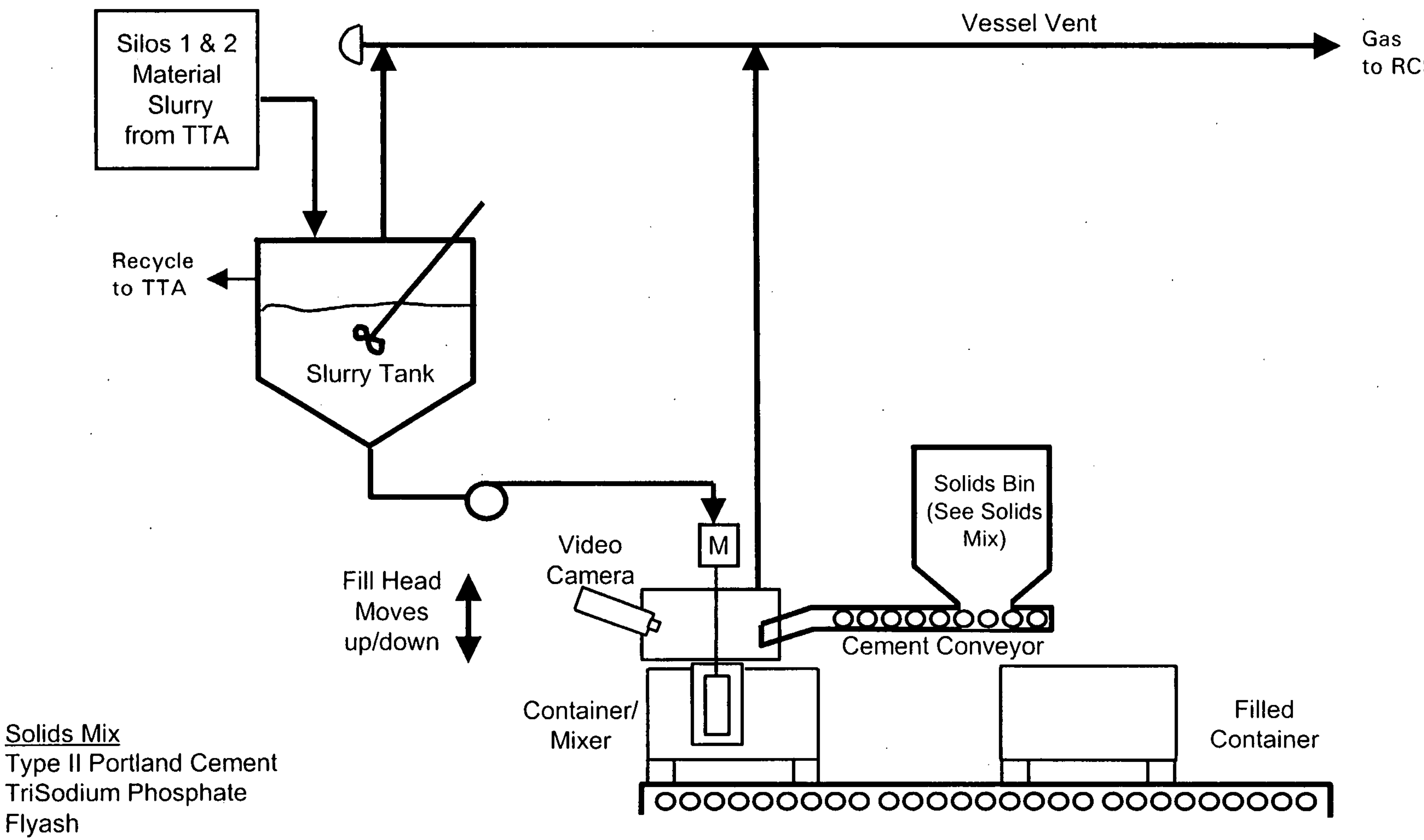

Figure 6.4-1
Simplified Process Diagram
Chemical Stabilization - Other

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This alternative involves construction of a feed preparation system to prepare and deliver a feed slurry containing both silos material and chemical additives to the container with built-in agitation, three container lines making up the nominal 105-TPD processing plant, and an air emissions system to provide necessary treatment of radionuclide particulate. The full-scale treatment facility also includes many support systems such as product curing, wastewater treatment, off-specification material rework, building ventilation, and personnel support facilities. Additionally, the remediation facility includes an interim storage facility capable of handling 45 days of production capacity in order to accommodate the waste verification process and intermittent disruptions in the FEMP waste shipping program.

This alternative involves the packaging, loading, and shipping (via truck or intermodal transportation) of chemically stabilized material for disposal at the NTS via truck or intermodal transportation. Approximately 6,106 shipping and disposal containers would be shipped to the NTS. If two containers were placed on one truck per shipment, approximately 3,053 direct truck shipments to the NTS would be required. For intermodal transport, two containers would be placed in an ISO container. One ISO container would be placed on a truck and two ISO containers would be placed on a railcar. This would result in 3,053 truck shipments from the FEMP to an intermodal facility, 1,527 railcar shipments by regular freight from an intermodal facility in the east to an intermodal facility in the west, and 3,053 truck shipments from the intermodal facility to the NTS.

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The estimated cost for this alternative is summarized below:

Capital Cost	$56 M
Engineering Cost	$24 M
O&M Cost	$83 M
D&D Cost	$36 M
Project Management Cost	$21 M
Waste Disposal Cost	$55 M
Cost of Money	$28 M
Summary Cost	$303 M

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7.0 EVALUATION OF ALTERNATIVES

7.1 Treatment Alternatives for the Silos 1 and 2 Material

The four alternatives evaluated in the revised FS for Silos 1 and 2 consist of two treatment technologies (vitrification and chemical stabilization), each represented by two specific process options (VIT1, VIT2 and CHEM1, CHEM2). Two process options for each treatment technology were chosen in order to provide a balanced analysis of each technology against the CERCLA evaluation criteria. Throughout the detailed analysis, discrete differences of each process design were identified. However, no fundamental differences in any of the CERCLA evaluation criteria were identified to exist between the two vitrification process options, or between the two chemical stabilization process options. It is clear from the detailed evaluation that the discriminating differences between the four original alternatives are associated with differences between the two treatment technologies (vitrification versus chemical stabilization), as opposed to differences between the individual processes evaluated under each technology.

No significant differences were identified in the detailed analysis of alternatives that provide a compelling reason to select a given process option over the other (i.e., CHEM1 vs. CHEM2 or VIT1 vs. VIT2) in either treatment technology. For this reason, the final remedial selection decision will be between the vitrification and chemical stabilization technologies. The treatment systems described in the revised FS are based upon data and other information compiled from POP testing and have been developed as viable ways to remediate the Silos 1 and 2 material. Equivalent vitrification or chemical stabilization processes that are consistent with the selected remedy may become commercially available and are not precluded from consideration, consistent with the final selected remedy, during remedial design. As previously stated, in addition to the treatment technology, the selected remedy for the Silos 1 and 2 material will also include retrieval of the Silos 1 and 2 material from the TTA, on-site treatment, off-site disposal of the treated material at the NTS, and the disposal of remediated soil and D&D debris consistent with the OSDF WAC.

7.2 Evaluation Criteria

Section 4 of the revised FS presents a comparative analysis of alternatives for the treatment of the Silos 1 and 2 material with respect to the nine evaluation criteria specified by the NCP to meet the requirements of CERCLA. This analysis is the second stage of the detailed evaluation process and forms the basis for identifying the preferred remedial alternative for the Silos 1 and 2 material.

The NCP divides the evaluation criteria used in this comparative analysis into three categories: threshold, primary balancing, and modifying. More detailed definitions of the evaluation criteria can be found in Section 3.1, Overview of the Detailed Analysis of the revised FS.

Threshold criteria consist of the two criteria that must be satisfied by the selected alternative:

- Overall protection of human health and the environment; and
- Compliance with ARARs.

These criteria are of greatest importance in the comparative analysis because they reflect the key statutory mandates of CERCLA, as amended. An alternative must satisfy both of these *threshold criteria* before it is eligible to be selected as the final remedy.

Primary balancing criteria consist of the five criteria under which the relative advantages and disadvantages of the alternatives are compared to determine the best overall remedy:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

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The first and second balancing criteria reflect the statutory preference for treatment as a principal element of the remedy and the bias against off-site land disposal of untreated material. Together with the third and fourth balancing criteria, they form the basis for determining the general feasibility of each potential remedy. In addition, the primary balancing criteria are used to determine whether costs are proportional to the overall protectiveness, considering both the remediation activity and the time period following restoration of the OU4 area. By this approach, it can be determined whether a potential remedy is cost-effective.

The final two criteria, identified in the NCP as *modifying criteria,* will be evaluated following public and agency comments on the revised FS and PP and will be addressed in the ROD amendment once a final proposed remedy is selected. The modifying criteria are:

- State acceptance; and
- Community acceptance.

Figure 7.2-1 summarizes the comparative analysis of the alternatives.

7.2.1 Threshold Criteria

7.2.1.1 Overall Protection of Human Health and the Environment

Both vitrification and chemical stabilization provide overall protection of human health and the environment, as defined by the NCP. Each alternative limits exposure to contaminants by removing the sources of contamination, effectively treating the source materials to minimize the mobility of contaminants, and disposing the treated material in a protective manner off-site at the NTS.

The *Environmental Assessment for Proposed Final Land Use at the Fernald Environmental Management Project* (DOE 1999) establishes the future land use of the FEMP to be continued under federal ownership with the area of OU4 being restored to a riparian and upland forest. This scenario is similar to that which was evaluated in the original OU4 FS (FEMP 1994a). In addition, the two technologies being compared in this evaluation are the same as those evaluated in the original OU4 FS. Similar to the original OU4 FS, all alternatives specify that the Silos 1 and 2 material will be treated and removed from the FEMP to the NTS for disposal, and all surrounding soil will be excavated, removed and disposed to meet final remediation levels documented in the OU2 ROD (FEMP 1995c) and the OU5 ROD (FEMP 1996b). Therefore, the residual risk outlined in the original OU4 FS are still applicable to evaluation of the current alternatives. The results of the original analysis state that long-term risk to the public is within CERCLA guidelines because the Silos 1 and 2 material and contaminated soil are treated and removed from the OU4 area.

