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INITIAL SCREENING OF ALTERNATIVES FOR OPERABLE UNIT 4 TASK 12 REPORT OCTOBER 1990

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INITIAL SCREENING OF ALTERNATIVES FOR OPERABLE UNIT 4

TASK 12 REPORT

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

REMEDIAL INVESTIGATION and FEASIBILITY STUDY

October 1990

U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE

FINAL

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LIST OF ACRONYMS

AEC	Atomic Energy Commission
AHP	analytical hierarchy process
ALARA	as low as reasonably achievable
ARARs	applicable or relevant and appropriate requirements
ASI	Advanced Sciences, Inc.
AWQC	Ambient Water Quality Criteria
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COE	U.S. Army Corps of Engineers
CPF	cancer potency factors
dcf	dose conversion factor
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EE/CA	engineering evaluation/cost analysis
EIE	Environmental Isolation Enclosure
EP	extraction procedure
EPA	U.S. Environmental Protection Agency
FFCA	Federal Facilities Compliance Agreement
FMPC	Feed Materials Production Center
HEPA	high efficiency particulate air
HVAC	heating, ventilation, and air conditioning
IT	IT Corporation
LSA	low specific activity
MCL	maximum contaminant level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NLO	National Lead of Ohio
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
PCB	polychlorinated biphenyls
RAOs	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
TBC	to be considered
WMCO	Westinghouse Materials Company of Ohio

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This document presents the Initial Screening of Alternatives for Operable Unit 4 at the Feed Materials Production Center (FMPC), Fernald, Ohio. This screening was conducted as part of the site-wide Remedial Investigation/Feasibility Study (RI/FS) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Operable Unit 4 includes the storage silos (two K-65 silos and Silo 3) and the potentially contaminated soils surrounding them.

REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) are medium-specific cleanup goals for protecting human health and the environment. They address the contaminants of concern as well as exposure routes and receptors identified in the baseline risk assessment. For Operable Unit 4, it must be demonstrated that remedial alternatives meet airborne and direct radiation RAOs at a point immediately adjacent to the silos, as well as drinking water RAOs in any perched water that might be encountered directly below the silos.

RAOs were developed based on chemical-specific applicable or relevant and appropriate requirements (ARARs). Moreover, additional RAOs were developed based on risk analysis for the pathways. The media for which RAOs were developed included: direct radiation, air, soils, sediments and surface water, groundwater, silo contents, and silo structures. An RAO that was applied across all media was that total cancer risk from radionuclides must be below 25 percent of the 10^{-4} to 10^{-6} lifetime risk goal set forth in the National Oil and Hazardous Substances Pollution Contingency Plan, or 2.5×10^{-5} to 2.5×10^{-7}.

GENERAL RESPONSE ACTIONS

General response actions are broad categories of media-specific remedial actions that will satisfy one or more of the RAOs. In the case of Operable Unit 4, these general response actions include no action, institutional action, containment with and without treatment, and removal with treatment and disposal.

IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

Technology types potentially capable of satisfying the applicable RAOs were identified for each general response action. These technology groups were further broken down into various process options. The process options and technologies were then screened on the basis of technical implementability. Those that were considered for assembly into alternatives are the following:

Containment:

- Environmental Isolation Enclosure
- Capping, including concrete-based covers, asphalt-based covers, soil-based covers, chemical sealants, and multimedia caps
- Subsurface flow control, including pumping wells, slurry walls, and grout curtains
- Run-on/runoff control, including sedimentation basins, diversion/collection, grading, and revegetation

Removal:

- Mechanical removal consisting of a crane and clamshell system
- Hydraulic removal, consisting of a mining pump equipped with a jetting ring and cutterhead
- Pneumatic removal consisting of a vacuum airlift equipped with a cutterhead

Structure Removal:

- Hydraulic Splitter
- Nonexplosive demolition agent
- Gas torch

Treatment/Disposal:

- Ex situ stabilization, including asphalt encapsulation, cement-based solidification, thermoplastic encapsulation, and vitrification
- In situ stabilization, including shallow soil mixing of cement and fly ash, vitrification, and surcharging
- Air treatment, including roughing filters, high efficiency particulate air (HEPA) filters, and carbon adsorption units
- Water treatment, including neutralization, precipitation, clarification, centrifugation, flotation, ion exchange, biodenitrification, and reverse osmosis
- On-property disposal, including above grade and below grade vaults and tumulus

The process options were finally evaluated for their effectiveness, implementability, and cost. The evaluation was in relation to other process options within the same technology group. In a few cases, process options were carried in parallel, awaiting further data.

DEVELOPMENT OF ALTERNATIVES

General response actions were combined in the form of process options to create an alternative that would potentially satisfy the RAOs. The alternatives were developed to provide a number of possible approaches to meeting these objectives. No-action alternatives, nonremoval alternatives, and alternatives that involve the removal of the silo contents to either an on-property or off-site location were developed. Because the materials and structures for Silos 1 and 2 are nearly identical, they are always treated in the same alternative. Silo 3 is treated in separate alternatives.

SUMMARY OF ALTERNATIVES - SILOS 1 AND 2

Alternative 0A - No Action

This alternative calls for no action and provides a baseline against which the other alternatives can be compared. It provides for the silos and its contents to remain unchanged without the implementation of any removal, treatment, containment, or mitigation technologies. However, it does include the installation of long-term monitoring equipment as well as the cost of the monitoring program.

Alternative 1A - Nonremoval, Silo Isolation

This nonremoval alternative for Silos 1 and 2 consists of enhancing the containment integrity of the silos and utilizing them as permanent disposal facilities. An impermeable clay cap and slurry walls are among the technologies considered for this alternative.

Alternative 2A - Nonremoval, In Situ Stabilization, and Cap

This nonremoval alternative for Silos 1 and 2 consists of in situ stabilization and capping. Conventional physical stabilization and vitrification were considered as options. However, vitrification was screened out as a process option due to concerns about the difficulty of implementability. The capping and isolation technologies, with the exception of the slurry wall, are identical to those described for Alternative 1A.

Alternative 6 - Removal, Treatment, and On-Property Disposal

This alternative for Silos 1 and 2 calls for the removal and conventional stabilization or vitrification of the silo contents prior to on-property disposal in an engineered disposal facility. This alternative includes silo demolition and disposal of the debris.

Alternative 7 - Removal, Treatment, and Off-site Disposal

This alternative for removal of the K-65 material is identical to Alternative 6 except that the material would be packaged for shipment to an approved off-site disposal facility.

Alternative 8 - Removal, Contaminant Separation, and On-Property Disposal

This removal alternative for the K-65 material is similar to Alternative 6, but adds an additional step of contaminant separation to remove various radionuclides and metals before stabilization and on-property disposal. This would result in significant volume reduction and allow for the possible recovery of precious metals. This alternative would include silo demolition and disposal of the debris.

Alternative 9 - Removal, Contaminant Separation, and Off-site Disposal

This alternative is identical to Alternative 8, except that the material would be packaged and shipped to an approved off-site disposal facility.

SUMMARY OF ALTERNATIVES - SILO 3

Alternative 0B - No Action

The no-action alternative for Silo 3, as was the case for Silos 1 and 2, provides a baseline, but no remedial action. Only installation of long-term monitoring equipment and the cost of the monitoring program are included.

Alternative 1B - Nonremoval, Silo Isolation

This nonremoval alternative for Silo 3 consists of enhancing the containment integrity of the silo and utilizing it as a permanent disposal facility. An impermeable clay cap and slurry walls are among the technologies considered for this alternative.

Alternative 2B - Nonremoval, In Situ Stabilization, and Cap

This nonremoval alternative for Silo 3 consists of in situ stabilization and capping. The capping and isolation technologies, with the exception of the slurry wall, are identical to those described in Alternative 1B.

Alternative 3 - Removal and On-Property Disposal

This alternative for Silo 3 calls for removal and conventional stabilization or vitrification prior to disposal in an engineered on-property disposal facility. This alternative includes silo demolition and disposal of the debris.

Alternative 4 - Removal of Metal Oxides and Off-site Disposal

This alternative for Silo 3 is identical to Alternative 3, except that the material would be packaged for shipment to an approved off-site disposal facility.

Alternative 5 - Removal and Replacement in Rehabilitated Silos

This alternative for Silo 3 provides for the removal of the metal oxides and their return to a rehabilitated Silo 3 or Silo 4 reconstructed as a permanent disposal facility. This alternative was not carried through to detailed analysis because of its inadequate effectiveness and implementability.

ALTERNATIVE EVALUATION MATRIX FOR SILOS 1 AND 2

CRITERIA	ALTERNATIVE OA	1A	2A	6	7	8	9
Short-Term Public Health	1	5	3	3	3	3	3
Short-Term Environmental Protection	1	5	3	2	3	4	3
Long-Term Public Health	1	1	3	4	5	4	5
Long-Term Environmental Protection	1	1	4	4	5	4	5
Reduction in Mobility, Toxicity, or Volume	1	2	4	4	5	5	5
Constructability	5	5	3	3	3	3	3
Reliability	2	4	3	5	4	4	5
Maintenance/Monitoring/Operation	5	3	3	3	5	3	5
Agency Approvals	1	2	2	2	3	3	3
Special Engineering & Equipment (Implementability)	5	5	1	3	3	3	3
SUMMATION	23	33	29	33	39	36	40

ALTERNATIVE EVALUATION MATRIX FOR SILO 3

CRITERIA	ALTERNATIVE OB	1B	2B	3	4	5
Short-Term Public Health	1	5	3	4	4	3
Short-Term Environmental Protection	1	5	3	4	3	3
Long-Term Public Health	1	1	4	4	5	2
Long-Term Environmental Protection	1	1	4	4	5	3
Reduction in Mobility, Toxicity, or Volume	1	3	4	5	5	1
Constructability	5	5	3	3	4	2
Reliability	2	4	3	4	4	2
Maintenance/Monitoring/Operation	5	3	3	3	5	3
Agency Approvals	1	2	2	3	4	1
Special Engineering & Equipment (Implementability)	5	5	1	3	3	3
SUMMATION	23	34	30	37	42	23

1 = Poor   3 = Average   5 = Good
2 = Below Average   4 = Above Average

FL/FMPC-0415-2/ES-1

FIGURE ES-1. ALTERNATIVE EVALUATION MATRIX - SILOS 1,2, AND 3

ALTERNATIVE COSTS FOR SILOS 1 AND 2

ALTERNATIVE	OA	1A	2A	6	7	8	9
NET PRESENT WORTH COST (CAPITAL/O&M) (millions of dollars)	.02 / 2.75	36.88 / 3.18	52.54 / 3.18	32.35 / 2.48	69.46 / .72	35.28 / 2.25	52.27 / .71

ALTERNATIVE COSTS FOR SILO 3

ALTERNATIVE	OB	1B	2B	3	4	5
NET PRESENT WORTH COST (CAPITAL/O&M) (millions of dollars)	.02 / 2.12	30.26 / 2.61	32.24 / 2.61	25.34 / 1.43	41.95 / .43	* / *

* Alternative eliminated before costs prepared

FL/FMPC-0415/ES-2

FIGURE ES-2. ALTERNATIVE COSTS SUMMARY - SILOS 1,2, AND 3

1.0

1.0 INTRODUCTION

1.1 PURPOSE

In accordance with the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Revision 3) for the Feed Materials Production Center (FMPC) at Fernald, Ohio, distinct tasks have been established. There are three tasks: (1) to develop remedial action alternatives and to screen technologies; (2) to refine, evaluate and screen alternatives; and (3) to conduct a detailed analysis of screened alternatives.

The purpose of this report is to document the refinement, evaluation, and screening of the identified remedial action alternatives for the K-65 silos (Silos 1 and 2) and the metal oxide silo (Silo 3) of Operable Unit 4. The alternatives are further developed and refined to provide the necessary differentiation required for the evaluation. The alternatives are then evaluated for effectiveness, implementability, and cost, followed by the alternative screening process to determine which should be carried forward for detailed analysis in a subsequent task. In accordance with U.S. Environmental Protection Agency, "Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA," (OSWER Directive 9355.3-1) this report also identifies additional data considered necessary for the detailed analysis and subsequent selection of a preferred action.

1.2 ORGANIZATION OF REPORT

This report will first introduce the alternatives identified in the previous task. Section 2.0 will discuss the identification and screening of technologies and process options. Section 3.0 reviews the development of alternatives. Section 4.0 will address the methodology for and the thought process behind the alternative screening process. This will include a discussion of the requirements for alternative development, evaluation, and screening as outlined in OSWER Directive 9355.3-1. In addition, Section 4.0 also discusses treatment and on-property/off-site disposal considerations. Section 5.0 will present the evaluation of the alternatives as they are rated against the evaluation criteria. Section 6.0 will rank the alternatives, recommend those alternatives for consideration in the subsequent detailed analysis of alternatives, and discuss additional data requirements.

1.3 BACKGROUND

On July 18, 1986, a Federal Facility Compliance Agreement (FFCA) was jointly signed by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) pertaining to the environmental impacts associated with the FMPC. The FFCA was entered into pursuant to Executive Order 12088 to ensure compliance with existing environmental statutes and implementing regulations. In particular, the FFCA was intended to ensure that environmental impacts associated with past and present activities at the FMPC are thoroughly and adequately investigated so that appropriate remedial response actions can be formulated, assessed, and implemented. Subsequent to the oral presentation of the Initial Screening of Alternatives for Operable Unit 4 in June 1989, a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120 Consent Agreement was executed.

In response, a site-wide RI/FS is in progress pursuant to the CERCLA 42USC9601. The performance of the RI/FS is in conformance with current EPA guidance and the guidelines, criteria, and considerations set forth in the National Oil and Hazardous Substances Contingency Plan (NCP) 40CFR300 and the Superfund Amendments and Reauthorization Act (SARA) 42USC11001 et. seq. of 1986.

1.3.1 Site Description

The FMPC is a uranium metal production facility located near Fernald, Ohio, approximately 18 miles northwest of Cincinnati. Figure 1-1 shows the FMPC location and a five mile radius of adjoining areas. The site covers approximately 1050 acres and is used for the production of uranium metal cores, target element cores, and the interim storage of low-level radioactive and mixed wastes. In addition to uranium production facilities, the site also contains waste storage facilities consisting of waste pits, storage silos, a burn pit, a clearwell, two fly ash piles, a sanitary landfill, and lime sludge ponds (Figure 1-2).

1.3.2 Operable Unit Description

Operable Unit 4 consists of the K-65 silos (Silos 1 and 2), the metal oxide silo (Silo 3), and unused Silo 4 located south of the waste pit area (Figure 1-3).

All four domed material storage silos are 80 feet in diameter, 36 feet high to the center of the silo dome, and 27 feet high to the top of the vertical walls. The walls are 8-inch concrete, as are the outer part of the domes, which taper to 4 inches in thickness at the center. The floor consists of 4-inch concrete over an underdrain system. This underdrain system consists of a 2-inch slotted pipe in an 8-inch gravel layer underlain by concrete and compacted clay. The entire K-65 silo exteriors have been coated with 0.75 inch of gunite and are surrounded by an earthen berm to a height of approximately 26 feet, while Silo 3 is free-standing (Figures 1-4 and 1-5).

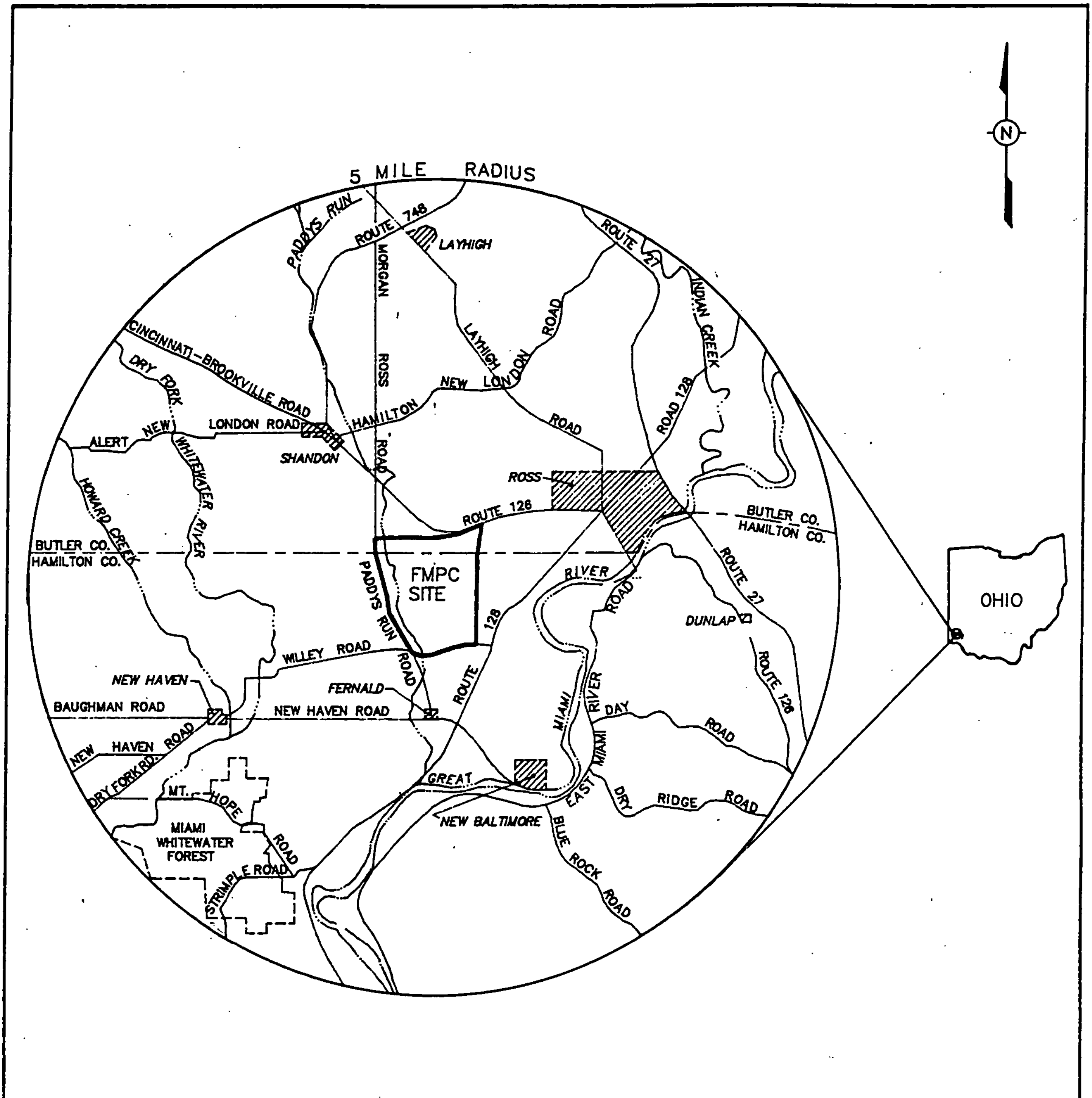

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FIGURE 1-1. FIVE MILE RADIUS MAP, FEED MATERIALS PRODUCTION CENTER

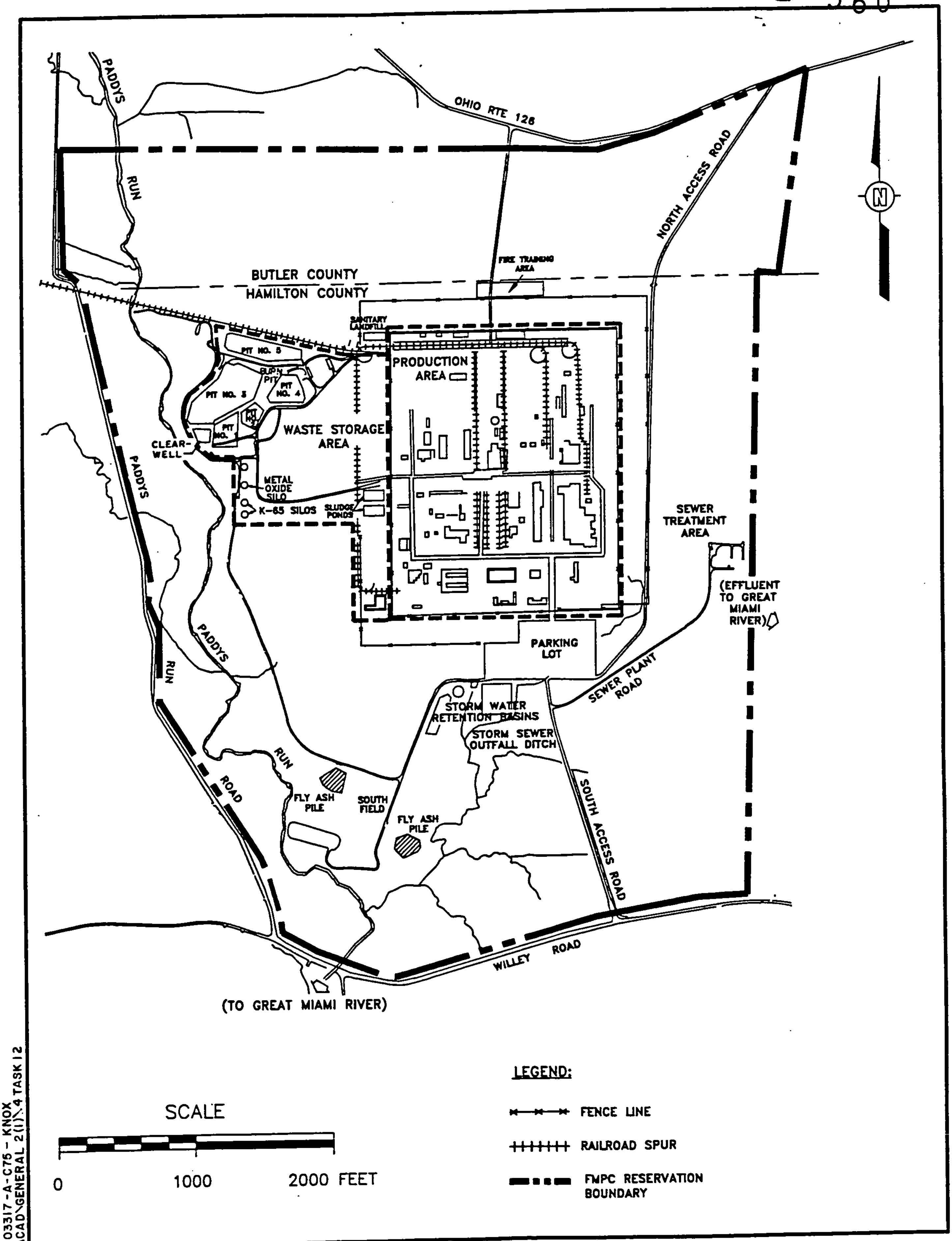


FIGURE 1–2. MAJOR FEATURES OF THE FEED MATERIALS PRODUCTION CENTER

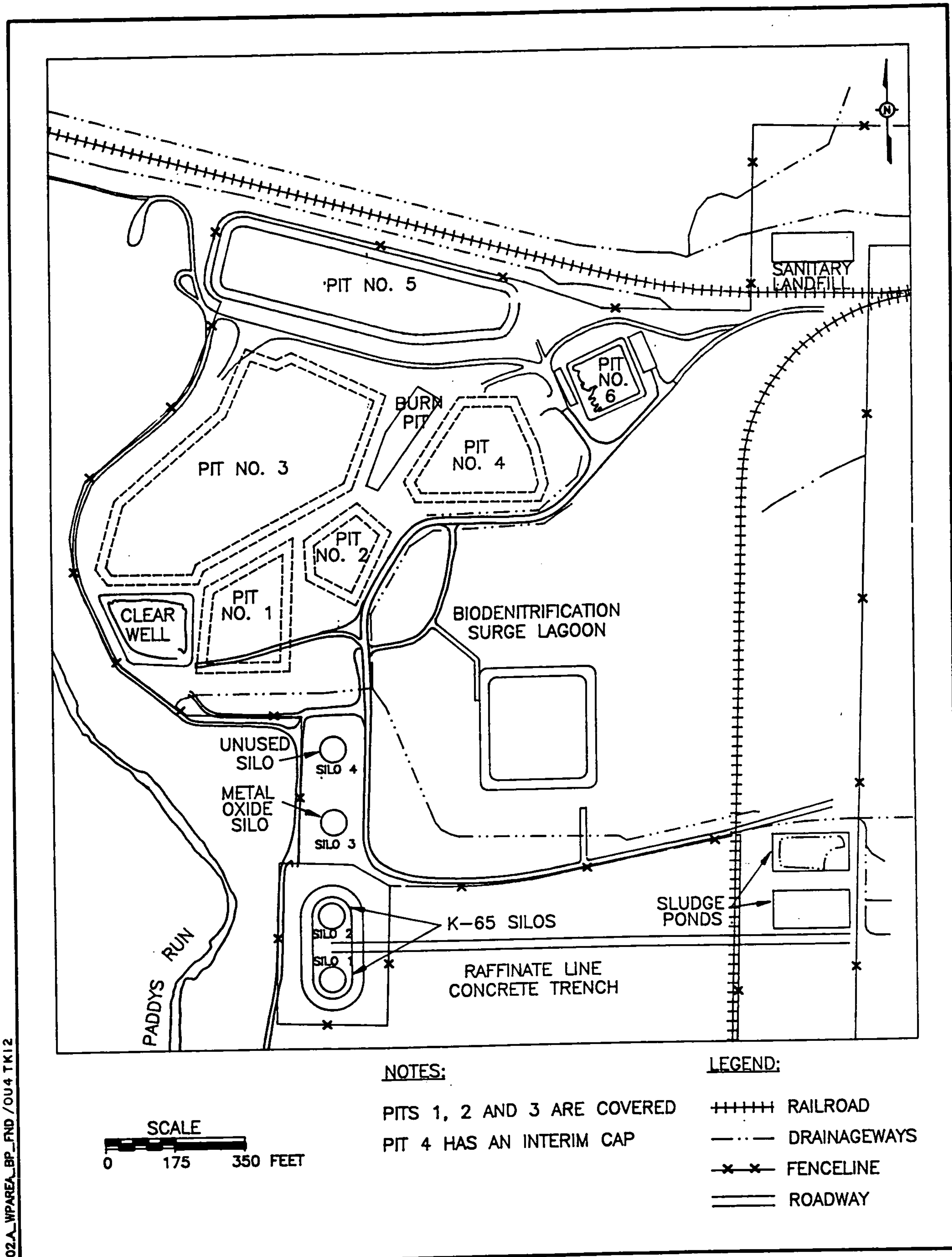
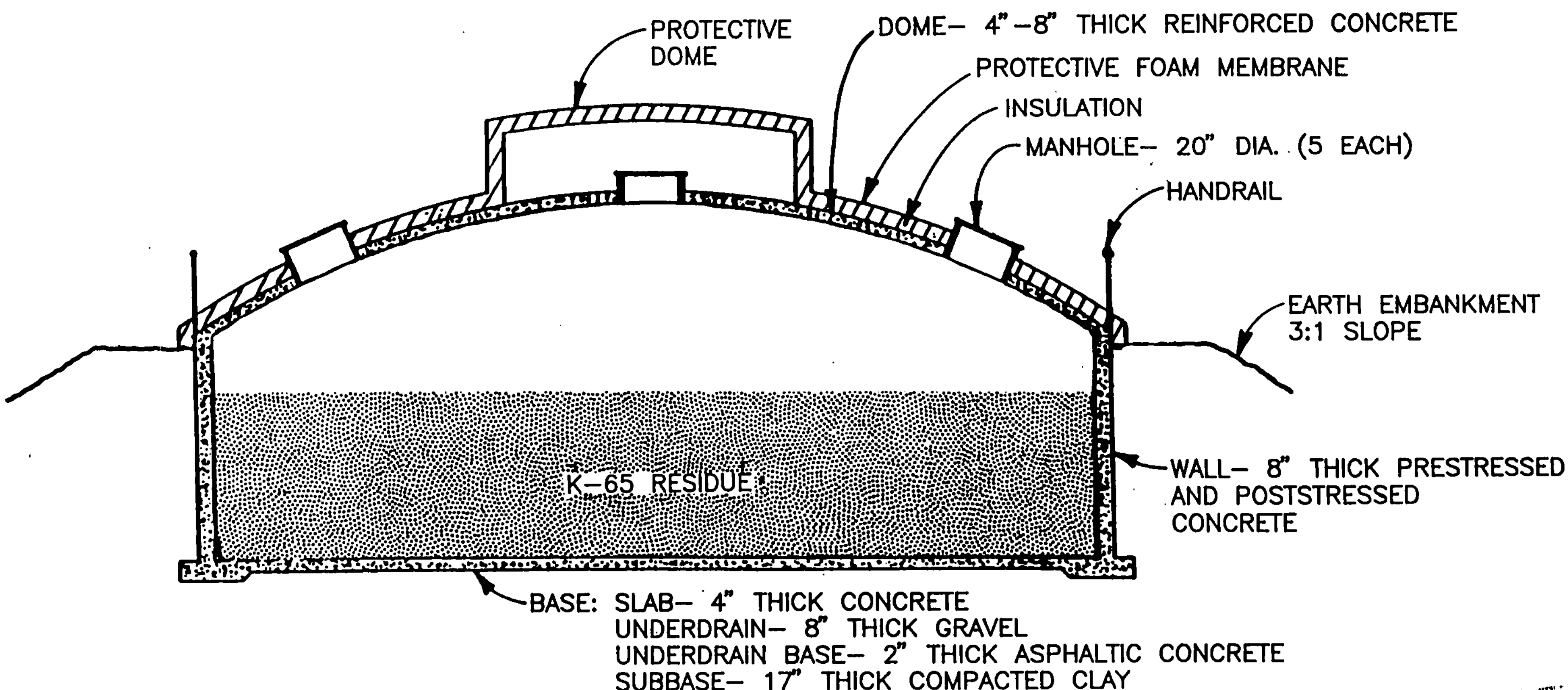


FIGURE 1-3. WASTE STORAGE AREA

- 560

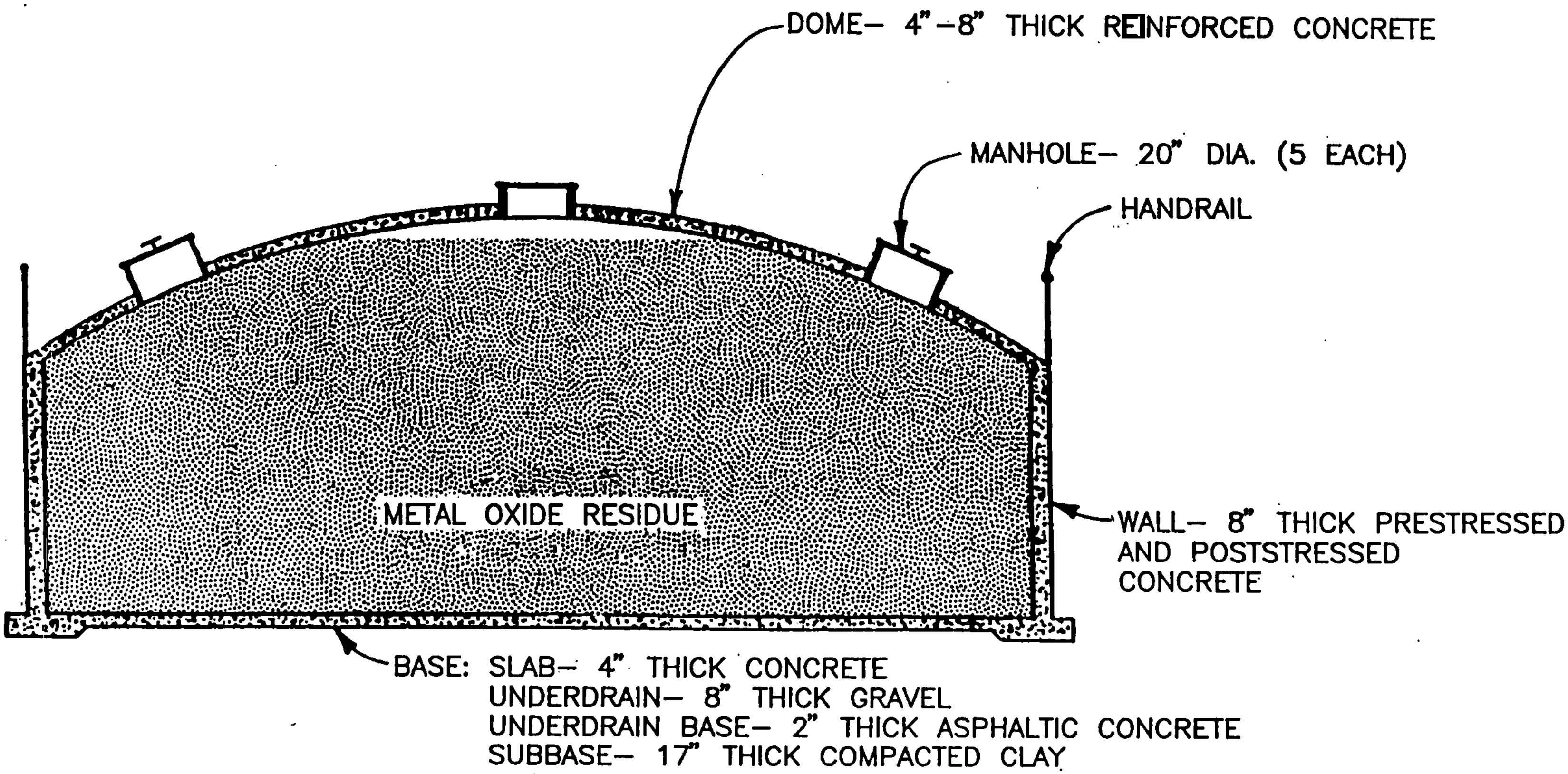


NOT TO SCALE

000024

303317–A–G30 OU4 TK 12 KNOX

FIGURE 1–4. TYPICAL CROSS–SECTION THROUGH SILOS 1 AND 2



NOT TO SCALE

FIGURE 1–5. CROSS–SECTION THROUGH SILO 3

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–560

303317–A–G29 OU4 TK 12 KNOX

The K-65 silos were used for the storage of radium-bearing residues formed as by-products of uranium ore processing. Silos 1 and 2 received residues from 1952 to 1958. Raffinates were pumped into the silos, where the solids would settle. The free liquid was decanted through a series of valves placed at various levels along the height of the silo wall. Settling and decanting continued until the silos were filled to approximately 4 feet below the top of the vertical wall.

Corrective actions have been performed in the past to maintain the integrity of the K-65 silos. These include repairing the walls and constructing a berm on a 1-1/2 to 1 slope (mid 1960s) and enlarging the berm to a 3 to 1 slope in the early 1980s. In 1985 a structural assessment was performed. This assessment revealed that the walls and base slab are structurally stable and can function as a containment of dry solids for a period of 10 to 15 years. However, the center 20-foot section of the dome was determined to be structurally unsound for a load greater than the existing static load (Camargo 1986). Remedial actions taken since 1985 include placement of protective covers constructed of steel and plywood over the center portion of each K-65 silo dome. Three inches of rigid polyurethane foam topped by a 45-mil waterproof, ultraviolet-resistant, urethane-finish coating was placed over each K-65 silo dome in 1987 to provide weather protection and insulation. During the installation process, a temporary radon removal system was installed to reduce radiation exposure to the workers.

Silos 3 and 4 were constructed in 1952 in a manner similar to Silos 1 and 2; however, the silos were designed to receive dry materials only. Raffinate slurries from refinery operations were dewatered in an evaporator and spray-calcined to produce dry materials for storage in the silo. The material was blown in under pressure to fill Silo 3, but Silo 4 was never used and remains empty today.

1.3.3 Nature and Extent of Contamination

The primary radioactive constituents of Silos 1 and 2 are radium (Ra-226), radon (Rn-222), uranium (0.71 weight percent U-235), and thorium (Th-230). The majority of the material is silica and metallic compounds. Table 1-1 lists the silos constituents and their approximate quantities, based on past sampling efforts. Tables 1-2 and 1-3 summarize the results of the current sampling efforts. Documentation of the past sampling efforts is included in the reference section.

TABLE 1-1
SILO WASTE CHARACTERISTICS

	Silos 1 and 2			Silo 3
Characteristic	Litz[a]	NLO[b]	Vitro[c]	DOE[d]
Moisture content (wt %)	-	-	30	-
Dry wt, kg	-	8.79×10^6	1.59×10^6	-
Estimated volume, m^3	-	5,522	3,155	3,902
Density, kg/m^3	-	-	1,179	-
Uranium, ppm	1,800 - 3,200	600	2,110	-
Lead, ppm	60,000 - 70,000	48,000 - 52,000	94,900	-
Radium, ppb	280 - 360	200	300	-
Barium, ppm	50,000	-	45,300	-
Iron, ppm	13,000 - 18,000	-	-	-
Gold, ppm	65 - 78	<40 - 60	-	-
Platinum, ppm	0.9 - 1.4	-	-	-
Palladium, ppm	13 - 18	-	-	-
Silver, ppm	18	<20	-	-
Copper, ppm	500 - 800	400 - 600	-	-
Cobalt, ppm	1,600 - 2,000	1,500 - 2,000	-	-
Nickel, ppm	3,500 - 3,700	2,000 - 3,000	-	-

Source: [a]Litz, J.E., 1974, "Treatment of Pitchblende Residues for Recovery of Metal Values," Hazen Research, Inc., for Cotter Corp., Canon City, CO.

[b]NLO, Inc, and Battelle Columbus Laboratories, 1980, "Scoping Investigation of Short-Term and Long- Term Storage Costs for Afrimet Residues-NFSS and FMPC," Report to the U.S. Dept. of Energy, Remedial Action Program Office, Washington, D.C.

[c]Vitro Corp., 1952, "Summation Report: Recovery of Radium from K-65 Residue," U.S. Atomic Energy Commission, KLX-1222.

[d]U.S. Department of Energy, 1987, "Remedial Investigation and Feasibility Study, Feed Materials Production Center, Fernald, Ohio, Task 1 Report: Description of Current Situation," DOE, Oak Ridge Operations Office, Oak Ridge, TN.

TABLE 1-2
RADIONUCLIDE CONCENTRATION SUMMARY IN THE SILOS

Nuclide (pCi/g)	Silo 1	Silo 2	Silo 3
Ac-227	NA[a]	NA	234 - 1363
Pa-231	NA	NA	266 - 931
Th-228	ND[b]	ND - 638	ND - 996
Th-230	10,569 - 43,771	8365 - 40,124	21,010 - 71,650
Th-232	ND - 766	ND - 851	ND - 1451
Ra-224	NA	NA	64 - 453
Ra-226	89, 280 - 192,600	657 - 145,300	467 - 6435
Ra-228	ND	ND	ND - 559
Pb-210	48,980 - 181,100	77,940 - 399,200	454 - 6427
U-234	326 - 897	129 - 1404	348 - 1935
U-235/236	ND - 56	ND - 74	ND - 158
U-238	398 - 920	46 - 1240	320 - 2043
U-Total (ppm)	1189 - 2753	137 - 3717	738 - 4554

[a]NA = Not Analyzed
[b]ND = Not Detected

Note: Data validation is currently in progress
Source: 1989 WMCO sampling

TABLE 1-3
CHEMICAL CONCENTRATIONS IN THE SILO WASTE

Contaminant	Silo 1 (µg/kg)	Silo 2 (µg/kg)	Silo 3 (µg/kg)
PCB Organics Analysis Data			
Aroclor-1248	ND - 8000	ND	ND
Aroclor-1254	1100-12000	420 - 6000	ND

Contaminant	Silo 1 (mg/kg)	Silo 2 (mg/kg)	Silo 3 (mg/kg)
Inorganic Analysis Data			
Aluminum	60.4 - 1430	464 - 2570	10,800 - 23,700
Antimony	ND	ND - 7.2	ND
Arsenic	14.7 - 68.4	57.5 - 1960	532 - 6380
Barium	1970 - 7860	89.2 - 8370	118 - 332
Beryllium	0.88 - 2.8	0.66 - 6.0	10.0 - 39.9
Cadmium	2.1 - 8.0	3.4 - 19.1	21.5 - 204
Calcium	2150 - 5700	2430 - 301,000	21,300 - 39,900
Chromium	21.0 - 165	12.9 - 68.8	139 - 560
Cobalt	349 - 1260	6.2 - 2430	ND - 3520
Copper	122 - 473	ND - 1790	1610 - 7060
Iron	4340 - 75,100	4010 - 37,800	13,900 - 67,600
Lead	35,800 - 85,100	153 - 29,800	646 - 4430
Magnesium	1500 - 6020	1520 - 8740	38,200 - 80,900
Manganese	33.5 - 257	74.2 - 403	2420 - 6500
Mercury	0.23 - 2.8	ND - 2.3	ND - 0.69
Nickel	629 - 2580	14.6 - 2200	1200 - 6170
Potassium	158 - 492	37.8 - 289	1300 - 22,800
Selenium	106 - 180	ND - 118	101 - 349
Silver	5.0 - 23.3	ND - 22.8	9.2 - 23.8
Sodium	360 - 13,100	226 - 4070	22,900 - 51,700
Thallium	ND - 0.52	ND - 1.4	3.1 - 73.9
Vanadium	72.2 - 240	21.9 - 214	418 - 4550
Zinc	14.4 - 212	11.2 - 154	301 - 672
Cyanide	0.52 - 4.4	ND - 4.5	ND

ND = Not Detected
Note 1: All detected volatile and semivolatile compounds resulted from laboratory contamination or are at or below the contract required quantification limits (CRQL)
Note 2: Data validation is currently in progress
Source: 1989 WMCO sampling

Radon and the elements resulting from its decay (daughter products, progeny, etc.) are the nuclides of concern from a health and environmental perspective. Radon is known to be diffusing out of the silos via cracks and structural joints. Radon and its daughter products are relatively mobile and capable of migrating through air and water. However, there is no evidence to date that any of the other contaminants have migrated into the environment from the silos. Due to the diffusion of radon into the berms, it is believed that the berms and subsoils contain elevated levels of Pb-210 and Po-210. The Pb-210 and Po-210 resulted from the decay of radon which diffused into the berm. There may have been leakage from the existing leachate collection system beneath the silos into the surrounding soils. Sampling of the berms and soil beneath the silos is scheduled, and upon completion will confirm the nature and extent of contamination and contaminant migration, if any.

Silo 3 contains uranium (0.71 weight percent U-235), thorium (Th-230), silica, a very small amount of radium (Ra-226), and other metal oxides. Silo 3 is not a significant radon source, and, due to the physical characteristics of the silo contents (dry and powdery), it is not believed to be the source of any contaminant migration to the surrounding and underlying environs. It is, however, still a source of radioactivity and a potential airborne contaminant hazard due to its dry, powdery consistency.

2.0

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

2.1 INTRODUCTION

This section discusses the development and screening of the technologies and process options used to assemble the remedial action alternatives for Operable Unit 4. The steps involved in this screening include:

- Develop media-specific remedial action objectives
- Develop media-specific general response actions
- Identify and screen remedial technologies within each general response action
- Identify and screen process options within each technology

In the case of Operable Unit 4, the general response actions were similar for each medium of concern; therefore, a single set of general response actions was used to determine technologies and process options. The following paragraphs discuss the process of alternative development and screening.

2.2 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) are medium-specific, operable unit-specific cleanup goals for protecting human health and the environment (EPA 1988a,b). The objectives must address the contaminants of concern and the exposure routes and receptors identified in the Operable Unit 4 Baseline Risk Assessment.

In determining RAOs, all significant sources and exposure pathways must be identified to ensure that the RAO for a single source or pathway adequately protects the receptor from the total risk that may be associated with the site. At the FMPC, this concern is addressed by limiting the risk from a single operable unit to 25 percent of the total allowable risk. Twenty-five percent was chosen as the allowable risk from a single operable unit because the FMPC RI/FS is being managed as four source operable units and a single environmental media operable unit. Conservatism is built into this criterion because the same receptor is not likely to be affected by the exposure pathways associated with all operable units. If a single operable unit is identified as contributing multiple significant sources or exposure pathways by which a single constituent may contact a receptor, operable unit-specific RAOs will address this issue.

As stated in the preamble to the NCP (EPA 1990a), chemical-specific applicable or relevant and appropriate requirements (ARARs) will be used to the degree possible to determine remediation goals for the operable unit. Where ARARs do not exist for a constituent, risk-based cleanup goals will be developed as suggested by EPA (EPA 1990a; EPA 1988b).

2.2.1 Point of Compliance

For each operable unit at the FMPC, the point of compliance must be identified. The point of compliance is the geographical location at which the RAO must be achieved. At most hazardous waste sites, the point of compliance is the nearest identified receptor location for each exposure pathway.

The baseline risk assessment for Operable Unit 4 identifies two major human exposure categories: current land-use exposures, and future potential land use exposures. The current exposure setting at the site is based on the assumption of active institutional control (e.g., fencing, restricted access, security measures, etc.). These controls are assumed to remain in place for 100 years, as required by DOE Order for radioactive waste management (5280.2A). After 100 years, it is assumed that no active controls can be relied on for protection of human health. Under these assumed conditions, the point of compliance under current exposure conditions would be the FMPC property boundary. However, to be health protective in developing RAOs once institutional controls are lost after 100 years, the point of compliance becomes the boundary of the waste unit.

For Operable Unit 4, it must be demonstrated that remedial alternatives achieve airborne and direct radiation RAOs at a point immediately adjacent to the silos and meet drinking water RAOs at a point in the Great Miami Aquifer at the boundary of the operable unit.

2.2.2 Contaminants of Concern

Contaminants of concern for Operable Unit 4 are identified in the baseline risk assessment. Those associated with significant current and future exposure pathways and associated media are listed in Table 2-1.

The baseline risk assessment points out that groundwater is not currently contributing to risk but is addressed because of potential future exposures.

2.2.3 Remedial Action Objectives Based on Applicable or Relevant and Appropriate Requirements

The development of RAOs is concurrent with the identification of ARARs. In the case of the FMPC, ARARs may need to be interpreted in relation to site-specific conditions to ensure sufficient

TABLE 2-1

CHEMICALS OF CONCERN FOR OPERABLE UNIT 4 BY MEDIA

Medium	Current and Future Chemical(s) of Concern	
Direct radiation	Direct penetrating radiation	
Air	Radon Radon progeny	
Soil[a]	Uranium Radium Thorium Radon progeny	
Sediment/surface water[a]	Uranium Radium Thorium Radon progeny	
Groundwater[a]	Uranium Radium Thorium Actinium Protactinium Arsenic Barium Beryllium Cadmium Chromium	Cobalt Copper Lead Manganese Mercury Nickel Selenium Silver Thallium Vanadium Zinc

[a]All silo constituents are chemicals of potential future concern if the silos begin to leak

health protection based on multiple sources and pathways. As stated in Section 2.1.1, 25 percent of the chemical-specific ARAR is the RAO for a single operable unit. The 25 percent may need to be adjusted if a single operable unit contains multiple sources or exposure pathways. For Operable Unit 4, however, the silos are considered a single source.

Chemical-specific ARARs have been identified for the control of direct penetrating radiation, airborne radon, and for some of the silo constituents that may reach the groundwater. These chemical-specific ARARs are listed in Table 2-2. In the case where both a maximum contaminant level (MCL) and a proposed MCL exists for a constituent, the proposed MCL is used to develop the RAO.

2.2.4 <u>Remedial Action Objectives Based on Risk Criteria</u>

For several silo constituents, no MCLs or proposed MCLs exist. In this case, the RAO is based on available toxicity information. EPA provides guidance on using toxicity-based references doses (RfDs) and cancer potency factors (CPFs) (EPA 1990) to determine acceptable intake levels in water (EPA 1988b). The method is similar to the manner used to develop MCLs (EPA 1989). Briefly, the RAO is estimated using the following steps:

- Determine the acceptable daily intake, or RfD, for noncarcinogens based on dose response data and appropriate safety factors.
- Determine the acceptable risk level for carcinogens.
- Determine the acceptable water concentration (c) based on the assumption that a 70-kilogram adult drinks two liters of water per day, such that:

  [(c mg/l)(2 liter/day)]/70 kg = RfD (mg/kg/day), for noncarcinogens or

  [(c mg/l)(2 liter/day)]/70 kg = (acceptable risk level)/CPF mg/kg/day), for carcinogens.

- Apply any site-specific or operable unit-specific relative source contribution factors. The acceptable risk level for carcinogens as specified by the NCP is 10^{-4} to 10^{-6}. Twenty-five percent of this is 2.5×10^{-5} to 2.5×10^{-7}.

2.2.5 <u>Summary of Operable Unit 4 Remedial Action Objectives</u>

RAOs for all relevant media associated with Operable Unit 4 are summarized in Figure 2-1. As shown, many of the RAOs for Operable Unit 4 are based on chemical-specific ARARs. Risk-based RAOs had to be developed for five inorganic metals for the groundwater pathway. RAOs for each medium are briefly summarized below. An RAO that must be applied across all media is that total cancer risk from radionuclides be below 25 percent of the 10^{-4} to 10^{-6} goal set forth in the NCP, or 2.5×10^{-5} to 2.5×10^{-7}.

TABLE 2-2

CHEMICAL-SPECIFIC ARARS APPLICABLE TO OPERABLE UNIT 4 REMEDIATION

Chemical-Specific	Standard	ARAR/TBC	Regulation
Radionuclide emission (except airborne Rn-222)	Public dose <10 mrem/yr	Applicable	40CFR61 Subpart H
Radon-222 emissions	No source <20 pCi/sq m-s	Applicable	40CFR61 Subpart Q
Radiation dose limits (All pathways)	100 mrem/year	To be considered	DOE Order 5400.5
Chemicals or radionuclides in drinking water	Arsenic <0.05 mg/L Barium <1.00 mg/L Cadmium <0.01 mg/L Chromium <0.05 mg/L Lead <0.05 mg/L Mercury <0.002 mg/L Selenium <0.01 mg/L Silver <0.05 mg/L Radium <5 pCi/L	Applicable	40CFR141.11 OAC3645-81-11
Chemicals or radionuclides in drinking water	Barium <5.0 mg/L Cadmium <0.005 mg/L Chromium <0.1 mg/L Selenium <0.05 mg/L	To be considered	40CFR Parts 141, 142, 143 Proposed Rule
Radionuclides in soils	Thorium Radium 5 pCi/g, first 15 cm soil 15 pCi/g, below 15 cm	Relevant and appropriate	40CFR192.02
Chemicals in surface water[a]	Arsenic <48 μg/L Beryllium <5.3 μg/L Cadmium <1.1 μg/L Chromium <11 μg/L Copper <12 μg/L Lead <3.2 μg/L Mercury <0.012 μg/L Nickel <160 μg/L Selenium <36 μg/L Thallium <40 μg/L Zinc <47 μg/L	To be considered	40CFR141

[a]Ambient water quality criteria for chronic freshwater fish exposures, included for protection of the environment

MEDIUM		REMEDIAL ACTION OBJECTIVE	GENERAL RESPONSE ACTION
1. DIRECT RADIATION		For Human Health:	
	1-1	Prevent current and future radiation doses from exceeding 25 mrem/year.	No Action Institutional Actions Containment Containment/Treatment Removal/Treatment/Disposal
		For Environmental Protection:	
	1-2	Prevent current and future radiation doses from causing detectable chronic effects.	
2. AIR		For Human Health:	
	2-1	Prevent current and future above-background airborne radiation doses from exceeding 2.5 mrem, and radon concentrations from exceeding risk levels in excess of 2.5E-05 to 2.5E-07 cancer risk.	No Action Institutional Actions Containment Containment/Treatment Removal/Disposal/Treatment
		For Environmental Protection:	
	2-2	Prevent current and future radiation emissions from causing detectable chronic effects.	
3. SOILS		For Human Health:	
	3-1	Prevent direct contact with berm soils and surface soils surrounding the silos.	No Action Institutional Actions Containment Containment/Treatment Removal/Disposal/Treatment
	3-2	Prevent erosion of soil to surface waterways that would result in cancer risks of 2.5E-05 to 2.5E-07, or noncarcinogenic hazards resulting in an HI of 0.25.	
	3-3	Prevent contact with radium and thorium to 5 pCi/g in the first 15cm of soil, and 15 pCi/g below. Prevent contact with other nuclides to concentrations resulting in doses greater than 25 mrem per year.	
		For Environmental Protection:	
	3-4	Prevent erosion of soil that would contribute to surface water concentrations of As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Tl, and Zn above 48, 5.3, 1.1, 11, 12, 3.2, 0.012, 160, 36, 40, and 47 ug/l respectively.	

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FIGURE 2-1. REMEDIAL ACTION OBJECTIVES AND ASSOCIATED GENERAL RESPONSE ACTIONS

MEDIUM		REMEDIAL ACTION OBJECTIVE	GENERAL RESPONSE ACTION
4. SEDIMENTS AND SURFACE WATER		For Human Health:	No Action Institutional Actions Containment Containment/Treatment Removal/Disposal/Treatment
	4-1	Prevent releases of silo constituents into creek sediments that would result in persons having direct contact with uranium, radium and radon daughters causing in excess of 2.5E-05 to 2.5E-07 cancer risk, and noncarcinogenic silo constituents resulting in HIs greater than 0.25.	
		For Environmental Protection:	
	4-2	Prevent releases of As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Tl, and Zn that would result in surface water concentrations of 48, 5.3, 1.1, 11, 12, 3.2, 0.012, 160, 36, 40, and 47 ug/l, respectively.	
5. GROUNDWATER		For Human Health:	No Action Institutional Actions Containment Containment/Treatment Removal/Disposal/Treatment
	5-1	Prevent releases of U, Ra, Th, Pa, Po, Pb, and Ac to the groundwater in excess of concentrations shown on Table 2-4. Prevent release of As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Se, Ag, Tl, Va, and Zn to the groundwater in excess of concentrations shown in Table 2-5.	
		For Environmental Protection:	
	5-2	None. Groundwater concentrations have not been found to represent an environmental hazard.	
6. SILO WASTES		For Human Health:	No Action Institutional Actions Containment Containment/Treatment Removal/Disposal/Treatment
	6-1	Prevent direct contact with waste.	
	6-2	Prevent circumstances that may provoke leaching of wastes to groundwater.	
	6-3	Prevent current and future radiation doses migrating from wastes from exceeding 25 mrem/year.	
		For Environmental Protection:	
	6-4	Prevent direct contact with waste.	

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FIGURE 2-1.
(CONTINUED)

MEDIUM		REMEDIAL ACTION OBJECTIVE	GENERAL RESPONSE ACTION
7. SILO STRUCTURES		For Human Health:	No Action
	7-1	Maintain integrity of silo structure to prevent silo failure and release of consituents within concrete structure into environment.	Institutional Actions
	7-2	Prevent exposure to any silo constituents that have migrated into the concrete silo structure.	Containment
		For Environmental Protection:	Containment/Treatment
	7-3	Maintain integrity of silo structure to prevent silo failure and release of consituents within concrete structure into environment.	Removal/Disposal/Treatment
	7-4	Prevent exposure to any silo constituents that have migrated into the concrete silo structure.	

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FIGURE 2-1.
(CONTINUED)

2.2.5.1 Direct Radiation

A goal of remediation of the silos is to prevent penetrating radiation doses to the public from exceeding 25 percent of the 100 mrem annual dose limit, as specified in DOE Order 5400.5. This order has been identified as a to-be-considered (TBC) for Operable Unit 4. Present baseline conditions do not meet this goal.

2.2.5.2 Air

Two ARARs were identified as applicable to Operable Unit 4: 40CFR61 subparts H and Q. Subpart H allows for a 10 mrem/yr limit to the public for all airborne radionuclides except Rn-222. Twenty-five percent of this limit is 2.5 mrem/yr. The objective identified for Rn-222 emissions: Subpart Q requires that radon flux from a single source cannot exceed 20 pCi/m^2/s. Because this ARAR applies to a single source, no relative source contribution factor is necessary.

2.2.5.3 Soils

Berm soils surrounding Operable Unit 4 and subsurface soils beneath the silos must meet the following objectives: prevent direct contact with soils, and prevent soils from migrating to surface waters and sediments. In both cases, the goal is to prevent contact with chemicals in the soils that would result in cancer risks of 2.5×10^{-5} to 2.5×10^{-7}, and noncancer hazards that would be above a hazard index of 0.25. Radionuclides concentrations must also satisfy DOE Order 5400.5, which limits the radiation dose to 100 mrem/yr (or an operable unit limit of 25 mrem/yr). The cleanup level for uranium (total) is 35 pCi/g based on a U.S. National Regulatory Commission (NRC) branch technical position. Currently, only uranium, radium, and thorium have been detected in soils, but it is suspected that Pb-210 may be in berm soils. However, the objective extends to all silo constituents because the potential exists for future silo leakage to contribute elevated levels of all constituents to the soils.

The environmental objectives of preventing contact with the soils are similar except quantitative goals are based on potential contributions to a receiving water body in excess of Ambient Water Quality Criteria (AWQC), as laid out in the Clean Water Act. AWQC are nonenforceable goals for protecting the environment.

2.2.5.4 Sediments and Surface Water

RAOs for sediments and surface water are based on the same criteria used to determine RAOs for soil.

2.2.5.5 Groundwater

Of great concern is the potential for the constituents of the silo to enter the underlying Great Miami Aquifer sometime in the future. RAOs developed for groundwater specify that future releases should not result in concentrations in the regional aquifer that exceed MCLs specified in 40CFR141. For chemicals without MCLs, future releases should not exceed risk-based derived cleanup levels. Specific groundwater RAOs for Operable Unit 4 are listed in Tables 2-3 and 2-4.

With the exception of radium, which has a promulgated MCL, RAOs for radionuclides, present as chemicals of concern were derived by dividing the allowable drinking water radiation dose of 4 mrem/yr (DOE Order 5400.5) by the annual drinking water intake (730 liters) and the radiation dose conversion factor (dcf). Thus for uranium, with a dcf of 2.69 x 10^{-4} mrem/pCi (EPA 1990), the resultant acceptable drinking water concentration is 20 pCi/L. Table 2-3 lists the resulting concentrations for all radionuclides associated with Operable Unit 4. These limits do not reflect the "sum" rule, which requires that the sum of the radiation dose from all radionuclides (excluding Ra-226, Ra-228, and radon) not exceed 4 mrem/yr. However, this requirement will be specifically considered in situations at the FMPC where more than one radionuclide contributes to a radiation dose near the 4 mrem/year limit.

Table 2-4 lists RAOs for the nonradioactive constituents of the silos. Five RAOs are based on RfDs (EPA 1990), as described in Section 2.1.5.

2.2.5.6 Silo Contents

The qualitative RAOs identified for the silo contents is to prevent direct contact with the contents and to prevent migration of the contents to the surrounding environment.

2.2.5.7 Silo Structures

Two qualitative RAOs exist for silo structures. One is to ensure that the silos do not degrade and result in a release of silo materials to the environment. Silo constituents also may have migrated into the concrete structures; thus contact with the structures should be prevented.

Nonradioactive chemicals of concern for Operable Unit 4 are inorganic substances that are chemical toxicants via the oral intake route. Therefore, RAOs are based on RfDs, not on CPFs. RfDs for calculating acceptable water concentrations are found in the IRIS database (EPA 1990b) and in the Health Effects Assessments Summary Tables (EPA 1990c).

TABLE 2-3

OPERABLE UNIT 4
GROUNDWATER REMEDIAL ACTION OBJECTIVES FOR RADIONUCLIDES

Constituent	Drinking Water Concentration Corresponding to 4 mrem/yr (pCi/L)	FMPC Action Level for a Single Operable Unit[a] (pCi/L)
U-234	19	4.8
U-235	21	5.3
U-238	21	5.3
Th-228	14	3.5
Th-230	10	2.5
Th-232	2	0.50
Pa-231	0.5	0.13
Po-210	3	0.75
Pb-210	1	0.25
Ac-227	0.4	0.10
Radium[b]	5	1.3

[a]Twenty-five percent of ARAR or risk-based standard
[b]Maximum contaminant level

TABLE 2-4

OPERABLE UNIT 4
GROUNDWATER REMEDIAL ACTION OBJECTIVES FOR CHEMICALS

Constituent	Basis for Remedial Objective	Acceptable Water Concentration (mg/L)	FMPC Action Level for a Single Operable Unit[a] (mg/L)
Arsenic	0.05 mg/L MCL	0.05	0.001
Barium	5.0 mg/L proposed MCL	5.0	1.3
Beryllium	0.005 mg/kg/d RfD	0.2	0.05
Cadmium	0.005 mg/L proposed MCL	0.005	0.001
Chromium	0.1 mg/L proposed MCL	0.1	0.03
Copper	1.3 mg/L[b]	1.3	0.3
Lead	0.05 mg/L[c]	0.05	0.01
Manganese	0.2 mg/kg/d RfD	7.0	1.8
Selenium	0.003 mg/kg/d RfD	0.1	0.03
Thallium	0.00007 mg/kg/d RfD	0.002	0.0005
Vanadium	0.007 mg/kg/d RfD	0.2	0.05
Zinc	0.2 mg/kg/d RfD	7.0	1.8

[a]Twenty-five percent of ARAR of risk-based standard
[b]EPA is considering a substantially lower number
[c]Drinking Water Health Advisory

2.3 GENERAL RESPONSE ACTIONS

General response actions are broad categories of media-specific remediation actions that will satisfy one or more of the remedial action objectives. In the case of Operable Unit 4, these general response actions include no action, institutional action, containment with and without treatment, and removal with treatment and disposal. Figure 2-1 shows the relationship between the remedial action objectives and these general response actions.

2.3.1 No Action

This general response action is required for consideration by the NCP and will be carried through as an alternative. The no-action alternative would provide no remediation and would simply leave the silos and silo material in their present state. It would include the installation of long-term monitoring equipment. The no-action alternative provides a baseline against which the other alternatives can be compared.

2.3.2 Institutional Actions

Institutional actions refer to actions taken by the responsible authorities to minimize the potential for danger to human health and the environment as a result of any ongoing activities. Examples of institutional actions include monitoring and access control. It should be noted that the no-action alternative may include some institutional actions.

2.3.3 Containment

Containment refers to the prevention of any uncontrolled leakage of materials, leachate, and/or gases by proper in situ isolation of the material. Isolation techniques in this category include run-on/runoff control, capping, and/or subsurface flow control.

2.3.4 Containment With Treatment

Containment with treatment is similar to containment as mentioned above, with the exception that the material would be stabilized in situ before isolation. Several stabilization technologies are available for this purpose.

2.3.5 Removal, Treatment, and Disposal

This general response action considers treatment of the silo material after removal from its present location. After the treatment process, the silo material would be disposed either on or off property.

2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

Technology types potentially capable of satisfying the applicable remedial action objectives were identified for each general response action. These technology groups were further broken down into various process options.

At this stage in the FS process, process options and technology groups were screened on the basis of technical implementability only. Figure 2-2 shows the results of this initial screening. The remaining technologies represent the potential pool of options to be evaluated by engineering judgment for assembly into remediation alternatives. Following is a brief description of the technologies under consideration with a discussion of appropriate process options.

2.4.1 Containment

2.4.1.1 Environmental Isolation Enclosure

Before initiating any silo contents removal under the removal alternatives, an Environmental Isolation Enclosure (EIE) would be constructed to enclose Silos 1 and 2 and/or Silo 3 and the surrounding work area (Figure 2-3). The purpose of the enclosed facility would be to create an isolated area, thus protecting the public, other site workers, and the environment from the contamination hazards associated with silo demolition and silo contents removal.

The EIE would be a tension arch structure with negative internal pressure. The design would incorporate equipment and manway airlocks as well as a remote-controlled gantry crane system over the silos. All exhausted air from the EIE would be filtered to meet site-specific air emission limits. The facility would be designed to withstand 100 mile per hour winds and include redundant safety systems such as a standby electrical power generator and heating, ventilation, and air conditioning (HVAC) system.

The construction of the EIE would require the following:

- Silo berm modifications (Figures 2-4 and 2-5)
- Utility and general construction/remediation support services at both interior and exterior work staging areas
- EIE foundation
- Gantry crane system (Figures 2-3 and 2-5), structural steel box girder frame with low bearing pressure grade beams or conventional footing foundations

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	None	Not Applicable	Required for consideration by NCP	Required for consideration by NCP
Institutional Actions	Monitoring	Radon Monitoring	Installation of appropriate environmental monitoring	Potentially applicable
		Monitoring Wells	Installation of wells for monitoring groundwater	Potentially applicable
		Leachate Monitoring	Installation of leachate collection/detection system	Potentially applicable
	Access Control	Physical Barriers	Fencing, security, limited road access, etc.	Potentially applicable
		Administrative Controls	Restricted access only, posted signs, etc.	Potentially applicable
Containment	Run-On/Runoff Control	Sedimentation Basin	Temporary storage of runoff to allow settling	Potentially applicable
		Diversion/Collection	Surface water routing controls	Potentially applicable
		Grading	Topography modification for route control	Potentially applicable
		Revegetation	Vegetative cover provides surface stability	Potentially applicable
	Capping	Concrete-Based Cover	Concrete slab poured over area of concern	Potentially applicable
		Asphalt-Based Cover	Asphalt poured over area of concern	Potentially applicable
		Soil-Based Cover	Compacted soil/bentonite cover over area of concern	Potentially applicable
		Chemical Sealant	Chemical stabilizers mixed with surface soils	Potentially applicable
		Multimedia Cap	Cap formed with various layers	Potentially applicable
	Subsurface Flow Control	Subsurface Drains	Gravity driven collection system	Not Applicable at required depths
		Grout Under Silos	High Pressure injection of low-slump grout	Not Applicable, Bathtub Effect
		Pumping Wells	Extraction/injection of water into ground	Potentially applicable
		Slurry Walls	A soil/bentonite grout wall emplacement	Potentially applicable
		Sheet Pilings	Steel forms driven into ground and joined	Not applicable at required depths
		Grout Curtains	Close-spaced grout injections isolate area	Potentially applicable

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FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Containment/ Treatment	Run-On/Runoff control	Sedimentation Basin	Temporary storage of runoff to allow settling	Potentially applicable
		Diversion/Collection	Surface water routing controls	Potentially applicable
		Grading	Topography modification for route control	Potentially applicable
		Revegetation	Vegetative cover provides surface stability	Potentially applicable
	Capping	Concrete-Based Cover	Concrete slab poured over area of concern	Potentially applicable
		Asphalt-Based Cover	Asphalt poured over area of concern	Potentially applicable
		Soil-Based Cover	Compacted soil/bentonite cover over area of concern	Potentially applicable
		Chemical Sealant	Chemical stabilizers mixed with surface soils	Potentially applicable
		Multimedia Cap	Cap formed with various layers	Potentially applicable
	Subsurface Flow Control	Subsurface Drains	Gravity driven collection system	Not applicable at required depths
		Grout Under Sites	High pressure injection of low slump grout	Not applicable, because of "bathtub effect"
		Pumping Wells	Extraction/injection of water into ground	Potentially applicable
		Slurry Walls	Grout walls formed by trenching and filling	Potentially applicable
		Sheet Pilings	Steel forms driven into ground and joined	Not applicable at required depths
		Grout Curtains	Close-spaced grout injections isolate area	Potentially applicable
	In Situ Stabilization	Shallow-soil mixing	Chemical-, and/or fly ash-based stabilization	Potentially applicable
		Vitrification	High voltage crystallization/glassification of solids	Potentially applicable
		Surcharging	Compaction of material by addition of soil cover	Potentially applicable

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FIGURE 2-2.
(CONTINUED)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Removal/ Treatment/ Disposal	Mechanical Removal	Loader/Dozer	Tractor- or wheel-mounted excavation vehicles	Not feasible due to material consistency and silo strength limitations
		Crane w/Clamshell System	Tractor-, wheel-, or skid-mounted hoisting system	Potentially applicable
		Conveyor System	Belt-type conveyor system excavates material	Not feasible due to material consistency and silo strength limitations
		Backhoe	Tractor- or wheel-mounted excavation vehicles	Not feasible due to material consistency and silo strength limitations
		Dragline System	Excavating tool pulled across material	Not feasible due to material consistency and silo strength limitations
	Hydraulic Removal	Jetting Ring w/Cutterhead	Water pump and vacuum system	Potentially applicable
	Pneumatic Removal	Pneuma/Dozer Dredging	In situ sludge pumping system	Not applicable because of material consistency
		Airlift Dredging	Expanding air pulls material behind it	Not applicable, requires depths > 20-30 ft
		Vacuum w/Cutterhead	Negative pressure displacement system	Potentially applicable
	Waste Stabilization	Asphalt-Based Solidification	Asphalt mixed with soil and solidified	Potentially applicable
		Cement-Based Solidification	Cement and fly ash mixed with soil and solidified	Potentially applicable
		Thermoplastic Encapsulation	Polymers mixed with soil and solidified	Potentially applicable
		Vitrification	High voltage crystallization/glassification of solids	Potentially applicable
	Silo Demolition	Hydraulic Splitter	High pressure water used to cut structure	Potentially applicable
		Wrecking Ball	Crane-mounted weight used to collapse structure	Not applicable, radioactive dust hazard
		Explosive Charges	Chemical explosives fracture structure	Not applicable, radioactive dust hazard
		Nonexplosive Demolition Agent	Expanding agents introduced into structure	Potentially applicable
		Gas Torch	Torch used to cut structure/rebar	Potentially applicable
	On Property Disposal	Above/Below Grade Vault	Above- or below-ground engineered facility	Potentially applicable
		Tumulus	Engineered facility, capped when filled	Potentially applicable
		Rehabilitated Silo	Restore structural integrity of silo	Not applicable for remediation
		Temporary Storage	Interim on-site storage facility	Potentially applicable
		Lined/Unlined Pits/Trenches	Simple non-structural disposal units	Not applicable for remediation
	Off Site Disposal	Rail Transport	Railroad transportation along available routes	Potentially applicable
		Truck Transport	Truck transportion along available routes	Potentially applicable

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FIGURE 2-2.
(CONTINUED)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Removal/ Treatment/ Disposal (Cont)	Physical Treatment	Air Stripping	Volatile mass transfer process	Not applicable for inorganic materials
		Solid/Liquid Separation	Separation of solids and liquids	Potentially applicable
		Oil/Water Separation	Gravity differential separates free oil and water	Not applicable, no free oil phase
		Polymerization	Combines monomers to form polymers	Not applicable, few polymerizable materials
		Reverse Osmosis	Diffusion through semipermeable membrane	Potentially applicable
		Selective Ion Removal	Ion-specific ion exchange process	Potentially applicable
		Soil Aeration	Air injectors remove volatile organics	Not applicable for inorganic materials
		Steam Stripping	Steam injection removes volatile organics	Not applicable for inorganic materials
	Chemical Treatment	Chemical Dechlorination	Reduces the amount of chlorinated compounds	Not applicable, few chlorinated compounds
		Oxidation/Ozonation/Photolysis	Organics destroyed by chemical oxidants	Not applicable for inorganic materials
		Hydrolysis	Decomposition of compounds using water	Not applicable, material fully hydrolized
		Leaching/Extraction	Impurities removed through solubility/affinity	Potentially applicable
		Neutralization	Acid or base addition to adjust pH	Potentially applicable
		Precipitation	Removal of metals by solubility adjustments	Potentially applicable
		Reduction	Reduction of the ionic state of a compound	Not applicable, few reducable materials
	Thermal Treatment	Drying/Calcination	Removes water and decomposes carbonates	Potentially applicable
		Incineration	Destroys hazardous organics and reduces volume	Not applicable for inorganic materials
		Thermal Desorption	Heating of a solid to drive off volatile organics	Not applicable for inorganic materials
	Biological Treatment	Biodenitrification	Nitrates/nitrites reduced to molecular nitrogen	Potentially applicable
		Biological Detoxification	Microbial action degrades organics	Not applicable for inorganic materials
		Land Farming	Microorganisms cultured in soil	Not applicable for inorganic materials
		Permeable Treatment Beds	Destroy and remove biodegradable organics	Not applicable for inorganic materials

FL/FMPC-0415-2/2-2d

FIGURE 2-2.
(CONTINUED)

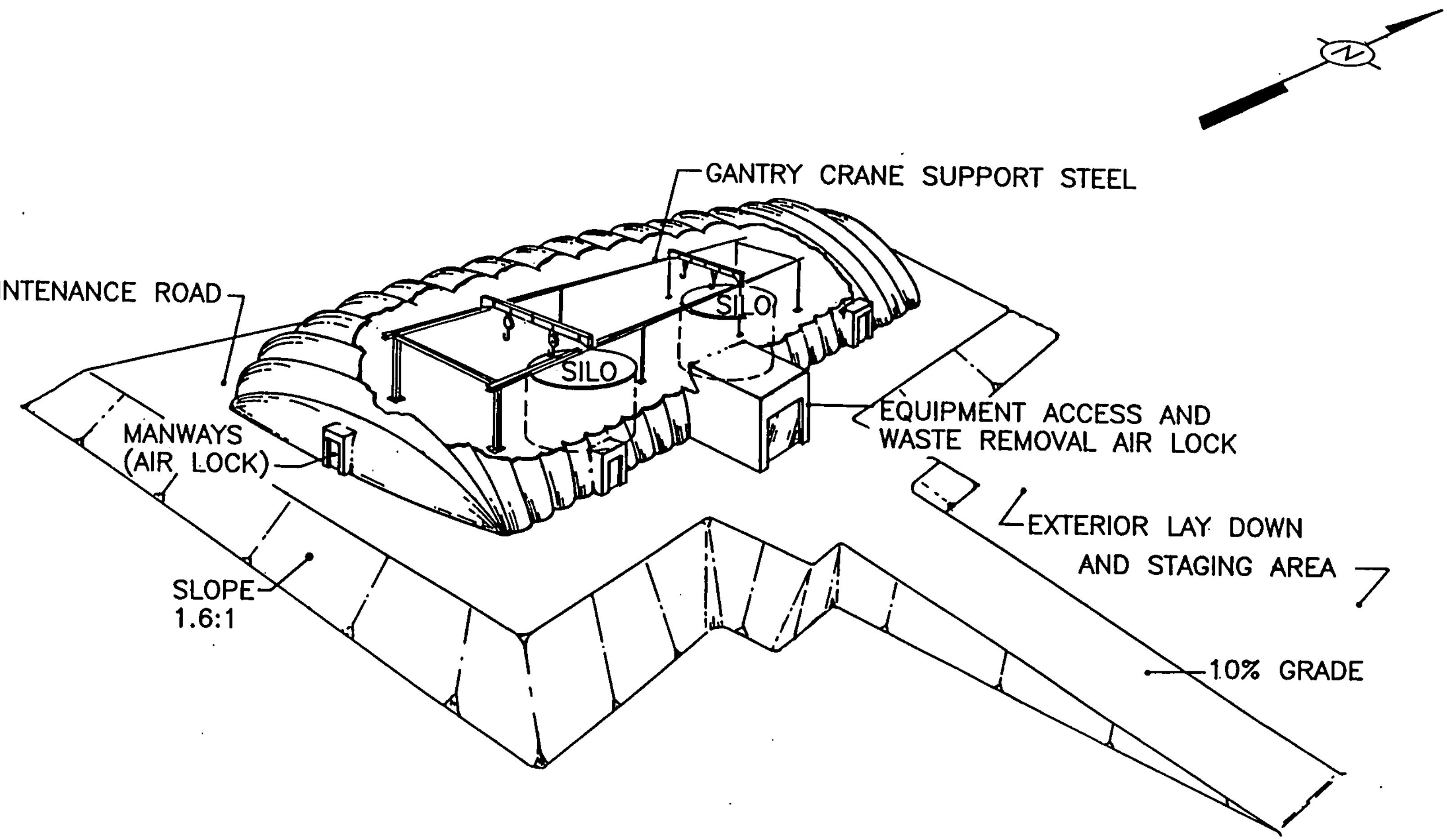

FIGURE 2-3. CONCEPTUAL VIEW OF ENVIRONMENTAL ISOLATION ENCLOSURE (EIE) OVER K-65 SILOS

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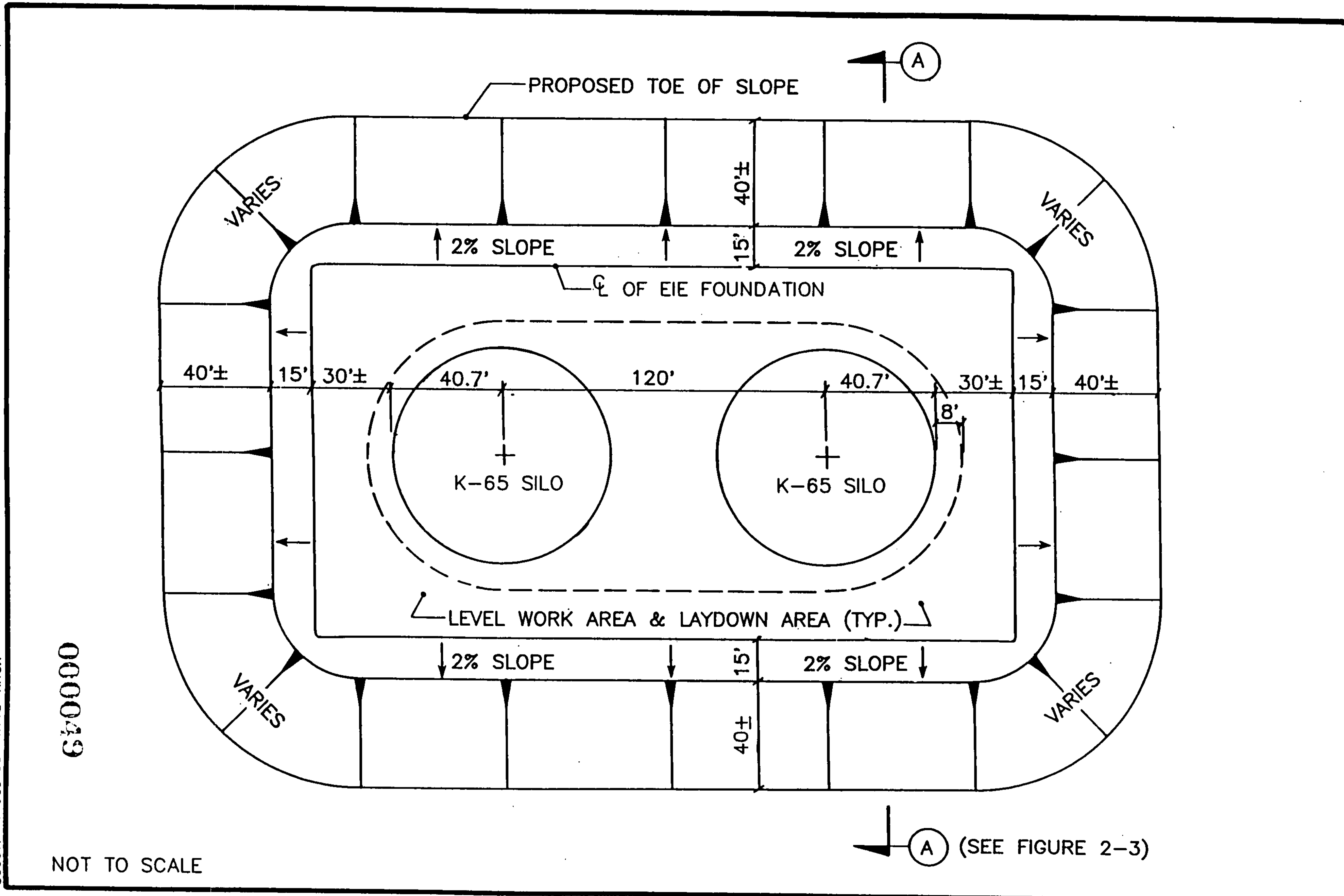

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FIGURE 2-4. PLAN VIEW OF EIE AND BERM MODIFICATION

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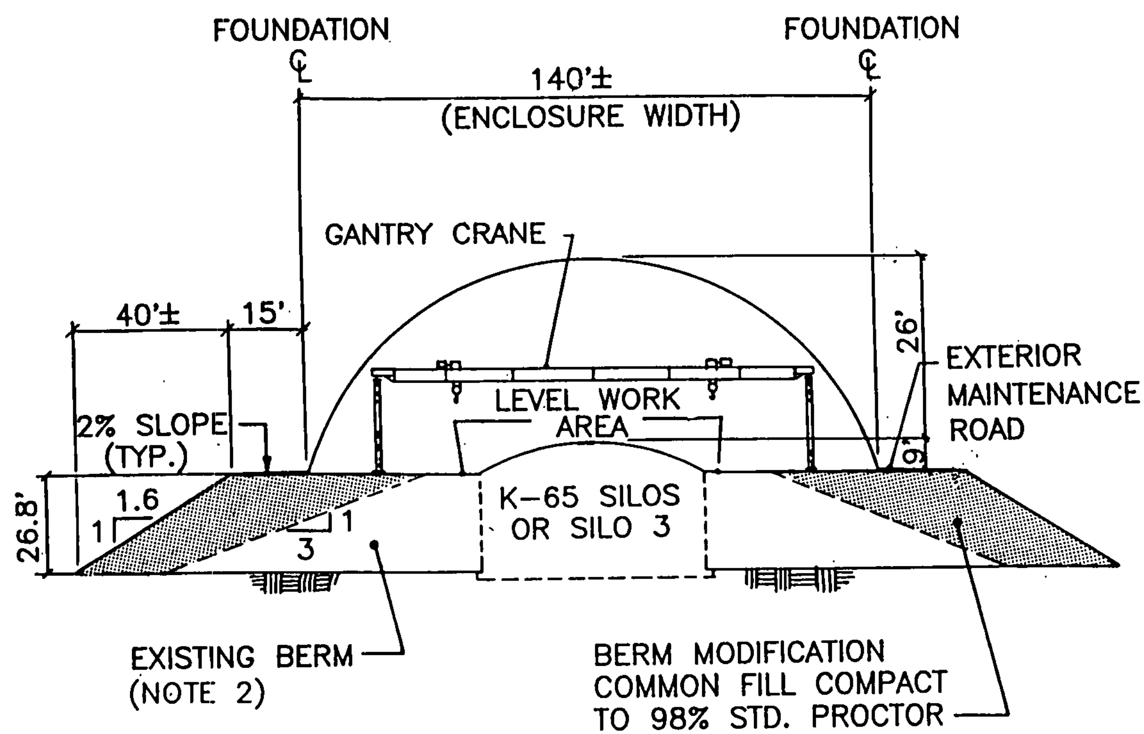

NOTES:

1. DESIGN EIE STRUCTURE FOR 100 MPH STORM
2. SILO 3, EIE, PRESENTLY HAS NO BERM, THEREFORE WOULD REQUIRE ADDITION OF ENOUGH FILL SOILS TO CONSTRUCT PROFILE SHOWN ON SECTION A-A.
3. SILO 3 EIE DIMENSIONS ARE 140' X 140'
4. EQUIPMENT & PERSONNEL ACCESS AIR-LOCK DETAILS NOT SHOWN
5. BERM MODIFICATIONS & GENERAL EIE DIMENSIONS MAY BE GREATER THAN SHOWN DUE TO UNKNOWN CONDITIONS
6. AIR TREATMENT SYSTEM DETAILS NOT SHOWN

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303317-A-C11 OU4 TK 12 KNOX

FIGURE 2-5. SECTIONAL VIEW OF EIE, SECTION A-A

- Remote-controlled traveling gantry crane with dual lifting hoists
- Remote-controlled video camera with tilt and pan capabilities
- Installation of HVAC system
  - High efficiency particulate air (HEPA) filters, carbon adsorbers, dehumidification equipment
  - Localized radon removal system if necessary
- Installation of equipment and personnel airlocks (main equipment airlock should be constructed on east side between silos)
- Equipment access ramp at maximum grade of 10 percent
- Installation of a central control station inside the EIE in a nonobstructive location to facilitate silo material handling activities, to include:
  - Crane system controls
  - Alarm and general monitoring equipment
  - Communications equipment
  - Radiation shielding, separate air supply, and separate manway leading to the exterior of the EIE

During EIE construction, similar pressurized enclosures could be erected in the exterior staging area to provide containment for silo material transfer, storage, and/or treatment activities.