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FIGURE 7.2-1
COMPARATIVE ANALYSIS SUMMARY

ITEM	VIT1/VIT2 Strongly Favors	VIT1/VIT2 Favors	Neutral	CHEM1/CHEM2 Favors	CHEM1/CHEM2 Strongly Favors
Overall Protection of Human Health and the Environment			↓		
Compliance with Applicable or Relevant and Appropriate Requirements			↓		
Long-Term Effectiveness and Permanence			↓		
Reduction of Toxicity, Mobility, or Volume Through Treatment		↓			
Short-Term Effectiveness				↓	
Implementability				↓	
Cost			↓		
State Acceptance - TBD					
Community Acceptance - TBD					

Both technologies produce a stabilized material that resists leaching and therefore reduces the potential for contaminant migration. As discussed in **Section 7.2.2.2,** Toxicity Characteristic Leaching Procedure (TCLP) results demonstrate prevention of contaminant mobility even in the event that the integrity of the original wasteform is degraded.

Overall protection at the NTS is provided by a combination of treatment to reduce the mobility of contaminants and exposure potential with a disposal configuration that isolates the treated waste from potential contaminant transport mechanisms and exposure pathways. The basic difference between the alternatives is the treatment technology (vitrification or chemical stabilization) used to stabilize the contaminants.

The nature and extent of impacts to biota from implementing the technologies are similar. Each alternative involves site preparation and construction for a processing facility, removal of the silos material from the TTA, remediation of the silos material, and transport of the treated material to the NTS for disposal. Short-term impacts include the temporary loss of habitats at the FEMP site and possible impacts from accidental spills of construction and operation materials. Mitigative measures would be employed to minimize these short-term risks.

The off-site disposal location is the NTS facility, which has been used by the DOE for disposal of low-level radioactive waste. The NTS incorporates engineering and institutional controls to isolate the treated waste from exposure pathways and is located in a climatic, demographic, and hydrogeologic setting that favors minimization of contaminant migration to both human and environmental receptors. In the event of long-term degradation of engineered features or loss of institutional controls, these site characteristics coupled with the reduction in contaminant leachability provided by the treatment process ensure that protectiveness of human health and the environment is maintained.

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7.2.1.2 Compliance with ARARs

The vitrification and chemical stabilization technologies attain the threshold criterion of compliance with ARARs. A comprehensive list of ARARs is presented in Appendix A of the revised FS. Key requirements are discussed in Section 3 of the revised FS within the evaluation of each alternative against this criterion. The following paragraphs summarize those evaluations.

Chemical-specific ARARs

Both vitrification and chemical stabilization technologies meet the chemical-specific ARARs associated with potential releases to groundwater, surface water, and air. The most critical chemical-specific ARAR relative to airborne releases relates to radon. The primary limit on radon emanation is the flux limit specified in National Emissions Standards for Hazardous Air Pollutants, 40 CFR Part 61 Subpart Q, of 20 picoCuries per square meter·second ($pCi/m^2 \cdot s$). This limit applies to interim storage or final disposal of Silos 1 and 2 material. Both alternatives meet this ARAR during interim storage and after disposal. Both alternatives meet requirements for control of radon, particulate, and other air emissions from remediation activities through incorporation of necessary air-emission treatment. The impact of radon emissions during remediation is evaluated as part of the short-term effectiveness criterion.

Location-specific ARARs

Vitrification and chemical stabilization technologies meet the location-specific ARARs as they relate to floodplains, wetlands, and endangered species and their habitats. Compliance with these alternatives is met through proper planning, siting, design, and operational procedures.

Action-specific ARARs

Vitrification and chemical stabilization technologies meet the action-specific ARARs identified for these alternatives. Appropriate engineering controls are implemented for each alternative to comply with Ohio Water Quality Standards and Air Quality Standards. Hazardous material transportation requirements are complied with by following the regulations under 40 CFR Parts 262 and 263, and the appropriate DOT shipping standards under 49 CFR Subchapter C Hazardous Materials regulations.

7.2.2 Primary Balancing Criteria

7.2.2.1 Long-term Effectiveness and Permanence

Both vitrification and chemical stabilization technologies ensure long-term protectiveness of human health and the environment through treatment. TCLP analysis indicates that all four processes evaluated in POP testing produced wasteforms that consistently met the NTS WAC and were durable based on leach rate data. The TCLP test is used to simulate the leaching effects of acidic groundwater infiltrating the disposal cell and contacting disposed waste. This test measures the ability of the stabilized waste particles to resist leaching, even if the original wasteform (e.g., monolith) has been compromised.

Both alternatives include treatment that permanently reduces the leachability of COCs. Off-site disposal at the NTS provides additional protection by eliminating access to the treated materials and preventing migration of constituents from the materials. Location of the NTS disposal facility in a sparsely populated, arid environment reduces potential for leachate generation, contaminant migration, and prevents direct contact with contaminants. Because the NTS is owned and maintained by DOE and used for the disposal of low-level wastes from other DOE sites, the uncertainties associated with institutional controls are minimal. As the result of a low average annual precipitation and depth to groundwater, impacts to human health and the environment from possible engineering and institutional controls failure are minimal.

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There are no long-term environmental impacts at the FEMP site pertaining to the removal of Silos 1 and 2 material and treatment processes. The projected FEMP site residual risk to viable receptors is less than the NCP criterion of 10^{-6} ILCR, and non-carcinogenic effects are expected to be below 0.2 (HI) specified by the NCP for both alternatives. Long-term environmental impacts at the NTS involve some permanent disturbance of soils (i.e., acquisition of borrow material) associated with disposal activities. Significant long-term impacts are not expected to water quality or hydrology, air quality, biotic resources, socioeconomics or land use, or cultural resources. Wetland or floodplain areas have not been delineated at the NTS.

7.2.2.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

Overall, this criterion favors vitrification due to the reduction in treated material volume.

Figure 7.2-2 presents a comparison of the expected primary and secondary waste disposal volumes associated with the vitrification and chemical stabilization alternatives.

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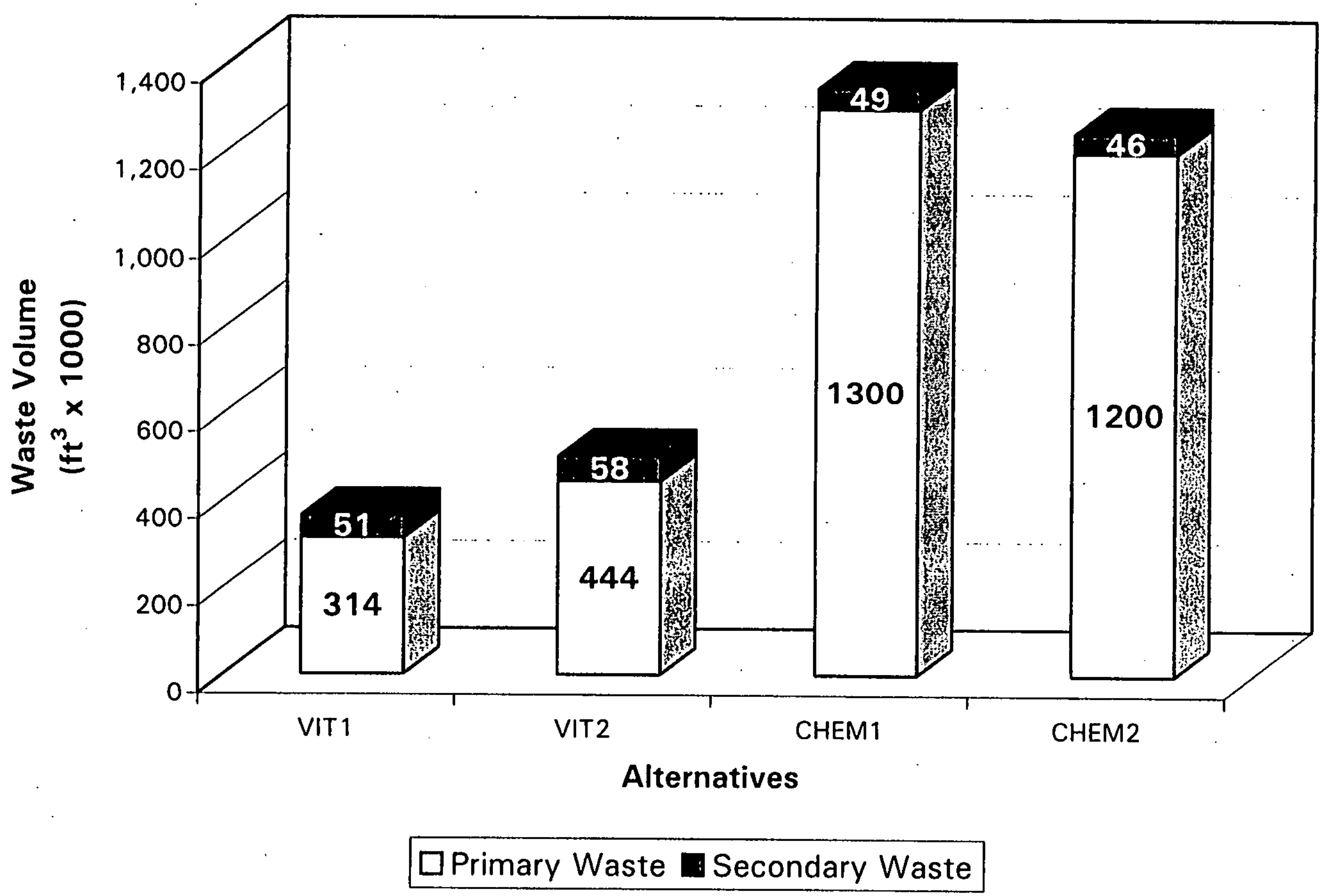
Figure 7.2-2
Total Solid Waste Volume Summary



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Both of the technologies are effective in reducing the mobility of COCs in the Silos 1 and 2 material through treatment. TCLP tests conducted on the treated surrogate material during POP testing indicate that either alternative can reduce the leachate concentrations of hazardous metals to below regulatory limits established under 40 CFR Part 261.24. Vitrification chemically binds the contaminants in a glass-like matrix that significantly reduces contaminant mobility. Chemical stabilization reduces the mobility of contaminants by either converting the contaminants into a less soluble form or by chemically binding them into a stabilized matrix.

POP testing of the vitrification alternative has demonstrated that the treatment method results in a reduction in volume of the Silos 1 and 2 material. The wide range in volume associated with the vitrified material is due to the wasteform produced in the vitrification process. A monolith has very little void space, approximately 2% resulting from air pockets. However, the frit wasteform has a sizeable amount of void space, approximately 50% due to the inefficiency in packaging non-uniform material. An overall increase in disposal volume, compared to the original volume of material in Silos 1 and 2, results from placing the treated material in thick-walled, concrete disposal containers which are required to provide the shielding necessary for protection of the public and workers during transportation activities.

Because of the chemical additives and fixatives added to the Silos 1 and 2 material for the chemical stabilization alternative, there is a resultant increase in volume of the treated material compared to the original volume of material in Silos 1 and 2. The volume increase is dependent on the waste loading of the Silos 1 and 2 material in the treatment formulation. An additional increase in overall disposal volume results from placing the treated material in thick-walled disposal containers.

The consideration of a solid secondary wastestream does not significantly affect the differences in the total volume of treated waste requiring disposal between the technologies. However, the vitrification alternatives have the greater potential to generate secondary wastestreams, which although their volume is relatively small, are more difficult to handle and to treat for disposal (i.e., salts, reduced metals, spent refractory, mixed waste).

The vitrified Silos 1 and 2 material reduces radon emanation more effectively than does the chemically stabilized material. However, the combination of radon mitigation provided by the chemically stabilized material plus the engineered barriers and packaging associated with the disposal of treated materials, effectively controls radon emanation. Both alternatives provide effective control of radon emanation from the treated Silos 1 and 2 material. The impact of radon emissions during remediation is evaluated as part of the short-term effectiveness criterion.

7.2.2.3 Short-term Effectiveness

The NCP identifies the components of short-term effectiveness as short-term risks to the community during implementation of the alternative; potential impacts to workers during RA; potential environmental impacts during implementation; and time until protection is achieved. Although each alternative is favorable in individual aspects of short-term effectiveness, from an overall perspective, this criterion favors chemical stabilization due to lower on-site worker risk and higher schedule certainty. The basis for determination of risks is detailed in Appendices B and E of the revised FS.

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Worker Risk

Vitrification presents an increased non-radiological risk to the worker during on-site operations due to the greater number of person-hours estimated to complete remediation and increased physical hazards in the work place. An occupational hazard analysis was performed on the proposed design for each alternative (Appendix B of the revised FS). The hazard analysis evaluated the potential physical and chemical hazards to the workers involved with the on-site O&M activities. **Table 7.2-1** presents a summary of the discriminating hazards posed to workers as determined by the analyses of the alternatives.

The vitrification process liberates essentially all of the radon from the Silos 1 and 2 material during treatment process. Chemical stabilization liberates less radon during the treatment process, but continues to generate radon during subsequent product handling operations. In both cases, sufficient radon control is provided to mitigate radon releases and attain environmental and worker protection limits. The calculated radon concentrations due to projected routine emissions for either alternative show no measurable impact to FEMP fenceline radon concentrations.

Both vitrification and chemical stabilization are able to meet the radon flux limit of 20 $pCi/m^2 \cdot s$ during interim storage at the FEMP and after disposal. Sufficient attenuation of radon is provided by the vitrified material without reliance on the packaging or disposal configuration. Although the chemical stabilization process provides attenuation of radon, it is reliant on packaging to meet the radon flux limit.

TABLE 7.2-1
SUMMARY OF KEY HAZARDS TO ON-SITE WORKERS

Physical hazards due to vehicle and container movement	Greater hazard for chemical stabilization due to greater number of containers
Fall Hazards	Greater hazard for vitrification - more elevated equipment
Exposure to hazardous chemicals and toxicants	Greater hazard for vitrification - toxic constituents (SO_x, NO_x, lead - storage of caustic for scrubber, and gases)
Electrical shock	Greater hazard for vitrification - higher power requirements, more complex electrical system
Human hazards	Greater hazard for vitrification - greater number of work hours
High or changing pressure	Greater hazard for vitrification - remote potential for over-pressurization of the melter; potential releases from Emergency Off-gas System
Thermal hazards	Greater hazard for vitrification - high temperature in melter; handling of molten glass; high temperature off-gas
Spills/loss of containment	Greater hazard for vitrification - molten glass, toxic off-gas constituents, higher radon concentrations and caustic storage result in greater consequences for spills, leaks, etc.

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Transportation Risk

Appendix E of the revised FS evaluates the short-term risks associated with the transportation, both by direct truck and intermodal shipments, of the treated silos material to the NTS. The implementation of either transportation option presents a minimal risk to the public, within the CERCLA target risk range of 1×10^{-4} to 1×10^{-6}. However, due to the greater number of shipments required to ship the larger volume of treated material, the transportation risk is incrementally higher for chemical stabilization.

For both technologies, transportation to the NTS complies with DOT regulations and DOE guidelines. The transportation of the Silos 1 and 2 material to the NTS by either truck or intermodal shipments is protective of human health and the environment. In addition, the anticipated shipping rate of 7 to 20 shipments per week does not represent a significant impact on total highway traffic.

Off-site Environmental Impact

Short-term impacts associated with both technologies includes temporary disruption of several acres of land at the FEMP site for construction of the treatment facility and material handling. There is a potential for increased fugitive dust during construction activities; however, appropriate controls minimize the potential short-term impacts.

Time to Achieve Protection

Due to a shorter design-construction start-up period, and more feasible schedule acceleration, chemical stabilization is preferred with respect to time to achieve protectiveness. **Figure 7.2-3** presents a comparative summary of the schedules for each alternative.

The time period between the approval of the ROD amendment and the initiation of treatment operations (i.e., design, construction, construction acceptance testing, preoperations, and start-up) for the Silos 1 and 2 remediation is estimated to be 62 months for vitrification, compared to 54 months for chemical stabilization. The difference of eight months between the two schedules is primarily attributed to the time required, based upon lessons learned during start-up of DOE vitrification facilities, to perform Proof of Process testing during start-up of the vitrification facility. In addition, the technical risk evaluation results in a calculated schedule uncertainty of 14-16 months for vitrification compared to 8-10 months for chemical stabilization.

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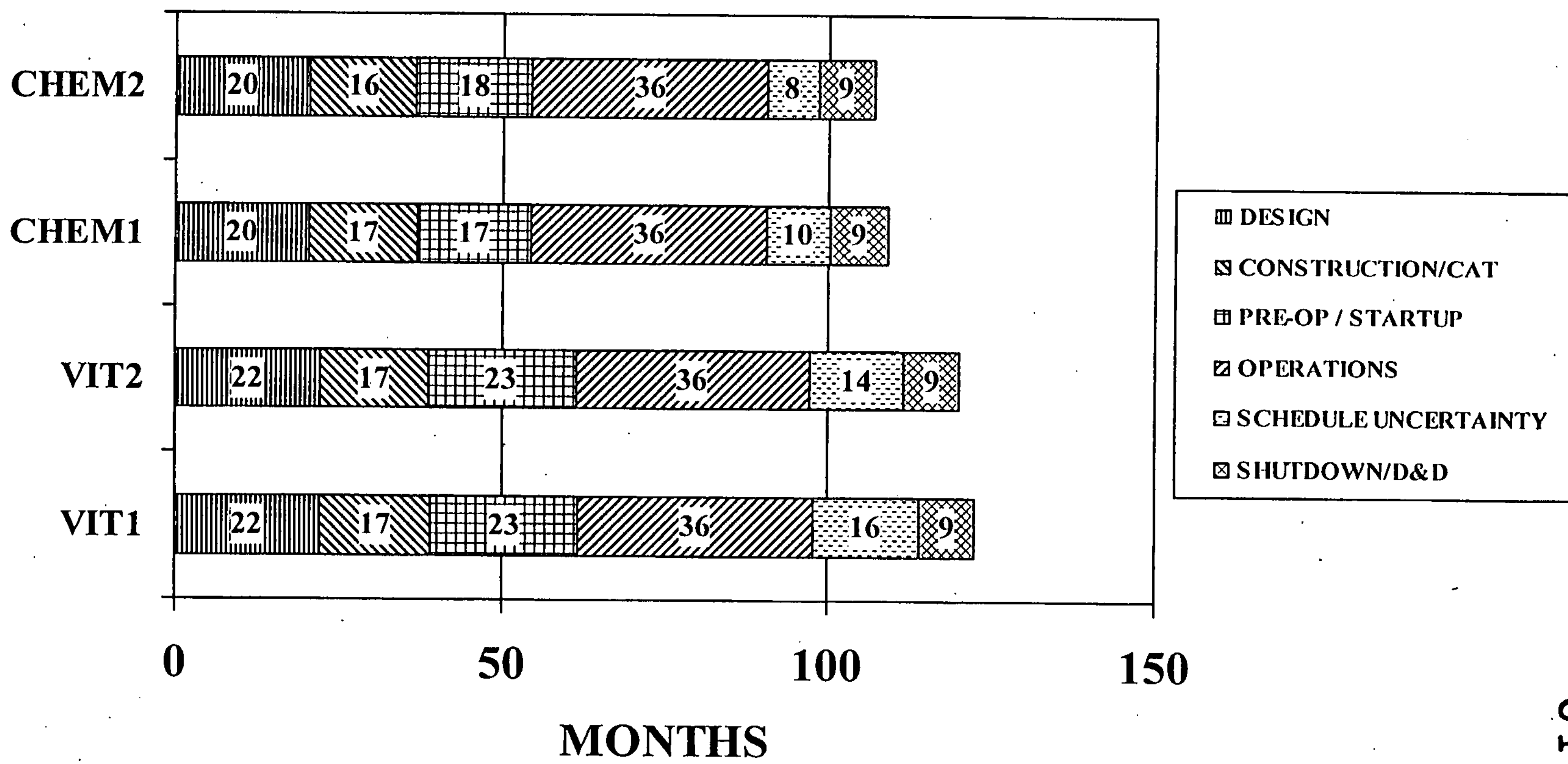
FIGURE 7.2-3

TIME TO ACHIEVE PROTECTION SCHEDULE COMPARISON



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While vitrification requires full-time (24 hr/day, 7 days/week) operation to complete treatment within the specified three-year period, the chemical stabilization can complete treatment within three years with less than full-time operation. Less than full-time operation would leave 'excess' operating time (shifts per day or days per week) available to recover from unplanned downtime. This excess operating time results in higher confidence in the ability of the chemical stabilization alternative to complete treatment within a given timeframe. **Figure 7.2-4** presents the total operating hours required to treat the Silos 1 and 2 material in three years at the scale proposed by the POP vendors.