2.4.1.2 Capping

Capping involves the installation of a barrier over the surface of the contaminated area to control erosion and to prevent the generation of leachate caused by surface water infiltration. Capping can also alleviate possible direct and/or indirect exposures. It is applicable to the nonremoval response actions and is generally used in combination with other technologies.

A cap can be single or multiple layers and can consist of asphalt, chemical sealant/stabilizer, clay, concrete, or multimedia. Chemical sealants and stabilizers require a homogeneous soil base, are typically feasible for small areas, but can be susceptible to cracking and weathering.

A multiple-layer cap would be utilized for Operable Unit 4 and would be designed in accordance with EPA guidelines under Resource Conservation and Recovery Act (RCRA). The guidelines recommend a three-layer system that consists of:

- An upper vegetative layer
- A drainage layer
- A low-permeability bottom layer

The vegetative layer would be supported by a topsoil cover. The drainage layer would consist of sand, and the low permeability layer would consist of clay with a permeability of less than 1×10^{-7} cm/s. The design would divert rainfall away from and minimize infiltration into the enclosed materials (Figure 2-6).

In addition to RCRA, cap design must be in accordance with applicable regulations, including 40CFR264 (Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities), 40CFR61 (National Emission Standards for Hazardous Air Pollutants), and 10CFR61 (Licensing Requirements for Land Disposal of Radioactive Waste).

2.4.1.3 Subsurface Flow Control

Slurry walls are the most commonly used subsurface barriers. Slurry walls are constructed in a vertical trench that is excavated and backfilled with a slurry. The slurry (which is usually a mixture of bentonite and water) assists in shoring the trench to prevent collapse and forms a filter cake on the trench walls that prevents fluid loss to surrounding ground.

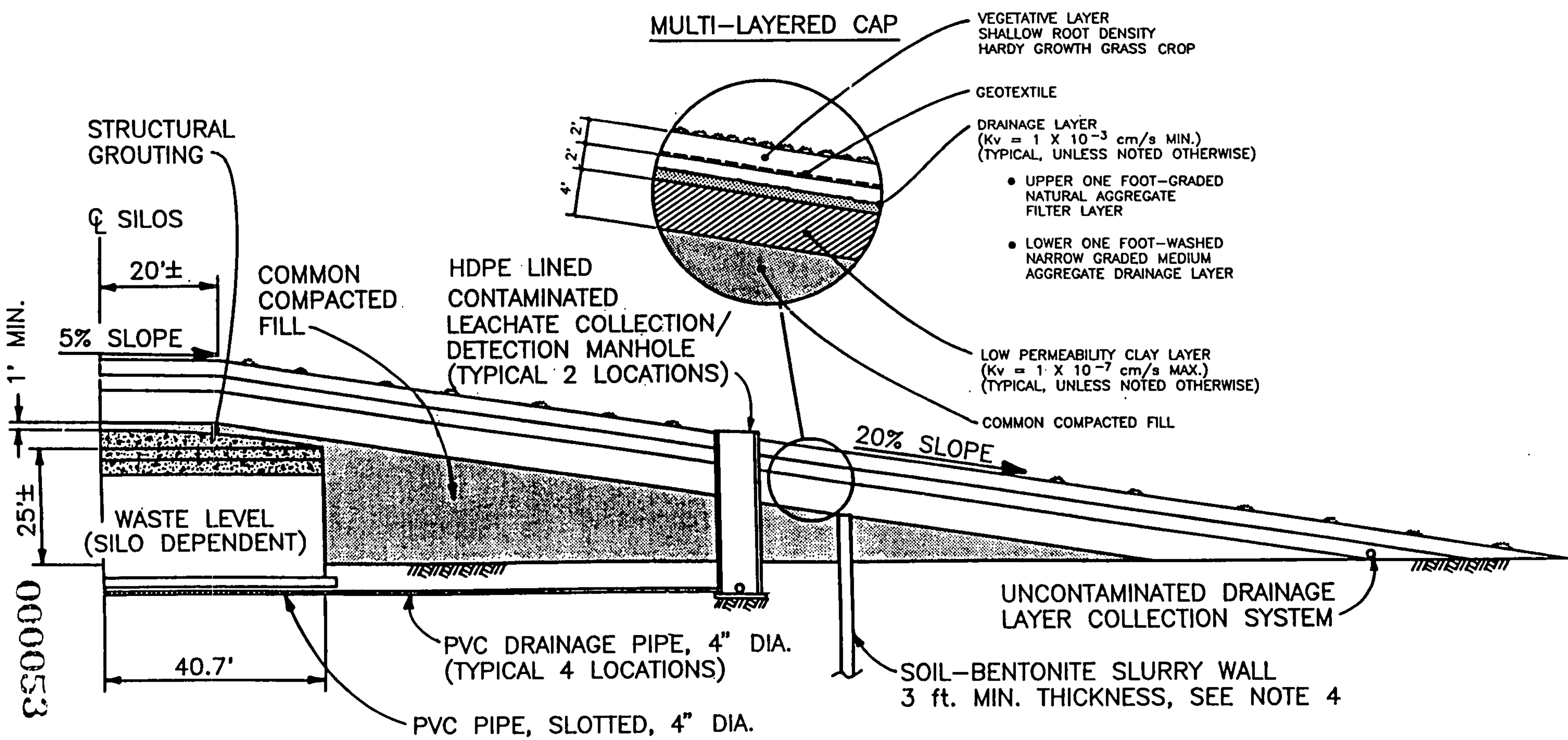
Other types of subsurface flow controls include pumping wells and injection grouting. Groundwater pumping includes the extraction of water from or the injection of water into wells to capture a plume or alter the direction of groundwater movement.

Injection grouting is the injection of a low slump mortar-type grout under relatively high pressure to displace and compress the surrounding soil particles. The grout pipes are installed in a predetermined design pattern to the required depth and grout is pumped until a refusal criterion is met or until ground heave is observed.

2.4.1.4 Run-On/Runoff Control

Run-on/runoff control refers to the control of any surface water streams and erosion around and above an area. This can be accomplished through the use of sedimentation basins, diversion/collection, grading, and revegetation.

Sedimentation is a method of containing surface water and runoff for a specific period of time to allow the settlement of suspended soil sediments before discharge. The basin is generally



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NOTES:

1. SURFACE RUN-OFF (UNCONTAMINATED) FROM CAP WILL BE DIRECTED TO SEDIMENTATION BASIN OR PADDYS RUN.
2. CAP AND DOME CAVITY GROUT THICKNESS WILL CONFORM TO THE 5 METER CRITERION PER 10 CFR 61.
3. Kv DENOTES VERTICAL PERMEABILITY.
4. SLURRY WALL WILL EXTEND INTO THE GREAT MIAMI AQUIFER A MINIMUM OF TWO FEET.
5. ALL GENERAL AND GRANULAR FILL, AS WELL AS CLAY, ARE ASSUMED TO BE REGIONALLY AVAILABLE.
6. GEOTEXTILE MAY BE USED TO FACILITATE CONSTRUCTION

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FIGURE 2-6. CAPPING PROFILE

pre-engineered and constructed by erecting suitable earthen dams, by using a natural depression, by excavation, or by a combination of these.

Surface water diversion and collection forms an essential part of surface water management and includes dams, dikes/berms, channels (earthen/pipe), waterways, terraces/benches, chutes, downpipes, seepage ditches/basins, levees, and flood walls. These techniques can be used as temporary or permanent measures for effective surface water control to prevent flooding, control erosion, and direct surface runoff.

Grading is a general term for techniques used for managing surface water runoff and for controlling infiltration and erosion. Soil spreading and compaction, which are essential components of grading, are used extensively in land development and at sanitary landfills. Grading modifies the topography and the runoff characteristics thus accomplishing infiltration and erosion control. One of the steps in grading is to establish continuous surface grades to eliminate possible ponding of surface runoff. This technology is often used in combination with surface sealing and revegetation.

Revegetation (providing a vegetative cover) assists in stabilizing the surface and is generally used in conjunction with capping and/or grading. It reduces erosion by wind and water and helps in developing a stable and naturally fertile surface environment. Revegetation can be useful for upgrading the appearance of a possible disposal site and would involve the selection of suitable plant species, seed bed preparation, seeding/planting, mulching and/or chemical stabilization, and fertilization and maintenance. Revegetation has application for both short-term stabilization, including intermediate covers at waste disposal sites, and long-term site reclamation.

2.4.2 Removal

2.4.2.1 Mechanical Removal

Mechanical removal would require the use of an overhead gantry hoist equipped with a clamshell or bucket capable of transferring the silo contents either directly into containers or onto a closed belt or bucket-type conveyor system for transport to a packaging facility. The major pieces of equipment that would be required are:

- Remotely operated front-end loaders
- Gantry supported clamshell
- Closed belt or bucket-type conveyor system

2.4.2.2 Hydraulic Removal

This system would use a mining pump equipped with a water blasting ring or cutter head to loosen and remove the silo contents as a slurry (Figure 2-7). Because only a portion of the silo contents is water-sprayed at any one time, a limited amount of water would be in the silo and the risk of leakage to the environment would be small. The existing leachate collection and detection system, if still intact, would be used to collect leakage. Additional leakage collection pipes could be installed beneath the existing system, if necessary.

This slurry would be pumped to solid/liquid separation equipment in the process building, which would provide filtration, centrifugation, sedimentation, drying, or evaporation to remove the liquid. The dewatered sludge would be transferred to a treatment or packaging area and the contaminated water would be recycled. This would result in the net generation of little, if any, wastewater requiring treatments in the wastewater treatment plant. The actual equipment to support this type of removal would be determined by slurry composition and final disposition of the sludge. The major pieces of equipment required would be:

- Combination blasting/suction hydraulic mining tool
- Mechanical cutter head
- Double-walled suction line (eight-inch flexible hose)
- Centrifuge, evaporators, and/or calciners

2.4.2.3 Pneumatic Removal

The pneumatic removal method would involve the use of a mechanical cutter head and an airlift to entrain the material in an airstream, which would be routed to a temporary storage system for separation of solids (Figure 2-8). This separation scheme would utilize filters, cyclone separators, and dust collectors, among other devices. The silo material would then be routed to a packaging facility and the filtered air recycled to the removal system or discharged. All operations would be conducted in closed vessels and all vents would be equipped with HEPA filters and carbon absorbers (if necessary) for emission control. The major pieces of equipment required would be:

- Rigid pipe suction nozzle
- Mechanical cutter head
- Double-walled suction line (eight-inch flexible hose)
- Cyclone separators, baghouse, HEPA filters

2.4.3 Structure Removal

Listed below are five process options that could be utilized for the demolition of Silos 1, 2, and 3 if required under the selected alternative. A short discussion listing the relative disadvantages and advantages of each technology is provided. The concrete walls are approximately eight inches thick

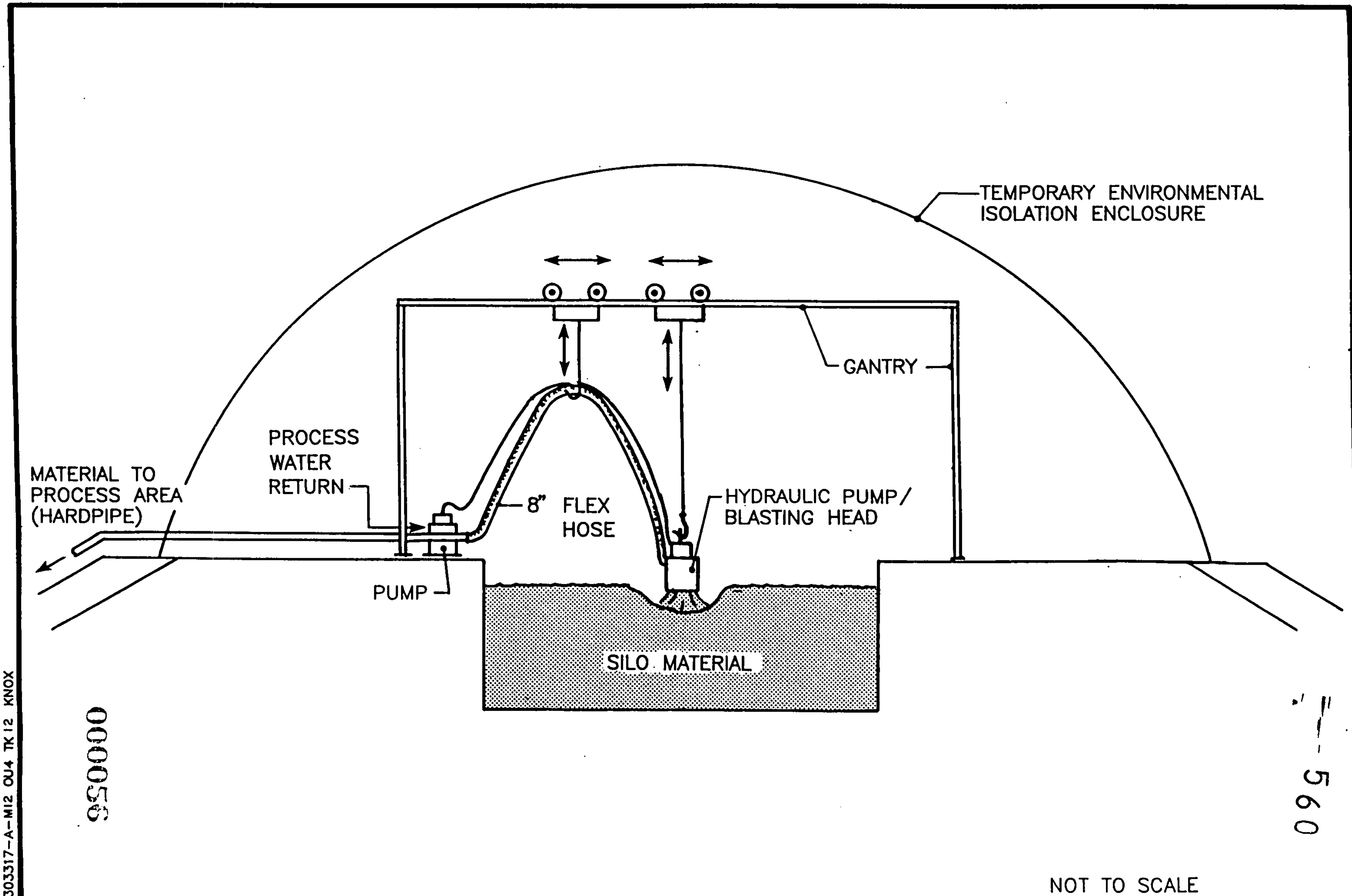

FIGURE 2-7. HYDRAULIC REMOVAL OF SILO MATERIAL

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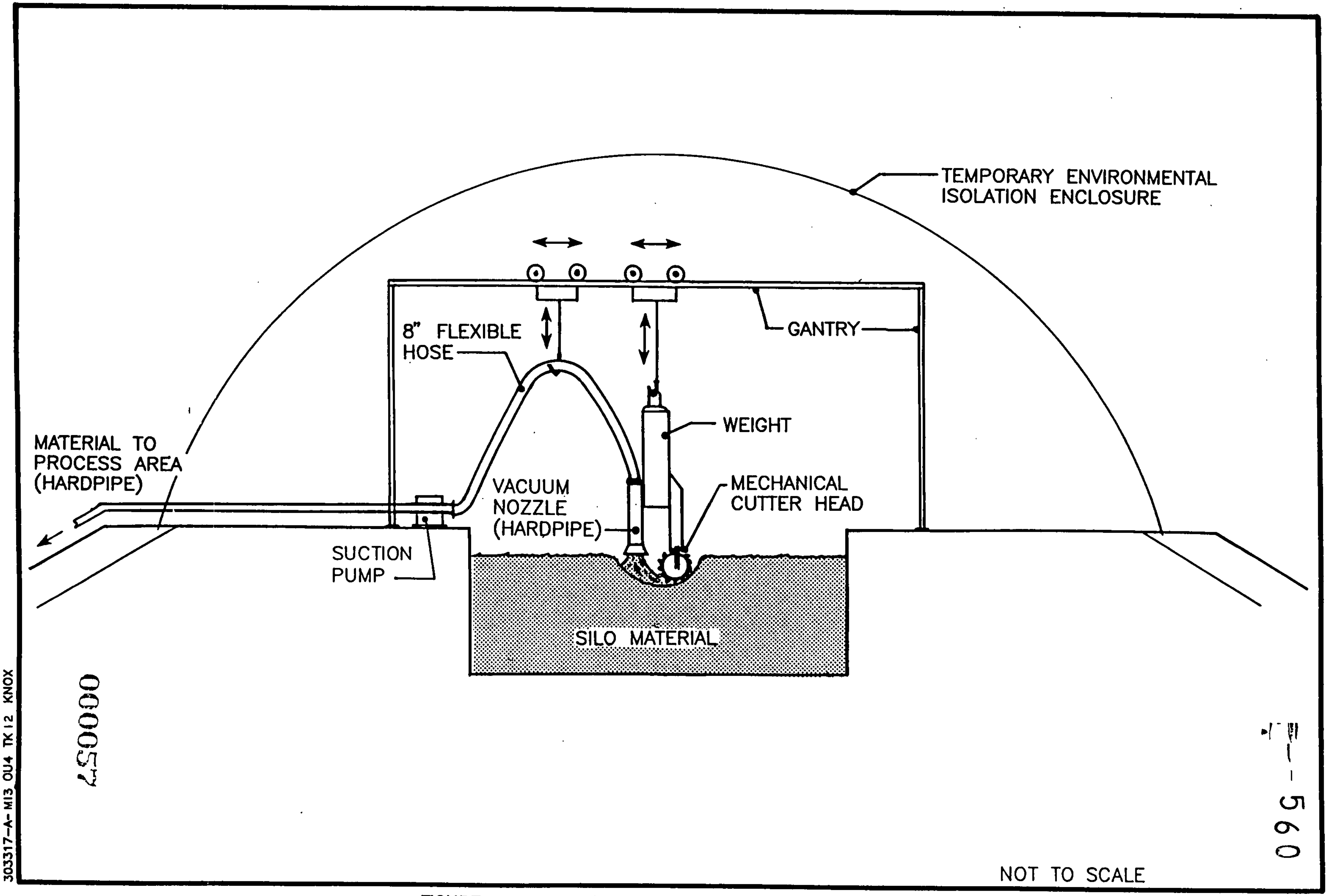

FIGURE 2-8. PNEUMATIC REMOVAL OF SILO MATERIAL

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
No Action	None	Not Applicable	N/A	N/A	N/A
Institutional Actions	Monitoring	Radon Monitoring	High	High	Low
		Monitoring Wells	High	High	Moderate
		Leachate Monitoring	Moderate	High	High
	Access Control	Physical Barriers	High	High	Low
		Administrative Controls	High	High	Low
Containment	Run-On/Runoff Control	Sedimentation Basin	High	High	Moderate
		Diversion/Collection	Moderate	Moderate	Low
		Grading	High	High	Low
		Revegetation	Moderate	High	Low
	Capping	Concrete-Based Cover	High	High	High
		Asphalt-Based Cover	High	High	Moderate
		Soil-Based Cover	Low	High	Low
		Chemical Sealant	Moderate	Moderate	Moderate
		Multimedia Cap	High	High	Moderate
	Subsurface Flow Control	Pumping Wells	High	Moderate	High
		Slurry Walls	Moderate	High	High
		Grout Curtains	Low	Low	High

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FIGURE 2-13. EVALUATION OF PROCESS OPTIONS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
Containment/ Treatment	Run-On/Runoff control	Sedimentation Basin	High	High	Moderate
		Diversion/Collection	Moderate	Moderate	Low
		Grading	High	High	Low
		Revegetation	Moderate	High	Low
	Capping	Concrete-Based Cover	High	High	High
		Asphalt-Based Cover	High	High	Moderate
		Soil-Based Cover	Low	High	Low
		Chemical Sealant	Moderate	Moderate	Moderate
		Multimedia Cap	High	High	Moderate
	Subsurface Flow Control	Slurry Walls	High	Moderate	High
		Pumping Wells	Moderate	High	High
		Grout Curtains	Low	Low	High
	In Situ Stabilization	Shallow-Soil Mixing	High	High	Moderate
		Vitrification	High	Moderate	Moderate
		Surcharging	High	High	High

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FIGURE 2-13.
(CONTINUED)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
Removal/ Treatment/ Disposal	Mechanical Removal	Crane w/Clamshell System	Moderate	High	Moderate
	Hydraulic Removal	Jetting Ring w/Cutterhead	High	High	Moderate
	Pneumatic Removal	Vacuum w/Cutterhead	Low	High	Moderate
	Waste Stabilization	Asphalt-Based Solidification	Moderate	Moderate	Moderate
		Cement-Based Solidification	Moderate	Moderate	Moderate
		Thermoplastic Encapsulation	Moderate	Moderate	Moderate
		Vitrification	High	Moderate	High
	Silo Demolition	Hydraulic Splitter	Moderate	Moderate	High
		Nonexplosive Demolition Agent	Moderate	Low	Low
		Gas Torch	High	High	High
	On Property Disposal	Above/Below Grade Vault	High	High	Moderate
		Tumulus	High	High	Low
		Temporary Storage	High	High	Low
	Off Site Disposal	Rail Transport	High	Moderate	Low
		Truck Transport	Moderate	Low	High

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FIGURE 2-13.
(CONTINUED)

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GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
Removal/ Treatment/ Disposal (Cont)	Physical Treatment	Solid/Liquid Separation	Moderate	Moderate	Moderate
		Reverse Osmosis	High	Moderate	Moderate
		Selective Ion Removal	High	Moderate	High
	Chemical Treatment	Leaching/Extraction	Moderate	Moderate	High
		Neutralization	High	High	Low
		Precipitation	Moderate	Moderate	Moderate
	Thermal Treatment	Drying/Calcination	High	High	Moderate
	Biological Treatment	Biodenitrification	High	High	Low

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FIGURE 2-13.
(CONTINUED)

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with wire-wound post-tensioned steel. The walls also have vertical prestressed steel tendons spaced around the wall as well as deformed reinforcing steel bars. It may be necessary to clean the inner surface of the silo before demolition.

2.4.3.1 Wrecking Ball

This method would utilize a large steel ball attached to a crane and has been proven to be an effective means to demolish concrete tanks such as the silos. The steel wire and rebar would require cutting with a gas torch once the concrete is demolished. The major drawback to this method is the substantial dust generation. As this dust would very likely contain radioactive contamination, this option is unsuitable for Silos 1, 2, and 3.

2.4.3.2 Explosive Charges

This method would be quite effective; however, it would create airborne radioactive contamination and excessive ground vibration; therefore it is an unsuitable option for all silos.

2.4.3.3 Hydraulic Splitter

This method uses a high pressure stream of water and is effective in cutting both concrete and steel. The operation can be conducted remotely to prevent the possibility of injury to workers due to unexpected collapse of the silo. This method would not generate airborne contamination as no dust would be created. Water used to cut the concrete would require collection and possible treatment if contaminated.

2.4.3.4 Nonexplosive Demolition Agent

This method would involve drilling a hole pattern into the silo and placing a demolition agent inside the holes. When mixed with water, the agent would expand and break the concrete. The reinforced steel would require cutting with a torch. This method would create no dust and would be effective only in breaking the silo into large pieces.

2.4.3.5 Gas Torch

A gas torch (similar to or the same type as used to cut steel) could be used to cut both the concrete and steel in the silo. Although this method would be effective, it might present a hazard to the workers in the event of a sudden silo collapse, unless it is performed remotely.

For Silos 1, 2, and 3, the demolition methods discussed above would be used inside an EIE with the exception of the wrecking ball and the explosive charges. Concerns about dust could be eliminated if demolition were to occur inside such a structure. Other features such as underground piping and tanks would require removal in addition to the silo. If an off-site disposal alternative is selected, the concrete rubble and piping would have to be sized to fit shipping containers. A combination of demolition technologies may be desirable to demolish the silos and reduce the debris to a volume suitable for on- or off-site disposal.

2.4.4 Treatment/Disposal

Ex situ stabilization involves the removal of the silo contents from its current location and a solidification/stabilization process to treat the silo contents. Although there are interpretive differences between solidification and stabilization, this discussion will treat them the same. Solidification may be necessary for preparation for disposal to reduce liquid volumes to acceptable levels and to provide structural integrity to prevent slumping, subsidence, and collapse when disposed. A number of different solidification agents are available as indicated below. Laboratory testing would be required to determine the proper solidification formula.

2.4.4.1 Ex Situ Stabilization

Ex situ stabilization technology offers the following possible process options for Silos 1, 2, and 3:

- Asphalt encapsulation: Ex situ asphalt stabilization could be achieved by removing the silo contents to a heated mixer where it would be blended with molten asphalt and extruded into a form. Activated powdered carbon could be blended with the material in an attempt to control radon emissions both during the mixing process and after the material is treated. The result of this process would be a monolithic product with excellent leach control properties.

- Stabilization with lime, fly ash, and activated carbon reagents: Silo contents and reagent mixing would be done in a cement mixer or covered pug mill equipped to scrub the radon off-gases. Activated carbon would help control the off-gassing of radon during and after treatment. It would be necessary to implement a completely self-contained system with off-gas control if the mixing of activated carbon in the waste is not determined to be beneficial. No other off-gassing is expected to occur because no ammonia is present and none of the reagents are expected to be acidic. The stabilized material would then be poured into forms for packaging and disposal. The potential for biological activity is very slight given the expected high pH of the mix and the fact that the activated carbon (mostly graphite) would not be attacked by bacteria.

- Stabilization with proprietary cement-based technologies: The silo contents would be conveyed to a mixer or pug mill where it would be mixed with water, the proprietary reagents, and activated carbon. The stabilized material would then be poured into boxes or bags for curing before disposal into the disposal facility.

- Stabilization with polymerized organic monomers: For this process option, the silo contents would be mixed in a drum or box with an organic monomer and an initiating agent or catalyst before deposition in the disposal facility.

2.4.4.2 In Situ Stabilization

This process option would stabilize the silo contents through the addition of cement and fly ash. Following silo dome removal, these materials would be added to the silo contents and mixed by augers lowered into the silos by the gantry crane. Although this process is commonly applied to shallow soil mixing, it can treat the entire depth of the silos. It is a relatively new process in this country, but has been used extensively in Japan.

Shallow soil mixing can be used to mix portland cement, fly ash, bentonite, or any other stabilizing agent into the silo contents. Because the silo contents are somewhat dry, especially that in Silo 3, the chemicals would be added as a slurry. The amount of stabilizing agent required and the subsequent volume increase would depend on the system used and would require treatability studies. If the volume of the silo contents was increased by more than 10 to 20 percent, the berms around the silos would have to be raised.

Core samples could be drawn to determine that adequate stabilization had been achieved because previous applications of this technology indicate that nonuniform mixing can be a problem.

2.4.4.3 Ex Situ Vitrification

Ex situ vitrification of the silo contents would require that the water content of the material be no greater than 30 percent by weight. A water content greater than this can cause foaming problems and increase power requirements. The material should have a water content of 15 to 20 percent (ideally) so that the material would resemble a fine, damp silt.

The dried material would be conveyed to the vitrification system surge hopper. The vitrification rate would be approximately 50 to 100 tons per day, so the surge hopper would be sized for approximately 100 tons of material. All equipment would be under negative pressure and vented to the air pollution control system, which would feature dehumidification and HEPA filtration and carbon absorption.

The glass melter of the vitrification unit could be either a conventional cold cap design, a drop tube device as is used on higher level radwaste, or a mechanically stirred melter. The melter would be electrically heated and designed to minimize emissions of radon, dust, and volatile metals. The glass from the melter would be cast into steel containers similar to low specific activity (LSA) boxes (four- to six-foot-cubes). The steel containers would be cooled by air and water during casting, and after cooling, the boxes would be sealed and placed in the disposal facility.

The vitrification facility would be enclosed in a ventilated process building. The equipment would be designed for remote operation to minimize exposure.

2.4.4.4 In Situ Vitrification

Following removal of the silo domes, vitrification equipment would be lowered into the domes. The electrodes used in the process would be installed in a grid pattern. Close spacing would be required because of the 25-foot depths.

In this process option, fume hoods would be installed over the active (melting) settings to capture any contaminated steam generated during the vitrification process. This steam would be condensed and treated by an air pollution control system separate from the general building ventilation system. This system would remove radon, volatile metals and fumes, and contaminated dust. Electrodes would be energized and blocks of silo contents melted. The melting process would be controlled so that all of the silo contents and much of the silo walls would be vitrified. The vitrified silo contents, silo walls, and adjacent portions of the berm would form a continuous monolithic mass that would not require additional structural support. Thermocouples would be placed along the bottoms of the silo walls to verify the extent of vitrification. Cores could also be drilled into the cooled glass to confirm complete vitrification.

2.4.4.5 Air Treatment

An air treatment system would be installed to minimize radon and radioactive particulate emissions to the environment and to maintain airborne contamination levels as low as possible in work area containments. During the design of the existing radon removal system, it was determined (by calculation and engineering judgment) that, given the rate of radon emission from the silo contents, the lowest inventory level to which the radon level could be reduced effectively would be one curie. Therefore, the conceptualization of the air treatment system assumed that the existing temporary radon removal system at Silos 1 and 2 would be upgraded and used to reduce the high equilibrium radon levels in the airspace of each silo to less than one curie before removing the silo domes.

Typical air treatment equipment would consist of roughing filters, HEPA filters, and carbon adsorption units. The specific arrangement for the air treatment system will be dependent on the type of remedial action chosen. To supplement the installed ventilation system, any vitrification equipment would need the built-in capability to treat gases generated during the vitrification process.

Also, as an option to supplement the general ventilation system, carbon adsorption trains could be installed to provide localized radon removal.

2.4.4.6 Water Treatment

Water treatment would be required for a wide variety of types, concentrations, and flows of wastewaters. Many of the waters would have metals contamination, low-level radioactivity, possibly low levels of organics, and high nitrate. To treat the relatively concentrated streams, bulk removal methods for metals would be utilized followed by additional treatment with ion exchange and denitrification as necessary.

Concentrated waters would be pH-adjusted and treated with chemicals to facilitate the formation and precipitation of insoluble metal compounds. Flocculation causes particle agglomeration. Solids would be separated from the water using one or a combination of methods, depending on the size and concentration of the particles. Clarification, filtration, centrifugation, and flotation would be considered. Sludges from these operations would be treated with solidification or vitrification.

Effluent from these processes would be further treated using ion exchange to remove residual contaminants. Typically, this would be necessary to treat water with low levels of radioactive metals and should allow direct discharge of the water. Various ion exchange resins having differing selectivity would be used, depending on the mixture of metals and other ions present in the water. Some resins would be regenerated using a suitable regenerant solution that removes the contaminant from the resin. This solution would be neutralized and then recycled back to the precipitation unit. Other resins would be used one time and then disposed of as a stabilized hazardous and/or radioactive waste.

The data available to date indicate no significant levels of organics. Therefore, it is assumed that the organics in the waste streams would be at such low concentrations that specific treatment for organics removal would not be required. Some wastewaters might require nitrate removal to meet surface water quality goals before they could be discharged. The existing biodenitrification system at the FMPC would likely be used for this service, although new units could be utilized such as small sequencing batch reactors. Biological denitrification would generate clean effluent for discharge, and the resultant biological sludge could be disposed of as part of Westinghouse Materials Company of Ohio's (WMCO's) ongoing waste operations program. To the extent practical, it is intended to utilize a common water system for a cost-effective operation. Any additional pre- or post-treatment units will be designed on a modular skid-mounted basis so that they can be used effectively as needed. Figure 2-9 presents a flow diagram for water treatment.

2.4.4.7 On-Property Engineered Disposal Facility

An Engineered Disposal Facility was considered for the on-property disposal of the waste material. A basic tumulus disposal concept would consist of mounding over waste that has been placed on a stable structural pad. An aboveground structure would be a reinforced vault-like concrete structure designed for permanent waste disposal. For reasons of structural integrity (cap subsidence) and concerns for water infiltration (leaching), both the tumulus and the aboveground structure should accept only containerized and highly stabilized waste forms. The design options that were considered for each are shown in Figures 2-10 through 2-12:

- Tumulus:
  - On-grade reinforced concrete structural pad incorporating the following:
    1. RCRA-type closure cap with a leachate collection and detection system
    2. RCRA-type impermeable liner and underlayment

- Aboveground Structure:
  - Design 1 - Vault constructed directly on-grade incorporating the following:
    1. Design 1A uses a liner system with a leachate collection and detection system
    2. Design 1B uses only a leachate collection and detection system

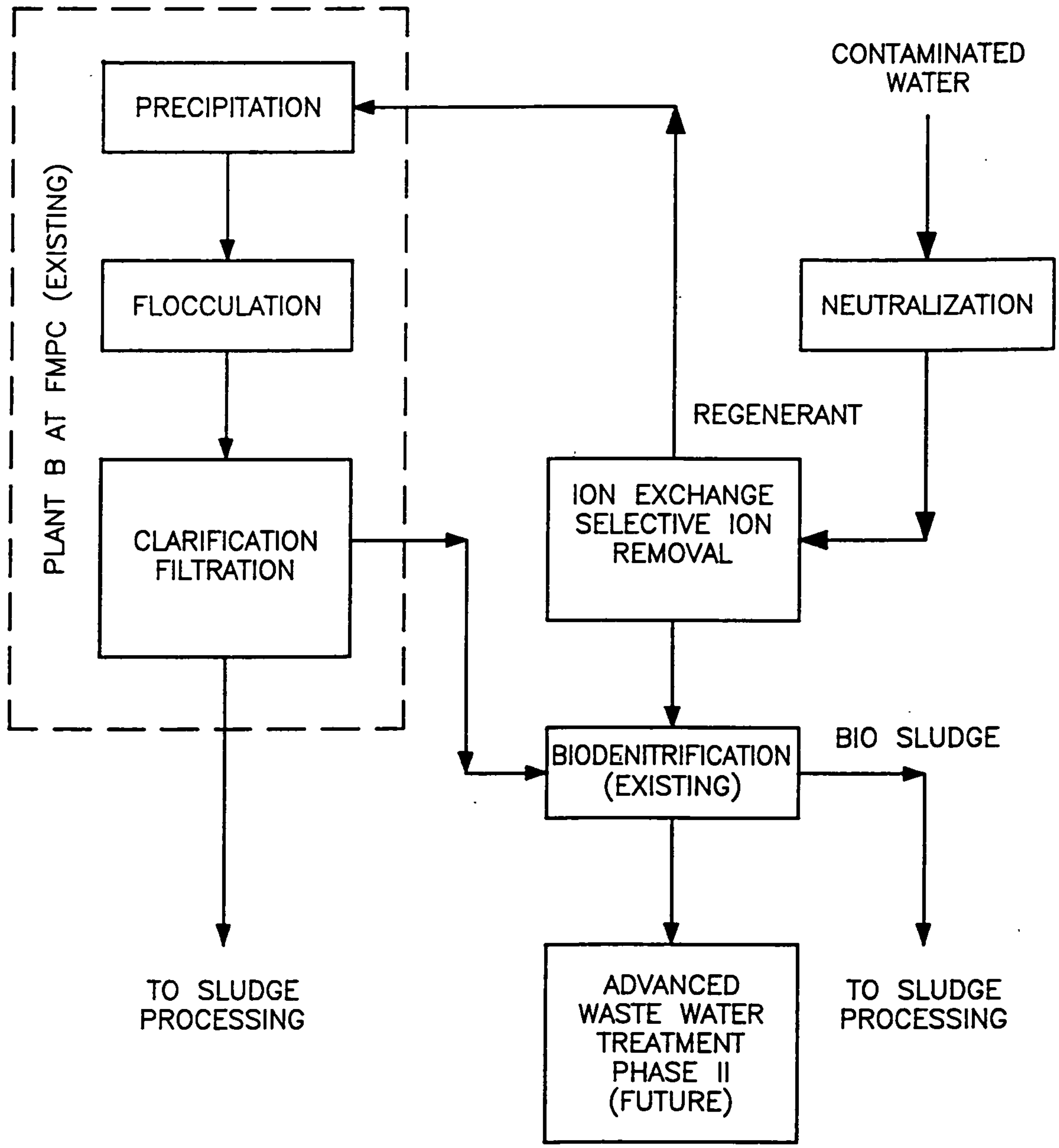
  - Design 2 - Vault constructed with a structural support slab placed six feet above-grade using an extended height reinforced concrete foundation incorporating the following:
    1. Design 2A uses a liner system with a leachate collection and detection system
    2. Design 2B uses only a leachate collection and detection system

A combined Engineered Disposal Facility for all operable units at the FMPC could be useful if available at the time of Operable Unit 4 remedial action.