7.2.2.4 Implementability

Overall this criterion favors chemical stabilization due to a greater degree of commercial demonstration of the treatment technology, less complexity of integrated systems, and greater confidence in its ability to be successfully implemented.

Figure 7.2-5 summarizes the implementability analysis.

The evaluation of implementability indicates that although both vitrification and chemical stabilization are feasible and can be successfully implemented, there are significant technical challenges such as process control, adaptation of the process to remote operation, feed preparation, and product handling that apply to each alternative. The operability characteristics of vitrification increase the uncertainty in its ability to be successfully implemented.

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TABLE 7.2-4
SUMMARY OF TOTAL REQUIRED OPERATING HOURS

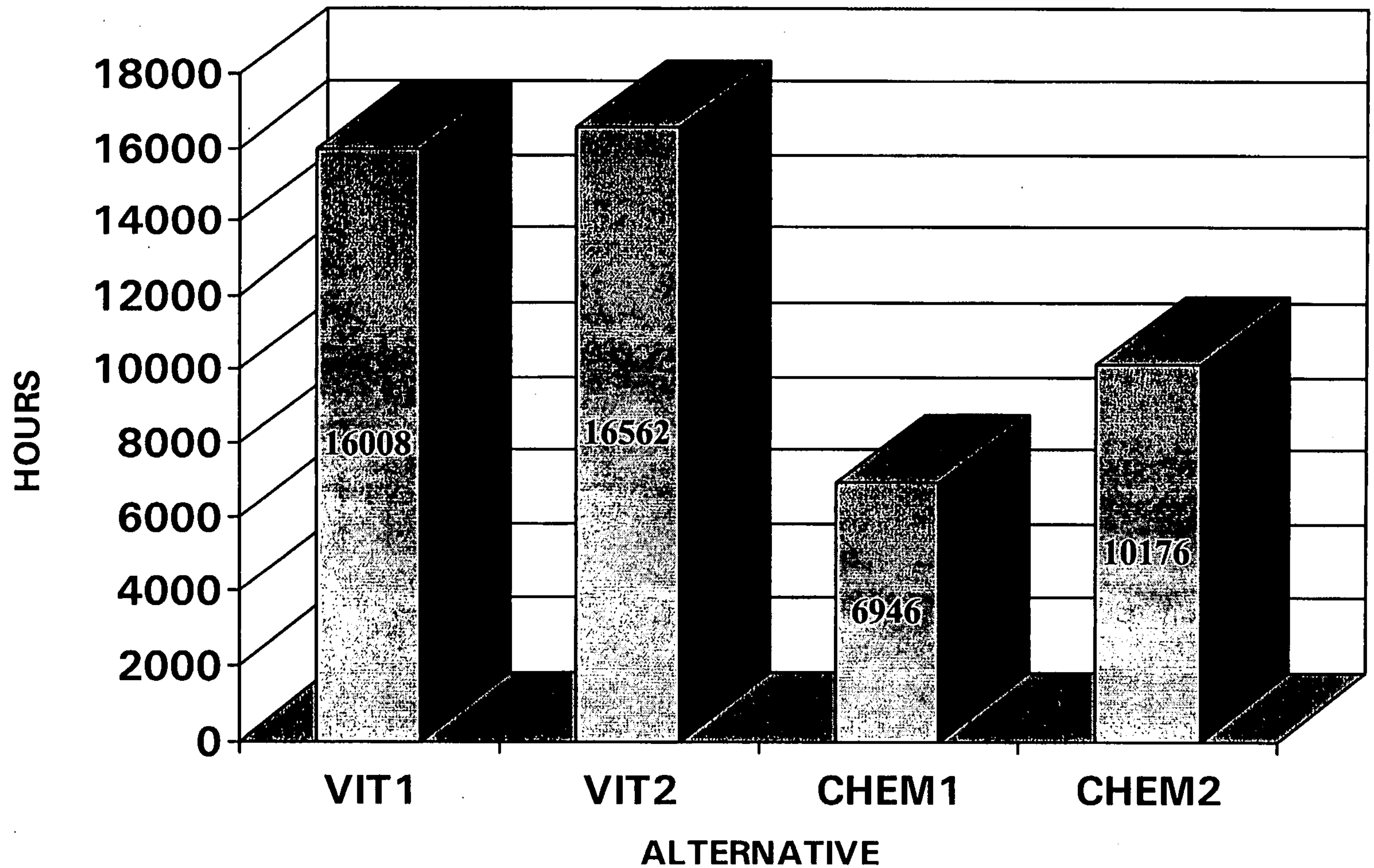

FIGURE 7.2-5
IMPLEMENTABILITY SUMMARY TABLE

ITEM	VIT1/VIT2			CHEM1/CHEM2	
	Strongly Favors	Favors	Neutral	Favors	Strongly Favors
Technical Feasibility					
Scaleup			↓		
Commercial Demonstration				↓	
Operability					
Ease of Operation				↓	
Reliability				↓	
Maintainability				↓	
Complexity				↓	
Ease of Acceleration				↓	
Constructability (Ease of Construction/Fabrication, Ease of D&D)				↓	
Administrative Feasibility (Licensing and Programmatic)			↓		
Availability of Services (Contractors, Equipment and Utilities)			↓		

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7.2.2.4.1 Technical Feasibility

Scaleup

Based on the results of the POP testing, both technologies can be scaled up to achieve the proposed full-scale treatment capacity required to remediate the Silos 1 and 2 material within the three-year operating period (see **Glossary**). The exception is the Vitrification — Joule-heated process option that has not been demonstrated at the required scale on radioactive or hazardous materials.

Scaleup issues exist for both technologies for the balance of plant systems. Chemical stabilization requires modification of specialized process equipment (e.g., filter press, mix-fill head) to be suitable for nuclear applications. Vitrification processes require designing a complex Off-gas System to scrub particulates and acid gases, and condition emissions before radon abatement. Similarly, a significant level of development to demonstrate systems such as feed stream drying and lead partioning in the off-gas is required for some vitrification processes.

Commercial Demonstration

On a commercial basis, chemical stabilization and vitrification have been successfully implemented to treat hazardous wastestreams. However, there is significantly more demonstrated experience in the commercial sector with the chemical stabilization technology for hazardous and radioactive waste treatment.

Three of the four process options have been demonstrated on a limited basis with material reasonably similar to Silos 1 and 2 material, at the scale being proposed by the POP Contractors. The only exception is Vitrification — Joule-heated, which would require a scaleup by a factor of 3 from that which has been demonstrated at the Savannah River, M-Area Site (5 TPD) on radioactive or hazardous material to achieve the 15 TPD proposed by the POP Contractor. The Vitrification — Other process option has been demonstrated at limited commercial facilities (ORMET Aluminum Inc., Hannibal, OH). The Chemical Stabilization — Cement-based technology has been applied above the proposed scale (Weldon Spring, MO). The Chemical Stabilization — Other process option has been demonstrated at one location (Barnwell, SC) at the proposed capacity.

Operability

Regarding ability to operate successfully, chemical stabilization has greater certainty than vitrification due to its ease of process control, less complexity and fewer unit operations (air emissions), and its greater ability to recover from upset conditions.

The operability characteristics of vitrification increase uncertainty in its ability to be successfully implemented. The integrated operation of complex systems increases the likelihood of process upsets and resulting downtime for VIT1 and VIT2. Complex process control parameters (e.g., viscosity, electrical conductivity, liquidus temperature, and sulfate formation) complicate melter operation. The hazards inherent to the vitrification process (high temperature) increase risks during maintenance and make recovery from upsets more difficult. For the same reasons, chemical stabilization is easier to maintain and less complex overall.

Both technologies are comprised of reliable individual components. However, the reliability of the integrated systems adapted for remote operation has not been demonstrated. DOE vitrification projects (Defense Waste Processing Facility, West Valley, NY and Savannah River M-Area) have experienced significant reliability concerns during start-up and initial operations. The vitrification alternative includes additional unit operations (off-gas) that have unknown reliability as an integrated system. For these reasons, chemical stabilization is favored for reliability.

From the standpoint of ease of schedule acceleration/recovery, chemical stabilization is favored. Chemical stabilization could accelerate/recover schedule by increasing the operating schedule to 24 hr/day, 7 days/week. Acceleration would result in additional costs to increase the plant capacity by increasing curing and storage space. The vitrification alternative would require additional melter trains or increased melter capacity combined with increased feed drying/preparation components, larger Off-gas System, as well as additional cooling and storage space to increase plant capacity.

Constructability

Constructability of chemical stabilization is considered easier than vitrification. This is due to the need for field assembly of the melter (i.e., custom refractory installation) compared to modularized components for chemical stabilization (mixer, filter press, mix-fill head) that can be fabricated and tested off-site. Additionally, there are greater quantities of piping, electrical and controls for the vitrification process.

7.2.2.4.2 Administrative Feasibility

Because remediation activities will be performed at the FEMP, permits and licenses are not required for either alternative. However, remediation activities will comply with the substantive requirements that would otherwise be required for permitting.

Treated material from each alternative is disposed at the NTS. Because the NTS is a DOE-owned facility, no special permits for disposal of treated Silos 1 and 2 material at the NTS are required. The DOE-NV has indicated that silos material, treated by either alternative, that meets the NTS WAC will be approved for disposal at the NTS. An addendum to the NTS performance assessment for the selected disposal location will determine the final depth and configuration for disposal.

7.2.2.4.3 Availability of Services

Contractors are available to competitively bid the design, procurement of materials and equipment, as well as construct and operate the remediation facilities needed to implement each alternative.

The NTS is an approved off-site disposal facility that has the equipment and facilities to safely dispose and manage the treated Silos 1 and 2 material.

7.2.2.5 Cost

The cost evaluation is based on estimates that were developed on information from the four preconceptual designs presented in Appendix G of the revised FS and the technology-specific POP testing information presented in Appendix H of the revised FS using a variety of cost-estimating methods.

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The cost estimates were developed for (1) capital costs; (2) O&M costs; (3) waste shipping and disposal costs; (4) D&D costs; (5) engineering costs; (6) project management costs; and (7) cost of money. The cost estimates are prepared as "bottom up" estimates, which evaluate and estimate each cost element identified in the preconceptual design. Therefore, the accuracy of the estimates is a function of the preconceptual designs. The accuracy of all four estimates is considered +50/-30%, consistent with CERCLA guidance. Given the fact that potential contractors will be given the opportunity to propose their unique designs based on their commercial experience, the actual design may change significantly. The subject accuracy establishes a range that is likely to capture that which is ultimately bid in response to a request for proposal to remediate the Silos 1 and 2 material and baselined following the ROD amendment. All estimates were developed in fiscal year 1999 (FY99) dollars so that the alternatives with costs incurred over differing time periods can be evaluated on an equivalent basis.

Table 7.2-2 and Figure 7.2-6 summarize the major cost elements for the four alternatives.

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TABLE 7.2-2
FEASIBILITY STUDY SUMMARY COST DATA (ALL ALTERNATIVES)

Alternative	Vitrification		Chemical Stabilization	
Process Option	VIT1	VIT2	CHEM1	CHEM2
Capital Cost	$69	$67	$55	$56
Operation and Maintenance Cost	$134	$133	$77	$83
Waste Disposal Cost	$25	$20	$58	$55
D&D Cost	$35	$38	$34	$36
Engineering Cost	$25	$25	$24	$24
Project Management Cost	$22	$22	$21	$21
Cost of Money	$46	$37	$28	$28
Summary cost (un-escalated)	$356	$342	$297	$303

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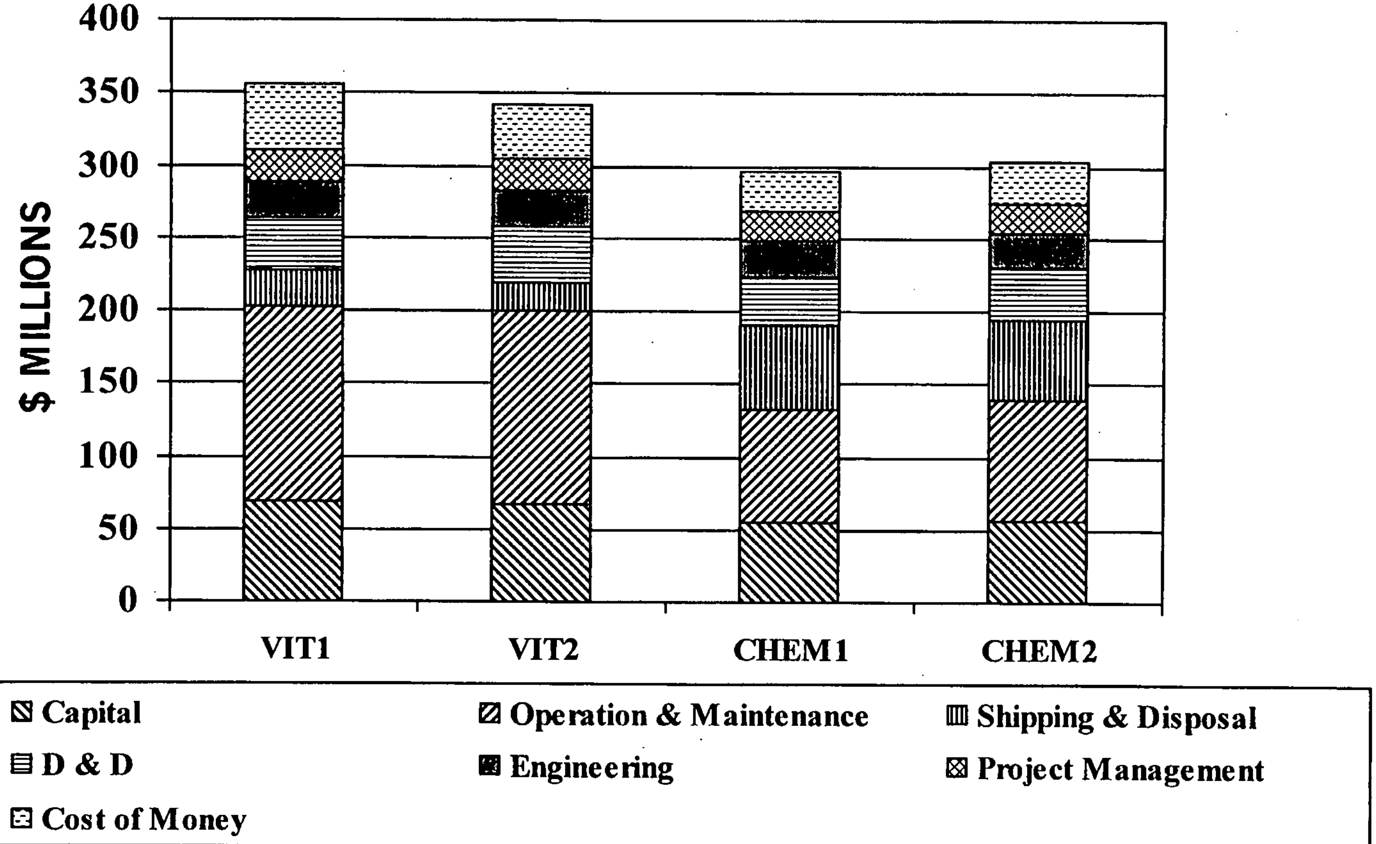
FIGURE 7.2-6
FEASIBILITY STUDY COST COMPARISON



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In general, all four process options are cost effective. That is, the costs appear proportional to the overall protectiveness provided by the alternatives, both during and following the remediation period. The cost differential between the vitrification and chemical stabilization alternatives is approximately 16%, with the cost of chemical stabilization being lower. The following discussion identifies the differences between the four alternatives for the key cost elements.

Capital Cost

The vitrification capital cost is higher than the chemical stabilization capital cost due to the complexity of the process equipment. The need for sizeable interim storage areas for chemical stabilization partially off-sets the higher equipment costs of the vitrification alternative.

Operations and Maintenance Cost

Vitrification has a higher O&M cost than chemical stabilization for the following reasons:

Vitrification operations are on a 24 hr/day, 7 days/week schedule;

Vitrification requires an additional 8 month proof of process testing (full-scale surrogate operations);

Vitrification has more expensive spare parts (specialized). Melter refractory life is limited and may need to be replaced during the 3 years of operation; and

Vitrification uses more costly consumables (chemicals, supplies) and utilities (electricity, natural gas).

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Waste Shipping and Disposal Cost

Chemical stabilization has higher packaging, transportation, and disposal costs than vitrification. The lower waste loading (chemical stabilization) produces a greater volume of treated material resulting in an increased number of disposal containers, shipments, and disposal volume.

D&D Cost

The D&D costs are roughly equivalent for both alternatives.

In general, vitrification has a higher D&D cost due to the more complicated plant layout (multiple floors, equipment). However, the difference is offset by the D&D cost of the chemical stabilization having more building debris to handle due to the larger interim storage facility.

Engineering Cost

Vitrification has a slightly higher engineering cost than chemical stabilization due to the complexity of the process design.

Project Management Cost

Vitrification has a higher project management cost than chemical stabilization due to the vitrification schedule being longer, with project management being a level-of-effort based on the schedule duration.

Cost of Money

Based on the contracting strategy adopted for the remediation of the Silos 1 and 2 material, the contractor must borrow money to finance the design and construction effort, well in advance of being reimbursed in accordance with a predetermined pay item schedule. Since vitrification has a higher upfront capital cost investment, vitrification has a higher cost of money than chemical stabilization.

7.2.2.6 State Acceptance

State acceptance of the preferred alternative will be addressed following the public comment period for the PP and will be included in the Responsiveness Summary of the ROD document.

7.2.2.7 Community Acceptance

Community acceptance of the preferred alternative will be addressed following the public comment period for the PP and will be included in the Responsiveness Summary of the ROD document.

<END OF SECTION>

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8.0 PREFERRED ALTERNATIVE

In accordance with the CERCLA process, the preferred alternative and the basis for its preference must be identified to allow the public an opportunity to provide input with regard to its acceptance. The preferred alternative can change in response to state or public comment or new information. This section identifies the preferred remedial alternative for the OU4 Silos 1 and 2 material based upon the detailed and comparative analysis discussion in **Sections 6.0** and **7.0**, respectively.

The preferred RA for the Silos 1 and 2 material is the complete removal of all material from Silos 1 and 2, on-site treatment by chemical stabilization, and off-site disposal of treated Silos 1 and 2 waste at the NTS. In addition, the preferred alternative includes the decontamination and dismantlement of all structures and remediation facilities and appropriate treatment and disposal of all secondary wastes. In the event secondary wastes generated during the treatment operations of the Silos 1 and 2 material or D&D activities cannot be disposed at the NTS, without additional treatment, these secondary wastes may be treated and/or disposed at an appropriately licensed off-site facility. Concrete from Silos 1 and 2 structures will undergo gross decontamination, demolition, size reduction, and packaging for shipment for off-site disposal at the NTS or an appropriately licensed commercial disposal facility. Contaminated soils and debris, excluding concrete from Silos 1 and 2 structures, will be disposed in accordance with either the FEMP OSDF WAC or an appropriately licensed commercial facility, such as the NTS or a permitted commercial disposal facility. Perched water encountered during remediation activities will be collected and directed to the FEMP OU5 water treatment facilities.