2.5 PACKAGING/TRANSPORTATION

The Department of Transportation (DOT) in Title 49 of the Code of Federal Regulations provides a number of general categories under which radioactive material may be shipped. Within the possible shipping designations allowed in the DOT regulations, there are four which apply to the K-65 and Silo 3 residues (with certain restrictions):

- Limited Quantities
- Low Specific Activity (LSA) material
- Type A package quantities
- Type B package quantities



303317-A-G56 OU4 TK12 KNOX
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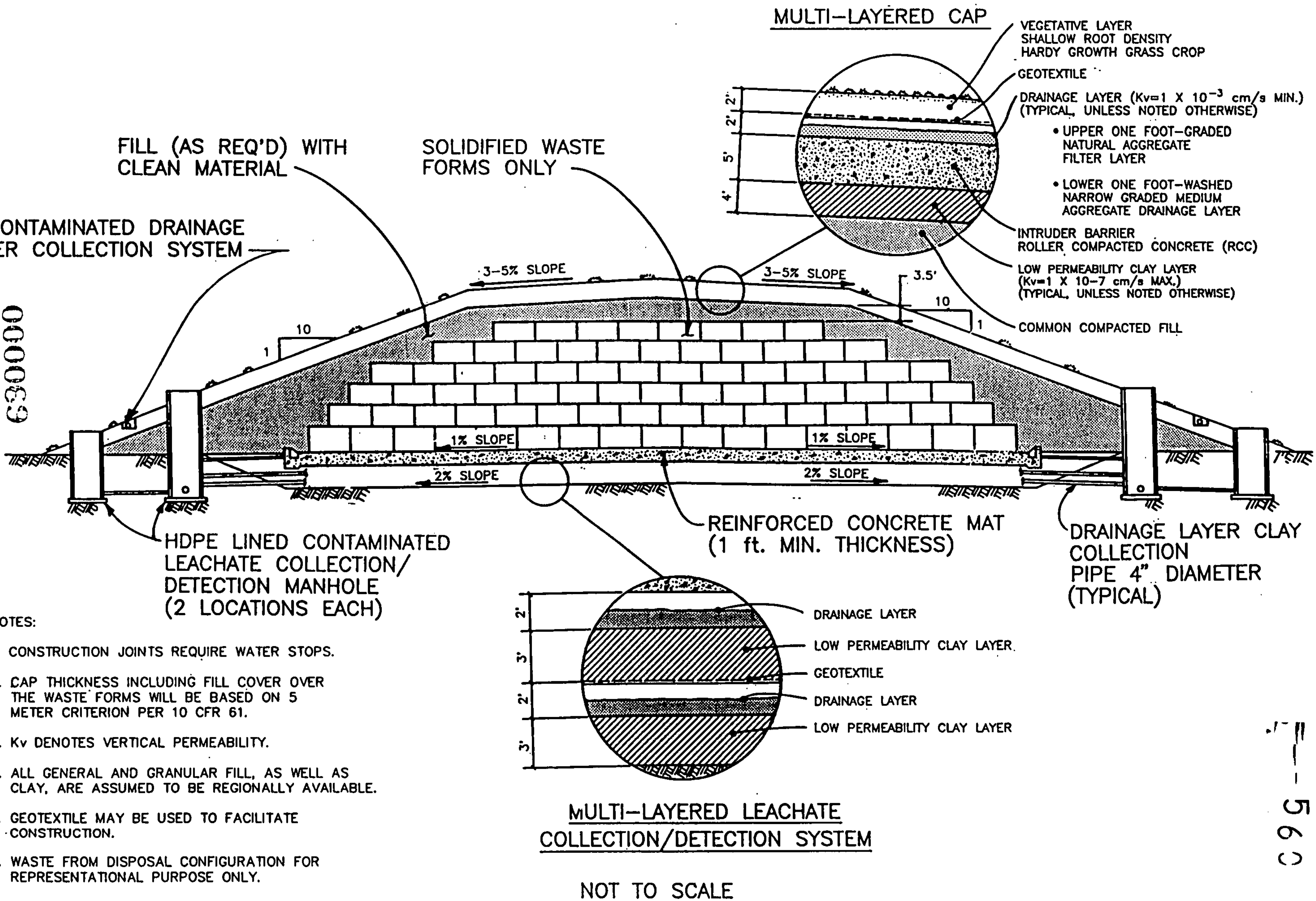
FIGURE 2-9. WATER TREATMENT- METALS REMOVAL, ION-EXCHANGE AND DENITRIFICATION



NOTES:

1. CONSTRUCTION JOINTS REQUIRE WATER STOPS.
2. CAP THICKNESS INCLUDING FILL COVER OVER THE WASTE FORMS WILL BE BASED ON 5 METER CRITERION PER 10 CFR 61.
3. Kv DENOTES VERTICAL PERMEABILITY.
4. ALL GENERAL AND GRANULAR FILL, AS WELL AS CLAY, ARE ASSUMED TO BE REGIONALLY AVAILABLE.
5. GEOTEXTILE MAY BE USED TO FACILITATE CONSTRUCTION.
6. WASTE FROM DISPOSAL CONFIGURATION FOR REPRESENTATIONAL PURPOSE ONLY.

FIGURE 2-10. TUMULUS SECTION

630000

303317-A-G78 OU4 TK12 KNOX

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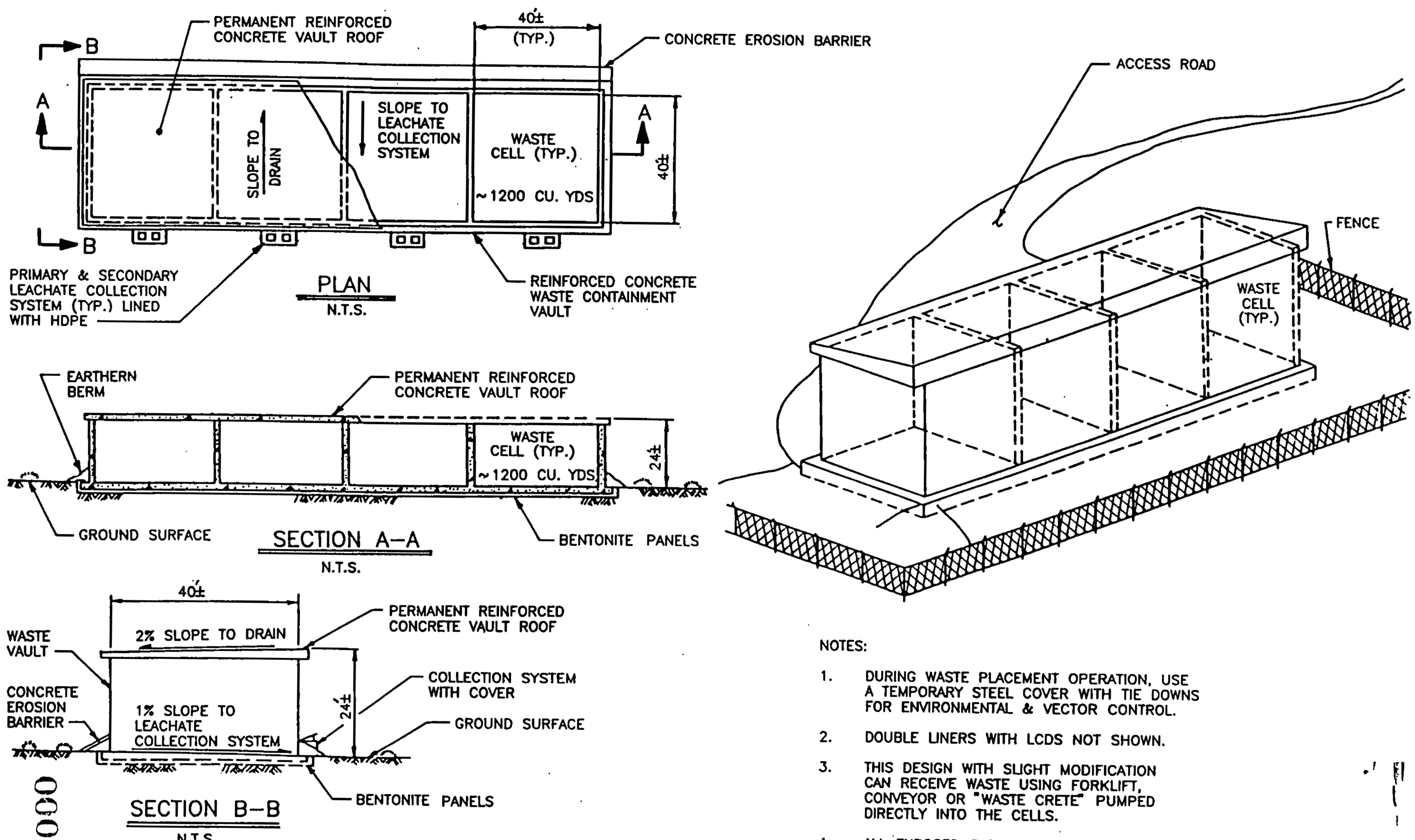

NOTES:

1. DURING WASTE PLACEMENT OPERATION, USE A TEMPORARY STEEL COVER WITH TIE DOWNS FOR ENVIRONMENTAL & VECTOR CONTROL.
2. DOUBLE LINERS WITH LCDS NOT SHOWN.
3. THIS DESIGN WITH SLIGHT MODIFICATION CAN RECEIVE WASTE USING FORKLIFT, CONVEYOR OR "WASTE CRETE" PUMPED DIRECTLY INTO THE CELLS.
4. ALL EXPOSED EXTERIOR SURFACES TO RECEIVE WATERPROOF COATING.
5. ELEVATION VIEW ENLARGED TO SHOW ROOF SLOPE.

303317-A-G73 OU4 TK12 KNOX

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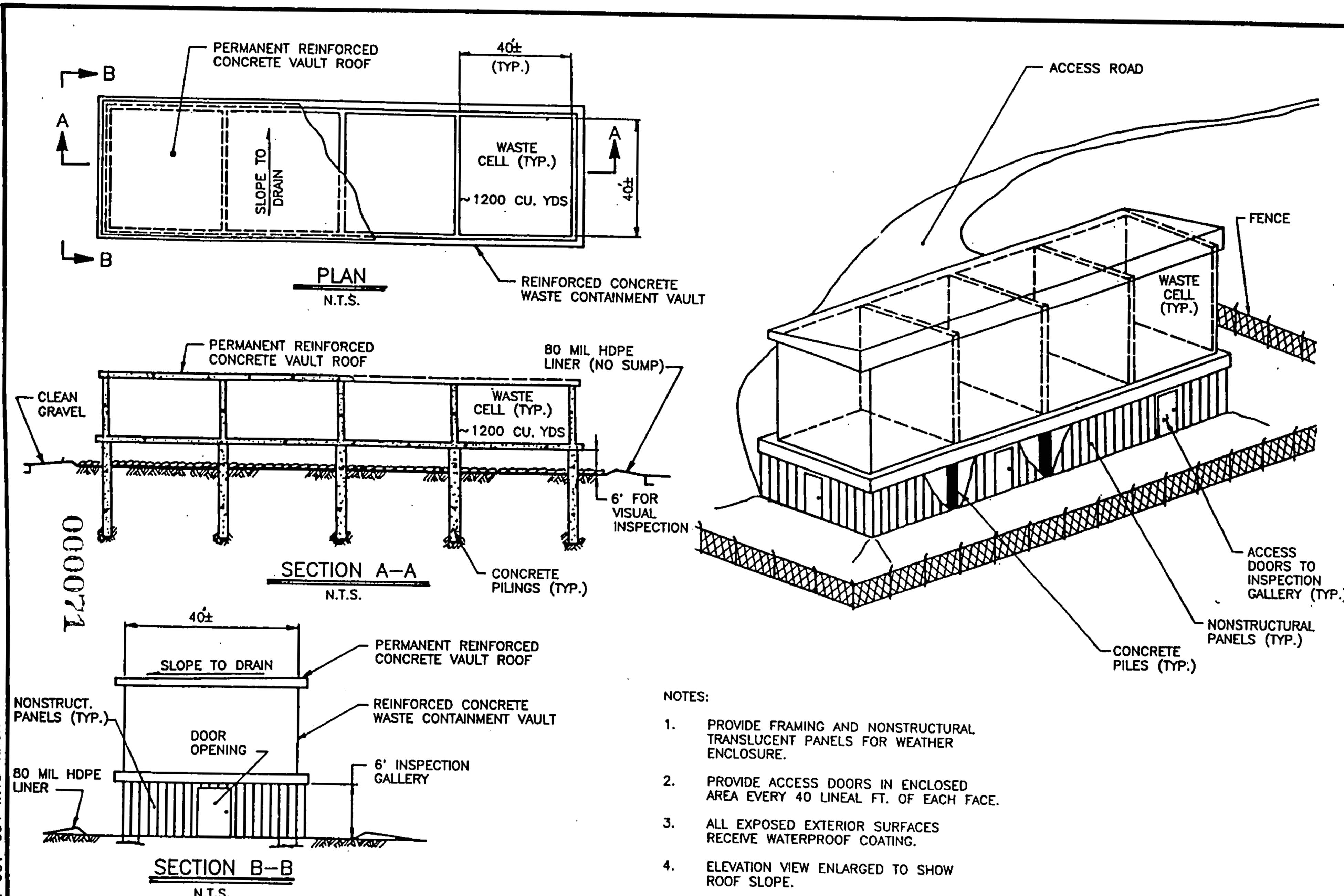
FIGURE 2-11. GREATER CONFINEMENT DISPOSAL VAULT FACILITY (GCD)



NOTES:

1. PROVIDE FRAMING AND NONSTRUCTURAL TRANSLUCENT PANELS FOR WEATHER ENCLOSURE.
2. PROVIDE ACCESS DOORS IN ENCLOSED AREA EVERY 40 LINEAL FT. OF EACH FACE.
3. ALL EXPOSED EXTERIOR SURFACES RECEIVE WATERPROOF COATING.
4. ELEVATION VIEW ENLARGED TO SHOW ROOF SLOPE.

000071

303317-A-G57 OU4 TK12 KNOX

FIGURE 2-12. GCD WITH STRUCTURAL SLAB AND VAULT PLACED ABOVE GRADE

Under each of these categories, the K-65 and Silo 3 residues will be specified as "normal form" because they have not been tested to meet the requirements of 49CFR173.469 (Tests for Special Form Radioactive Materials).

2.5.1 Limited Quantities

"Limited Quantities" of radioactive material is a designation for shipping the least restricted articles and the smallest quantities of radioactive material. Generally, items such as radioactive watches, clocks, and fire alarms are shipped under this category. Although the K-65 and Silo 3 residues could be made to conform to the restrictions of this classification, it would not be practical. This classification places a restriction on the activity level allowed in each shipping container and, due to the relatively high level of radioactivity found in the residues, it will require well over a billion packages to ship the residues. The logistics of inventorying and accounting for this number of packages alone renders this shipping classification unsuitable for the shipping of the silo contents.

2.5.2 Low Specific Activity

The advantage to shipping radioactive material as LSA is to gain exemptions from using specification packaging (i.e., Type A, Type B, etc.). Whereas the other packaging and shipping classifications place a limit on the curie content of a package, the LSA classification places a limit on the specific activity of each package.

There are several subparts to the definition of LSA material, two of which may apply to the silo contents. The silo material may meet the definition of 49CFR173.403(n)(1) (Definitions) as "Uranium or thorium ores and physical or chemical concentrates of those ores." However, if it is decided that these residues are not ores or ore concentrates, they must meet the restrictions of 49CFR173.403(n)(4) (Definitions) which states: "Material in which the radioactivity is essentially uniformly distributed and in which the average concentration of the contents does not exceed:

(i) 0.0001 millicuries per gram of radionuclides for which the A_2 quantity is not more than 0.05 curie;
(ii) 0.005 millicuries per gram of radionuclides for which the A_2 quantity is more than 0.05 curie, but not more than 1 curie; or
(iii) 0.3 millicuries per gram of radionuclides for which the A_2 quantity is more than 1 curie."

(Note: A_2 is the maximum activity of normal form radioactive material permitted in a Type A package.)

In order to apply this second definition, it must be noted that 49CFR173.433(b)(3) (Requirements for Determination of A_1 and A_2 Values for Radionuclides) states that "In the case of a mixture of different radionuclides, where the identity and activity of each radionuclide is known, the permissible activity of each radionuclide $R_1, R_2, \ldots R_n$ must be such that $F_1 + F_2 + \ldots F_n$ is not greater than unity, when:

$$F_1 = \frac{\text{Total activity of } R_1}{A_i(R_1)}$$

$$F_2 = \frac{\text{Total activity of } R_2}{A_i(R_2)}$$

$$F_n = \frac{\text{Total activity of } R_n}{A_i(R_n)}$$

Where $A_i(R_2, R_2, \ldots R_n)$ is the value of A_1 or A_2 as appropriate for nuclide $R_1, R_2, \ldots R_n$."

(Note: A_1 is the maximum activity of special form radioactive material permitted in a Type A package.)

Another explanation for the above formula is that the Operable Unit 4 radionuclides in the decay chain present in the silos will have to be divided into three categories: those with an A_2 value equal to or less than 0.05 curies, those with an A_2 value greater than 0.05 but not more than 1 curie, and those with an A_2 value greater than 1 curie. Based on present information, the radionuclides in all three of the silos are from the U-238 decay chain and fall into the categories just mentioned.

2.5.3 Type A

The silo residues can be shipped in Type A packaging which requires that the activity level in each package not exceed the A_2 value for the radionuclide of concern. 49CFR173.411 (General Design Requirements) and .412 (Additional Design Requirements for Type A Packages) list the design and performance specifications for Type A packaging. Type A packages are designed to more stringent requirements than LSA packages and are typically used for the packaging of materials with greater levels of radioactivity. Type A containers are generally more expensive than LSA containers.

Due to the activity levels of the silo residues and the package activity level restrictions for Type A packages, the silo contents are estimated to require more than one million packages. As in the

Limited Quantities discussion, the logistics for storing and accounting for this large quantity of packages would be prohibitive.

2.5.4 Type B

Type B packaging is required for all material which exceeds Type A packaging requirements. 49CFR173.411 (General Design Requirements) and 10CFR71.51 (Additional Requirements for Type B Packages) list the design and performance requirements for Type B packages. Type B packaging is constructed to much higher standards than either Type A or LSA packaging and is therefore much more expensive.

Generally, shipments of Type B quantities are made in a primary disposable container that is placed in a Type B overpack for transportation purposes only. The main advantages to Type B shipments are the use of larger packaging and less risk during shipment due to the higher grade packaging. The main disadvantages are cost, increased number of truck trips, and obtaining Type B overpacks. The silo contents can be shipped in Type B containers.

2.6 EVALUATION OF PROCESS OPTIONS

After the initial screening of technologies and process options, the surviving process options were evaluated individually for their effectiveness, implementability, and cost in relation to the other process options within the same technology group. These evaluations again were based on engineering judgement and not detailed analysis. Figure 2-13 shows the results of these evaluations.

2.6.1 Effectiveness Evaluation

Specific technology processes that have been identified were evaluated further on their effectiveness relative to other processes within the same technology type. This evaluation focused on: (1) the potential effectiveness of process options in handling the waste and meeting the remediation goals identified in the remedial action objectives; (2) the potential impacts to human health and the environment during the construction and implementation phase; and (3) how proven and reliable the process is with respect to the contaminants and conditions at the site.

2.6.2 Implementability Evaluation

Implementability encompasses both the technical and administrative feasibility of implementing a technology process. As previously discussed, technical implementability was used as an initial screen of technology type and process options to eliminate those that were clearly ineffective or unworkable at a site. Therefore, this subsequent, more detailed evaluation of process options placed greater emphasis on the institutional aspects of implementability, such as the ability to obtain necessary permits for off-site actions, the availability of treatment, storage, and disposal services (including capacity), and the availability of necessary equipment and skilled workers to implement the technology.

2.6.3 Cost Evaluation

At this stage in the process, the cost analysis was made on the basis of engineering judgement. Each process was evaluated as to whether costs are high, low, or medium relative to other process options in the same technology group.

3.0

3.0 DEVELOPMENT OF ALTERNATIVES

In assembling the following alternatives, general response actions were combined in the form of process options to create an alternative that would potentially satisfy the RAOs of Operable Unit 4. After completing the evaluation of process options, specific process options were selected that best represented each technology type. These process options were used in assembling the remediation alternatives and provided a basis for developing performance specifications during preliminary screenings. Note that the specific process actually used to implement the remedial action at a site may not be selected until the remedial design phase. In some cases, more than one process option was selected to represent a technology type if there were sufficient differences in performance such that one would not adequately represent the other (e.g., stabilization versus vitrification). During assembly of the remediation alternatives, the technology of contaminant separation was considered separate from treatment technologies. This separation was not accounted for during the screening and evaluation of technologies and process options, primarily because contaminant separation involves several process options already listed under treatment technology and does not contribute any new process options by itself. Figure 3-1 details the above process and Figures 3-2 and 3-3 summarize the results of the combinations. A detailed description of each alternative is presented in Section 5.0.

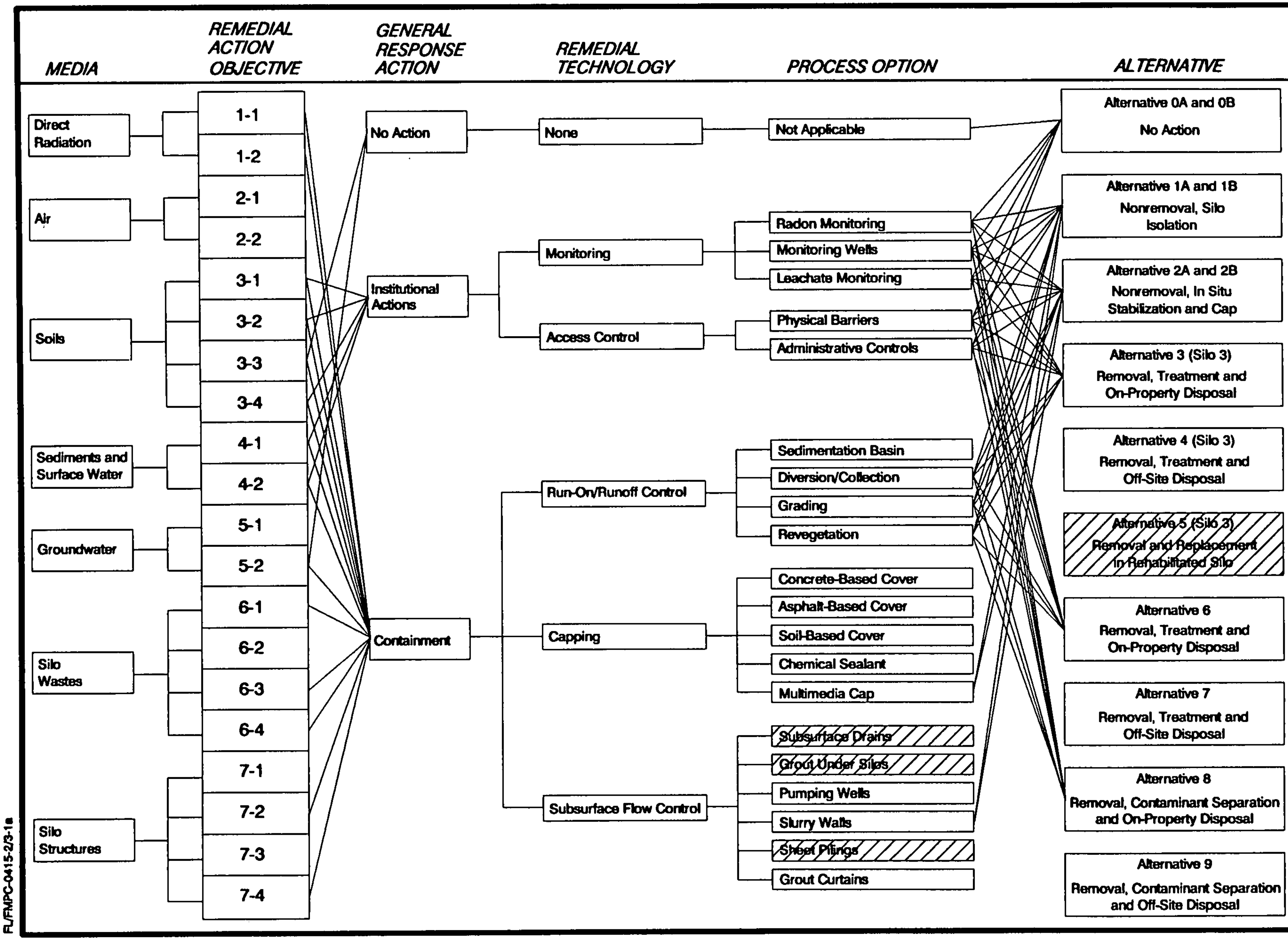


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FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS

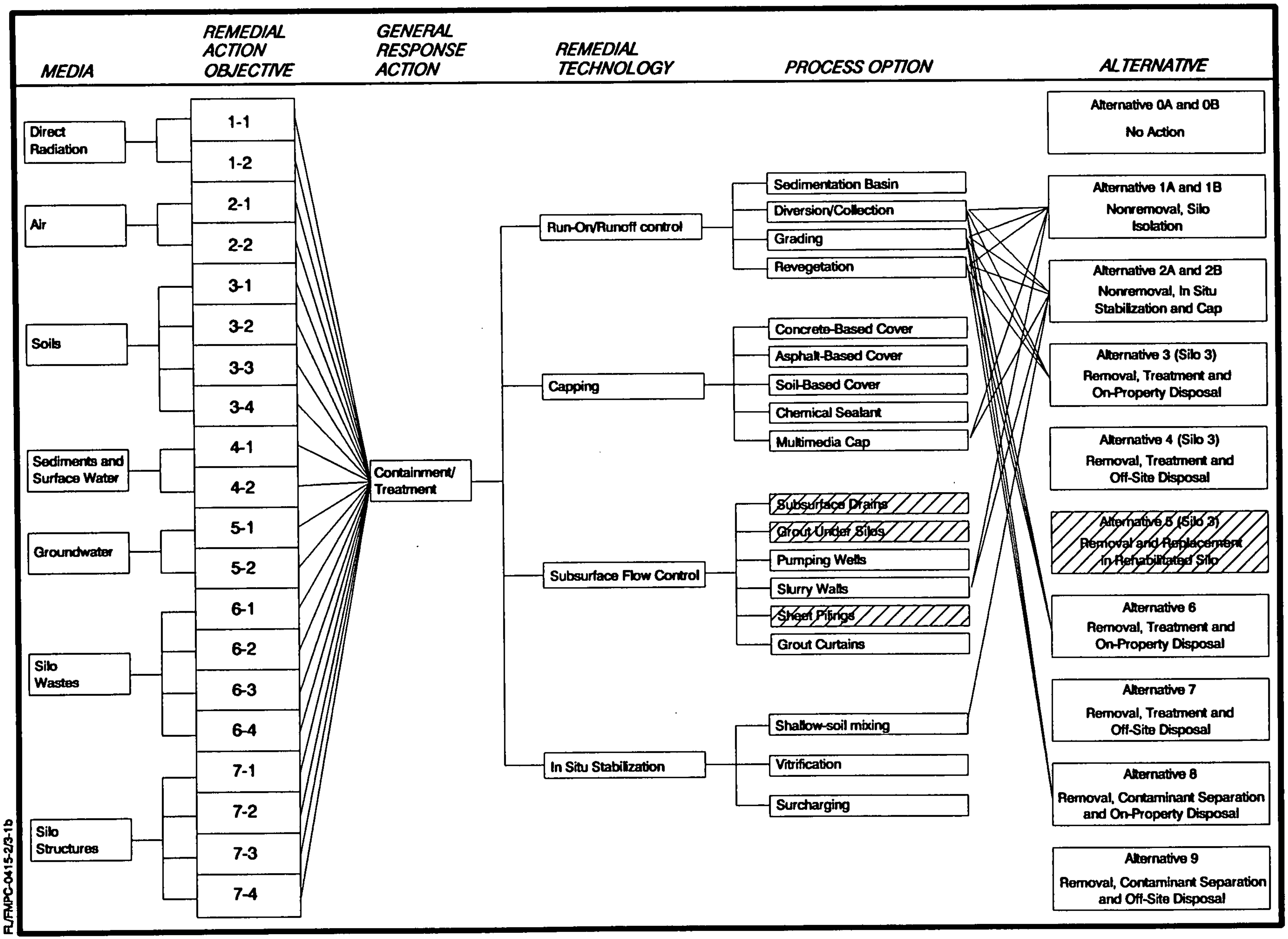

FIGURE 3-1.
(CONTINUED)

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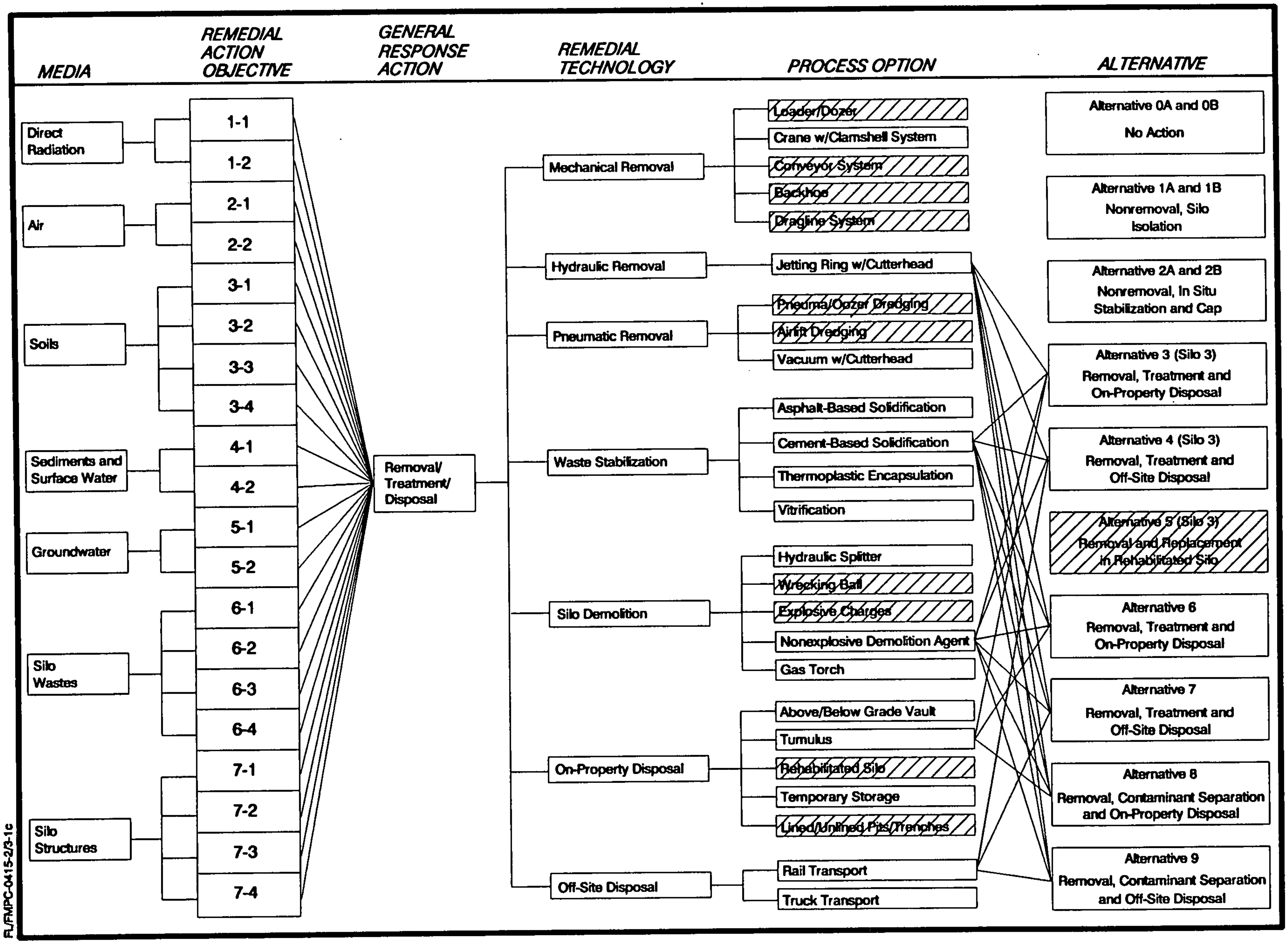

FIGURE 3-1.
(CONTINUED)

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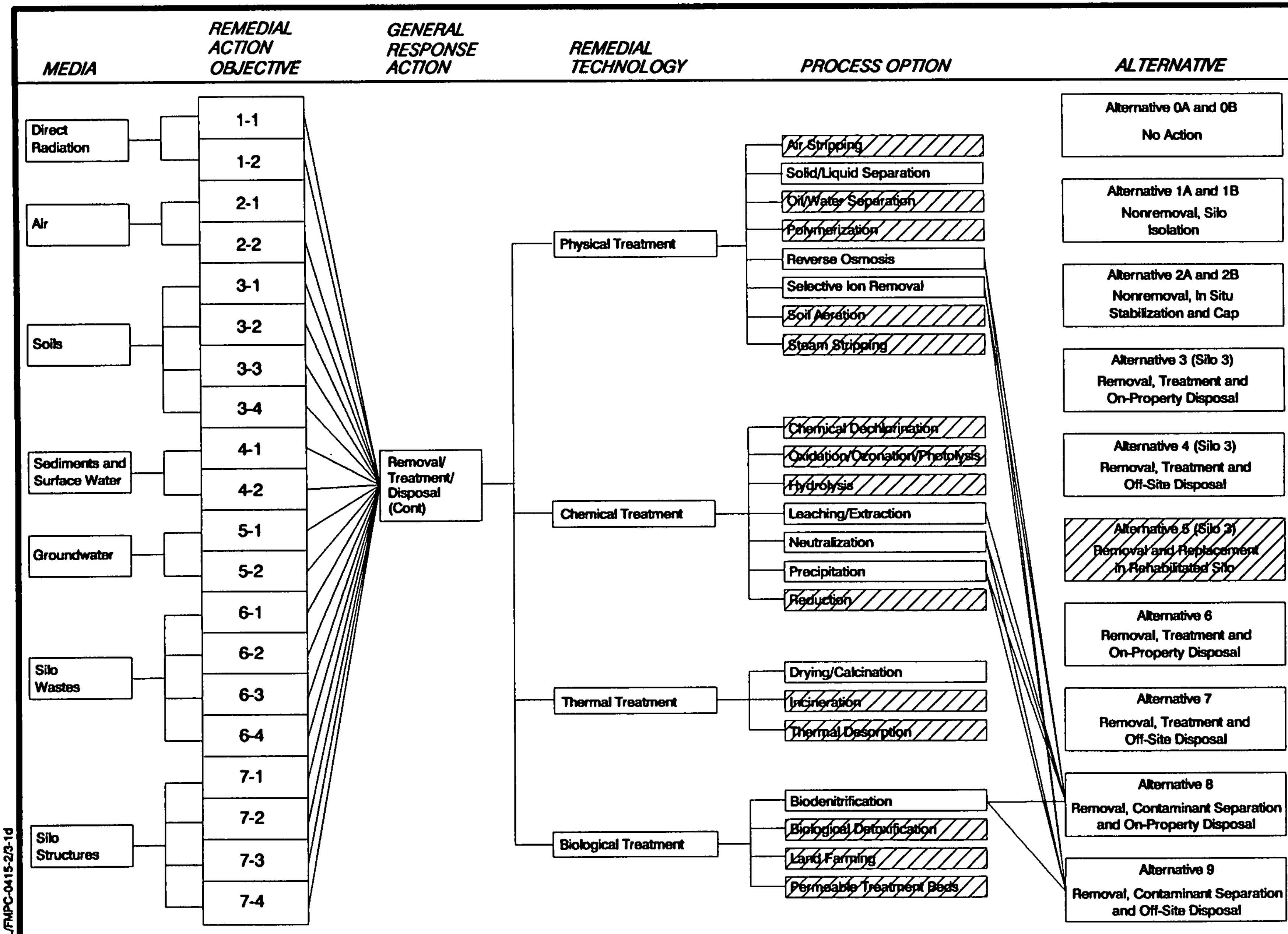

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FIGURE 3-1.
(CONTINUED)

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ALTERNATIVE / PROCESS OPTIONS	0A No Action	1A Nonremoval, Silo Isolation	2A Nonremoval, In Situ Stabilization and Cap	6 Removal, Treatment and On Property Disposal	7 Removal, Treatment and Off Site Disposal	8 Removal, Contaminant Separation and On Property Disposal	9 Removal, Contaminant Separation and Off Site Disposal
Radon Monitoring	X	X	X	X		X	
Wellpoint Monitoring	X	X	X	X		X	
Leachate Monitoring	X	X	X	X		X	
Physical Barriers	X	X	X	X		X	
Adminstrative Controls	X	X	X	X		X	
Diversion/ Collection		X	X	X		X	
Grading		X	X	X		X	
Revegetation		X	X	X		X	
Multimedia Cap		X	X				
Slurry Walls		X	X				
Shallow Soil Mixing			X				
Jetting Ring w/ Cutterhead				X	X	X	X
Cement-Based Solidification				X	X	X	X
Non-Explosive Demolition Agent				X	X	X	X
Tumulus				X		X	
Rail/Truck Transport					X		X
Reverse Osmosis							X

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FIGURE 3-2. REMOVAL ACTION ALTERNATIVES AND PROCESS OPTIONS (SILOS 1 AND 2)

ALTERNATIVE / PROCESS OPTIONS	0A No Action	1A Nonremoval, Silo Isolation	2A Nonremoval, In Situ Stabilization and Cap	6 Removal, Treatment and On Property Disposal	7 Removal, Treatment and Off Site Disposal	8 Removal, Contaminant Separation and On Property Disposal	9 Removal, Contaminant Separation and Off Site Disposal
Selective Ion Removal						X	X
Leaching/Extraction						X	X
Neutralization						X	X
Precipitation						X	X
Biodenitrification						X	X

FIGURE 3-2.
(CONTINUED)

FL/FMPC-0415-2/3-2

ALTERNATIVE / PROCESS OPTIONS	0B No Action	1B Nonremoval, Silo Isolation	2B Nonremoval, In Situ Stabilization and Cap	3 Removal, Treatment and On Property Disposal	4 Removal, Treatment and Off Site Disposal	5 Removal and Replacement in Rehabilitated Silo
Radon Monitoring	X	X	X	X		
Wellpoint Monitoring	X	X	X	X		
Leachate Monitoring	X	X	X	X		
Physical Barriers	X	X	X	X		
Administrative Controls	X	X	X	X		
Diversion/Collection		X	X	X		
Grading		X	X	X		
Revegetation		X	X	X		
Multimedia Cap		X	X			
Slurry Walls		X	X			
Shallow Soil Mixing			X	X	X	
Jetting Ring w/ Cutterhead				X	X	
Cement-Based Solidification				X	X	
Non-Explosive Demolition Agent				X	X	
Tumulus				X		
Rail/Truck Transport					X	

FIGURE 3-3. REMEDIAL ACTION ALTERNATIVES AND PROCESS OPTIONS (SILO 3)

4.0

4.0 ALTERNATIVE SCREENING METHODOLOGY

4.1 INTRODUCTION

Operable Unit 4 remedial action alternatives developed in the previous task had been assembled by combining process options from viable technologies in an attempt to meet the established RAOs. Those technologies deemed not applicable or infeasible were eliminated. The resultant alternatives were based primarily on RAOs and implementability concerns. There were few details identified at this stage for the individual process options and sizing requirements; remediation time frames were not fully characterized. It is the intent of the alternative screening to characterize these parameters more fully, to refine the alternatives accordingly, and to conduct the screening of alternatives by comparatively evaluating them on the basis of effectiveness, implementability, and cost in accordance with the NCP at 40CFR300.430(e & f) (Remedial Investigation/Feasibility Study and Selection of Remedy).

This section will review the alternative screening requirements outlined in OSWER Directive 9355.3-1, briefly discuss ARARs, and introduce waste disposal considerations and their influence on the alternative ranking process.

4.2 REFINEMENT OF ALTERNATIVES

The following parameters were developed for each alternative:

- Remediation time frame and treatment rate (process throughput, i.e., pound/hour)
- Size, configuration, and availability of on-property extraction and treatment systems
- Physical area required for containment structures and support areas
- Packaging and transportation requirements for disposal options
- Permits and regulatory conditions and limitations of both on-property and off-site disposal options

The remediation time frame is dependent on the size and configuration of the alternatives. These factors were considered in the preliminary design of each alternative, based on best engineering judgement. Two or more options were selected for some alternatives to maintain a variety of sizes and/or configurations.

Previously developed alternatives were modified if there were concerns about implementability or feasibility of the original concept. These modifications included changes to system configurations, implementation strategies, and the addition of treatment or containment technologies. Those alternatives that could not be modified to reduce or eliminate these concerns were eliminated from further analysis, as were those judged to be similar but significantly inferior to other alternatives.

4.3 ALTERNATIVE EVALUATION PROCESS

The refined alternatives were evaluated against three broad criteria: effectiveness (short and long term), implementability, and cost. Because the purpose of this evaluation was to reduce the number of alternatives that undergo a more thorough and extensive analysis, alternatives were evaluated more generally in this phase than they will be during the subsequent detailed analysis task. The detailed analysis will subject the remaining alternatives to nine specific criteria and their individual factors rather than the three general criteria used in the alternative screening process. The individuals conducting the alternative screening reviewed the nine criteria to better understand the direction and intent of the detailed analysis. The relationship between the screening criteria and the nine criteria for the detailed analysis is illustrated in Figure 4-1.

To ensure confidence in the results of the alternative screening process, two independent evaluations of the defined alternatives were completed. Per OSWER Directive 9355.3-1, the first evaluation made direct qualitative comparisons between similar alternatives for each of the general evaluation criteria. This identified the most promising alternatives in each grouping (i.e., on-property disposal alternatives, removal alternatives, etc.). The second evaluation, though relying on the same inputs as the first evaluation, generated a quantitative ranking of the alternatives. During this ranking, the alternatives were individually evaluated and assigned a relative rating value for each of the same evaluation criterion. The values were used to determine an overall ranking for comparison across alternatives. Although each evaluation approached the alternative screening process differently, the results of each were identical in terms of which alternatives should be retained for detailed analysis in the next Feasibility Study task.

Section 5.0 of this report discusses the anticipated performance of the alternatives in relation to each of the evaluation criterion. A standard rating terminology is used (i.e., poor, below average, average, above average, and good) to ensure a more uniform and consistent performance evaluation. These terms are used in a relative sense, i.e., a rating of average in a particular category means that an alternative is average relative to all of the alternatives considered. Section 6.0 of this report presents the results of the quantitative evaluation and those alternatives to be carried forward to the detailed analysis of alternatives.

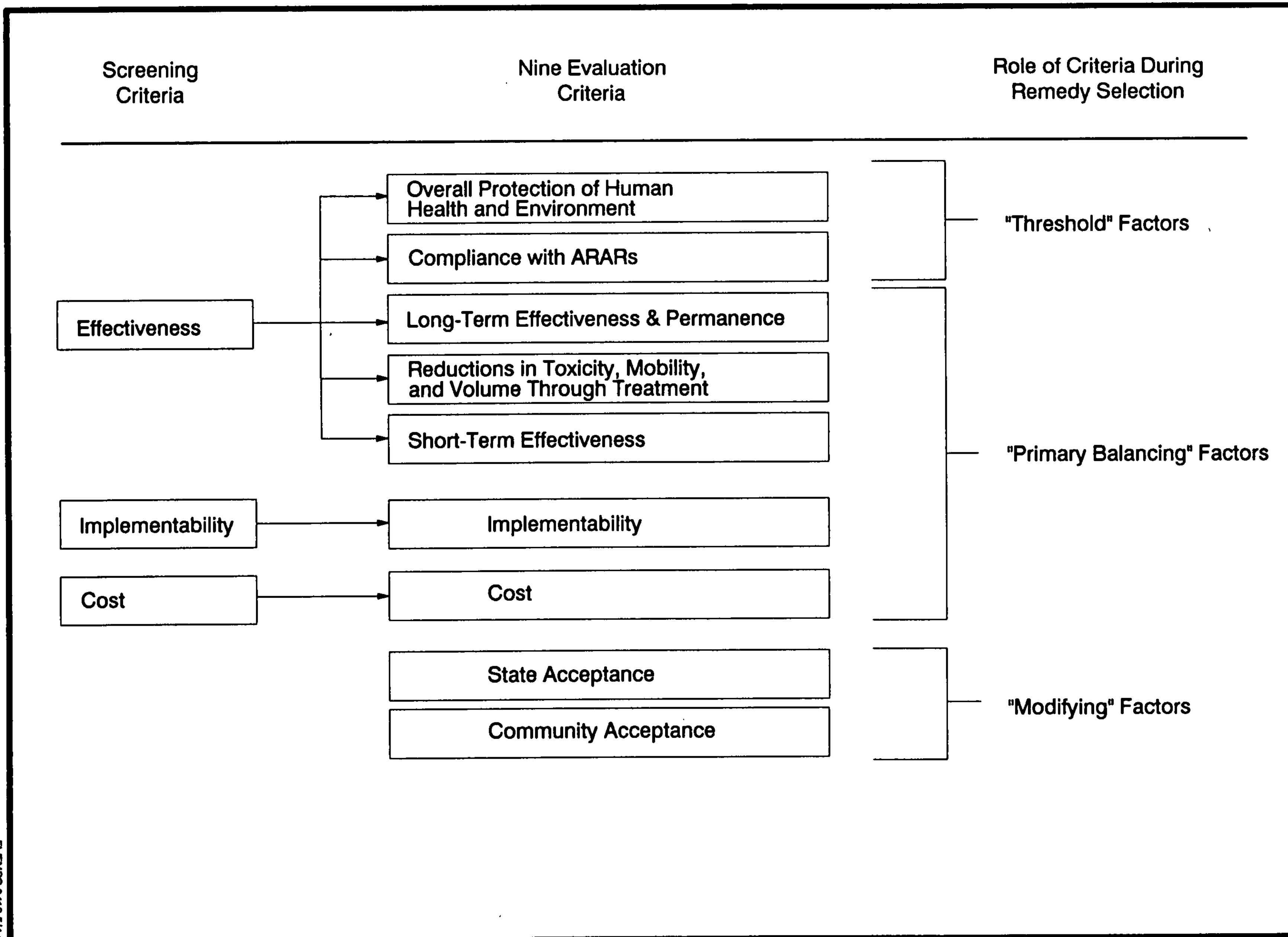

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FIGURE 4-1. RELATIONSHIP OF SCREENING CRITERIA TO THE NINE EVALUATION CRITERIA

4.3.1 Effectiveness Evaluation

A key aspect of the screening evaluation is the effectiveness of an alternative in protecting human health and the environment in accordance with the NCP at 40CFR300.430(e)(7)(i) (Remedial Investigation/Feasibility Study and Selection of Remedy)(Effectiveness). In addition to determining the effectiveness of the alternative in meeting the RAOs, each alternative was evaluated as to its effectiveness in achieving reductions in toxicity, mobility, and volume through treatment. Both short- and long-term effectiveness were evaluated, with the short-term referring to the construction and implementation period and the long-term referring to the postremediation period.

4.3.2 Implementability and Reliability Evaluation

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining the components of a remedial action alternative in accordance with the NCP at 40CFR300.430(e)(7)(ii) (Remedial Investigation/Feasibility Study and Selection of Remedy)(Implementability). It provides a means of evaluating the compatibility of an alternative with site-specific conditions.

The technical feasibility evaluation considered the following:

- Construction
- Operation
- Regulations
- Maintenance
- Monitoring
- Material/equipment replacement
- Ongoing treatment and/or monitoring
- Discharge/emission/disposal

The administrative feasibility evaluation considered the following:

- Permitting and licensing approval
- Availability of on-property/off-site treatment, storage, and disposal services
- Availability of equipment
- Availability of design, operating, and support personnel

The reliability of each alternative was also evaluated in terms of the effects and impacts of possible downtime and/or process upsets on the performance of each alternative.

4.3.3 Cost Evaluation

Cost estimates were prepared for each alternative to allow a comparison of costs among similar alternatives in accordance with the NCP at 40CFR300.430(e)(7)(iii) (Remedial

Investigation/Feasibility Study and Selection of Remedy)(Cost). This effort provided for the identification of alternatives that would cost substantially more than a similar alternative but would not provide a commensurate increase in protection of public health or environmental protection. These costs are rough estimates for comparison purposes only, and are not to be construed as construction/remediation estimates. The data uncertainties associated with the silo, berm, and subsoil contaminants, at this stage of the RI/FS for Operable Unit 4, forced these estimates to be very approximate. Cost estimates for items common to all alternatives or indirect costs (engineering, financial, supervision, and outside contractor support) were not detailed in the estimates.

The cost estimates are based on a variety of cost-estimating data such as cost curves, generic unit costs, vendor information, conventional cost-estimating guides, commercial remedial costs, and prior similar estimates as modified by site-specific information.

Total costs are taken into consideration during the screening of alternatives. Capital costs are those costs associated with the process involved including materials, labor, waste packaging, off-site waste transportation, and disposal. The operation and maintenance (O&M) costs include those for processing and demobilization (for residue removal alternatives) plus post-remediation O&M. The post-remediation O&M costs are those associated with monitoring wells and tumulus or cap maintenance over a 30-year period and also include the documentation costs, and the costs involved for a periodic review of remedial actions, at least every five years after the initiation of such action, for as long as the hazardous substances remain at the site. This documentation program is a requirement under CERCLA Section 121(c). Potential future remedial action costs are not considered because future remediation efforts are not currently defined.

4.3.4 Innovative Technologies

Technologies are classified as innovative if they are fully developed but lack sufficient cost or performance data for routine use at CERCLA sites. The nature of innovative technologies is such that a relatively complete performance and cost evaluation is not possible at this time due to insufficient data. Nevertheless, these technologies were carried through the screening phase if there was reason to believe that they offered the potential for comparable or superior impacts than other available approaches or if they offered the potential for lower costs for similar tests of performance than demonstrated treatment technologies in accordance with the NCP at Section 40CFR300.430 (Remedial Investigation/Feasibility Study and Selection of Remedy).

4.4 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

CERCLA requires that remedial actions achieve a level or standard of control that is applicable or relevant and appropriate to any hazardous substances, pollutants, or contaminants that will remain on property. Three classifications of ARARs are considered; 1) contaminant-specific, 2) location-specific, and 3) action-specific. Contaminant-specific ARARs address the acceptable amount or concentration of a specific pollutant that may be found in or discharged to soil, water, and air. Location-specific ARARs are based on the specific setting and nature of the site, and action-specific ARARs relate to technology or activity-based requirements or limitations on the specific response actions taken with respect to the type of waste. Thus, the determination of the potential ARARs for proposed actions at a site is based on factors specific to that site and the individual action; that is, on the nature of the contamination, the location of the site, and the general scope of the identified remedial action alternatives.

4.5 WASTE DISPOSAL CONSIDERATIONS

Evaluating the off-site versus on-property disposal issue for the silo contents is a complex process involving many subjectively evaluated criteria. Much of the data required to make a technical decision have not been obtained, and the detailed analysis of alternatives has not been performed. In an effort to provide additional insight, this issue was evaluated against much of the same criteria used to evaluate the alternatives. The advantages and disadvantages of each option are examined and briefly discussed in the sections that follow. These considerations shaped much of the alternative evaluations and played an important role in the overall ranking of alternatives. Land disposal restrictions (LDR) impacts on disposal alternatives are discussed in this section.

4.5.1 Long-Term Effectiveness

Long-term effectiveness is defined as the effectiveness of an alternative in meeting the remedial action objectives during that period following remediation. Task 13 will provide additional information on this topic. For cost estimating purposes, CERCLA defines this period as 30 years. There are advantages to the off-site disposal options for long-term effectiveness. The disposal site used for cost estimation is the Nevada Test Site (NTS). A western site such as NTS is superior to Fernald in terms of demographics, meteorology, hydrology, and security. Additionally, long-term management, monitoring, and maintenance are already committed regardless of the presence of the silo materials. Whereas the silo material will be an inconsequential part of the total waste buried at a western site, it will constitute a significant portion of the total radioactivity at Fernald should it remain on property.

4.5.2 Short-Term Effectiveness

In terms of short-term effectiveness, there are advantages to all on-property disposal options, especially the no-action and nonremoval options. These options result in a significantly reduced exposure and risk potential to workers and the public alike during the remediation operation, when compared to those options that require removal, treatment, and/or off-site disposal. Off-site disposal will expose both communities and the environment to transportation-related risks.

Disposal pretreatment processes for on-property or off-site disposal alternatives will factor heavily in determining the short-term effectiveness of a disposal option. This is because the treatment processes will require the silo materials to be exposed to workers, the public, and the environment for a greater period of time. Should an on-property disposal alternative require greater treatment than an off-site disposal option, all other points being equal, the short-term effectiveness ranking of the on-property disposal option will be less.

4.5.3 Reduction in Toxicity, Mobility, and Volume through Treatment

At this screening stage, this criterion does not play an important role in the on-property versus off-site question. Performance to this criterion is equally important to both on-property and off-site disposal options.

4.5.4 Implementability

Technically, the easiest alternative to implement is the no-action alternative. As the technologies become more complex, they will be more difficult to implement. If on-property disposal is allowed, an enhanced burial design may be required, as will some type of waste treatment. Both of these requirements add to the difficulty of implementation. The off-site option would involve locations that are already permitted and have both institutional and physical controls in place. Thus, the entire permit/hearing process would be avoided as well as the engineering and construction of the local on-property facility.

Implementing an off-site disposal option may be much easier for the technical reasons just cited. Furthermore, public acceptance may be greater at an established site than at Fernald.

4.5.5 Cost

The lowest estimated cost options are the no-action and nonremoval alternatives. Should future remediation be required for the no-action or nonremoval alternatives, these alternatives may prove to be very expensive. When comparing an on-property alternative requiring an engineered disposal facility to a similar off-site disposal option, the estimated costs for the latter are substantially higher.

When considering the O&M costs associated with maintaining the on-property disposal facility (100 years per 10CFR61, Licensing Requirements for Land Disposal of Radioactive Waste), the off-site disposal option is generally less expensive than its on-property counterpart. The annual maintenance and monitoring costs at most approved disposal sites are already committed and will not be significantly affected by the addition of the silo material. However, the annual O&M costs to maintain an engineered disposal facility at Fernald will be greater than for an off-site, approved disposal facility.

4.5.6 Overall Protection of Human Health and the Environment

The on-property disposal option may require a superior treatment process and an engineered disposal facility with multiple and redundant containment features to match the protection provided by established regulations and procedures. However, transportation of the silo material to an off-site disposal area presents a risk that must also be considered. Shipment of the material by truck is currently being evaluated, although the number of shipments and the associated risk could be reduced if the shipments were made by rail. For example, if a railroad spur to a western site could be constructed for this purpose, it could be used by other federal facilities in the future.

4.5.7 Land Disposal Regulations

Land disposal regulations (LDR) will be complied with for both on-property and off-site disposal. Before any land disposal is implemented or any other suitable treatment will be completed, contaminant separation, solidification, and/or vitrification is required so that the material will pass toxicity characteristic leaching procedure (TCLP) or best demonstrated available treatment (BDAT) standards.

5.0

5.0 SCREENING OF ALTERNATIVES

The alternatives will be evaluated per the methodology defined in Section 4.0 of this report. The results of the alternative evaluation will be used to conduct the ranking of alternatives in Section 6.0. For the evaluation performed in this section, the alternatives were formally ranked according to their ability to meet the general screening criteria. The following numerical scale was used to rate the alternatives:

- 1 = Poor
- 2 = Below Average
- 3 = Average
- 4 = Above Average
- 5 = Good

During the screening of alternatives the following assumptions were used:

- The samples obtained during the 1989 sampling program, which have been used in the Phase I testing, are representative of the entire contents of Silos 1 and 2. (The Silo 3 sampling appears adequate, and further sampling is not anticipated).
- The results of the treatability testing will be available in time to be incorporated into the selection of the alternative.
- A five-foot depth of soil under the silo and five-foot radial section of the berm around the silo are sufficiently contaminated to require treatment. (This assumption will be resolved by the analyses of materials from the slant and berm boring programs).
- Any actions to be taken on the silos as a result of the current engineering evaluation/cost analysis (EE/CA) study will not impact the ability to perform the alternative selected in the RI/FS.

Note that, for consistency, the number system that is in use in this report preserves the alternative numbers of earlier Operable Unit 4 reports but separates Silos 1 and 2 from Silo 3. Thus, Section 5.1 deals with Silos 1 and 2 (the K-65 silos) and includes Alternatives 0A, 1A, 2A, 6, 7, 8, and 9. Silo 3 is covered in Section 5.2, including Alternatives 0B, 1B, 2B, 3, 4, and 5.

The potential list of ARARs for Operable Unit 4 is given in Appendix A.

5.1 ALTERNATIVES - SILOS 1 AND 2

5.1.1 Introduction

Alternatives have been developed for Silos 1 and 2 to provide a number of possible approaches for meeting the RAOs. In addition to the no-action alternative, two alternatives that do not call for the removal of the K-65 material are proposed. Alternative 1A would provide enhancement of the physical integrity of the existing silos to permit their use as permanent disposal facilities. Alternative 2A entails stabilizing or vitrifying the silo contents in place in the silos.

Four alternatives that involve the removal of K-65 material are offered. Alternative 6 would remove the material from the silos, treat it, and then prepare it for placement in an on-property engineered disposal facility. Alternative 7 would follow similar procedures except the treated material would be transported off site. Alternative 8 adds the process of contaminant separation to the material treatment component followed by placement in an engineered on-property disposal facility. Alternative 9 differs from Alternative 8 only in transporting the separated material to an approved disposal facility. Any contaminated perched water encountered during the removal of the silos, silo contents, berms, or contaminated subsoils would be pumped and treated in the FMPC advanced wastewater treatment system or in the proposed site-wide water treatment system.

The following section provides detailed descriptions of these alternatives, their evaluations (including estimated costs), and the relative screening results.

5.1.2 Alternative 0A - No Action

5.1.2.1 Description

This alternative would call for no action and provides a baseline against which the other alternatives can be compared. It would provide for the silos and the silo contents contained therein to remain unchanged without the implementation of any removal, treatment, containment, or mitigation technologies. It would include the installation of long-term monitoring equipment, such as groundwater monitoring stations, air monitors for radioactivity, area radiation monitors, and a silos and berm maintenance program. The necessary equipment could be installed within six months. No change in the present site characteristics would be made. No additional space would be needed because the space required by monitoring equipment would be inconsequential. No new waste would be generated, and no permits would be required.

5.1.2.2 Evaluation

Effectiveness

Short- and long-term protection of public health would be poor because an unmitigated source of radioactive contamination would continue to exist in a structure that is in a deteriorated physical condition. Short- and long-term protection of the environment would be poor for the reasons cited above. No reduction in toxicity, mobility, or volume through treatment would occur in this alternative; therefore, it is rated poor.

Because this alternative would leave radioactive substances on property, a review would be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA Section 121(c).

Implementability

This alternative rates good in constructability because no significant changes would be made, and the installation of monitoring equipment would be routine. This alternative is below average in reliability. Although the effort of installing monitoring equipment could be done with complete reliability, the silo structure's roof is at the end of its life and the rest of the structure has a limited life expectancy. Maintenance of the monitors, silos, and berms is relatively routine; therefore this alternative is good for maintenance and monitoring. This alternative is rated poor in regard to agency approvals because no remediation or mitigation would be carried out. The alternative is rated good for implementability because all aspects of the work to be done would be routine. No special engineering and equipment would be required.

Under CERCLA, a reevaluation must be completed every five years because the material is being left in place.

Costs

No costs would be associated with the silo facilities themselves. The total estimated net present worth capital cost for this alternative would be $23,000, with a total net present worth O&M cost of $2.75 million.

5.1.2.3 Additional Data Needs

No additional data are required because no actions would result from their acquisition.

5.1.3 Alternative 1A - Nonremoval and Silo Isolation - Silos 1 and 2

5.1.3.1 Description

The general response action for Alternative 1A requires isolation of Silos 1 and 2 with no requirement for removal and treatment of the waste, berm, and subsoils. Silos 1 and 2 would be utilized as permanent disposal facilities in conjunction with the following additional remedial technology and process options:

- Complete filling of silo void space with structural grout
- Soil-bentonite slurry around the north, east, and south sides of the silos
- Multilayered impermeable cap
- Leachate collection/detection system

The soil in the berm and under Silos 1 and 2 may contain significant levels of Pb-210 and Po-210 from the decay and diffusion of radon. There are no data to confirm or refute this. On-going studies will address the possibility of this concern. Pending verification, it is assumed that the berm material and soils beneath Silos 1 and 2 are not characteristically hazardous.

A temporary batch plant would be established to provide the required structural grout. The structural grout would be injected through the existing silo manways to fill the void spaces of the silos. The grout would serve as a radon barrier and would minimize any possibility of impermeable cap subsidence during construction. To divert subsurface flow around the silos, a soil-bentonite slurry wall would be constructed along three sides of the perimeter of Silos 1 and 2 and would extend into the Great Miami Aquifer. The bentonite would be obtained off site and mixed on-property with existing acceptable soils to produce a three-foot-wide slurry wall with an approximate depth of 50 feet.

A multilayered cap consisting of the following elements would control erosion and minimize generation of leachate as a result of rain water infiltration:

- Upper vegetative layer
- Drainage layer
- Low permeability clay layer with a maximum vertical permeability of 1×10^{-7} cm/s
- Leachate collection/detection system

The combination of the slurry wall and impermeable cap would be designed to minimize exposure of any contaminated material and soil to the environment. The cap would intersect and extend beyond the slurry wall. The impermeable cap would have spatial requirements of approximately 6.5

acres. This would result in the partial relocation of Paddys Run to minimize the possibility of lateral erosion to the cap. Relocation of Paddys Run would require compliance with substantive conditions of the U.S. Army Corps of Engineers (COE) permit program and other environmental constraints. This has an effect on implementability. It is assumed that all general and granular fill and a clay with a vertical permeability of less than 1.0×10^{-7} cm/s are regionally available. Beneath the cap and Silos 1 and 2, a leachate collection/detection system would be placed to collect leachate produced by rain water infiltration.

Additional on-property spatial requirements would be required for mixing the slurry wall constituents, construction equipment, and staging area.

Remediation would take approximately one year from the initial staging of construction.

Subsidence will occur because of the loads imposed from the structural grout and impermeable clay cap placed over the material. Also, leachate will be generated as contaminated pore water is driven from the material in Silos 1 and 2. This could be collected by the leachate collection system and processed by the FMPC wastewater treatment system. During construction, an additional staging area would be required for equipment and construction activities. There would be no packaging requirements.

5.1.3.2 Evaluation

Effectiveness

The short-term effectiveness relating to the protection of human health would be good because there would be no material handling activities; therefore, the associated risks would be nonexistent. It is possible that with dedicated long-term maintenance and monitoring, the long-term effectiveness could be maintained even though the material had not been removed or treated. However, the alternative remains poor in this category because it is uncertain if the containment techniques utilized would prevent contaminant migration over the long term. Leakage of the cap or failure of the slurry wall to function as expected could possibly result in contamination of the groundwater. Data on current contamination levels for the areas under the silos, which would impact the design of the containment technology, are not available.

The short- and long-term effectiveness in the protection of the environment are rated good and poor, respectively, for the reasons stated above. This alternative rates below average in reduction of toxicity, mobility, or volume through treatment. Although the containment provided would reduce the mobility of the contaminants for the short term, there would be no reduction in toxicity or volume (except through subsidence consolidation).

Because this alternative would leave hazardous substances on property, a review would be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA Section 121(c).

Implementability

This alternative rates good in constructability because the technologies are proven and available. The reliability of the operations making up this alternative is above average because the process options are proven technologies. Perpetual maintenance and monitoring would be required to ensure that the RAOs continue to be met. This alternative rates average in this category.

Agency approval for on-property disposal of untreated material in a structure that does not meet RCRA standards will prove to be more difficult to obtain than for removal and/or treatment alternatives. This alternative rates below average in this category. No special engineering, equipment, or technical expertise would be required. This alternative rates good in this category. Partial relocation of Paddys Run has environmental constraints.

Cost

The total estimated net present worth capital cost for this alternative would be $36.88 million with a total net present worth O&M cost of $3.18 million.

5.1.3.3 Additional Data Needs

Additional sampling is required to determine the extent of soil and water contamination and the geochemical behavior of contaminant migration. This applies to all subsequent alternatives.

5.1.4 Alternative 2A - Nonremoval, In Situ Stabilization, and Cap - Silos 1 and 2

5.1.4.1 Description

The general response action for Alternative 2A provides for the stabilization of the material within the confinement of the wall structure of Silos 1 and 2 after removal of the silo dome and before construction of a slurry wall and impermeable cap. The process options considered for the remedial technology of in situ stabilization at this stage of the FS were:

- Vitrification
- Shallow Soil Mixing (SSM)

In situ vitrification was included as an innovative technology. A maximum eight-megawatt electrical power source, melters, fume hood, air pollution control system, and support facilities would be required for the vitrification process. As a result of the process, the walls of the silos and possibly a portion of the berm would be vitrified. A pilot-scale study would be required to determine voltage, intrusion depth, and associated technical criteria for the vitrification process. Presently, the remediation of Silos 1 and 2 based on vitrification would take approximately three years from the initial pilot-scale study and site work to project walkdown. Because of the unknown schedule for full-scale testing, additional time for remediation using vitrification may be needed. Vitrification was screened out as a process option because of the questionable effectiveness of the vitrification process at the depths required (20 and 22 feet for Silos 1 and 2, respectively), substantial testing and development, and the quality assurance required to validate the thoroughness of the process.

As a stabilization technology, SSM of cement and fly ash and the associated construction techniques are proven and effective. Stabilizing agents would be mixed into the material by augers lowered into the silo. The final volume of the contents is estimated to increase by 30 percent, which may require raising the berms to compensate for increased silo wall stresses and to contain the increased volume of material. SSM would be the preferred process option for in situ stabilization.

To accomplish the stabilization process, opening the silos to the atmosphere would be required. Therefore, an EIE would be needed before silo dome removal and material stabilization could begin for containment of the material and protection of public health and the environment (Figure 2-2).

The EIE would be a tension arch structure with a negative internal pressure designed to withstand 100 mph winds. Before installation of the EIE, modification to the existing berm of Silos 1 and 2 would be required, with allowance for a maintenance road around the EIE perimeter. The EIE will enclose 36,400 square feet around Silos 1 and 2 and would require 16,000 square feet for support equipment and facilities. An additional 30,000 square feet would be required for a capping material staging area and grout preparation facilities. The EIE will incorporate a remote-controlled traveling gantry crane, remote control station, and HVAC system. On completion of in situ stabilization processes, if radon levels are found to be unacceptable, a shallow grout pad would be placed over the stabilized material before dismantling the EIE.

The cap and slurry wall construction, configuration, and spatial requirements would be identical to those described in Alternative 1A.

The required remediation time from the initial stabilization pilot-scale study and site work to the final capping would be approximately three years. For this alternative, generated waste would be:

- Water from dehumidification of the EIE air
- Compactable, low-level waste (anticontamination clothing, gloves, HEPA filters, etc.)
- Equipment too contaminated to warrant decontamination

For the EIE process operation, substantive conditions of the existing National Emission Standards for Hazardous Air Pollutants (NESHAP) or National Pollutant Discharge Elimination System (NPDES) permits would be complied with as necessary due to discharge of air and water off the FMPC property. As with Alternative 1A, the relocation of a section of Paddys Run due to the spatial requirements of capping would require compliance with substantive conditions of the COE permit program. Environmental constraints of relocating a section of Paddys Run must be considered.

5.1.4.2 Evaluation

Effectiveness

The short-term effectiveness relating to the protection of human health would be average in that no material would be removed and there would be no risk of a material-handling accident. The use of the EIE would greatly reduce the chance for accidental public exposure during remediation. The long-term effectiveness evaluation of this alternative must take into account the fact that the material would be permanently located over the Great Miami Aquifer and near populated areas. Because the long-term stability of the immobilized material should be quite good, the long-term effectiveness of this alternative is judged to be above average.

Because this alternative would leave radioactive substances on property, a review would be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA Section 121(c). The short-term effectiveness in the protection of the environment would be average for the reasons stated in the previous section. The long-term effectiveness would be above average because the material mobility reduction and the impermeable cap would greatly reduce the migration of contaminants to the air or groundwater. The volume of the silo contents would increase during chemical stabilization. The mobility and toxicity characteristics of the waste would be greatly reduced by the isolation and immobilization technologies employed. This alternative is judged to be above average in reduction of toxicity, mobility, or volume through treatment.

Implementability

The silo isolation and chemical stabilization technologies are proven and known to be effective. The constructability of this alternative would be average. The reliability of this alternative's processes would be average for chemical stabilization. Perpetual maintenance and monitoring would be required to ensure that the RAOs continue to be met. This alternative rates average in this category. Partial relocation of Paddys Run has environmental constraints.

Agency approval of in situ disposition of silo material might prove to be more difficult to obtain than for removal alternatives. This alternative rates below average in this category. The isolation and chemical stabilization technologies identified for this alternative are proven and the required equipment would be readily available, but not for the depths required. This alternative rates poor in this category.

Cost

The total estimated net present worth capital cost for this alternative would be $52.54 million with a total net present worth O&M cost of $3.18 million.

5.1.4.3 Additional Data Needs

Treatability studies would be required to confirm and refine the additives required for a conventional stabilization option.

5.1.5 Alternative 6 - Removal, Treatment, and On-Property Disposal - Silos 1 and 2

5.1.5.1 Description

The general response action for Alternative 6 requires removal, treatment, and on-property disposal of the contents of Silos 1 and 2, the silo structures, and surrounding berms and subsoils (Figure 5-1). To accomplish the general response action, several remedial technologies were investigated including:

- Mechanical removal
- Pneumatic removal

- Hydraulic removal
- Residue stabilization
- Silo demolition
- On-property disposal

The removal of the materials from Silos 1 and 2 could be performed by either mechanical, pneumatic, or hydraulic methods. Mechanical removal of the materials by a backhoe or front-end loader has been eliminated based on the characteristics of the material as well as the geometry of the silo structure. Observations made during sampling as well as an initial inspection of the samples obtained indicate that the material may be in the form of a slurry under a layer of surface crust. Material in this form would be very difficult to handle in a controlled manner with a backhoe or front-end loader. Also, due to the geometry of each silo (80-foot diameter, 28-foot depth), the material may not be accessible by backhoe, and placement of a backhoe on the berm near a silo could lead to the collapse of the silo wall.

A dragline would not be effective for removing the silo material for the same reasons as mentioned for the backhoe. A dragline is most effective in large open areas. Thus, the method of operating a dragline would restrict the amount of material that would be removed from a silo. Also, as with the backhoe, operating a dragline from the berm could lead to the collapse of the silo wall.

A clamshell operated from an overhead gantry likely would be the most effective means of mechanically removing the silo material if the material is not in the form of a slurry. It could also be used to remove dome debris and silo wall material after demolition.

Pneumatic removal of the materials also has been eliminated as a removal option because the material is wet. Conversely, hydraulic removal of the material should be very effective because the material is already wet. Hydraulic mining also lends support to stabilization by cement because of the addition of water to the material. A hydraulic mining head/pump would be suspended over the surface of the material by a gantry. The gantry provides flexibility in placing the mining head/pump over the entire exposed surface of the silo materials. The main component of a hydraulic mining system would be a pump that removes slurried material. Attached to the suction of the pump is a jetting ring and, as an option, a mechanical cutting head (Figure 2-8).

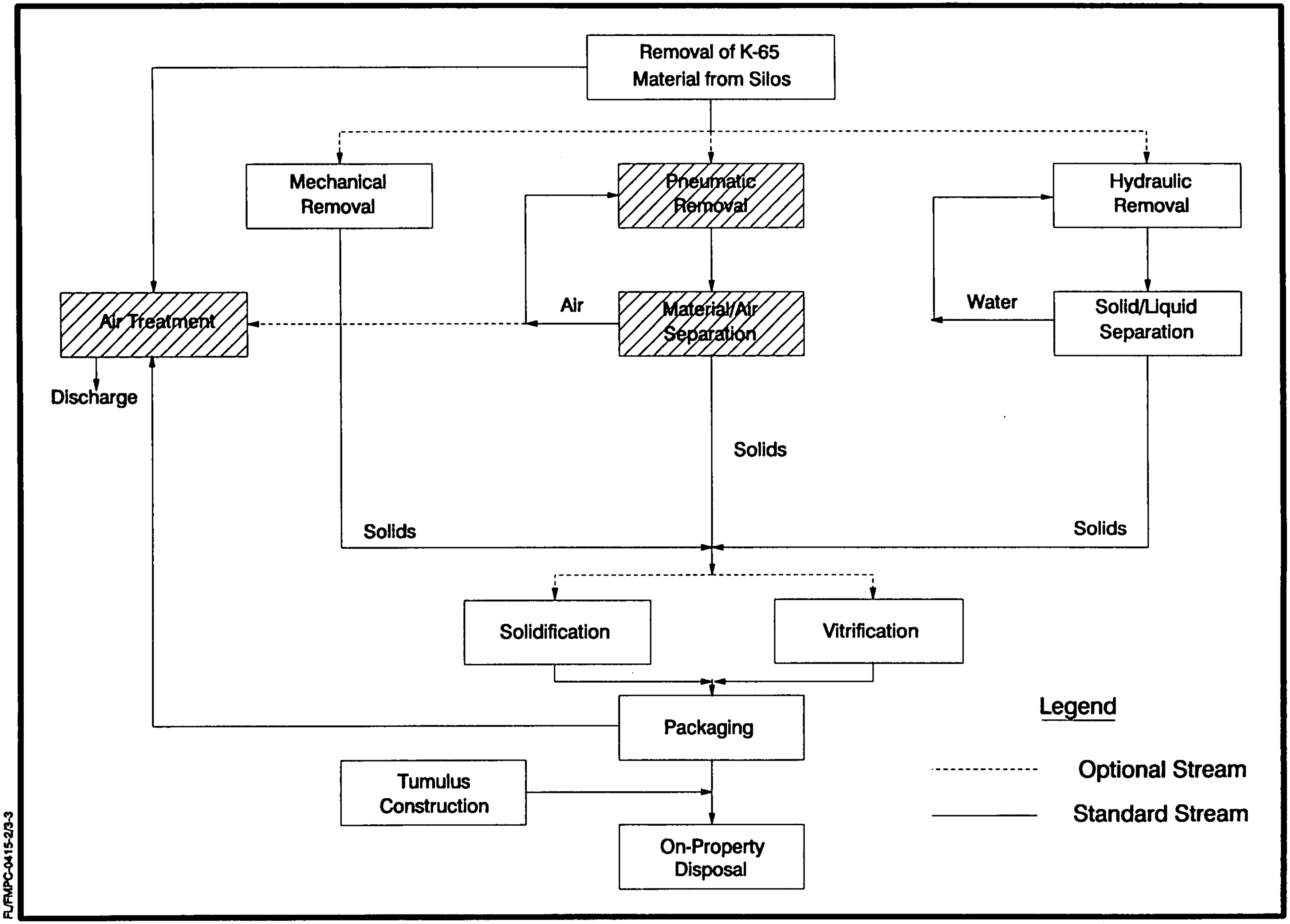

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FIGURE 5-1. ALTERNATIVE 6 - REMOVAL, TREATMENT, ON-PROPERTY DISPOSAL - SILOS 1 AND 2

Stabilization process options investigated were asphalt-based solidification, cement-based solidification, thermoplastic encapsulation, and vitrification. Because the silo materials are high in silica content, the most applicable stabilization technologies are vitrification and stabilization with cement and fly ash. The other technologies (asphalt encapsulation and thermoplastic encapsulation) would require additional costs and material handling (dewatering and heating) without providing adequate protection of public health and the environment. However, polymers may be added as an aid in the cement/fly ash stabilization. Although additional handling is required for ex situ vitrification, the waste material volume is also reduced. Therefore, vitrification will be further evaluated.

On-property disposal process options considered are an above grade vault, temporary storage, and a tumulus. An on-property tumulus or above grade waste disposal facility could be constructed. The proposed tumulus disposal concept basically consists of mounding over material that has been placed on a stable structural pad. The above grade structure is a reinforced vault-like concrete structure designed for permanent material disposal. Both the tumulus and the aboveground structure would accept only dry material placed in noncorrosive containers and/or highly stabilized/solidified material forms (Figure 2-10).

This alternative would require the provision of an EIE, an on-property engineered disposal facility, stabilization equipment (conventional or vitrification), a packaging method, and miscellaneous utilities. Material removal equipment required would be a water supply system for hydraulic removal and an air supply and an air treatment system for vacuum removal. A program for long-term maintenance and environmental monitoring would be necessary.

The selected method of material removal would have a bearing on the size and configuration of equipment installed. Material characterization is not yet complete, and the results of scheduled sampling activities would have an effect on the material handling, packaging, air, and water treatment systems design. Each of the removal methods described earlier would be designed to handle one to five cubic feet of material per minute.

If hydraulic removal is used, the large majority of the water used in the removal process would be recycled through the cutting head. Thus, under the worst scenerio, only the water occupying the process equipment would need treatment for discharge at the end of the operations. Chemical stabilization would use essentially all removal process water in the solidification mixture. Vitrification would not result in a net water demand during the operations.

Conventional stabilization would require process equipment including mixers, conveyors, and some type of automated packaging equipment. Vitrification would require specialized equipment such as a glass melter, fume hood/cap, and an air pollution control system. Either of these stabilization methods would require support facilities separate from those supporting removal activities.

Installation of the EIE, including all removal, stabilization, and packaging equipment, would take approximately five months. Removal of the material, processing, and packaging would take an additional 18 months. Demolition and disassembly/demobilization would require approximately six months. During this time, the on-property disposal facility would be prepared to receive waste. The total remediation time for this alternative would be approximately three years.

The spatial requirements would be:

- 36,400 square feet (260 feet x 140 feet) - EIE
- 10,000 square feet (100 feet x 100 feet) - process/packaging building adjacent to the EIE
- 15 acres - tumulus or equivalent engineered disposal facility

The packaging of the material for on-property disposal would be performed in an enclosed facility to prevent accidental release of radioactive material to the environment.

The waste generated for this alternative would be:

- Water from dehumidification of EIE air
- Compactable low-level waste (anticontamination clothing, gloves, HEPA filters, etc.)
- Equipment too contaminated to warrant decontamination

For any air emissions or water discharge, substantive conditions of the NESHAP and NPDES permits would be complied with.

5.1.5.2 Evaluation

Effectiveness

The short-term public health effectiveness would be average because of the risks associated with the material handling during removal, treatment, and movement of the silo residues. The long-term public health effectiveness would be above average because even though the waste is stabilized, the fact that it would be disposed of in a tumulus over the Great Miami Aquifer is a shortcoming.

The short-term environmental protection of this alternative would be below average because of impacts due to material handling and enclosure and tumulus construction. The long-term environmental protection effectiveness of this alternative would be above average because the waste mobility reduction and impermeable clay cap of the on-property tumulus would greatly reduce the potential for the migration of contaminants to the air or groundwater.

Because this alternative would leave hazardous substances on property, a review would be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA Section 121(c).

Overall, this alternative is judged to be above average in the effectiveness category because of the significant decrease in the mobility of the material provided by the stabilization or vitrification techniques. Although the toxic content of the material would not be reduced, the toxicity characteristic would be greatly reduced. The volume of the disposed material would increase if the stabilization option is selected.

Implementability

Although the technologies presented would be available and proven, the treatment processes might require special design and engineering. This alternative rates average in constructability. The reliability of this alternative is judged to be good because the steps to be taken are proven technologies. Perpetual maintenance and monitoring would be required to ensure that the on-property disposal facility would continue to meet the RAOs. This alternative is rated average in maintenance/operation. Agency approval to permanently store stabilized silo material above the Great Miami Aquifer might prove to be difficult even though the material would have been treated. This alternative is rated below average in this category.