8.1 Removal Treatment by Chemical Stabilization, and Disposal at the NTS

Chemical stabilization is proposed as the preferred alternative, based on the conclusion that chemical stabilization has an overall advantage over vitrification when evaluated against the five primary balancing criteria. Specifically, the advantages of chemical stabilization in implementability and short-term effectiveness (worker risk and time to achieve protection) are judged to outweigh the advantages of vitrification due to its lower treated waste volume.

Both alternatives provide long-term protection of human health and the environment. This is achieved by treatment to immobilize the COCs present in the material, followed by off-site disposal at the NTS. Because the NTS is maintained by DOE and used for the disposal of low-level wastes from other DOE sites, the uncertainties associated with institutional controls are minimal. As the result of a low average annual precipitation and depth to groundwater, impacts to human health and the environment from possible engineering and institutional controls failure are minimal.

The cost estimates associated with the four alternatives differed by approximately 16%, where the accuracy of the estimates is considered +50/-30% (consistent with CERCLA). Therefore, cost is not deemed to be a significant discriminator for evaluation of the alternatives.

The three discriminating criteria for comparison of the vitrification and chemical stabilization technologies were determined to be reduction of toxicity, mobility, and volume; short-term effectiveness; and implementability. **Figure 8.1-1** presents a summary of the comparison of the vitrification and chemical stabilization technologies against these criteria, as well as each criterion's subcriteria.

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8.1.1 Reduction of Toxicity, Mobility, or Volume through Treatment

Vitrification is preferred when evaluating the criterion of reduction of toxicity, mobility, and volume. Vitrification results in approximately one-third the disposal volume of that produced by chemical stabilization. This results in fewer truck shipments to the NTS and a resultant decrease in risk to the public during transportation compared to chemical stabilization. Transportation to the NTS complies with DOT regulations and DOE guidelines and transportation of the Silos 1 and 2 material to the NTS by either truck or intermodal shipments is protective of human health and the environment per CERCLA guidelines. In addition, the anticipated shipping rate of 7 to 20 shipments per week does not represent a significant impact on total highway traffic.

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FIGURE 8.1-1
SUMMARY OF DISCRIMINATING CRITERIA AND THEIR COMPONENTS

ITEM	VIT1/VIT2 Strongly Favors	VIT1/VIT2 Favors	Neutral	CHEM1/CHEM2 Favors	CHEM1/CHEM2 Strongly Favors
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT		⬇			
Treated Waste Volume		⇩			
Secondary Waste Generation			⇩		
Reduction in Mobility of COCs			⇩		
Radon Attenuation by Treated Waste Form		⇩			
SHORT-TERM EFFECTIVENESS				⬇	
Worker Risk				⇩	
Transportation Risk		⇩			
Off-site/Environmental Impact			⇩		
Time to Achieve Protection				⇩	
IMPLEMENTABILITY				⬇	
Scaleup			⇩		
Commercial Demonstration				⇩	
Operability				⇩	
Ease of Acceleration				⇩	
Constructability				⇩	
COST			⬇ (between Neutral and Favors)		

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8.1.2 Short-term Effectiveness

Chemical stabilization is preferred over vitrification under the criteria of short-term effectiveness due to the additional physical hazards posed to the worker by vitrification **(see Table 7.2-1)** and the advantage of chemical stabilization in time to achieve protection. As stated previously, the chemical stabilization process results in a greater volume of treated waste that must be handled, transported, and disposed at the NTS. However, the additional exposure risks and physical hazards to the worker and the public posed by the handling and shipping of the additional containers are within CERCLA guidelines and are outweighed by the additional physical hazards posed to the worker by vitrification.

The vitrification processes are estimated to operate for three years at 24 hr/day, 7 days/week. The chemical stabilization processes are estimated to operate for three years between 16 - 24 hr/day, 5 days/week. Based on government estimates in general industry, one worker is injured for approximately every 29,410 person-hours worked and one worker is fatally injured for every 2,000,000 person-hours worked. Although engineering and administrative controls will be in place for both alternatives to minimize risk to workers, the additional work hours necessary for vitrification to complete remediation of the Silos 1 and 2 material in three years results in a greater hazard to the worker.

Because vitrification is a high temperature process, it presents a thermal hazard to the worker doing maintenance work on the melter or the off-gas system, or handling molten glass in the event of a spill. In contrast, chemical stabilization operates at ambient temperature and, therefore, does not present a thermal hazard to the workers performing maintenance on the treatment system or the air emissions system.

In addition, the vitrification process has higher power requirements and a more complex electrical system than the chemical stabilization process. Therefore, vitrification presents a greater electrical shock hazard to the worker than chemical stabilization.

Both vitrification and chemical stabilization processes have treatment systems to manage radon and radionuclide particulate. However, because vitrification is a thermal process, it has a more complex off-gas treatment system than the chemical stabilization process. This not only presents a thermal hazard, mentioned previously, to the worker but also a potential chemical hazard. Workers performing maintenance on the off-gas treatment system associated with the vitrification process are at risk of exposure to toxicants in the off-gas (i.e., SOx, NOx, lead, acid gases) and hazardous chemicals used in the off-gas treatment system (i.e., storage and handling of caustic for scrubber).

8.1.3 Implementability

Both vitrification and chemical stabilization are difficult to implement because of the nature of the Silos 1 and 2 material requiring remote operations. However, operational risks for both can be controlled. Chemical stabilization is preferred because there is more demonstrated commercial experience with this technology, it is less complex than vitrification and therefore more certain in its ability to be successfully implemented, and it offers the opportunity for schedule acceleration and recovery in the event of unplanned downtime.

Both vitrification and chemical stabilization have encountered difficulties in treating radioactive wastes in the DOE-complex. However, there is significantly more demonstrated experience in the commercial sector with the chemical stabilization technology than with the vitrification technology. In addition, based on evaluation of existing facilities, the production rate proposed for the vitrification process is at the limit of the current capacity of existing vitrification facilities treating radioactive material, while the production rate proposed for the chemical stabilization process is within limits of the current capacity of existing chemical stabilization facilities.

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To treat Silos 1 and 2 material within a three-year time period, the vitrification process would have to produce 15 tons of vitrified material per day. Within the limited experience of the vitrification technology, there are no facilities in the DOE-complex and only two facilities in the commercial sector operating at the required capacity. This limited experience at the required capacity results in increased uncertainty as to whether the current technology has the capability to treat Silos 1 and 2 material at the required capacity. In comparison, to treat Silos 1 and 2 material within a three-year time period, the chemical stabilization process would have to process 12 cubic yards of Silos 1 and 2 material per day. There have been a number of chemical stabilization facilities in both the DOE-complex and the commercial sector that have operated at the required capacity. Because there is a greater degree of commercial demonstration of the chemical stabilization process at the required capacity, there is less uncertainty in its ability to treat Silos 1 and 2 at the required capacity.

Vitrification has more unit operations associated with it than chemical stabilization and is therefore considered to be more complex to operate than chemical stabilization. The integrated operation of complex systems associated with the vitrification process increases the likelihood of process upsets and resulting downtime. In addition, the complexity of process control associated with vitrification complicates melter operation. Included in the complexity of the process control are critical parameters that are not readily measured, such as viscosity, electrical conductivity, liquidus temperature, and sulfate formation. Furthermore, as stated under the discussion of short-term effectiveness, the hazards inherent to the vitrification process increase the risk to the worker during maintenance activities.

The two vitrification processes propose to operate 24-hours per day for seven days per week for three years. The two chemical stabilization processes propose to operate 16 to 24 hr/day for 5 days/week for three years. Based on the current designs, the chemical stabilization process has a better opportunity to improve schedule and accelerate remediation. In addition, based on current designs, the chemical stabilization has a better opportunity to recover from process upsets or other downtime.

Based on the above evaluation, chemical stabilization is the preferred alternative to implement. Chemical stabilization has a greater degree of commercial demonstration at the required capacity, is less complex to operate, and provides more opportunity to recover from process upsets and other downtime, as well as more opportunity to improve schedule.

8.2 Soils and Debris

The OSDF will be available for disposal of debris from the existing Silos 3 and 4 structures and associated facilities (superstructures and RTS). Soil and debris from D&D activities associated with these facilities will be disposed in the OSDF if they meet the OSDF WAC for disposal. Any soils and debris that do not satisfy the OSDF WAC would be disposed at the NTS or an appropriately licensed commercial facility.

Criteria for disposal of waste materials into the OSDF are documented in the *Waste Acceptance Criteria Attainment Plan for the On-site Disposal Facility* (FEMP 1998c). The current version was issued in June 1998 following approval by the EPA and Ohio EPA. The OSDF WAC for debris were established in the OU3 ROD (FEMP 1996a). The OSDF WAC Attainment Plan provides that these criteria can be applied to debris for other OUs, including OU4, consistent with provisions of the ROD for each OU.

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The OU3 ROD classified debris into ten distinct material categories based upon similar or inherent properties and configuration. Two categories, Category C – Process-related Metals and Category J – Product, Residues, and Special Materials, were administratively excluded from on-site disposal. In evaluating on-site disposal for concrete (Category E), the OU3 ROD evaluated primarily structural concrete. The evaluation did not consider the potential impact of prolonged contact with residues or other contaminants, such as a concrete storage silo.

The concrete in Silos 1 and 2 has been in contact with contaminated material for over 30 years. Because of the relatively mobile COCs and the high moisture content associated with Silos 1 and 2 material, there is a significant potential for migration of contaminants into the concrete. The depth and extent of the migration of the COCs into the concrete and the effort and cost of adequately decontaminating the concrete is uncertain.

Therefore, the concrete from Silos 1 and 2 has been administratively excluded from disposal in the OSDF. The concrete from Silos 1 and 2 will undergo gross decontamination followed by demolition, size reduction, and packaging for off-site disposal. Disposal of concrete from Silos 1 and 2 will be at the NTS or an appropriately licensed commercial facility.