Special design and engineering of the treatment processes and specialized handling and treatment equipment might be required. The technology and equipment are generally available and proven; therefore, this alternative rates average in this category.

Cost

The total estimated net present worth capital cost for the cement-based stabilization alternative would be $32.35 million with a total net present worth O&M cost of $2.48 million. The total estimated net present worth capital cost for vitrification would be $35.05 million with a total net present worth O&M cost of $3.09 million.

5.1.5.3 Additional Data Needs

Treatability studies would be required to determine process parameters for stabilization or vitrification, such as type and quantity of the required additives.

5.1.6 Alternative 7 - Removal, Treatment, and Off-Site Disposal - Silos 1 and 2

5.1.6.1 Description

The general response action for Alternative 7 is identical to Alternative 6 with the exception that treated material would be disposed of off site instead of on property (Figure 5-2).

The removal and treatment technologies and process options investigated and determined to be viable for Alternative 6 also would be applicable to Alternative 7. Off-site disposal process options investigated were rail transport and truck transport. Both options are potentially applicable to this alternative.

This alternative would require the provision of an EIE, an approved disposal facility, stabilization equipment (conventional or vitrification), a packaging and shipping method, and miscellaneous utilities. Material removal equipment required would include a water supply system for hydraulic removal. The configuration, required equipment, and capacities for the removal methods would be identical to those for Alternative 6 and will not be described here. The material handling, packaging, and treatment system designs would be dependent on material characterization, which has not yet been completed.

Conventional stabilization would require process equipment that includes driers, mixers, conveyors, and some type of automated packaging equipment. Vitrification would require specialized equipment such as a glass melter, fume hood/cap, and an air pollution control system. Either of these stabilization methods would require separate additional support facilities, besides those supporting removal activities.

Installation of the EIE, including all removal, stabilization, and packaging equipment, would take approximately five months. Removal of the material, processing, and packaging would take an

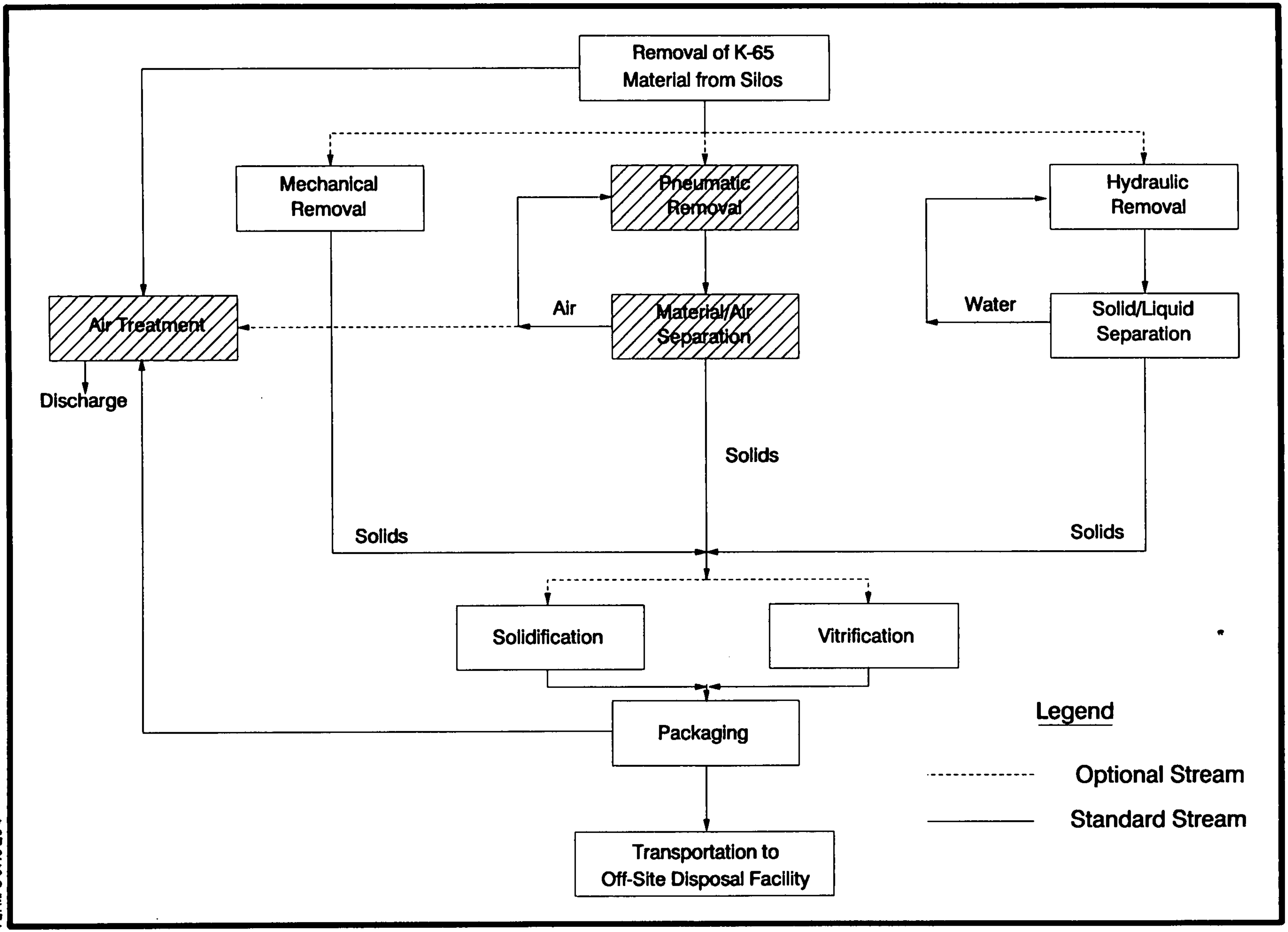

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FIGURE 5-2. ALTERNATIVE 7 - REMOVAL, TREATMENT, OFF-SITE DISPOSAL - SILOS 1 AND 2

additional 18 months. Demolition and disassembly/demobilization would require approximately six months. The total remediation time for this alternative would be approximately three years.

The spatial requirements would be:

- 36,400 square feet (260 feet x 140 feet) - EIE
- 10,000 square feet (100 feet x 100 feet) - Process/packaging building adjacent to the EIE

The packaging options available for the treated Silos 1 and 2 material would be LSA containers and Type B containers. Type A quantities and limited quantities would not be considered for the reasons mentioned previously.

- LSA - To meet the LSA limits, the material would have to be blended with material of a lesser activity. One choice for this material is the silo berm as it might be slightly contaminated and also would require disposal. LSA boxes measuring 96 cubic feet could be used for this disposal option.

- Type B - No material blending would be required for shipment as a Type B quantity as there are no activity limits for Type B packages. The material would be placed in 55-gallon drums and packaged into Type B overpacks.

The material, regardless of the packaging option selected, would be transported by truck or rail to an approved disposal facility.

The waste generated for this alternative would be:

- Water from dehumidification of EIE air
- Compactable low-level waste (anticontamination clothing, gloves, HEPA filters, etc.)
- Equipment too contaminated to warrant decontamination

In the event of air emissions or water discharge, substantive conditions of the existing NESHAP or NPDES permits would be complied with. Permits/licenses would be required to transport the material to an approved disposal facility.

5.1.6.2 Evaluation

Effectiveness

The short-term public health effectiveness of this alternative is average because of the removal, treatment, and other miscellaneous material handling operations that would increase the risk of a handling accident and subsequent public exposure. Additional risk of public exposure would be incurred during material transport to the disposal facility. Long-term public health effectiveness of this alternative is good because the treated material would be disposed of in a facility likely to be more geographically remote from population centers and located in a more suitable environment.

The short-term environmental protection effectiveness of this alternative is average for the reasons stated above. The long-term environmental protection effectiveness of this alternative is good due to the disposal of the treated material in a preferred geologic setting that experiences little precipitation.

The contaminants could be immobilized by both conventional stabilization and vitrification, although no reduction in toxicity or volume would be realized. Conventional stabilization would actually increase the volume of the disposed waste. This alternative is rated good in this category due to its immobilization potential.

Implementability

This alternative is identical to Alternative 6 in constructability and is rated average.

This alternative has certain difficulties inherent in effecting the disposal of the silo material. It, nevertheless, rates above average in reliability.

The option would involve locations that are already permitted and have both institutional and physical controls in place. Thus, the entire permit/hearing process would be avoided, as well as the engineering and construction of the local on-property engineered disposal facility. Therefore, it would require no local operation and maintenance efforts. This alternative rates good in maintenance and operation.

Numerous regulatory requirements would have to be satisfied before shipping the radioactive material to the disposal site, including acceptance by states through which the material may be transported. This alternate rates average in agency approvals.

This alternative is identical to Alternative 6 in special engineering and equipment and is rated average.

Cost

The total estimated net present worth capital cost for cement-based stabilization alternatives would be $69.46 million with a total net present worth O&M cost of $720,000.

The total estimated net present worth capital cost for the vitrification alternative would be $68.31 million with a total net present worth O&M cost of $1.64 million.

Transportation costs were estimated assuming shipment of residues in Type B containers.

5.1.6.3 Additional Data Needs

Treatability studies would be required to determine the effectiveness of the process options and to determine process parameters.

5.1.7 Alternative 8 - Removal, Contaminant Separation, and On-Property Disposal - Silos 1 and 2

5.1.7.1 Description

The general response action for Alternative 8 is identical to Alternative 6 with the addition of a contaminant separation process (Figure 5-3). The separation of radioactive and hazardous components from the nonhazardous components in the Silos 1 and 2 material would greatly reduce the volume of material to be disposed of as low-level radioactive waste. This process is not likely to be effective for separation of contaminants present in the silo walls and the surrounding soil and berm wall. Although this may be a more expensive alternative to implement, the reduced volume of radioactive and hazardous material would greatly reduce the final disposal and transportation costs, which are the major costs of the other disposal alternatives.

Research is available on various leaching methods used on uranium mill tailings. The leaching method chosen for the separation of this material is a nitric acid leaching process. A salt leach or hydrochloric acid leaching process would be less effective due to the high quantity of lead present in the material. Lead is present mainly as Pb-210, a radioactive isotope, and Pb-206. Lead in concentrations exceeding the toxicity characterization level as defined by RCRA make it a hazardous waste. The lead would be removed efficiently by either of the latter leaching methods.

The material would be received as a slurry. The slurry might have to be dewatered before initial treatment. Contaminant separation would utilize process technologies demonstrated to be effective in previous applications (Seely 1977; Mound Laboratories 1951; Battelle 1981). The process would

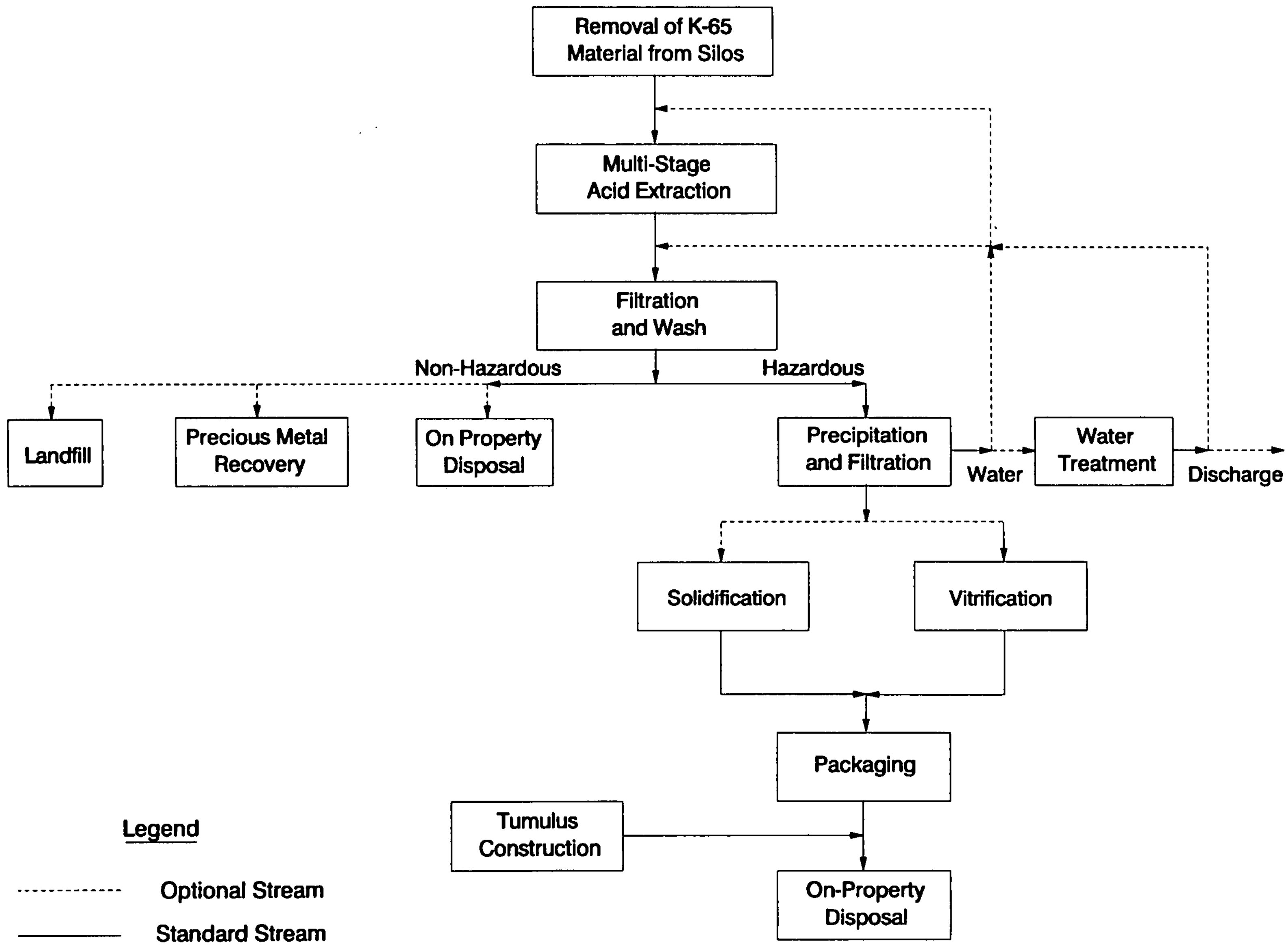

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FIGURE 5-3. ALTERNATIVE 8 - REMOVAL, CONTAMINANT SEPARATION, ON-PROPERTY DISPOSAL - SILOS 1 AND 2 begin with a multistage, nitric acid leaching that would dissolve the uranium, radium, and lead, the major radionuclides of concern. This leaching process would also dissolve the barium, calcium, iron, nickel, and copper. The lead, barium, nickel, and copper are the primary hazardous constituents in the material. To assist in the solubilization of the uranium, it might be necessary to add an oxidizing agent as well as hydrochloric acid, both of which have been shown to improve leaching effectiveness. Although the chemistry of these reactions is fairly well known, this leaching step would require laboratory bench-scale testing to confirm the effectiveness of the leaching. The bench-scale tests would also help in estimating acid requirements and quantity of sludge generated.

After leaching, the mixture would be filtered and washed to remove the dissolved components from the remaining sludge. The filtrate containing the hazardous and radioactive components would be treated with sodium hydroxide, sodium carbonate, and/or sodium sulfate/phosphate to a pH of about 10.5 to precipitate the lead, barium, radium, uranium, nickel, and copper. This process would also precipitate calcium and some iron. The supernatant water would be recycled or treated before discharge. The precipitated sludge would be solidified or vitrified as previously described.

If the initial leaching is sufficiently effective, the remaining washed material would be considered nonhazardous, which would allow low-cost disposal in a nonhazardous landfill. As this material contains approximately $10 million worth of precious metals (gold, platinum, and palladium), an option in lieu of disposal could be the recovery of these metals by smelting. Gold exists in the material at a ratio of 1.36 troy ounces per ton and is routinely recovered in ores containing as little as 0.1 troy ounce per ton. The silos contain approximately 12,000 troy ounces of gold, 2700 troy ounces of platinum, and 35,000 troy ounces of palladium. The material could be sold to a smelter for recovery. An on-property smelting operation would not be cost-effective due to the relatively small quantities involved.

This alternative would require the provision of an EIE, a tumulus or similar aboveground engineered disposal facility, packaging facilities, material removal and handling equipment, material treatment and contaminant-separation equipment, and miscellaneous utilities. Treatability tests for leaching and separation would also be required.

The material removal method and stabilization option selected would have a bearing on the size and configuration of the equipment installed. The configuration, required equipment, and capacities for the removal methods would be identical to that for Alternative 6 and will not be described here.

Conventional stabilization would require process equipment including driers, mixers, conveyors, and some type of automated packaging equipment. Vitrification would require specialized equipment such as a glass melter, fume hood/cap, and an air pollution control system. Either of these stabilization methods would require support facilities separate from those supporting removal activities.

The contaminant separation equipment would likely consist of a series of agitated batch tanks, precipitation tanks, and associated piping and hardware. The equipment would be remotely operated in a separate material processing building.

Installation of the EIE, including all of the removal, stabilization, contaminant separation, and packaging equipment, would take approximately five months. Removal of the material, treatment/separation, and packaging would take an additional 18 months. Demolition and disassembly/demobilization would require approximately six months. The total remediation time for this alternative would be approximately three years.

The spatial requirements are as follows:

- 36,400 square feet (260 feet x 140 feet) - EIE
- 14,400 square feet (120 feet x 120 feet) - process/packaging building adjacent to EIE
- Eight acres - tumulus or equivalent

The packaging of the Silos 1 and 2 material containing hazardous components for on-property disposal would be performed in an enclosed facility to prevent accidental release of radioactive material to the environment. Good engineering practices emphasizing compatibility between the container and material, as well as package retrievability, would be followed when choosing a container. LSA or Type B containers would be used depending on the concentration of the radionuclides in the final waste form.

The waste generated for this alternative would be:

- Wastewater from hydraulic removal method (recycled where possible)
- Water from dehumidification of EIE air
- Neutralized nitric acid waste stream to be treated in the on-property biodenitrification pond and compactable, low-level waste (anticontamination clothing, gloves, HEPA filters, etc.)

In the event of air emissions or water discharge, substantive conditions of the existing NESHAP or NPDES permits would be complied with.

5.1.7.2 Evaluation

Effectiveness

The short-term effectiveness for protecting human health is average because of the material handling involved during removal, treatment, contaminant separation, packaging, and disposal. The long-term effectiveness is above average. The material has been treated, immobilized, reduced in volume, and placed in an engineered secure disposal facility. However, the continued presence of this concentrated material on property is a disadvantage.

The short- and long-term effectiveness for protecting the environment is above average for the reasons stated above.

This alternative is good in the category of reduction in toxicity, mobility, or volume through treatment because it very effectively reduces the volume and mobility through contaminant separation and stabilization/vitrification. The resultant radioactive residues, although greatly reduced in volume, would be more concentrated in its separated form.

Implementability

Proven extraction technologies and equipment exist. Specific process design parameters for each technology would be determined through treatability studies. The treatment and contaminant separation processes would require detailed design and engineering. Constructability rates average for this alternative.

This alternative is above average in reliability because of the use of proven technologies and the effective treatment and disposal of silo materials.

Because this alternative would leave hazardous substances on-property, a review would be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA Section 121(c).

Perpetual maintenance and monitoring would be required to ensure that the on-property disposal facility continued to meet the RAOs. This alternative rates average in this category.

This alternative is average in agency approvals because, in spite of the effective treatment and stabilization, it would provide a lower level of long-term human health and environmental protection due to on-property disposal.

This alternative rates average in special engineering and equipment. The stabilization and contaminant separation processes would require treatability studies and special design and engineering.

Cost

The total estimated net present worth capital cost for this alternative would be $35.28 million with a total net present worth O&M cost of $2.25 million.

5.1.7.3 Additional Data Needs

As previously stated, the stabilization and contaminant separation processes would require treatability studies to determine effectiveness and process parameters.

5.1.8 Alternative 9 - Removal, Contaminant Separation, and Off-Site Disposal - Silos 1 and 2

5.1.8.1 Description

The general response action for Alternative 9 is identical to Alternative 8 with the exception that the treated material would be disposed of off site (Figure 5-4). The disposal process options investigated were rail transport and truck transport. Both options are potentially applicable to this alternative.

This alternative would require the provision of an EIE, material removal and handling equipment, treatment and contaminant separation equipment, treatability testing for leaching and separation, a packaging and shipping method, and miscellaneous utilities. An approved disposal facility would also be required. The material removal method and stabilization option selected would have a bearing on the size and configuration of the equipment installed. The configuration, required equipment, and capacities for the removal methods would be identical to that for Alternative 8 and will not be described here.

Conventional stabilization would require process equipment that includes driers, mixers, conveyors, and some type of automated packaging equipment. Vitrification would require specialized equip

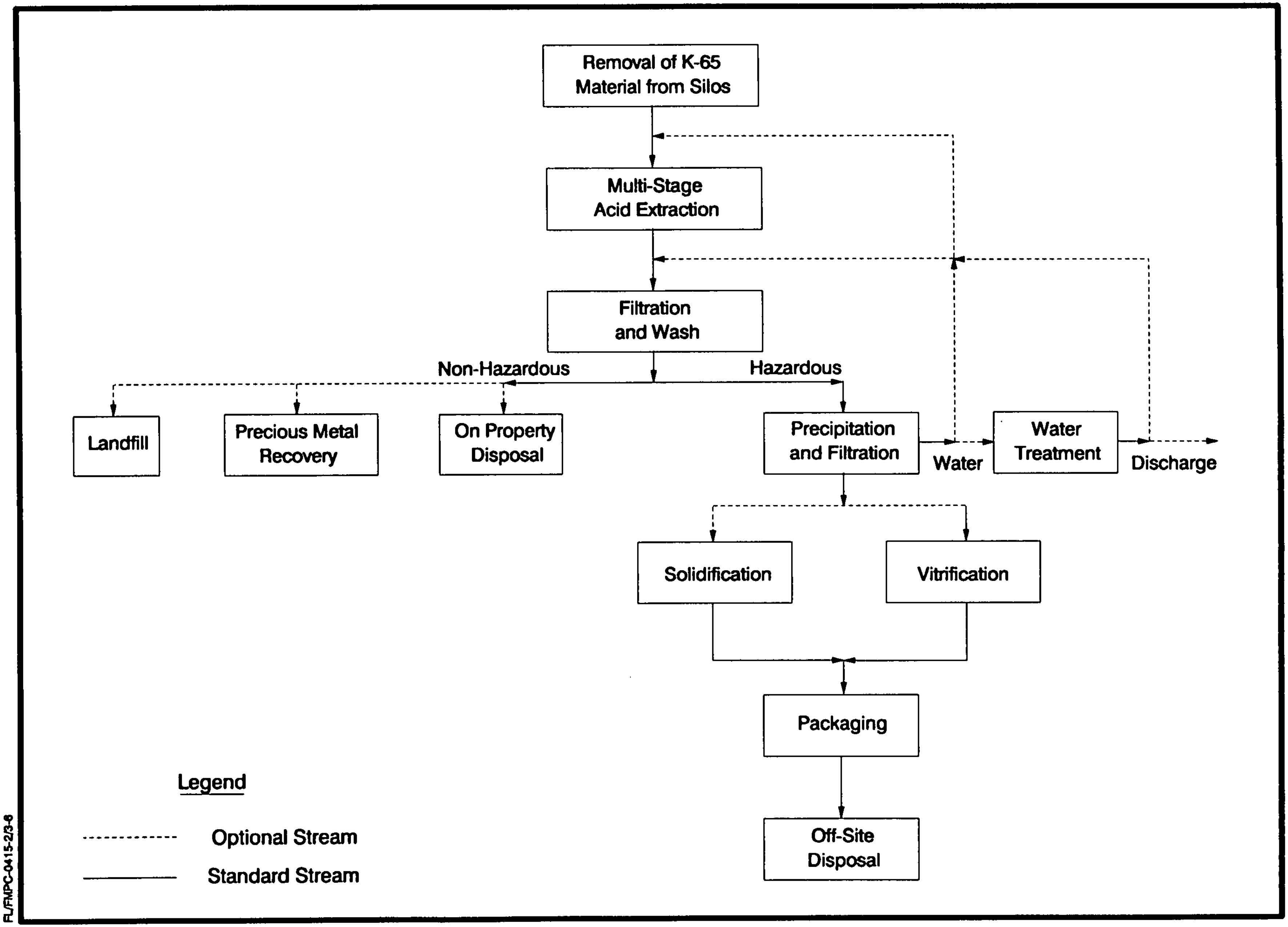

FIGURE 5-4. ALTERNATIVE 9 - REMOVAL, CONTAMINANT SEPARATION, OFF-SITE DISPOSAL - SILOS 1 AND 2

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ment such as a glass melter, fume hood/cap, and an air pollution control system. Either of these stabilization methods would require support facilities separate from those supporting removal activities.

The contaminant separation equipment would likely consist of a series of agitated batch tanks, precipitation tanks, and associated piping and hardware.

Installation of the EIE, including all of the removal, stabilization, contaminant separation, and packaging equipment, would take approximately five months. Removal of the material, treatment/separation, and packaging would take an additional 18 months. Demolition and disassembly/demobilization would require approximately six months. The total remediation time for this alternative would be approximately three years.

The spatial requirements would be as follows:

- 36,400 square feet (260 feet by 140 feet) - EIE
- 14,400 square feet (120 feet x 120 feet) - process/packaging building adjacent to EIE

No material blending would be required for shipment of the residual waste as Type B quantities because there are no activity limits for Type B packaging. The residual waste would be placed in 55-gallon drums and packed into Type B overpacks. The less-contaminated, but radioactive berm material could be shipped as LSA quantities in 96-cubic-foot LSA boxes. Both the LSA boxes and Type B overpacks would be transported by truck or rail to an approved disposal facility.

The generated waste for this alternative would be:

- Wastewater from the hydraulic removal method (recycled where possible)
- Water from dehumidification of EIE air; nitric acid waste stream to be treated in the on-property biodenitrification pond
- Compactable, low-level waste (anticontamination clothing, gloves, HEPA filters, etc.)
- Equipment too contaminated to warrant decontamination.

In the event of air emissions or water discharge, substantive conditions of the existing NESHAP or NPDES permits would be complied with. Permits/licenses would be required to transport the material to an approved disposal facility.

5.1.8.2 Evaluation

Effectiveness

This alternative's short-term effectiveness for protecting human health is average because of the extensive material handling required and the long-distance transportation of the material to a disposal facility. The long-term effectiveness is good because the disposal of the material is in a facility likely to be more geographically remote from population centers and located in a more suitable environment.

The short-term protection of the environmental is average for the reasons stated in the previous section. The long-term effectiveness is good because the disposal of the treated and separated material would be in a geologically stable facility that experiences little precipitation.

This alternative is good in reduction in toxicity, mobility, or volume through treatment because it very effectively reduces the volume and mobility through contaminant separation and stabilization/vitrification. The resultant radioactive waste, although greatly reduced in volume, would be more concentrated in its separated form.

Implementability

The technologies presented are available and proven, although the treatment and contaminant separation processes will require detailed design and engineering. Constructability rates average in this alternative.

This alternative ranks good in reliability because of the use of a permitted disposal facility.

This alternative ranks good in maintenance and operation. The option would involve locations that are already permitted and have both institutional and physical controls in place. Thus, the entire permit/hearing process would be avoided, as well as the engineering and construction of the local on-property facility. Therefore, it would require no local operation and maintenance efforts. This alternative rates good in maintenance and operation.

This alternative rates average in agency approvals. There would be numerous regulatory requirements to satisfy before shipping the radioactive material, including acceptance by states through which it may be transported.

This alternative rates average in special engineering and equipment. The stabilization and contaminant separation processes would require treatability studies and detailed design and engineering.

Cost

The total estimated net present worth capital cost for this alternative would be $52.27 million with a total net present worth O&M cost of $714,000. Costs were estimated using Type B shipping containers for transporting the material.

5.1.8.3 Additional Data Needs

The stabilization and contaminant separation processes would require treatability studies to determine effectiveness and process parameters.

5.2 ALTERNATIVES - SILO 3

5.2.1 Introduction

Alternatives have been developed to provide a number of possible approaches to meeting the RAOs of Silo 3, which contains metal oxide material. In addition to the no-action alternative, two alternatives that do not call for the removal of the metal oxide material are proposed. Alternative 1B would provide enhancement of the physical integrity of the existing silo to permit its use as a permanent disposal facility. Alternative 2B would take the approach of stabilizing or vitrifying the material in place in the silo.

Three alternatives that include the removal of metal oxide material from Silo 3 are offered. Alternative 3 would remove and treat the material and prepare it for placement in an on-property engineered disposal facility. Alternative 4 would follow similar procedures except that the treated material would be transported off site. Alternative 5 would permanently store the waste in rehabilitated Silo 3 or 4. Any contaminated perched water encountered during the removal of the silos, silo contents, berms, or contaminated subsoils would be pumped and treated in the FMPC advanced wastewater treatment system or in the proposed site-wide water treatment system. The following sections provide detailed descriptions of these alternatives, the evaluations including estimated costs, and the relative screening results.

5.2.2 Alternative 0B - No Action

5.2.2.1 Description

This alternative is the no-action alternative and provides a baseline against which the other alternatives can be compared. It provides for the silo and the silo material to remain as they are without the implementation of any removal, treatment, containment, or mitigating technologies, but includes the installation of long-term monitoring equipment.

This alternative would require the provision of groundwater monitoring stations, air monitors for radioactivity, area radiation monitors, and a silo maintenance program. The necessary monitoring equipment could be installed within six months. No change in the present site characteristics would be made. No additional space would be needed; the space taken by monitoring equipment would be within the existing silo area and would be inconsequential. No new waste would be generated. No permits would be required.

5.2.2.2 Evaluation

Effectiveness

Short- and long-term protection of public health would be poor because an unmitigated source of radioactive contamination would continue to exist in a structure that is in poor physical condition. Short- and long-term protection of the environment would be poor for the same reasons.

No reduction in toxicity, mobility, or volume through treatment would occur in this alternative; therefore it is rated poor.

Because this alternative would leave hazardous substances on property, a review would be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA Section 121(c).

Implementability

This alternative rates good in constructability because no significant changes would be made and the installation of monitoring equipment would be routine. This alternative is below average in reliability. Although the effort of installing monitoring equipment could be done with complete reliability, the silo structures have a limited and poorly defined life expectancy. Maintenance of the monitors, silos, and berms is relatively routine; therefore, this alternative ranks good. This alternative is rated poor in regard to agency approvals because no remediation or mitigation would be carried out. No special engineering and equipment would be required; therefore, the alternative is rated good in this category. All aspects of the work to be done would be routine.

Cost

The total estimated net present worth capital cost for this alternative would be $23,000 with a total net present worth O&M cost of $2.12 million.

5.2.2.3 Additional Data Needs

None required.

5.2.3 Alternative 1B - Nonremoval and Silo Isolation - Silo 3

5.2.3.1 Description

The general response action for Alternative 1B is identical to Alternative 1A with the following exceptions. Silo 3 lacks a berm such as the one surrounding Silos 1 and 2; therefore, it will require additional fill material in construction of the impermeable cap. Due to the difference in the nature of material stored in Silo 3 (metal oxide) versus Silos 1 and 2 (K-65), the concern for lead contamination of the surrounding soil does not exist.

The impermeable cap would have a spatial requirement of approximately four acres. As a consequence of a lesser cap size, the remediation from initial staging of construction through a project walkdown would take approximately eight months.

This alternative would require the construction of an impermeable clay cap, slurry wall, and grouting of the void space under the dome, the partial relocation of Paddys Run, and the provision of a leachate collection system. A long-term maintenance and environmental monitoring program would need to be established.

Remediation would take approximately one year from the initial staging of construction equipment to final closure of the silos. The impermeable cap would cover approximately four acres. The partial relocation of Paddys Run would require compliance with substantive conditions of the COE permit program and other environmental constraints. Under this alternative no waste would be generated. During construction, a staging area for equipment would be required. There would be no packaging requirements.

5.2.3.2 Evaluation

Effectiveness

Because there are no material handling activities, none of the associated risks would be present. The short-term effectiveness for protection of human health would be good. Due to the uncertainty that the containment techniques utilized would prevent contaminant migration, the long-term effectiveness for this alternative ranks poor. Leakage of the cap or failure of the slurry wall to function as expected could possibly result in groundwater contamination. Data on current contamination levels for the areas under the silos are not available. They could affect the design of the containment technology.

Because this alternative would leave hazardous substances on-property, a review would be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA Section 121(c).

For the reasons stated above, this alternative rates good and poor, for short- and long-term effectiveness in protecting the environment. This alternative rates average in reduction in toxicity, mobility, or volume through treatment because, although the containment provided would reduce the mobility of the contaminants for the short term, there is no reduction in toxicity or volume (except through subsidence/consolidation).

Implementability

This alternative rates good in constructability because the technology is available and proven. The reliability of the operations making up this alternative is above average. Perpetual maintenance, monitoring, and the required five-year review would be required to ensure that the remedial action objectives continue to be met. This alternative rates average in this category.

Agency approval for on-property disposal of untreated material might prove to be more difficult to obtain than for removal and/or treatment alternatives. This alternative rates below average in this category. Partial relocation of Paddys Run has environmental constraints.

No special engineering, equipment, or technical expertise would be required. This alternative is rated good in this category.

Cost

The total estimated net present worth capital cost for this alternative would be $30.26 million with a total net present worth O&M cost of $2.61 million.

5.2.3.3 Additional Data Needs

Additional sampling is required to determine the extent of soil and groundwater contamination, the behavior of contaminant migration, and the physical properties of the soil. This applies to all subsequent alternatives.

5.2.4 Alternative 2B - Nonremoval, In Situ Stabilization, and Cap - Silo 3

5.2.4.1 Description

This nonremoval alternative for Silo 3 is similar to Alternative 2A for Silos 1 and 2. It provides for the stabilization and isolation of the silo contents. In situ chemical stabilization would be utilized in addition to capping and slurry walls.

Because the treatment of the material would require that the silo be open to the atmosphere, an EIE, separate from Silos 1 and 2, would be necessary for containment and protection of public health.

Following the installation of the EIE, the silo dome would be removed and the material stabilized. The volume increase associated with stabilization would require berm extension. A slurry wall would be installed to provide an additional barrier to prevent contaminant migration. The cap would be identical to that required for Alternative 1B.

This alternative would require the construction of an EIE. The EIE would require approximately 19,600 square feet. It would utilize earth moving equipment as well as stabilization equipment and miscellaneous utilities. A long-term maintenance and environmental monitoring program would be necessary. Conventional stabilization would require augers and mixers. Stabilization technologies require about 16,000 square feet for support facilities.

The remediation of the silo based on stabilization would take approximately two to three years from the initial pilot-scale study and site work to final capping.

The waste that would be generated for this alternative would be:

- Water from dehumidification of EIE air
- Compactable, low-level waste (anticontamination clothing, gloves, HEPA filters, etc.)
- Equipment too contaminated to warrant decontamination

In the event of air emissions or water discharge, substantive conditions of the existing NESHAP or NPDES permits would be complied with. The relocation of Paddys Run would require compliance with substantive conditions of the COE permit program and other environmental constraints.

5.2.4.2 Evaluation

Effectiveness

The short-term effectiveness for protecting human health would be average in that no material is removed and there would be no risk of a material handling accident. The use of the EIE would greatly reduce the chance for accidental public exposure during remediation. The long-term effectiveness evaluation of this alternative must take into account the fact that the material would be permanently located over the Great Miami Aquifer and near a populated area. Because the long-term stability of the immobilized residue should be quite good, the long-term effectiveness of this alternative is judged to be above average.

The short-term effectiveness for protecting the environment would be average for the reasons stated in the previous section. The long-term effectiveness would be above average because the waste mobility reduction and the impermeable cap would greatly reduce the migration of contaminants to the air or groundwater. The volume of the silo waste would increase during chemical stabilization, but the mobility and toxic characteristics of the waste would be greatly reduced. This alternative is judged to be above average in reducing the toxicity, mobility, or volume through treatment.

Because this alternative would leave hazardous substances on-property, a review would be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA Section 121(c).

For a nonremoval alternative, with its immobilization and isolation of the residues, this alternative would provide above-average long-term public health and environmental protection. However, perpetual maintenance and monitoring coupled with the possibility of future remediation make this alternative one of the least favorable.

Implementability

The silo isolation and chemical stabilization technologies are proven and known to be effective. The constructability of this alternative would be average. The reliability of this alternative's process would be average for chemical stabilization. This alternative rates average in maintenance/ operations because perpetual maintenance and monitoring would be required to ensure that the RAOs continue to be met. Agency approval for on-property disposal might prove to be more difficult to obtain than for removal alternatives. This alternative rates below average in this category. Partial relocation of Paddys Run has environmental constraints.

This alternative rates poor in relation to special engineering and equipment. The isolation and chemical stabilization technologies identified for this alternative are proven and the required equipment normally would be readily available but not for the depths required. Chemical stabilization would require substantial testing and development.

Cost

The total estimated net present worth capital cost for this alternative would be $32.24 million with a total net present worth O&M cost of $2.61 million.

5.2.4.3 Additional Data Needs

Treatability studies would be required to confirm and refine the conventional stabilization option.

5.2.5 Alternative 3 - Removal, Treatment, and On-Property Disposal - Silo 3

5.2.5.1 Description

The general response actions for Alternative 3 are removal, treatment, and disposal of Silo 3 materials (Figure 5-5).

To accomplish the general response action, several remedial technologies were investigated including:

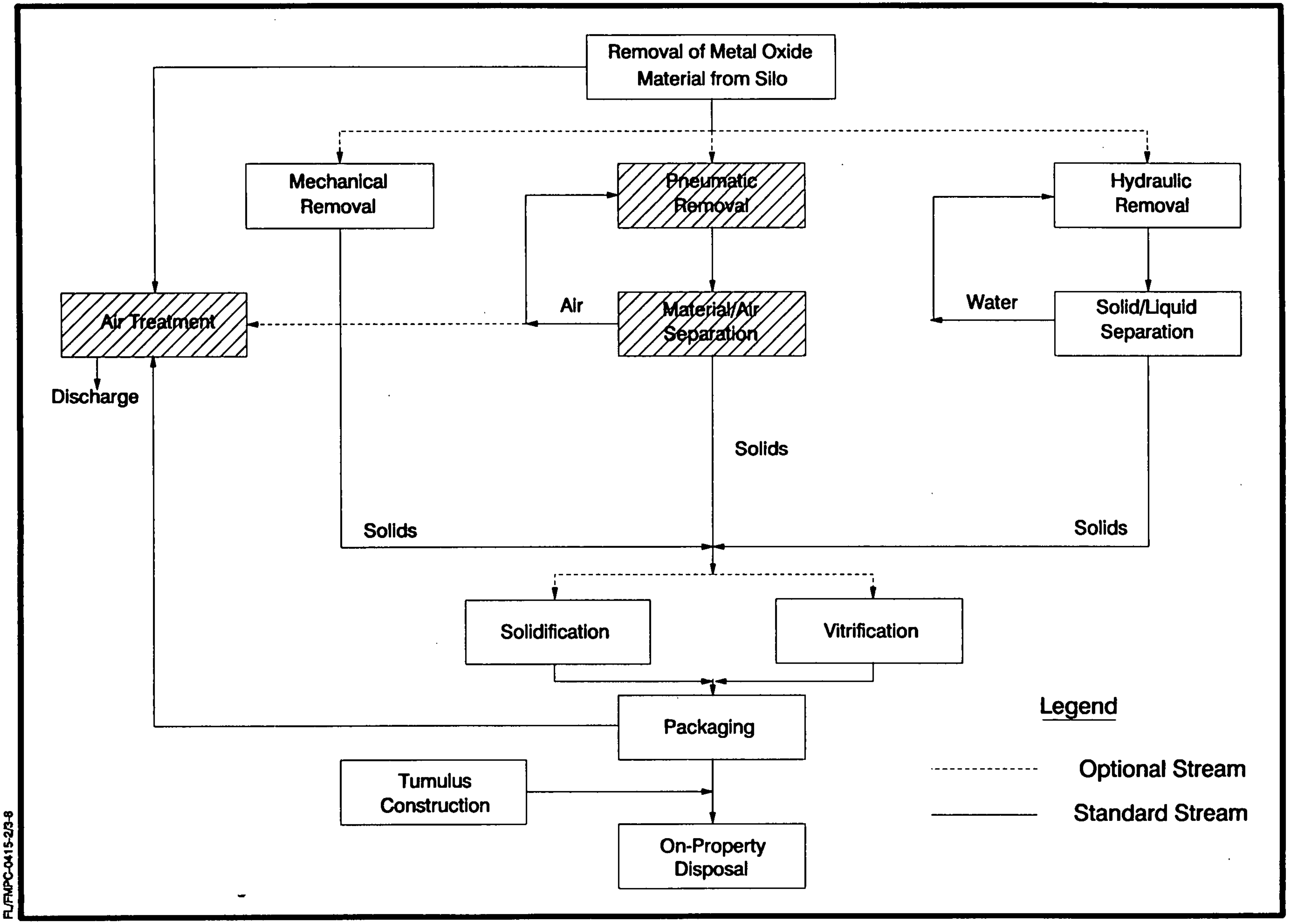

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FIGURE 5-5. ALTERNATIVE 3 - REMOVAL, TREATMENT, ON-PROPERTY DISPOSAL - SILO 3

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- Mechanical removal
- Pneumatic removal
- Hydraulic removal
- Residue stabilization
- Silo demolition
- On-property disposal
- Disposal

The first stage in developing Alternative 3 involved the conceptual design of a system capable of safely removing the contents of Silo 3. The best design would incorporate remote operation capabilities in order to minimize worker exposure to the metal oxides. Other factors considered when evaluating the removal options included:

- The metal oxides contained in Silo 3 are dry and were originally pneumatically conveyed into the silo.
- The material will require some form of stabilization after removal due to the presence of leachable metals.