Based on the current operating schedule, the FEMP OSDF will not be available for disposal of soil and debris generated from D&D of the Silos 1 and 2 remediation facilities. Therefore, for costing purposes, the revised FS and PP assume that all soil and debris from D&D of the OU4 remediation facilities will be disposed at the NTS. However, should programmatic changes occur and the OSDF become available, soil and debris meeting the OSDF WAC would be disposed in the OSDF in the same manner as discussed above for Silos 3 and 4 and associated facilities.

8.3 Perched Water

The OU5 RI/FS process examined perched groundwater on a site-wide basis. It should be noted, however, that the ACA provides that each OU address perched groundwater envisioned to be encountered as a consequence of conducting RAs. An example of such an incidence is the collection of perched groundwater in deep excavations completed to remove underground tank systems (Silos 1 and 2 decant sump tank), pits, or foundations. This collected water will be directed to the OU5 wastewater treatment systems.

Process wastewaters generated during RAs conducted by all OUs will be directed to the OU5 treatment systems [i.e., AWWT facility]. Operable Unit 5 has established pretreatment requirements to ensure that incoming wastewater streams do not exceed available treatment capabilities.

8.4 Summary

Chemical stabilization is recommended as the preferred treatment alternative because it meets the threshold criteria and provides the best balance of tradeoffs compared to vitrification with respect to the five balancing criteria. Specifically, the advantages of chemical stabilization in implementability (commercial demonstration, operability, ease of acceleration, and constructability) and short-term effectiveness (worker risk and time to achieve protection) are judged to outweigh the advantages of vitrification due to its lower treated waste volume.

The preferred alternative will satisfy the statutory requirements of CERCLA Section 121(b). The selected remedy will achieve a standard or level of control consistent with all federal and State of Ohio ARARs and TBCs. The preferred alternative will also be performed in accordance with all pertinent DOE orders. Utilization of chemical stabilization satisfies the preference for remedies that employ treatment as a principal element. By chemically binding the contaminants into a solid matrix, the leachability of contaminants are reduced to levels that are below RCRA regulatory limits. As a result, chemical stabilization and off-site disposal will provide permanent treatment for the Silos 1 and 2 material. In addition, the cost is proportional to the overall protectiveness provided by the preferred remedy.

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9.0 COMMUNITY PARTICIPATION

9.1 Community Acceptance

Community acceptance is one of the criteria that DOE and EPA are committed to considering during the decision-making process for selecting a remedy for the Silos 1 and 2 material. The NCP specifies that the public be given the opportunity for input in selection of RAs. Specifically, the NCP [40 CFR 300.430(f)(3)] specifies that after a PP is prepared, the public be provided a reasonable opportunity for submission of comments on the PP and the supporting analysis, including the FS. This interaction with the community is critical to the CERCLA process and to making sound environmental decisions.

To augment public involvement throughout the decision-making process, the DOE-FEMP chartered the Critical Analysis Team (CAT). The CAT, which is comprised of three independent technical and process oriented leaders, is focused on evaluating the technical basis and objectivity of the development and evaluation of the remedial alternatives. Through their development, the revised Silos 1 and 2 FS and this PP have considered the constructive input of the CAT. The CAT has provided independent feedback to the public on its technical evaluation of the documentation supporting this PP (FS, POP test reports).

During the preparation of the draft FS and PP, the DOE has sponsored several community briefings and workshops both locally and at the NTS to share the data supporting the evaluation of alternatives on an informal basis. DOE has been able to solicit feedback and inform stakeholders. **Table 9.1-1** presents a summary of these public involvement opportunities.

TABLE 9.1-1
SUMMARY OF PUBLIC INVOLVEMENT OPPORTUNITIES

Meeting Topic	Location/Date
Preliminary Screening of Alternatives	FEMP/December 1998
Presentation of Proof of Principle testing data	FEMP/July 13, 1999
Summary of Detailed Analysis of Silos 1 and 2 FS	FEMP/October 12, 1999
Fernald Citizens Advisory Board (FCAB)	FEMP/October 14, 1999
FS overview with FCAB	FEMP/November 4 and 6, 1999
Summary of Comparative Analysis of Silos 1 and 2 FS	FEMP/November 17, 1999
Nevada Test Site Citizens Advisory Board Summary of Silos 1 and 2 FS Comparative Analysis	Las Vegas, Nevada/December 1, 1999
FCAB Proposed Plan Summary	FEMP/December 6, 1999

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The public is encouraged to review and comment on both alternatives (i.e., not just the preferred alternative) considered for remediation of the Silos 1 and 2 material,. Both alternatives are discussed in detail in **Section 7.0** of this PP. Additional details on the remedial alternatives can be found in Sections 3 and 4 of the revised FS. The FS is available in the Administrative Record file at the PEIC.

The actual selection of the alternative to be implemented will be made only after comments received during the public comment period have been reviewed and analyzed. The DOE and EPA will consider all public comments on this PP in preparing the ROD amendment. Depending on comments received, the selected final remedy for the Silos 1 and 2 material presented in the ROD amendment could be different from the preferred alternative. All written and verbal comments received during the public comment period will be summarized and responded to in the *Responsiveness Summary* section of the ROD amendment. The ROD amendment for Silos 1 and 2 material is scheduled to be issued in the spring of 2000.

9.2 Community Participation

The community is encouraged to read and provide comments on the revised FS for Silos 1 and 2 and this PP. The revised FS describes the RA alternatives that were considered for treatment of the Silos 1 and 2 material and describes the merits and shortcomings of each. This PP puts forth a preferred RA alternative for the Silos 1 and 2 material based upon the content and conclusions of the FS.

A final remedy will be made only after hearing and considering community comments and concerns. Based upon those comments, the preferred alternative may be modified, another alternative presented in this PP selected, or a new alternative selected based on information gathered from the community before and during the comment period.

The revised FS for Silos 1 and 2 and this PP and other supporting documents are available from the Administrative Record, located at the PEIC and at the EPA offices in Chicago, Illinois. Addresses for these Administrative Record locations are provided below.

Your comments may either be presented publicly at a community meeting or submitted by mail to:

Mr. Gary Stegner
U.S. Department of Energy
Fernald Area Office
P.O. Box 398705
Cincinnati, Ohio 45239-8705

513-648-3153

Mr. James A. Saric
U.S. EPA, 5HRE 8J
77 W. Jackson Blvd.
Chicago, Illinois 60604

312-886-0992

The date, time and location of the public meeting and dates for the comment period have been announced in the local media and are posted at the Administrative Record locations; addresses and hours are as follows:

Public Environmental Information Center
10995 Hamilton-Cleves Highway
Harrison, Ohio 45030

513-648-7480

Monday, 7:30 a.m. to 8 p.m.
Tuesday – Thursday, 7:30 a.m. to 5 p.m.
Friday, 7:30 a.m. to 4:30 p.m.

U.S. EPA Region V
77 W. Jackson Blvd.
Chicago, Illinois 60604

312-886-0992

Monday – Friday, 8 a.m. to 5 p.m.

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The OEPA is participating in the RI/FS and RA processes at the FEMP. For additional information concerning the state's role in the cleanup process at the FEMP or regarding the specifics of the revised FS and this PP contact:

Tom Schneider
Ohio Environmental Protection Agency
401 E. Fifth Street
Dayton, Ohio 45402-2911

513-285-6466.

For additional information on public participation activities related to the revised Silos 1 and 2 FS, PP, or the FEMP site, visit the DOE-FEMP website at http://www.fernald.gov/.

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APPENDIX A

SUMMARY OF KEY

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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INTRODUCTION

This appendix presents a summary of the key applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) criteria that pertain to the remedial alternatives which were retained in the Detailed Analysis of Alternatives (Section 3) of the *Revised Feasibility Study for Silos 1 and 2*[1]. A summary of the description and evaluation of the alternatives is presented in **Sections 7** and **8** of this Proposed Plan (PP). The tables presented in this appendix include both ARARs established under federal and state environmental laws, and TBCs that were determined to be necessary to ensure protection of human health and the environment.

This appendix has three tables in accordance with the three types of ARARs: Chemical-specific, Location-specific, and Action-specific. The tables list the retained alternatives 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 by the strategy for compliance with the ARAR during implementation of the alternative. This format and contained information is consistent with the U.S. Environmental Protection Agency's *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (OSWER 9200.1-23P, July 1999).

A detailed listing and discussion of compliance with ARARs is provided in *Appendix A* of the *Revised Feasibility Study for Silos 1 and 2*. A list of acronyms presented in the tables are defined below.

[1] *Revised Feasibility Study for Silos 1 and 2*, 1999, is available for review in the Administrative Record at the PEIC (refer to **Section 9.0** of this PP).

LIST OF ACRONYMS

ARAR	- Applicable or Relevant and Appropriate Requirement
CFR	- Code of Federal Regulations
DOE	- U.S. Department of Energy
FEMP	- Fernald Environmental Management Project
OAC	- Ohio Administrative Code
RCRA	- Resource Conservation and Recovery Act
TBC	- to be considered
TSD	- Treatment, Storage, and Disposal Facility

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TABLE A-1

KEY ARARS FOR SILOS 1 AND 2 MATERIAL REMEDIAL ACTION ALTERNATIVES, CHEMICAL-SPECIFIC

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Implementation	Basis for Compliance
VIT1 VIT2 CHEM1 CHEM2	Radionuclide Emissions (Except Airborne Radon-222), 40 Code of Federal Regulations (CFR) Part 61 Subpart H.	Applicable	Radioactive materials within Silos 1 and 2 might contribute to the dosage to members of the public from the air pathway during implementation of remedial actions since the National Emissions Standards for Hazardous Air Pollutants applies to operating units.	The pollution control equipment for the silos and treatment system off-gas emissions will be designed to limit discharge of radionuclides to acceptable levels.
VIT1 VIT2 CHEM1 CHEM2	Radon-222 Emissions, 40 CFR Part 61 Subpart Q.	Applicable	Facilities such as Silos 1 and 2 qualify as sources since they contain radium-226 in sufficient concentrations to emit radon-222. This requirement is applicable only to storage and disposal of radium-bearing by-product material.	The radon-222 flux rate standard of 20 $pCi/m^2 \cdot s$ would be met during storage. This is due to stabilization followed by containerization of the treated Silos 1 and 2 material.
VIT1 VIT2 CHEM1 CHEM2	Residual Radioactive Material Proposed 10 CFR Part 834.	To be Considered	Management of radium and thorium bearing waste might result in the release of radon to the environment. The above-background concentration of radon-222 in the air above an interim storage facility must not exceed: 100 pCi/L at any part, an annual average of 30 pCi/L over the facility, or an annual average of 0.5 pCi/L above background or above any location outside the site.	The pollution control equipment for the silos and treatment system will be designed to limit emanation of radon to acceptable levels.

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TABLE A-2

KEY ARARS FOR SILOS 1 AND 2 MATERIAL REMEDIAL ACTION ALTERNATIVES, LOCATION-SPECIFIC

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Implementation	Basis for Compliance
VIT1 VIT2 CHEM1 CHEM2	Compliance with Floodplain/Wetlands Environmental Review Requirements, 10 CFR Part 1022 (Executive Order 11990).	Applicable	This requirement is applicable because the Fernald Environmental Management Project (FEMP) is a U.S. Department of Energy (DOE) facility. Several alternatives might result in destruction or modification of wetland areas.	These alternatives would comply with all National Environmental Policy Act (NEPA) evaluation and documentation requirements. NEPA documentation will also specify public notice requirements, wetland assessments, and any mitigative measures that may be required.

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TABLE A-3

KEY ARARS FOR SILOS 1 AND 2
REMEDIAL ACTION ALTERNATIVES, ACTION-SPECIFIC

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Implementation	Basis for Compliance
VIT1 VIT2 CHEM1 CHEM2	NEPA Implementation 10 CFR Part 1021.2	Applicable	This requirement is applicable because the FEMP is a DOE facility, and this requirement requires NEPA evaluation for specific actions at DOE facilities.	NEPA evaluations will be prepared for the selected remedial alternative in accordance with established procedures.
VIT1 VIT2 CHEM1 CHEM2	Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes. 40 CFR Part 191.03(b)	Relevant and Appropriate	Radiation levels associated with the Silos 1 and 2 material are similar to those associated with waste regulated by this requirement.	Remediation activities will have the necessary controls in place to ensure protection of the public.
VIT1 VIT2 CHEM1 CHEM2	Implementation of Health and Environmental Protection Standards for Uranium Mill Tailings, 40 CFR Part 192 Subpart C.	Relevant and Appropriate	Radioactive materials in Silos 1 and 2 are primarily by-product residues from uranium processing. Requirements for design of controls should be consistent with design of controls for other residual radioactive materials such as mill tailings.	Remediation activities will have the necessary controls in place to ensure protection of human health and the environment.
VIT1 VIT2 CHEM1 CHEM2	Treatment, Storage, or Disposal Facility Standards; 40 CFR Part 264 Subpart B [Ohio Administrative Code (OAC) 3745-54-13 through 16].	Relevant and Appropriate	Residues that exhibit a characteristic similar to Resource Conservation and Recovery Act (RCRA) hazardous waste removed from Silos 1 and 2 might be treated, stored, and disposed in accordance with treatment, storage, and disposal (TSD) facility standards. These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste.	These alternatives would undertake actions to comply with the TSD Facility general standards.

TABLE A-3

KEY ARARS FOR SILOS 1 AND 2
REMEDIAL ACTION ALTERNATIVES, ACTION-SPECIFIC

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Implementation	Basis for Compliance
VIT1 VIT2 CHEM1 CHEM2	Closure, 40 CFR Part 264 Subpart G. 40 CFR Part 264.111 (OAC 3745-55-11). 40 CFR Part 264.114 (OAC 3745-55-14). 40 CFR Part 264.116 (OAC 3745-55-16).	Relevant and Appropriate	These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste and some remedial alternatives might require closure as outlined in this standard.	These alternatives would undertake actions to comply with the closure requirements for the treatment facility.
VIT1 VIT2 CHEM1 CHEM2	Container Storage, 40 CFR Part 264 Subpart I 40 CFR Part 264.171 - 178 (OAC 3745-55-71 through -78).	Relevant and Appropriate	These requirements are relevant and appropriate for alternatives using containers for temporary storage or storage before disposal. These 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.
VIT1 VIT2 CHEM1 CHEM2	Tank Systems, 40 CFR Part 264 Subpart J (OAC 3745-55-91 through 96).	Relevant and Appropriate	Design criteria, operating standards, and inspections for tank treatment units might be relevant and appropriate for alternatives using treatment or storage in a tank before disposal. 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 Silos 1 and 2 material and the treatment process for which the tank is designed. The design will include secondary containment capable of detecting and collecting releases. Approved inspection and maintenance procedures will be established before management of material in the tanks.

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TABLE A-3 (continued)

Alternative Number	Regulatory Title and Citation	ARAR/TBC	Rationale for Implementation	Basis for Compliance
VIT1 VIT2 CHEM1 CHEM2	Radiation Dose Limit (All Pathways), Proposed 10 CFR Part 834.	To be Considered	Radiation sources from this OU (i.e., a DOE-owned facility) might contribute to the total dosage to members of the public.	Where appropriate, the treatment facility design will include high efficiency particulate air 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 Advance Wastewater Treatment Facility. Treatment of the waste source will reduce contributions to dose from radon and reduce the likelihood of migration of radionuclides.

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GLOSSARY OF TERMS

Administrative Record (AR): Documents including correspondence, public comments, Records of Decision, and technical reports upon which the agencies base their remedial action selection. The Administrative Record is made available for public review so that community members have the opportunity to provide comments to the U.S. Department of Energy (DOE) on proposed cleanup activities at the FEMP site. The Administrative Record for the Fernald Environmental Management Project (FEMP) site is located at the Public Environmental Information Center (PEIC).

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

Applicable or Relevant and Appropriate Requirements (ARARs): "Applicable" requirements mean those standards, criteria, or limitations promulgated under federal or state law that are required specific to a substance, pollutant, contaminant, action, location, or other circumstance at a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) site. "Relevant and appropriate" requirements mean those standards, requirements, or limitations that address problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to that particular site.

By-product Material: (1) Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content [Section 11(e)(2) of the Atomic Energy Act (AEA)].

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): A federal law that provides a comprehensive framework to deal with the investigation and cleanup of hazardous substances released into the environment from a waste site.

Constituents of Concern (COCs): Contaminants detected at waste sites that present significant contributions to overall site risk. At the FEMP, these include:

- other radionuclides (besides uranium) including radium, thorium, and technetium;
- organic chemicals including trichloroethene and dichloroethane (degreasing solvents); and
- inorganic chemicals including arsenic, manganese, and cadmium.

Explanation of Significant Differences (ESD): A public record documenting a significant change to the remedy selected in the Record of Decision.

Feasibility Study (FS): Provides a full evaluation of cleanup alternatives based on information gathered during the remedial investigation.

Hazardous Waste: Those wastes that are designated hazardous by EPA under 40 Code of Federal Regulation (CFR) Part 261.

NOTE: Byproduct material as defined in Section 11(e)(2) of the AEA is specifically exempted from regulation as a hazardous waste in 40 CFR Part 261(a)(4). However, this material may exhibit a characteristic of hazardous waste that can pose a substantial or potential hazard to human health or the environment when improperly managed, thereby making certain hazardous waste provisions of the Resource Conservation and Recovery Act relevant and appropriate to the management of this material.

Low Specific Activity (LSA): Radioactive material that, by its nature, has a limited specific activity, or radioactive material for which limits of estimated average specific activity apply.

National Priorities List (NPL): A formal listing of the nation's highest priority hazardous waste sites, as established by CERCLA, that have been identified for investigation and possible remediation. Sites are ranked by the EPA based on their potential impacts to human health and the environment.

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

Operable Unit (OU): A term used to describe a logical grouping of environmental media or waste management facilities at a cleanup site.

Picocuries per liter (pCi/L) and picocuries per gram (pCi/g): Concentration terms expressing the total activity of radioactive constituent present within a given mass/volume (i.e., gram or liter) of a medium (i.e., soil or water). A picocurie is equivalent to the radioactivity present in one trillionth of one gram of radium.

Proposed Plan (PP): A document that summarizes DOE's preferred cleanup strategy, the rationale for the preference, and alternatives presented in the detailed analysis of the FS. The Proposed Plan solicits public review and comment on all alternatives under consideration.

Public Environmental Information Center (PEIC): An information repository located approximately 2.5 kilometer (1.5 miles) 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,

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fact sheets, and textbooks. For additional information about the PEIC, call (513) 648-7480 during normal operating hours (See **Section 9.0**).

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 record documenting the final determination of the selected alternative. Records of Decision are legally binding documents that are developed in consideration of public comments and fulfill CERCLA requirements. FEMP CERCLA decisions are signed by representatives of EPA Region 5 and the DOE.

ROD-Amendment: A public record documenting a fundamental change to the remedy selected in the ROD.

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

Remedial Investigation (RI): Identifies the nature and extent of contamination at a site. Also provides an assessment of the potential risks associated with a site.

Removal Action: Cleanup actions taken to address a near-term environmental or public health concern due to the release or significant potential for release of hazardous substances. Removal actions are implemented at waste sites to address more immediate concerns while the RI/FS process is underway.

Resource Conservation and Recovery Act (RCRA): A 1976 act that 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.

Three Year Operating Period: A three year operating period was established to treat all the Silos 1 and 2 material as a common design basis for all alternatives evaluated in the FS. This assumption is documented in Appendix G of the FS.

To Be Considered (TBC) Criteria: Nonpromulgated advisories, criteria, or guidance developed by EPA, other federal agencies, or states that provide information necessary to develop CERCLA remedies.

Toxicity Characteristic Leaching Procedure (TCLP): Analytical test designed to determine the leachability of RCRA metals and organics under the conservative conditions of the waste form breaking down in an acidic medium similar to what might be expected in a sanitary landfill.

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