Mechanical removal was first considered because excavation of dry material with equipment such as backhoes, overhead cranes/buckets, bulldozers and/or draglines, etc., is common. Due to the dry and potentially dusty characteristics of the metal oxides, control of the material during excavation with any of the aforementioned mechanical equipment would be difficult. Also, worker exposure to the material would be high due to inherent need for extensive hands-on operation of such equipment. For these reasons, with the exception of utilizing an overhead crane for the silo dome removal, mechanical removal was screened out as a removal option.

Pneumatic removal of the metal oxides was considered as a removal option with the advantages of providing a higher level of dust control and requiring less hands-on operation than the mechanical removal option. The expectation that the bulk of the metal oxide material is dry and consists of fines and the fact that the material was originally pneumatically conveyed into Silo 3 are conducive to pneumatic removal; however, there is a possibility that a pneumatic system would encounter material that now cannot be pneumatically conveyed. Operational problems could be significant if there are wide variations in the bulk density and the specific gravity of the material. Increases in the bulk density (i.e., "chunks" and/or hardened sections of material) could lead to difficulties in initially entraining the material in an airstream. The assistance of a mechanical cutter head at the suction of the vacuum nozzle would remedy this problem but would contribute to dusting problems. Increases in the specific gravity of the material would likely result in settling of the material in the process lines. Due to these potential difficulties with bulk density and specific gravity, pneumatic removal was eliminated as a removal option.

After evaluating each of the removal process options, hydraulic mining was chosen as the preferred removal technology. Hydraulic mining in sand has demonstrated material-handling capacities with sand ranging from 1350 cubic feet per hour at a discharge head of 90 feet of water to 6750 cubic feet per hour at a discharge head of 120 feet of water. Typically, pumpable slurries can consist of up to 30 percent solids. Hydraulic mining of the metal oxides should provide effective control of potential dusting problems as well as lend support to cement-based solidification due to the addition of water to the material.

A berm similar to the existing berm surrounding Silos 1 and 2 would function as a support for the foundation of an EIE and would also provide a base for a gantry system installed to support material removal.

Stabilization process options investigated included asphalt-based solidification, cement-based solidification, and vitrification. Vitrification was eliminated because silica must be added to achieve a matrix suitable for vitrification. Treatability studies will further define the effectiveness of cement- and asphalt-based solidification in eliminating the leaching characteristics of the metal oxides. Either stabilization method would require an EIE to provide an all-weather work environment and protection to the local community and environment against accidental releases of the metal oxides. This EIE would be identical to Alternative 2B.

Upon removal of the metal oxides, silo demolition could occur. This would require partial removal of the added berm to allow access to the Silo 3 walls. The EIE foundation would be located so that removal of berm material adjacent to the silo walls would not affect the EIE or crane foundation. The EIE and crane would remain in place during demolition. A demolition method is contingent on the level of contamination that remained after the removal of the metal oxides. High contamination levels would require more controlled demolition practices. Options for silo demolition include:

- Mechanical cutter
- Hydraulic splitter
- Nonexplosive demolition agent
- Gas torch

An on-property tumulus or aboveground waste disposal facility would be constructed for the disposal of the silo material. The proposed tumulus disposal concept basically consists of mounding over waste that has been placed on a stable structural pad. The aboveground structure would be a reinforced vault-like concrete structure designed for permanent waste disposal. Both the tumulus and the aboveground structure would accept only dry material placed in noncorrosive containers and/or highly stabilized/solidified forms (Figure 2-10). The tumulus would require about 12 acres.

For hydraulic removal, a water supply and a water treatment system would be required. Also needed would be an on-property disposal facility, miscellaneous utilities, and a long-term maintenance and environmental monitoring program.

Remediation would take approximately two years from installation of the EIE to decontamination and disassembly of process equipment.

The treatment and packaging of the waste material for on-property disposal would be performed in an enclosed facility to prevent accidental release of radioactive material to the environment. This facility would require about 10,000 square feet. Good engineering practices emphasizing compatibility between the container and material as well as package retrievability would be followed when choosing a container.

The waste generated for this alternative would be:

- Wastewater from hydraulic removal (to be recycled where possible)
- Water from dehumidification of EIE air
- Compactable, low-level waste (anticontamination clothing, gloves, HEPA filters, etc.)
- Equipment too contaminated to warrant decontamination

In the event of air emissions or water discharge, substantive conditions of the existing NESHAP or NPDES permits would be complied with.

5.2.5.2 Evaluation

Effectiveness

The short-term effectiveness for protecting human health would be above average. Although this action would involve the risk of a handling accident during removal, packaging, or transport to the on-property disposal facility, the silo material in its present state would be relatively stable and of low radiological activity. The long-term effectiveness would be above average because the material would have been stabilized, but it would be located over the Great Miami Aquifer and near a populated area.

The short- and long-term effectiveness for protecting the environment are as stated above for human health.

This alternative would be good in reducing the toxicity, mobility, or volume through treatment because all of the material would be stabilized.

Because this alternative would leave hazardous substances on-property, a review would be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA Section 121(c).

Implementability

The removal methods and the on-property disposal facility being considered are based on available and proven technologies. This alternative would rate average in constructability. The reliability of this alternative would be above average.

This alternative is rated average in maintenance/operations because perpetual maintenance and monitoring would be required to ensure that the RAOs continue to be met.

Agency approval for the on-property disposal of silo contents might prove to be difficult because of its location over the Great Miami Aquifer. This alternative is rated average in this category.

This alternative rates average in relation to special engineering and equipment because it would not require any skills or equipment that are not presently available. However, the removal equipment might require minor modification.

Cost

The total estimated net present worth capital cost for this alternative would be $25.34 million with a total net present worth O&M cost of $1.43 million.

5.2.5.3 Additional Data Needs

The results of the silo treatability studies are required to determine the effectiveness of the process option and determine process parameters.

5.2.6 Alternative 4 - Removal, Treatment, and Off-Site Disposal - Silo 3

5.2.6.1 Description

The general response action for Alternative 4 is identical to Alternative 3 with the exception that the treated material would be disposed of off site instead of on property (Figure 5-6).

The removal and treatment technologies and process options investigated and determined to be viable for Alternative 3 would be applicable to Alternative 4. Disposal process options investigated were rail transport and truck transport. Both options are potentially applicable to this alternative.

This alternative would require the provision of an EIE and material removal equipment identified in Alternative 3. For hydraulic removal, a water supply and a water treatment system would be required. Also needed would be miscellaneous utilities, a packaging and shipping method, and an approved disposal facility.

Remediation would take approximately two years from installation of the EIE to decontamination and disassembly of process equipment. The packaging options available for the Silo 3 material would be LSA containers and Type B containers. Type A quantities and limited quantities would not be considered for reasons discussed in Appendix E.

- LSA - Stabilization with cement and fly ash should result in specific activities that would meet LSA shipping requirements. LSA boxes measuring 96 cubic feet could be used.
- Type B - To ship the material as Type B quantities would not require waste blending because there are no activity limits for Type B packaging. The treated material would be placed in 55-gallon drums and placed in Type B overpacks.

The silo material, regardless of the packaging option selected, would be transported by truck or train to an approved disposal facility. The waste generated for this alternative would be:

- Water from dehumidification of EIE air
- Compactable low-level waste (anticontamination clothing, gloves, HEPA filters, etc.)
- Equipment too contaminated to warrant decontamination

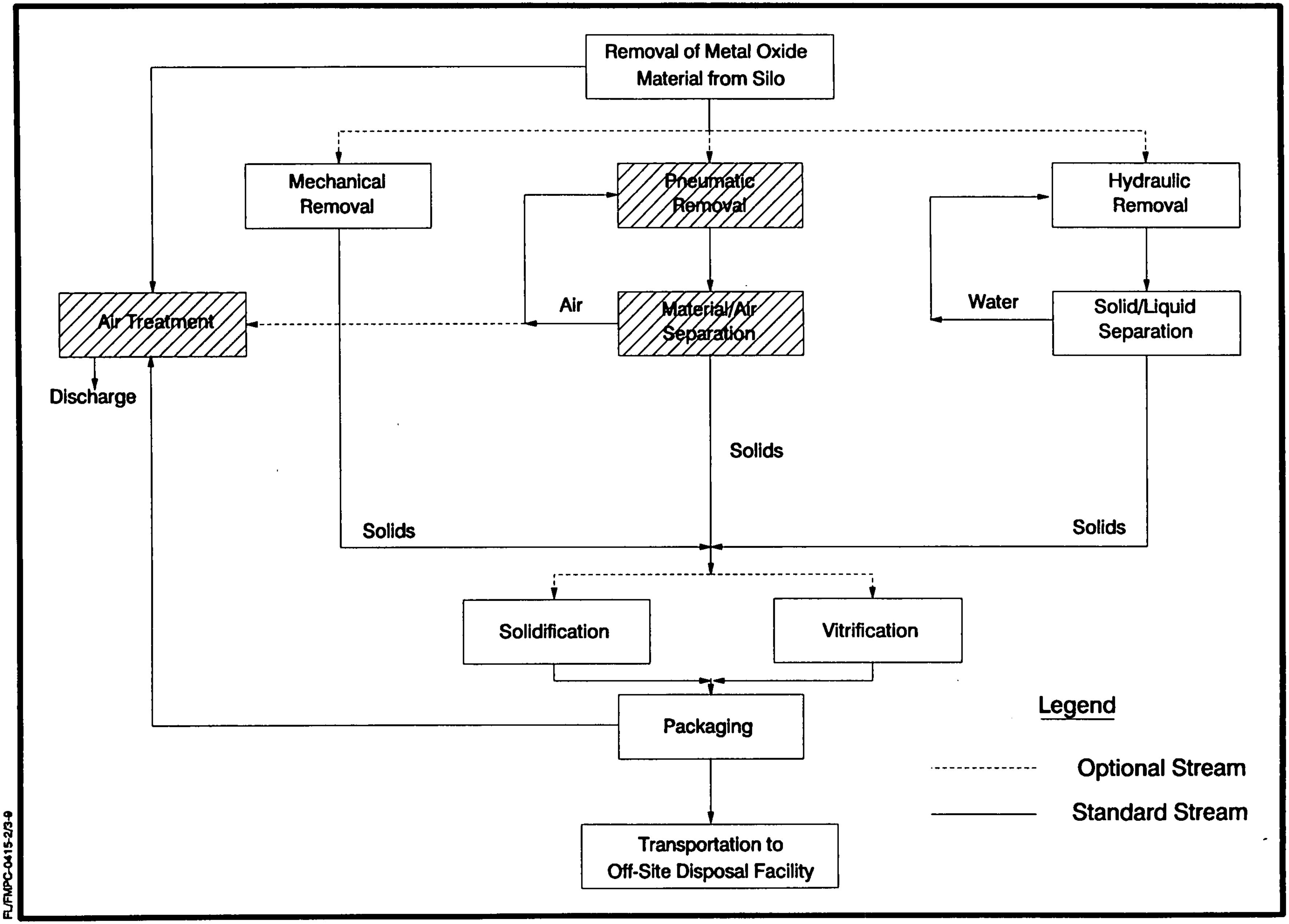

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FIGURE 5-6. ALTERNATIVE 4 - REMOVAL, TREATMENT, OFF-SITE DISPOSAL - SILO 3

In the event of air emissions or water discharges, substantive conditions of the existing NESHAP or NPDES permits would be complied with. Permits/licenses would be required to transport the material to an approved disposal facility.

5.2.6.2 Evaluation

Effectiveness
The short-term effectiveness for protecting human health would be above average because of the required handling of the silo contents. The long-term effectiveness is good because the materials would be better isolated from the public in a remote disposal facility.

The short-term effectiveness for protecting the environment would be average for the reasons aforementioned. The long-term effectiveness would be good because the silo contents would be stabilized and stored in a remote facility that experiences very little precipitation with favorable geologic conditions.

This alternative would be good in reducing toxicity, mobility, or volume through treatment because the silo contents would have been stabilized.

Implementability
Because this alternative would not require the construction of an on-property disposal facility, the constructability of this alternative is above average. The reliability of Alternative 4 is judged to be above average because of transportation concerns involving delays in completing the remedial alternative that could be encountered in preparing for and conducting waste shipments.

In maintenance/operation this alternative is judged to be good because, being an off-site disposal alternative, there would be no local maintenance or operational requirements.

This alternative rates above average relative to agency requirements because they are completely defined for disposal; however, the sensitivity of transporting radioactive materials across state borders must be addressed.

This alternative rates average in special engineering and equipment because it would require no additional skills and/or equipment beyond those identified in Alternative 3, with the possible exception of special packaging that may be required for shipment.

Cost

The total estimated net present worth capital cost for this alternative would be $41.95 million with a total net present worth O&M cost of $430,000. Costs for transportation were estimated based on shipment in Type B containers.

5.2.6.3 Additional Data Needs

The results of the treatability studies are required to determine the effectiveness of the process option and determine process parameters.

5.2.7 Alternative 5 - Removal and Replacement in Rehabilitated Silo - Silo 3

5.2.7.1 Description

Under this alternative the material would be permanently stored in either Silo 3 or Silo 4 following rehabilitation. Rehabilitation would be performed on the silo while it is empty. After final placement of the untreated materials, a berm and a cap would be installed.

Pneumatic removal would be utilized to avoid the need for sludge drying and water treatment. The cap and berm design would be identical to that described in Alternative 1A.

This alternative would require provision of an EIE, a material transfer system, partial relocation of Paddys Run, impermeable clay cap, slurry wall, grout, pressure grouting, earth moving equipment, and miscellaneous utilities. For hydraulic removal, a water supply and water treatment system would be required. A program for long-term maintenance and environmental monitoring would also be required. The impermeable cap for Silo 3 or Silo 4 would cover approximately four acres.

Remediation would take approximately two years from the initial staging of construction equipment to final closure of the silos.

The generated waste for this alternative would include:

- Water from dehumidification of EIE air
- Compactable, low-level waste (anticontamination clothing, gloves, HEPA filters, etc.)
- Equipment too contaminated to warrant decontamination
- Wastewater from hydraulic removal (if utilized)

Substantive conditions of the existing NESHAP or NPDES permits would be complied with if necessary to discharge to the air or water off the FMPC property. The relocation of Paddys Run would require compliance with substantive conditions of the COE permit program.

5.2.7.2 Evaluation

Effectiveness

The short-term effectiveness for protecting human health would be average for the Silo 3 rehabilitation because of the handling required in moving the Silo 3 contents to and from Silo 4. There would be no advantage to packaging the material for this alternative because the risk associated with transferring the material between silos is nearly equal to that for packaging. The risk of a material-handling accident and subsequent exposure to the public would be increased by the repeated handling. For disposal in a rehabilitated Silo 4, the short-term effectiveness would be considered average due to the one-time handling of the Silo 3 material. Overall, short-term effectiveness is considered average for Alternative 5. The long-term effectiveness for protecting human health would be below average because the material would not have been physically stabilized and the use of a rehabilitated silo would not ensure the long-term isolation of the contaminants.

This alternative's short-term effectiveness for protecting the environment would be average for the Silo 3 rehabilitation because of the increased risk of a handling incident and subsequent contamination of the local environment. Also, for the same reason as discussed above, short-term effectiveness for the disposal of the Silo 3 material in a rehabilitated Silo 4 would be considered average. There would be no reduction in risk by not packaging the material because the risks for packaging and transferring are nearly equal. The long-term effectiveness would be average for the reasons stated in the previous paragraphs.

This alternative rates poor in reducing toxicity, mobility, or volume through treatment. Although the material would remain reasonably stable in its presently dry and powdery form, its toxicity and volume would not have been reduced.

Because this alternative would leave hazardous substances on property, a review would be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA Section 121(c).

Implementability

This alternative rates below average in constructability because the complete rehabilitation of a 38-year-old structure built in 1952 cannot be ensured. The reliability of this alternative rates below average because the long-term isolation of the metal oxide residue in the rehabilitated silo cannot be ensured. Partial relocation of Paddys Run has environmental constraints.

This alternative rates average in maintenance/operation because the rehabilitated silo would require perpetual monitoring and maintenance to ensure that the RAOs would be met over the long term. Agency approval for this alternative is unlikely because this is a nontreatment, nonremoval action that would permanently store the waste in a facility of questionable structural integrity. It rates poor in this category.

This alternative rates average in special engineering and equipment because there would be no requirements for special engineering or equipment.

Agency approval for this alternative is unlikely because this is a nontreatment, nonremoval action that would permanently store the material in a facility of questionable structural integrity. It rates poor in this category.

This alternative rates average in special engineering and equipment because there would be no requirements for special engineering or equipment.

Cost

A cost estimate for this alternative has not been developed because it is being eliminated from further consideration based on an inadequate degree of effectiveness and implementability.

5.2.7.3 Additional Data Needs

None are required.

6.0

6.0 GENERAL SUMMARY

6.1 ALTERNATIVES RECOMMENDED FOR DETAILED ANALYSIS - SILOS 1 AND 2

Following the evaluation performed in Section 5.2, the alternatives for Silos 1 and 2 were formally ranked according to their ability to meet the general screening criteria. The following numerical scale was used to rate the alternatives:

- 1 = Poor
- 2 = Below Average
- 3 = Average
- 4 = Above Average
- 5 = Good

The evaluation criteria were applied equally to the alternatives; that is, the criteria were not weighted. Figure 6-1 presents this quantitative evaluation. The results show that the alternatives achieved generally similar scores with the exception of Alternative 0A - "No Action." Although Alternative 0A will not be a possible candidate for the preferred alternative, it will be kept as a baseline condition.

Because of the relatively close scores of the remaining alternatives in this ranking process, those alternatives listed below are recommended for further development and refinement in the detailed analysis of alternatives:

- 1A - Silo Isolation, Silos 1, 2
- 2A - In Situ Stabilization, Silos 1, 2
- 6 - Removal, Treatment, and On-Property Disposal, Silos 1, 2
- 7 - Removal, Treatment, and Off-Site Disposal, Silos 1, 2
- 8 - Removal, Contaminant Separation, and On-Property Disposal, Silos 1, 2
- 9 - Removal, Contaminant Separation, and Off-Site Disposal, Silos 1, 2

Figure 6-1 also lists the cost for each alternative.

6.2 ALTERNATIVES RECOMMENDED FOR DETAILED ANALYSIS - SILO 3

Following the evaluation performed in Section 5.3, the alternatives were formally ranked according to their ability to meet the general criteria. The following numerical scale was used to rate the alternatives:

CRITERIA	ALTERNATIVE OA	1A	2A	6	7	8	9
Short-Term Public Health	1	5	3	3	3	3	3
Short-Term Environmental Protection	1	5	3	2	3	4	3
Long-Term Public Health	1	1	3	4	5	4	5
Long-Term Environmental Protection	1	1	4	4	5	4	5
Reduction In Mobility, Toxicity, or Volume	1	2	4	4	5	5	5
Constructability	5	5	3	3	3	3	3
Reliability	2	4	3	5	4	4	5
Maintenance/Monitoring/Operation	5	3	3	3	5	3	5
Agency Approvals	1	2	2	2	3	3	3
Special Engineering & Equipment (Implementability)	5	5	1	3	3	3	3
SUMMATION	**23**	**33**	**29**	**33**	**39**	**36**	**40**
NET PRESENT WORTH COST (CAPITAL/O&M) (millions of dollars)	.02 / 2.75	36.88 / 3.18	52.54 / 3.18	32.35 / 2.48	69.46 / .72	35.28 / 2.25	52.27 / .71

1 = Poor 2 = Below Average 3 = Average 4 = Above Average 5 = Good

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FIGURE 6-1. ALTERNATIVE SCREENING MATRIX FOR SILOS 1 AND 2

- 1 = Poor
- 2 = Below Average
- 3 = Average
- 4 = Above Average
- 5 = Good

The evaluation criteria were applied equally to the alternatives; that is, the criteria were not weighted. Figure 6-2 presents this quantitative evaluation. The results show that the alternatives achieved generally similar scores, with the exception of Alternative 5. As a result of this evaluation, Alternative 5 is not recommended for further development and consideration. Alternative 5 requires excessive and possibly redundant waste handling at the expense of public health and environmental protection and fails to offer any significant advantages not provided by other alternatives.

Because of the relatively close scores of the remaining alternatives in this ranking process, the alternatives listed below are recommended for further development and refinement in the detailed analysis of alternatives:

- 1B - Silo Isolation, Silo 3
- 2B - In Situ Stabilization, Silo 3
- 3 - Removal, Treatment, and On-Property Disposal, Silo 3
- 4 - Removal, Treatment, and Off-Site Disposal, Silo 3

Figure 6-2 lists the net present worth costs for each alternative.

CRITERIA	OB	1B	2B	3	4	5
	ALTERNATIVE					
Short-Term Public Health	1	5	3	4	4	3
Short-Term Environmental Protection	1	5	3	4	3	3
Long-Term Public Health	1	1	4	4	5	2
Long-Term Environmental Protection	1	1	4	4	5	3
Reduction In Mobility, Toxicity, or Volume	1	3	4	5	5	1
Constructability	5	5	3	3	4	2
Reliability	2	4	3	4	4	2
Maintenance/Monitoring/Operation	5	3	3	3	5	3
Agency Approvals	1	2	2	3	4	1
Special Engineering & Equipment (Implementability)	5	5	1	3	3	3
SUMMATION	**23**	**34**	**30**	**37**	**42**	**23**
NET PRESENT WORTH COST (CAPITAL/O&M) (millions of dollars)	**.02 / 2.12**	**30.26 / 2.61**	**32.24 / 2.61**	**25.34 / 1.43**	**41.95 / .43**	*** / ***

1 = Poor 3 = Average 5 = Good
2 = Below Average 4 = Above Average

* Alternative eliminated before costs prepared

FIGURE 6-2. ALTERNATIVE SCREENING MATRIX FOR SILO 3

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APPENDIX A

APPENDIX A

POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

APPENDIX A
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

A.1 INTRODUCTION

The U.S. Department of Energy (DOE) must generally comply with all provisions of federal environmental statutes and regulations, as well as all applicable state and local requirements. In performing the Remedial Investigation/Feasibility Study (RI/FS) and subsequent remedial actions for Operable Unit 4 within the Comprehensive Environmental Response, Compensation, and Liability Act/Superfund Amendments and Reauthorization Act of 1986/National Oil and Hazardous Substances Pollution Contingency Plan (CERCLA/SARA/NCP) framework, the Feed Materials Production Center (FMPC) is required to comply with all applicable or relevant and appropriate requirements (ARARs). The purpose of this appendix is to list potential ARARs and/or their sources.

Applicable requirements are those federal and state regulatory requirements that directly and fully address or regulate the hazardous substance, pollutant, contaminant, action being taken, or other circumstance at a CERCLA site. Examples of federal statutes specifically cited in CERCLA from which requirements may apply include the Toxic Substances Control Act (TSCA), the Safe Drinking Water Act (SDWA), the Clean Air Act (CAA), the Clean Water Act (CWA), and the Marine Protection Research and Sanctuaries Act (MPRSA). Relevant and appropriate requirements are those federal and state human health and environmental regulatory requirements that address problems or situations sufficiently similar to those encountered at CERCLA sites and are appropriate to the circumstances of release or threatened release, so that their uses are well suited to the particular site. In such cases, application of these requirements would be relevant and appropriate although not mandated by law. Relevant and appropriate requirements are intended to carry the same weight as applicable requirements.

A.2 POTENTIAL ARARs FOR OPERABLE UNIT 4

In accordance with current U.S. Environmental Protection Agency (EPA) guidance, ARARs are to be progressively developed and applied on a site-specific basis as the RI/FS proceeds. The initial step in the process entails the listing of all potential ARARs for the remedial action process at the subject site. A comprehensive listing of potential ARARs for all of the operable units for the FMPC was completed as part of the Feasibility Study Work Plan. The potential ARARs for the FMPC were categorized into the following EPA-recommended classifications:

- Chemical-Specific ARARs - Usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values for each chemical of concern. These values establish the acceptable amount or concentration of a chemical that may be found in or discharged to the environment.

- Location-Specific ARARs - Restrictions placed on the concentration of a chemical or the conduct of activities solely because they occur in special locations.

- Action-Specific ARARs - Usually technology- or activity-based requirements or limitations on actions taken with respect to waste management and site cleanup.

A list of potential ARARs is given in Figure A-1. Also included in the list is the rationale for the implementation of each potential ARAR and the alternatives affected.

FIGURE A-1

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Radionuclide Emissions (Except Airborne Radon-222)	40 CFR 61, Subpart H Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem per year.	Applicable	Radioactive materials within this operable unit could contribute to the dose to members of the public from the air pathway during implementation of remedial actions (since NESHAPS applies to operating units).	All

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Radon-222 Emissions	40 CFR 61, Subpart Q No source at a DOE facility shall emit more than 20 pCi/m^2-s of radon-222 as an average for the entire source during periods of storage and disposal.	Applicable	Facilities within this operable unit qualify as sources since they contain radium-226 in sufficient concentrations to emit radon-222.	All

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Radioactive Materials in Ohio River and in Receiving Waters Outside the Mixing Zone	OAC 3745-1-32 (c) (9) Gross alpha particle activity (including radium-226, but excluding radon and uranium) shall not exceed 15 pCi/l and combined radium-226 and radium-228 shall not exceed 5 pCi/l in receiving waters of the Ohio River. The concentration of gross total beta particle activity shall not exceed 50 pCi/l; the concentration of total strontium-90 shall not exceed 8 pCi/l in receiving waters of the Ohio River.	Applicable	Radioactive materials in this operable unit could be released such that they could contribute to radioactivity in receiving waters of the Ohio River.	All

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Prevention of Air Pollution Nuisance	OAC 3745-15-07 The emission or escape into open air from any source whatsoever in such a manner or in such amounts as to endanger the health, safety, or welfare of the public or to cause unreasonable injury or damage to property shall be declared a public nuisance and is prohibited.	Applicable	During the process of stabilization, or removal and treatment, some potential exists for emissions of radionuclides and toxic chemicals to the air, which could endanger individuals or damage property.	2A, 2B, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Control of Fugitive Dust	OAC 3745-17-08 Requires the minimization or elimination of visible emissions of fugitive dust generated during grading, loading, or construction operations and other practices which emit fugitive dust.	Applicable	The implementation of remedial action alternatives will require the movement of dirt and other material likely to result in fugitive dust emissions.	2A, 2B, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
National Ambient Air Quality Standard for Particulate Matter	40 CFR 50.7 OAC 3745-17 Particulate emissions from a major stationary source shall not exceed 60 $\mu g/m^3$ annually or 150 $\mu g/m^3$ per 24-hour period.	Relevant and Appropriate	During the process of in-situ stabilization or treatment some potential exists for particulate emissions to open air. (Probably not a major source; therefore, only relevant and appropriate.)	2A, 2B, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Radiation Doses, Levels, and Concentrations in Restricted and Unrestricted Areas.	10 CFR 20.101-105 OAC 3701-38 Radiation doses, levels, and concentrations for restricted and unrestricted areas shall not exceed specified limits.	Relevant and Appropriate	Radioactive materials in this operable unit can contribute radiation doses, levels, and concentrations to individuals in restricted and unrestricted areas, which could exceed the specified limits.	All

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
National Ambient Air Quality Standard for Lead	40 CFR 50.12 OAC 3745-71 Lead emissions from a major stationary source shall not exceed 1.5 $\mu g/m^3$ based on a quarterly average.	Relevant and Appropriate	During the process of stabilization, or removal and treatment, some potential exists for emissions of lead to open air. (Probably not a major source; therefore, only relevant and appropriate).	2A, 2B, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Chemicals in Drinking Water	40 CFR 141.11 The following maximum contaminant levels (MCLs) for inorganic chemicals are the maximum levels of a contaminant in water which is delivered to a free flowing outlet of the ultimate user of a public water system: • Arsenic 0.05 mg/l • Barium 1.00 mg/l • Cadmium 0.010 mg/l • Chromium 0.05 mg/l • Lead 0.05 mg/l • Mercury 0.002 mg/l • Nitrate 10.0 mg/l • Selenium 0.01 mg/l • Silver 0.05 mg/l	Relevant and Appropriate	The requirement is not applicable since no public water system (as defined in 40 CFR 141) is involved. It is relevant and appropriate to protecting drinking water sources from the same contaminants found in the operable unit. These contaminants may migrate or leach into the underlying aquifer as a consequence of remedial actions.	All

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Chemicals in Drinking Water	40 CFR 141.12 The following MCLs for organic chemicals are the maximum levels of a contaminant in water which is delivered to a free flowing outlet of the ultimate user of a public water system: • Chloroform 0.1 mg/l • Ethyl-benzene 0.7 mg/l* • Pentachlorophenol 0.2 mg/l* • PCBs 0.0005 mg/l* • Tetrachloroethylene 0.005 mg/l* • Toluene 2.0 mg/l* • Trichloroethylene 0.005 mg/l • 1,1,1-Trichloroethane 0.2 mg/l • Xylene 10.0 mg/l* * Proposed	Relevant and Appropriate	The requirement is not applicable since no public water system (as defined in 40 CFR 141) is involved. It is relevant and appropriate to protecting drinking water sources from the same contaminants found in the operable unit. These contaminants may migrate or leach into the underlying aquifer as a consequence of remedial actions.	All

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale For Implementation	Alternative Number
Radionuclides in Drinking Water	40 CFR 141.15 OAC 3745-81-15 Maximum Contaminant Levels for radioactivity in community water systems are set as follows: • 5 pCi/l of combined radium-226 and radium-228 • 15 pCi/l of gross alpha particle activity (including radium-226, but excluding radon and uranium) 40 CFR 141.16 OAC 3745-81-16 The average annual concentration of beta particle and photon (i.e., gamma) radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem.	Relevant and Appropriate	Radioactive materials in this operable unit could be released such that the radioactive materials could contribute to radioactivity in community water system.	All

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Chemicals in Drinking Water	40 CFR 141.50 - 141.51 - National Primary Drinking Water Standards OAC 3745-81-11 Maximum Contaminant Level Goals (MCLGs) for potential chemicals of concern in community water systems are as follows: MCLGs (mg/l) Cadmium 0.005 Ethylbenzene 0.7 Lead 0.02 Mercury 0.002 Toluene 2.0	Relevant and Appropriate	Contents of the operable unit may migrate into the underlying aquifer and into drinking water systems as a consequence of remedial actions. MCLGs are considered as potential relevant and appropriate requirements, following a determination made for the circumstances of the release on a site-specific basis.	All

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Residual Radioactive Material	40 CFR 192, Subparts A and C Control of residual radioactive material from inactive uranium processing sites shall be designed to: • Be effective for up to 1000 years, to the extent reasonably achievable, and in any case, for at least 200 years. • Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not exceed an average release rate of 20 pCi/m^2-s or increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than 0.5 pCi/l.	Relevant and Appropriate	Radioactive materials in this operable unit are primarily residues from uranium processing. Requirements for design of controls should be consistent with design for control of other residual radioactive materials such as mill tailings.	All

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-560

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Chemicals in Drinking Water (Solid Waste Disposal Facility)	40 CFR 257.3-4 A facility shall not contaminate an underground drinking water source beyond the solid waste boundary (outermost perimeter of the waste). The concentration of chemicals shall not exceed background levels or MCLs, whichever is higher.	Relevant and Appropriate	Wastes may migrate into the underlying aquifer and potentially contaminate drinking water systems as a consequence of remedial actions. The ARAR is relevant and appropriate since the operable unit may contain the listed chemicals.	All

Inorganic Chemicals	MCLs mg/l
Arsenic	0.05
Barium	1.00
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate	10.0
Selenium	0.01
Silver	0.05

000158

5 60

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement		ARAR/TBC	Rationale for Implementation	Alternative Number
Chemicals in Drinking Water (Solid Waste Disposal Facility) (continued)	Organic Chemicals	MCLs mg/l			
	Endrin	0.0002			
	Lindane	0.004			
	Methoxychlor	0.1			
	Toxaphene	0.005			
	2, 4-D	0.1			
	2, 4, 5-TP Silvex	0.01			

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Chemicals in Drinking Water (Hazardous Waste Disposal Facility)	40 CFR 264, Subpart F A facility shall not contaminate the uppermost aquifer underlying the waste management area beyond the point of compliance, which is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated area. The concentration of chemicals shall not exceed background levels or MCLs, whichever is higher. Inorganic Chemicals — MCLs mg/l Arsenic 0.05 Barium 1.00 Cadmium 0.01 Chromium 0.05 Lead 0.05 Mercury 0.002 Nitrate 10.0 Selenium 0.01 Silver 0.05	Relevant and Appropriate	Wastes may migrate into the underlying aquifer and potentially contaminate drinking water systems as a consequence of remedial actions. The ARAR is relevant and appropriate, since the operable unit may contain the listed chemicals.	All

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement		ARAR/TBC	Rationale for Implementation	Alternative Number
Chemicals in Drinking Water (Hazardous Waste Disposal Facility) (continued)	Organic Chemicals	mg/l			
	Endrin	0.0002			
	Lindane	0.004			
	Methoxychlor	0.1			
	Toxaphene	0.005			
	2, 4-D	0.1			
	2, 4, 5-TP Silvex	0.01			

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Radiation Dose Limit (All Pathways)	DOE Order 5400.5, Chapter II, Section 1.a The exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways.	To be considered	Radiation sources within this operable unit could contribute to the total dose to members of the public from this DOE facility.	All

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Radiation Dose Limit (Drinking Water Pathway)	DOE Order 5400.5, Chapter II, Section 1.d Provide a level of protection for persons consuming water from a public drinking water supply operated by the DOE so that persons consuming water from the supply shall not receive an effective dose equivalent to or greater than 4 mrem in a year.	To be considered	Radioactive materials within this operable unit could contribute to the dose to members of the public from drinking water.	All

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Chemical Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Chemical Reference Dose Guidance Intended to be Protective of Human Health	U.S. EPA Health Effects Assessment Guidance - "Health Effects Assessment Summary Tables (HEAST)" and/or "Integrated Risk Information System" Beryllium 0.005 mg/kg/d Manganese 0.2 mg/kg/d Selenium 0.003 mg/kg/d Thallium 0.0007 mg/kg/d Vanadium 0.007 mg/kg/d Zinc 0.2 mg/kg/d	To be considered	40 CFR 300 requires that in the absense of an ARAR for a contaminant, guidance documents are to be considered when establishing concentrations of contaminants that are protective of human health and the environment.	All

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Location Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Area Affecting Stream or River	U.S. Fish and Wildlife Coordination Act 16 U.S.C. 661 40 CFR 6.302 (a) Adverse impacts of activities associated with the destruction or loss of wetlands are to be avoided where practicable alternatives exist. 40 CFR 6.302 (g) After consultation with the U.S. Fish and Wildlife Service and appropriate State agency, actions necessary to protect fish and wildlife from impacts associated with modifying streams or areas affecting streams are to be implemented.	Applicable	In-situ isolation or stabilization would require diverting and/or rechanneling the flow of Paddys Run in order to have sufficient ground area to cap the silos. Such action would be coordinated with State and Federal wildlife agencies to ensure preservation of wetlands and aquatic biota and wildlife.	1A, 1B, 2A, 2B

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Location Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Location Standards for Solid Waste Disposal Facilities	40 CFR 257.3-1 Facilities in floodplain areas shall not restrict the flow of the base flood, reduce temporary water storage capacity of the floodplain, or result in a release of waste so as to pose a hazard to human health.	Relevant and Appropriate	The alternatives which involve contour grading and capping of areas within this operable unit may result in placement of fill material in the floodplain.	1A, 1B, 2A, 2B

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Location Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Location Standards for Hazardous Waste Treatment, Storage, or Disposal Facilities	40 CFR 264.18 • Floodplain considerations- TSD facilities located in 100-year floodplains must be designed, constructed, operated and maintained to prevent washout of hazardous waste by a 100 year flood unless: - procedures are implemented to allow all waste to be removed safely before flooding to a permitted location not vulnerable to flooding, or - no adverse effects on human health or the environment will result if washout occurs considering the characteristics of the waste and potential impacts of a washout on surface waters, sediments and surface soils within the floodplain.	Relevant and Appropriate	The hazardous wastes which may be removed from silos 1, 2, and 3 may be treated, stored, and disposed at a facility located within a 100-year floodplain.	3, 6, 7, 8, 9

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Location Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Floodplain Management	Executive Order 11988 Federal agencies proposing actions to be located in a floodplain must first evaluate the potential adverse effects those actions may have on the natural and beneficial values served by the floodplain.	To be considered	Paddys Run, west of the K-65 silos, is a floodplain area. The alternatives which involve in situ stabilization and capping may result in placement of fill material in the floodplain.	All

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Location Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Protection of Wetlands	Executive Order 11990 Federal agencies are directed to avoid construction located in wetlands unless the agency head finds: (1) no practical alternative to such construction, and (2) the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use. Federal agencies proposing actions that may adversely impact wetlands shall consider certain factors relevant to the proposal's effect on the survival and quality of the wetlands. These include: a) public health, safety, and welfare, including water supply, quality, recharge and discharge; pollution; flood and storm hazards; and sediment and erosion;	To be considered	The implementation of the alternatives involving in-situ isolation and capping of the K-65 silos may impact Paddys Run and adjacent wetlands areas.	All

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Location Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Protection of Wetlands (continued)	b) maintenance of natural systems, including conservation and long-term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish, wildlife, timber, and food and fiber resources; and			
	c) other uses of wetlands in the public interest, including recreational, scientific and cultural uses.			

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Discharge of Treatment System Effluent	40 CFR 122.41 (i) OAC 3745-33-05 <u>Monitoring Requirements</u> Discharges must be monitored to assure compliance. Discharges will be monitored for: • the mass of each pollutant • the volume of each pollutant • frequency of discharge and other measurements as appropriate. 40 CFR 136.1 - 136.4 Approved test methods must be followed for waste constituents to be monitored. Detailed requirements for analytical procedures and quality controls are provided. Sample preservation procedures, container materials, and maximum allowable holding times are prescribed.	Applicable	Required of all direct discharges to waters of the U.S. in order to ensure effluent limitations, water quality standards, and toxic pollutant limitations are being met.	1A, 1B, 1C, 2A 2B, 2C, 3, 4, . 6, 7, 8, 9

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Discharge of Treatment System Effluent	40 CFR 122.41 (i) Comply with additional substantive conditions such as: • Duty to mitigate any adverse effect of any discharge; and • Proper operation and maintenance of treatment systems.	Applicable	Required of all direct discharges to waters of the U.S. All alternatives have the potential to result in discharges of wastewaters produced during treatment of wastes.	1A, 1B, 1C, 2A, 2B, 2C, 3, 4, ; 6, 7, 8, 9

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Discharge of Treatment System Effluent	40 CFR 122.44(a) Best Available Technology Use of best available technology (BAT) economically achievable is required to control toxic and nonconventional pollutants. Use of best conventional pollutant control technology (BCT) is required to control conventional pollutants. Technology-based limitations may be determined on a case-by-case basis. 40 CFR 122.44 OAC 3745-33-04 Water Quality Standards Applicable federally approved State water quality standards must be complied with. These standards may be in addition to or more stringent than other Federal effluent standards under the CWA. 40 CFR 122.44(e) Discharge limitations must be established at more stringent levels than technology-based standards for these pollutants.	Applicable	Applicable to direct discharges of wastewater to waters of the U.S. Treatment of produced waters that will be discharged to waters of the U.S. will be required to meet all applicable effluent limitations, water quality standards and toxic pollutant discharge standards as determined by State and/or Federal agencies having discharge permitting authority.	1A, 1B, 1C, 2A, 2B, 2C, 3, 4, 6, 7, 8, 9

000173

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Criteria Relating to the Disposition of Uranium Tailings or Wastes	10 CFR 40, Appendix A Establishes technical and long-term surveillance criteria relating to the siting, operation, decontamination, decommissioning, and reclamation of mills and tailings or waste systems and sites at which such mills and systems are located. These criteria include: • Selection of sites with features which contribute to the goal of permanent isolation of wastes; • Disposal in a manner such that no active maintenance is required to preserve conditions of the site; • Minimization of the number of disposal sites; • Minimization of water and wind erosion potential;	Relevant and Appropriate	Materials within this operable unit are similar to uranium mill tailings and thus have similar health and environmental risks.	1A, 1B, 2A, 2B, 3, 6, 8

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Criteria Relating to the Disposition of Uranium Tailings or Wastes (continued)	• General design considerations for above-ground disposal facilities including caps; • Compliance with basic groundwater protection standards imposed by 40 CFR 192, Subparts D and E; • Conduct a preoperational monitoring program to provide complete baseline data on the site and its environs; • Establish a groundwater monitoring program to detect leakage of hazardous constituents and to establish the needed groundwater protection standards; and • Long-term site surveillance with an annual inspection by the government agency retaining ultimate custody of the site.			

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal On-Site	10 CFR 61, Subpart C Land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposure to humans are within the limits established in the following performance objectives: • Annual dose equivalent limit of 25 mrem (whole body), 75 mrem (thyroid) and 25 mrem (any other organ) for any member of the public due to radioactive materials which may be released from the land disposal facility. • Protection of any inadvertent intruder into the disposal site at any time after active institutional controls over the disposal site are removed.	Relevant and Appropriate	Facilities which are to be used for on-site land disposal of radioactive materials contained within this operable unit should meet the performance objectives of facilities for similar radioactive materials from NRC-licensed facilities.	3, 6, 8

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal On-Site (continued)	• Operations at the disposal facility must be conducted in accordance with 10 CFR 20. • Long-term stability and elimination of the need (to the extent practicable) for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.			

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal On-Site	10 CFR 61 Subpart D Technical requirements for land disposal facilities for radioactive waste must be satisfied. These include: • Disposal site suitability requirements for land disposal; • Design criteria for a land disposal site; • Operation and closure criteria; • Environmental monitoring requirements; • Waste classification requirements; and • Waste characteristics requirements.	Relevant and Appropriate	Facilities which are to be used for on-site land disposal of radioactive materials contained within this operable unit should meet the performance objectives of facilities for similar radioactive materials from NRC-licensed facilities.	3, 6, 8

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Discharge of Treatment System Effluent	40 CFR 125.100 <u>Best Management Practices</u> Develop and implement a Best Management Practices (BMP) program to prevent the release of toxic or hazardous constituents to waters of the U.S. 40 CFR 125.104 The BMP program must: • Establish specific procedures for the control of toxic and hazardous pollutant spills and runoff. • Include a prediction of direction, rate of flow, and total quantity of toxic and hazardous pollutants where experience indicates a reasonable potential for equipment failure.	Relevant and Appropriate	All of the proposed actions have the potential for releases and runoff from this operable unit. The requirement is not applicable because BMP under the NPDES permit program applies only to ancillary facilities from manufacturing units that may have releases of toxic or hazardous waste. The purpose of the BMP program is relevant and appropriate to prevent releases from spills or runoff during the implementation of remedial actions.	All

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials	40 CFR 192, Subparts B and C Remedial actions shall be conducted at any site, or other real property or improvement thereon containing residual radioactive materials from inactive uranium processing sites so as to provide reasonable assurance that: • Radium-226 concentrations in land averaged over any area of 100 m^2 shall not exceed the background level by more than 5 pCi/g averaged over the first 15 cm of soil below the surface and 15 pCi/g averaged over 15 cm thick layers of soil more than 15 cm below the surface. • Annual average radon decay product concentrations (including background) in any occupied or habitable building shall not exceed 0.02 WL, or in any case it shall not exceed 0.03 WL. • Gamma radiation level in any occupied or habitable building shall not exceed background level by more than 20 μR/hr.	Relevant and Appropriate	Radioactive materials in this operable unit are primarily residues from uranium processing. Requirements for remedial actions should be consistent with design at other uranium processing facilities.	1A, 1B, 2A, 2B, 3, 4, 6, 7, 8, 9

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
On-site Solid Non-hazardous Waste Management Facilities	40 CFR 241.200-241.201 Develop a solid, non-hazardous waste handling plan to determine what waste shall be accepted and identify any special handling required. Also, determine specific wastes to be excluded and identify them in the plan. An alternative method of disposal for excluded wastes must also be a part of the solid waste handling plan.	Relevant and Appropriate	Solid, non-hazardous wastes generated as a result of remediation must be managed in accordance with Federal and State regulations.	1A, 1B, 1C, 2A, 2B, 2C, 3, 6, 8

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Solid, Non-hazardous Waste Treatment and Disposal Facility Design Considerations	40 CFR 241.202 ORC 6111.45 OAC 3745-27-06 Site selection and utilization consistent with public health and welfare, and air and water quality standards and adaptable to appropriate land-use plans. A plan for the design shall be prepared by a professional engineer and approved by the responsible agency prior to authorization for construction. At a minimum, design shall consider hydrogeology, climate, socioeconomic impacts, land use, decomposition gases, leachate vector control, and aesthetics (pertinent details follow). 40 CFR 241.204 Water Quality The location, design, construction, and operation of the land disposal site shall conform to the most stringent of applicable water quality standards established in accordance with, or effective under, the provisions	Relevant and Appropriate	Treatment/disposal facilities for solid, non-hazardous waste must be planned and designed by the facility owner, with the design approved by the Ohio EPA.	1A, 1B, 1C, 2A, 2B, 2C, 3, 6,: 8

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Solid, Non-hazardous Waste Treatment and Disposal Facility Design Considerations (continued)	of the Federal Water Pollution Control Act, as amended. 40 CFR 241.205 Air Quality The design, construction, and operation of the land disposal site shall conform to applicable ambient air quality standards and source control regulations established under the authority of the Clean Air Act, as amended, or Ohio EPA or local standards effective under that Act, if the latter are more stringent. 40 CFR 241.209 Cover Material Cover material shall be applied as necessary to minimize infiltration of precipitation and provide a pleasing appearance.			

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Solid, Non-hazardous Waste Treatment and Disposal Facility Design Considerations (continued)	40 CFR 241.211 Compaction Solid waste shall be compacted to the smallest practicable volume. Safety The land disposal site shall be designed, constructed, and operated in such a manner as to protect the health and safety of personnel associated with the operations. Pertinent provisions of the Occupational Safety and Health Act of 1970 (Pub. L. 91-596) and regulations promulgated thereunder shall apply.			

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Hazardous Waste Determinations	40 CFR 260, Appendix I Outlines the procedure to be followed under: • 40 CFR 261.2 to identify whether a particular material of concern is a "solid waste"; • 40 CFR 261.4 (a) to identify whether a particular exclusion applies to the material eliminating it from definition as a "solid waste"; • 40 CFR 261.3 to identify whether a particular solid waste may be classified as a hazardous waste under Subpart C or Subpart D of 40 CFR 261; and • 40 CFR 261.4 (b), 40 CFR 260.20, and 40 CFR 260.22 to determine if a material, otherwise classified as a "hazardous waste" under Subpart C or Subpart D, may be excluded from RCRA jurisdiction.	Relevant and Appropriate	Silos 1, 2, and 3 may contain listed or characteristic hazardous waste which must be treated, stored and disposed of in accordance with RCRA.	4, 5, 6, 7, 8, 9

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Empty Containers	40 CFR 261 Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if: • no more than 2.5 cm (one inch) of residue remains on bottom or inner liner; • less than 3% by weight of total capacity remains (less than 110 gallon container); • less than .3% by weight of total capacity remains (greater than 110 gallon container). Containers that have held acutely hazardous ("p" listed) wastes are "empty" and exempt from further RCRA regulation if: • they or their inner liners have been triple rinsed with an adequate solvent and the inner liner has been removed from the container.	Relevant and Appropriate	Containers used to treat or store hazardous waste from silos 1, 2, and 3 may contain hazardous waste residues which must be removed before the containers may be re-used or disposed of.	1C, 2C, 3, 4, 6, 7, 8, 9

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Generators Who Treat, Store, or Dispose of Hazardous Waste On-Site	40 CFR 262.10 Any "generator", as defined by 40 CFR 260.10, who treats, stores, or disposes of hazardous wastes on-site must do the following: • determine, in accordance with 40 CFR 262.11, whether or not the waste is hazardous; • obtain a U.S. EPA identification number in accordance with 40 CFR 262.12 for the purposes of hazardous waste accumulation, recordkeeping, and additional reporting.	Relevant and Appropriate	Hazardous waste removed from the silos for on-site treatment, storage, or disposal becomes subject to the generator requirements.	1C, 2C, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Generators Who Transport Hazardous Waste for Off-site Treatment, Storage or Disposal	40 CFR 262.20 Any generator who transports hazardous waste for off-site treatment, storage or disposal must originate and follow-up the manifest for off-site shipments. 40 CFR 262.30 Before transporting a hazardous waste the generator must package, label, mark and placard the shipment in accordance with U.S. DOT regulations.	Relevant and Appropriate	Hazardous waste removed from the silos for offsite treatment, storage, or disposal becomes subject to the generator requirements.	1C, 2C, 3, 4, 7, 9

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Waste Accumulation On-Site by Generator	40 CFR 262.34 Generators may accumulate hazardous waste on-site for 90 days or less (without meeting permitting standards for storage facilities) provided that they: • use appropriate U.S. DOT containers; • mark accumulation beginning date on tanks/containers; • label and mark tanks/containers in accordance with U.S. DOT requirements; • placard transport vehicle or offer appropriate placards to transporter; • follow interim status standards for less than 90 day storage including: - weekly container and storage areas inspections	Relevant and Appropriate	Hazardous waste removed from the silos and waste treatment residues are only subject to the 90-day generator accumulation requirements if the waste is stored on site for 90 days or less. If hazardous waste is stored for more than 90 days the full permitting standards for TSD facilities must be met.	1C, 2C, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Waste Accumulation On-site by Generator (continued)	- maintenance of aisle space between containers wide enough for person to walk carrying emergency equipment - maintain enough space between containers to allow for visual inspection from top and one side of all containers - put in place appropriate emergency preparedness procedures and equipment - maintain spill response pillows or absorbent - conduct RCRA response training for personnel - put in place a written contingency plan - avoid storage of incompatible wastes in same containment area.			

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Generator Recordkeeping and Reporting	40 CFR 262, Subpart D • Generators must keep copies for three years of the following documents: - Manifests - Biennial and exception reports - Test results, waste analyses or other determinations made in accordance with 40 CFR 262.11 • Generators must submit biennial reports by March 1, of each even numbered year. • Generators must submit exception reports within 35 days of shipment.	Relevant and Appropriate	Hazardous waste removed from the silos are subject to the generator requirements.	1C, 2C, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Standards	40 CFR 264, Subpart B, General Standards • Waste Analysis (40 CFR 264.13)- Operators of a facility must obtain a detailed chemical and physical analysis of a representative sample of each hazardous waste to be treated, stored, or disposed of at the facility prior to treatment, storage, or disposal. • Security (40 CFR 264.14)- Operators of a facility must prevent the unknowing or unauthorized entry of persons or livestock into the active portions of the facility, maintain a 24-hour surveillance system, or surround the facility with a controlled access barrier and maintain appropriate warning signs at facility approaches.	Relevant and Appropriate	Hazardous waste removed from the silos must be treated, stored (if more than 90 days), and disposed of in accordance with TSD facility standards.	1C, 2C, 3, 4, 6, 7, 8, 9

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Standards (continued)	• Inspections (40 CFR 264.15)- Operators of a facility must develop a schedule and regularly inspect monitoring equipment, safety and emergency equipment, security devices and operating and structural equipment that are important to preventing, detecting or responding to environmental or human health hazards, promptly or immediately or immediately remedy defects, and maintain an inspection log.			
	• Training (40 CFR 264.16)- Operators must train personnel within 6 months of their assumption of duties at a facility in hazardous waste management procedures relevant to their positions including emergency response training.			

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Preparedness and Prevention	40 CFR 264, Subpart C TSD operators must design, construct, maintain and operate facilities to minimize the possibility of a fire, explosion or any unplanned sudden or non-sudden release of hazardous waste to air, soil, or surface water which could threaten human health or the environment. 40 CFR 264.32 All facilities must be equipped with an internal communication or alarm system, a telephone, or a two-way radio for calling outside emergency assistance, fire control, spill control, and decontamination equipment and water at an adequate volume and pressure to supply water hose streams, foam producing equipment, automatic sprinklers or water spray systems.	Relevant and Appropriate	Hazardous waste removed from the silos must be treated, stored (if more than 90 days), and disposed of in accordance with TSD facility standards.	1C, 2C, 3, 4, 6, 7, 8, 9 :

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Preparedness and Prevention (continued)	40 CFR 264.33 All fire and spill- control and decontamination equipment must be tested and maintained as necessary to assure proper emergency operation.			
	40 CFR 264.34 All personnel must have immediate access to emergency communication or alarm systems whenever hazardous waste is being handled at the facility.			
	40 CFR 264.35 Aisle space must be sufficient to allow unobstructed movement of personnel, fire and spill control, and decontamination equipment.			
	40 CFR 264.37 Operators must attempt to make arrangements, appropriate to the waste handled, for emergency response by local and state fire, police and medical personnel.			

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Contingency Plan and Emergency Procedures	40 CFR 264, Subpart D Each facility operator must have a contingency plan designed to minimize hazards to human health or the environment due to fires, explosions, or any unplanned releases of hazardous waste constituents to the air, soil, or surface/groundwater. 40 CFR 264.52 Contingency plans should address procedures to implement a response to hazardous substance incidents, internal and external communications, arrangements with local emergency authorities, an emergency coordinator list, a facility emergency equipment list indicating equipment descriptions and locations and a facility personnel evacuation plan.	Relevant and Appropriate	Hazardous waste removed from the silos must be treated, stored (if more than 90 days), and disposed of in accordance with TSD facility standards.	1C, 2C, 3, 4, 6, 7, 8, 9

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Contingency Plan and Emergency Procedures (continued)	40 CFR 264.55 Each facility must have an emergency coordinator who has responsibility for coordinating all emergency response measures, is on the premises or on call at all times, is thoroughly familiar with all aspects of the contingency plan, facility operations, location and characteristics of waste handled, location of pertinent records, and facility layout, and who has the authority to commit the resources necessary to implement the contingency plan.			

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Operating Record	40 CFR 264.73 An operating record must be maintained by each facility which contains: - waste analysis plans and test records - inspection logs and training reports - contingency plan and incident reports - manifest information and map of disposal area - outline for groundwater assessment program, all monitoring, testing, and analytical data - closure and post-closure plans, cost estimates - demonstration reports for variances (security, groundwater, food chain crops)	Relevant and Appropriate	Hazardous waste removed from the silos must be treated, stored (if more than 90 days), and disposed of in accordance with TSD facility standards.	1C, 2C, 3, 4, 6, 7, 8, 9

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Reporting	40 CFR 264.75-77 Facilities must submit to the appropriate authorities the following reports: - Biennial reports - Reports of unmainifested wastes - Reports of releases, fires, and explosions - Groundwater monitoring data when contamination is discovered (within 7 days) - Notice of facility closure.	Relevant and Appropriate	Hazardous waste removed from the silos must be treated, stored (if more than 90 days), and disposed of in accordance with TSD facility standards.	1C, 2C, 3, 4, 6, 7, 8, 9

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Operating Record	40 CFR 264, Subpart E 40 CFR 264.73- Operating Record requirements Operators must maintain a written operating record at the facility which contains the following: • description and quantity of each hazardous waste received; • method(s) and date(s) of treatment as required by Appendix I; • location of each hazardous waste received and quantity at each location (including a location map for disposal facility); • inspection and monitoring records; and • other records and reports as specified.	Relevant and Appropriate	Records on hazardous wastes removed from the silos must be maintained in accordance with TSD facility standards.	1C, 2C, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Groundwater Monitoring and Response Requirements	40 CFR 264, Subpart F Owners or operators of TSD facilities must operate a groundwater monitoring program unless the facility: - is an engineered structure - does not receive or contain liquid wastes or waste containing free liquids - is designed to exclude run on and run off - has inner and outer containment layers enclosing the waste - has leak detection built into each layer - operator will provide for continual operation and maintenance of the leak detection systems during the active life, closure and post closure of the facility	Relevant and Appropriate	Hazardous waste removed from the silos must be treated, stored (if more than 90 days), and disposed of in a properly designed and operated TSD facility.	1C, 2C, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Groundwater Monitoring and Response Requirements (continued)	- will not allow hazardous constituents to migrate beyond the containment layer prior to the end of the post closure period - there is no potential for migration of liquid from the unit to the uppermost aquifer prior to the end of the post closure care period.			

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Operation of Hazardous Waste Disposal Facility	40 CFR 264, Subpart F Groundwater Monitoring Owners and operators of new hazardous waste disposal facilities must conduct a groundwater monitoring program to include: (1) under 40 CFR 264.99 if releases are detected; (2) institute a corrective action program under 40 CFR 264.100 if a groundwater protection standard is exceeded or if concentration limits established under 40 CFR 264.94 are exceeded between the compliance point and the downgradient facility property boundary; (3) or a detection monitoring program under 40 CFR 264.98. The design of the groundwater monitoring system shall be according to 40 CFR 264.97.	Relevant and Appropriate	Requirement is relevant and appropriate to those alternatives where wastes are removed and being placed in a new, replacement or expanded hazardous waste disposal facilities to insure hazardous substances are not leaching out to the soil or groundwater.	3, 6, 8

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action,	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment (in a Unit)	40 CFR 264, Subpart J (Tanks) Design and operating standards for tank unit within which hazardous waste is treated.	Relevant and Appropriate	Design criteria and operating standards for tank treatment units is relevant and appropriate for alternatives utilizing treatment in a tank prior to disposal.	3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Release From Solid Waste Management Units	40 CFR 264.95 Point of compliance is vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer.	Relevant and Appropriate	Specific goals and objectives of regulations for treatment units to meet design and operating standards are relevant and appropriate for alternatives. Treatment design and operating standards are relevant and appropriate to those alternatives proposing treatment of waste before disposal.	All

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Release From Solid Waste Management Units	40 CFR 264.97 The groundwater monitoring system must have wells at locations and depths to yield samples from the upper-most aquifer that (1) represents background levels and (2) represent the quality of groundwater passing the point of compliance. 40 CFR 264.99 The operator must monitor the groundwater to determine if waste management units are in compliance with standards outlined in 264.93	Relevant and Appropriate	Operable Unit 4 wastes may migrate into the underlying aquifer and contaminate drinking water sources as a consequence of remedial actions.	All

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Closure with No Post-closure Care	40 CFR 264.111 OAC 3745-66-11 General performance standard requires elimination of need for further maintenance and control; elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products. 40 CFR 264.114 OAC 3745-66-14 During the partial and final closure, all contaminated equipment, structures and soils must be properly disposed. 40 CFR 264.258 Removal or decontamination of all waste residues, contaminated containment system components (e.g., liners, dikes), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and management of them as hazardous waste.	Relevant and Appropriate	Hazardous waste removed from the silos which are treated or stabilized and packaged and disposed of on-site in a properly designed land disposal unit require no post-closure care.	3, 6, 8

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Closure with Waste in Place (See Capping for Additional Associated Requirements)	40 CFR 264.117 OAC 3745-66-17-20 Post-closure care must begin after completion of closure and continue for 30 years. 40 CFR 264.310 (b) OAC 3745-66-11 After closure, the owner or operator must comply with all post-closure requirements 40 CFR 264.117-264.120 including maintenance of cover, monitoring of leachate and groundwater monitoring required in 40 CFR 264, Subpart F.	Relevant and Appropriate	Waste remaining in place after closure requires post-closure care and monitoring to insure elimination of escape of hazardous constituents, leachate, and contaminated run-off.	1A, 1B, 2A, 2B, 3, 6, 8

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Container Storage	Containers of RCRA hazardous waste must be: 40 CFR 264.171 OAC 3745-55-70 through -78 • Maintained in good condition; 40 CFR 264.172 • Compatible with hazardous waste to be stored; and 40 CFR 264.173 • Closed during storage (except to add or remove waste). 40 CFR 264.174 Inspect container storage areas weekly for deterioration.	Relevant and Appropriate	These requirements are relevant and appropriate to alternatives utilizing containers for temporary storage or storage before disposal. Requirement is not applicable because wastes (including associated contaminated construction wastes) are not solid waste and therefore not hazardous by waste definition.	1C, 2C, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Container Storage (continued)	40 CFR 264.175 Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system. 40 CFR 264.177 Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier. 40 CFR 264.178 At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.			

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Construction of Hazardous Waste Disposal Facilities	40 CFR 264.301 Minimum Technology Requirements Install two liners or more, including a top liner that prevents waste migration into the liner, and a bottom liner that prevents waste migration through the liner. Install leachate collection system above and between liners. Construct run-on and run-off control system capable of handling the peak discharge of a 25-year storm. Control wind dispersion of particulates.	Relevant and Appropriate	Requirement is relevant and appropriate to those alternatives where wastes are removed and being placed in a new, replacement or expanded hazardous waste disposal facility to prevent hazardous substances from being leached into surrounding soil and groundwater.	3, 6, 8

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Capping (See also Closure with Waste in Place for Additional Associated Requirements)	40 CFR 264.310(a) OAC 3745-66-11 Placement of a cap over waste (e.g., closing a landfill, or closing a waste pile as a landfill, or similar action) requires a cover designed and constructed to: • Provide long-term minimization of migration of liquids through capped area; • Function with minimum maintenance; • Promote drainage and minimize erosion or abrasion of the cover; • Accommodate settling and subsidence so that the cover's integrity is maintained; and • Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.	Relevant and Appropriate	Disposal in place or in a landfill will require a cap to prevent migration of waste constituents due to leaching. The requirement is not applicable because the wastes are excluded from the definition of solid wastes and therefore cannot be a part of the subset of hazardous waste. The wastes contain hazardous constituents, pollutants or contaminants and therefore the requirement is relevant and appropriate.	1A, 1B, 2A, 2B, 3, 6, 8

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Capping (See also Closure with Waste in Place for Additional Associated Requirements) (continued)	40 CFR 264.117 (c) OAC 3745-66-17-20 Restrict post-closure use of property as necessary to prevent damage to the cover. 40 CFR 264.310 (b) OAC 3745-66-11 Prevent run-on and run-off from damaging cover. 40 CFR 264.310 (b) OAC 3745-66-11 Protect and maintain surveyed benchmarks used to locate waste cells (landfills, waste piles). 40 CFR 264.310 (b) OAC 3745-66-11 Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necesary to correct the effects of settling, subsidence, erosion, or other events, monitoring of leachate and groundwater monitoring.			

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal Restrictions	40 CFR 268 Generally prohibits the placement of restricted RCRA hazardous wastes in land-based units such as landfills, surface impoundments, waste piles and land treatment facilities, unless: • they have been treated in accordance with technology-based or treatment-based standards specified under 40 CFR 268.40-43; • they remain hazardous but treatment has been waived under a "National Capacity Extension" as specified under 40 CFR 268.30-33 and the receiving unit meets the RCRA Sec. 3004 (O) minimum technology requirements including double liner, leachate collection system and groundwater monitoring;	Relevant and Appropriate	If restricted RCRA wastes are removed from the silos they may only be placed in a land disposal unit after they have been treated in accordance with the land disposal treatment requirements or have qualified for a waiver or variance from the treatment requirements.	1C, 2C, 3, 4, 6, 7, 8, 9

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal Restrictions (continued)	• a treatability variance has been set for the waste accordance with 40 CFR 268.44; • an equivalent treatment method petition has been approved where the site manager can demonstrate that another technology can achieve an equivalent measure of performance in accordance with 40 CFR 268.42; • a no-migration petition has been approved in accordance with 40 CFR 268.6; • the site manager can have the waste delisted by demonstrating that the waste does not meet any of the criteria under which the waste was listed and other factors (including additional constituents) would not cause the waste to be hazardous.			

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Slurry Wall	40 CFR 268, Subpart D If the soils excavated for the construction of a slurry wall contain hazardous constituents in concentrations determined to be above health-based protection levels, they must be disposed of properly. If constituents are those that are prohibited from disposal in new land disposal facilities other treatment and disposal will be required.	Relevant and Appropriate	Excavated soils near silos may contain hazardous constituents from silos. Soils will be disposed of with silo contents. Excavated soils for construction of a slurry wall may have to be disposed of with silo contents if contaminated. Degree and extent of contamination, if any, depends on location and close proximity to contaminated area. Requirement is not applicable as waste is not considered solid waste and therefore is not hazardous waste under RCRA.	1A, 1B, 2A, 2B

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal Restrictions on Storage of Restricted Waste	40 CFR 268.50 The storage of hazardous waste restricted from land disposal under RCRA Section 3004 and 40 CFR 268, Subpart C is prohibited unless: • Wastes are stored in tanks or containers by a generator or the on-site operator of a TSD facility solely for the purpose of accumulation of such quantities as to facilitate proper treatment or disposal. • Generators storing waste under this provision must also comply with 40 CFR 262.34 including the 90-day storage limitation. • TSD facility operators storing waste under this provision must also: - clearly mark each container to identify the contents and the beginning date for accumulation of the waste;	Relevant and Appropriate	Restricted hazardous waste removed from the silos may be stored or accumulated prior to treatment, packaging, and disposal if the land disposal accumulation requirements are met.	1C, 2C, 3, 4, 6, 7, 8, 9

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal Restrictions on Storage of Restricted Waste (continued)	- clearly mark each tank with a description of contents, quantity of contents, and beginning accumulation date, or record such information in the facility operating record - comply with operating record requirements under 40 CFR 264.73 • TSD facility operators may store wastes under this provision for up to one year.			

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Wastewater Treatment	OAC 3745-31 New wastewater treatment facilities and/or industrial processes which produce process wastewater must meet substantive permitting requirements.	Relevant and Appropriate	FMPC now has a central wastewater treatment facility. The implementation of remedial alternatives will result in new process waste streams which may be incompatible with the existing wastewater treatment facility and which may require the construction and operation of a separate facility to treat those wastes prior to discharge.	1A, 1B, 1C, 2A, 2B, 2C, 3, 4, : 6, 7, 8, 9

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Residual Radioactive Material in Soil	DOE Order 5400.5, Chapter IV Concentrations of residual radioactivity in soil in areas for unrestricted use shall not exceed background concentrations averaged over an area of 100 m^2 by the following: • Generic guidelines for radium-226, radium-228, thorium-230, and thorium-232: a) 5 pCi/g, averaged over the first 15 cm of soil below the surface; and b) 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface. • For other radionuclides, the residual concentration of the radionuclides in soil shall be derived from the basic dose limit (100 mrem effective dose equivalent per year) by means of an environmental pathway analysis	To be considered	Radioactive materials in this operable unit could deliver an effective radiation dose exceeding 100 mrem per year if released onto soil in areas for unrestricted use.	1A, 1B, 1C, 2A, 2B, 2C, 3, 4, 6, 7, 8, 9

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FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Residual Radioactive Material in Soil (continued)	using site specific data where available. Procedures for derivations of residual radioactivity are given in "A Manual for Implementing Residual Radioactive Material Guidelines" (DOE/CH-8901). • Determination of "hot spots" and "hot spot" cleanup limits are contained in DOE Order 5400.5, Chapter IV and DOE/CH/8901. • Explicity formulas for calculating residual concentration guidelines for mixtures are given in DOE/CH-8901. • An exception to the above is that residual radioactive materials above the guidelines shall be managed in accordance with Chapter II of this Order, and the requirements of Section 6 of Chapter IV.			

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal On-Site	DOE Order 5820.2A, Chapter III DOE solid low-level wastes shall be managed in accordance with DOE Order 5820.2A, Chapter III and the additional requirements cited therein.	To be considered	Radioactive materials within this operable unit, although not classified as low-level waste, may be disposed of on-site in conjunction with materials from other operable units which contain low-level waste. Disposal of the materials from this operable unit must then comply with the low-level waste disposal requirements.	3, 6, 8

FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal On-Site	DOE Order 5820.2A, Chapter IV DOE waste containing byproduct material shall be stored, stabilized in-place, and/or disposed of consistent with the requirements of the residual radioactive material guidelines contained in 40 CFR 192.	To Be Considered	Radioactive materials within this operable unit meet the definition of byproduct material (DOE Order 5820.2A, Attachment 1, page 1, paragraph 3) and therefore are to be managed in accordance with DOE requirements for waste containing byproduct materials.	1A, 1B, 1C, 2A, 2B, 2C, 3, 4, 6, 7, 8, 9

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Residual Radioactive Material as Surface Contamination	US NRC Regulatory Guide 1.86 Surface contamination guidelines for release of equipment and building components for unrestricted use, and if buildings are demolished, for contamination in the ground, shall not be exceeded.	To be considered	Radioactive materials in this operable unit could cause surface contamination levels to exceed the required guidelines.	All

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FIGURE A-1 (Continued)

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Remediation of Sites Having Radioactive Wastes from Uranium Processing	DOE Plan for Implementing EPA Standards for UMTRA Sites (UMTRA-DOE/AL-163)(January 1984)- Presents direction for implementing EPA standards on uranium mill tailings remedial action sites. DOE Technical Approach Document-Revision II (UMTRA-DOE/AL-050425.0002)(December 1987)- Presents the technical approach for remediation of uranium mill tailings remedial action sites. DOE Remedial Action Planning and Disposal Cell Design (UMTRA-DOE/AL 400503)(January 1989)- Presents direction for complying with the proposed 40 CFR 192 for planning and disposal cell design for uranium mill tailings remedial action sites.	To be considered	Materials within this operable unit have similar chemical and radiological properties as uranium mill tailings. Directions for remediation of mill tailings sites contained within these documents can provide guidance not found in promulgated regulations.	3, 6, 8

FIGURE A-1 (Continued)
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO
POTENTIAL ARARs
OPERABLE UNIT 4 ALTERNATIVES

Action Specific

Chemical, Location, or Action	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Remediation of Sites Having Radioactive Wastes from Uranium Processing (continued)	DOE Project Surveillance and Maintenance Plan (UMTRA-DOE/AL 350124)- Presents direction for surveillance and maintenance of uranium mill tailings remedial action sites.			

APPENDIX

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APPENDIX B

SILO ANALYTICAL DATA

TABLE B-1

RADIONUCLIDE CONCENTRATION IN THE SILO WASTE

SILO 1

Nuclide (pCi/g)	S1NE1A	S1NE1B	S1NE1C	S1SE1	S1SE2	S1SW1	S1NW1
Th-228	ND	ND	ND	ND	ND	ND	ND
Th-230	21,412	39,693	30,751	10,569	20,848	40,818	43,771
Th-232	ND	ND	ND	ND	ND	ND	766
Ra-226	108,100	192,600	166,400	116,800	89,280	181,200	163,300
Ra-228	ND	ND	ND	ND	ND	ND	ND
Pb-210	181,100	83,110	77,460	71,920	48,980	69,480	54,350
U-234	815	326	622	663	814	594	897
U-235/236	ND	ND	ND	ND	56	ND	50
U-238	920	398	610	545	758	532	687
U-Total (ppm)	2753	1189	1831	1633	2280	1602	2066

SILO 2

Nuclide (pCi/g)	S2SW1	S2NW1	S2NE2	S2SW2	S2NE1	S2NW2
Th-228	ND	ND	ND	411	ND	638
Th-230	31,825	32,784	8365	29,716	40,124	25,391
Th-232	ND	ND	ND	851	ND	ND
Ra-226	145,300	61,780	657	104,900	65,520	68,310
Ra-228	ND	ND	ND	ND	ND	ND
Pb-210	141,900	145,200	87,930	77,940	150,700	399,200
U-234	859	1107	974	121	848	1404
U-235/236	ND	74	47	ND	36	70
U-238	661	1069	874	46	814	1240
U-Total (ppm)	1972	3210	2620	137	2437	3717

ND = Not Detected

Note: Data validation is currently in progress
Source: Winter 1989 WMCO sampling

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TABLE B-1 (Continued)

RADIONUCLIDE CONCENTRATION IN THE SILO WASTE

SILO 3

Nuclide (pCi/g)	21	22	23	24	25	26
Ac-227	523	416	234	1363	534	706
Pa-231	521	401	266	NA	556	889
Th-228	907	ND	554	ND	459	859
Th-230	41,911	33,881	21,010	71,650	40,968	41,555
Th-232	1451	ND	815	911	411	ND
Ra-224	453	451	64	213	295	335
Ra-226	2589	2192	467	6435	3073	1862
Ra-228	525	559	82	ND	392	441
Pb-210	2437	2221	454	6427	2493	1910
U-234	1935	1618	348	1524	1467	1910
U-235/236	152	117	ND	127	54	76
U-238	2043	1649	320	1600	1392	1860
U-Total (ppm)	4040	4305	738	2595	3064	4554

SILO 3

Nuclide (pCi/g)	27	28	29	30	33
Ac-227	421	412	443	773	566
Pa-231	458	NA	564	931	431
Th-228	ND	996	537	ND	949
Th-230	53,227	63,649	61,190	68,759	65,488
Th-232	ND	755	672	581	672
Ra-224	370	106	137	449	313
Ra-226	1518	3702	4169	2240	4451
Ra-228	325	ND	117	360	415
Pb-210	1084	2589	3553	1942	3674
U-234	1317	1052	1843	1643	1600
U-235/236	80	42	158	75	118
U-238	1243	994	1951	1574	1878
U-Total	2740	1463	1114	4050	3854

NA = Not Analyzed
ND = Not Detected

Note: Data validation is currently in progress
Source: Winter 1989 WMCO sampling

TABLE B-2

CHEMICAL CONCENTRATION REPORT FOR SILOS 1, 2, AND 3
OPERABLE UNIT 4

PCB Organics Analysis Data (µg/kg)

SILO 1

Sample Location	S1NE1A	S1NE1B	S1NE1C	S1NW1	S1SE1	S1SE2	S1SW1
Aroclor-1248	3700	ND	ND	1700	2500	7300	2400
Aroclor-1254	8100	1100(J)	1300(J)	3900	3500	10,000	5600
Second Dilution			**Second Dilution**				
Aroclor-1248	4100(J)	NA	NA	2800(J)	4000(J)	8000	3200(J)
Aroclor-1254	8700(J)	NA	NA	5700(J)	5800(J)	12,000	6600(J)
Blank Reference	Blank 1	Blank 1	Blank 2	Blank 1	Blank 1	Blank 1	Blank 1

SILO 2

Sample Location	S2NE1	S2NE2	S2NW1	S2NW2	S2SW1	S2SW2
Aroclor-1248	ND	ND	ND	ND	ND	ND
Aroclor-1254	1900	420(J)	3000	1300(J)	3300	3900
Second Dilution			**Second Dilution**			
Aroclor-1248	ND	NA	ND	ND	ND	ND
Aroclor-1254	2000(J)	NA	5400(J)	1500(J)	3700(J)	6000(J)
Blank Reference	Blank 2	Blank 2	Blank 2	Blank 2	Blank 1	Blank 2

SILO 3 and BLANKS

Sample Location	26	27	28	29	Blank 1	Blank 2
Aroclor-1248	ND	ND	ND	ND	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND	ND
Second Dilution		**Second Dilution**				
Arcolor-1248	NA	NA	NA	NA		
Aroclor-1254	NA	NA	NA	NA		
Blank Reference	Blank 1	Blank 1	Blank 1	Blank 1		

Organic Qualifiers
J - Compound detected below the contract required quantification limit (CRQL)
ND - Compound analyzed for but not detected
B - Compound was found in the method blank
NA - Not analyzed
Note 1: S1 indicates Silo 1, S2 indicates Silo 2, 21-33 indicate Silo 3
Note 2: Data validation is currently in progress
Source: Winter 1989 WMCO sampling.

TABLE B-2 (Continued)

CHEMICAL CONCENTRATION REPORT FOR SILOS 1, 2, AND 3
OPERABLE UNIT 4

Inorganics Analysis Data (mg/kg)
SILO 1

Sample Location	S1NE1A	S1NE1B	S1NE1C	S1NW1	S1SE1	S1SE2	S1SW1
Parameter							
Aluminum	1260	60.4	1380	450	364	1430	733
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	57.0	47.9	45.8	54.5	14.7	68.4	61.0
Barium	4340	1970	4140	5000	2720	2190	7860
Beryllium	2.8	1.3	1.4	1.1	0.88(B)	2.4	1.3
Cadmium	4.4	2.3	2.9	2.1	3.0	8.0	2.7
Calcium	5580	2320	2150	4130	3500	5700	5410
Chromium	43.3	25.8	22.8	21.0	165	111	42.6
Cobalt	1260	404	1210	681	349	814	657
Copper	473	122	410	217	126	307	209
Iron	24,100	9090	7170	4340	22,600	75,100	8370
Lead	35,800	61,400	85,100	81,300	38,900	38,800	76,900
Magnesium	2770	3270	3620	1900	1500	6020	2830
Manganese	178	36.5	83.1	33.5	94.2	257	54.0
Mercury	2.8	0.47	0.72	0.43	0.23	0.60	0.56
Nickel	1970	815	2580	1180	629	1350	1140
Potassium	158(B)	347(B)	424(B)	350(B)	173(B)	293(B)	492(B)
Selenium	172	139	170	162	106	180	168
Silver	9.8	5.0	23.3	9.5	6.3	13.1	9.8
Sodium	360(B)	5730	13,100	7080	1640	2610	7010
Thallium	0.09(B)	0.38(B)	ND	0.49(B)	0.24(B)	ND	0.52(B)
Vanadium	240	111	110	105	72.2	140	106
Zinc	212	14.4	26.3	24.7	23.9	57.3	17.8
Cyanide	0.52	1.4	1.4	2.9	0.99	1.6	4.4

Inorganic Qualifiers
ND - Compound analyzed for but not detected above instrument detection level (IDL)
B - Compound found between IDL and CRQL

Note 1: S1 indicates Silo 1, S2 indicates Silo 2, 21-33 indicate Silo 3
Note 2: Data validation is currently in progress
Source: Winter 1989 WMCO sampling

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TABLE B-2 (Continued)

CHEMICAL CONCENTRATION REPORT FOR SILOS 1, 2, AND 3
OPERABLE UNIT 4

Inorganics Analysis Data (mg/kg)
SILO 2

Sample Location	S2NE1	S2NE2	S2NW1	S2NW2	S2SW1	S2SW2
Parameter						
Aluminum	2570	1360	1250	1180	464	551
Antimony	ND	ND	ND	ND	7.2(B)	6.4(B)
Arsenic	1960	330	71.3	57.5	81.4	64.5
Barium	2460	89.2	1190	3090	8370	8000
Beryllium	2.0	0.66(B)	6.0	2.7	1.6	2.1
Cadmium	19.1	4.1	5.6	5.0	3.6	3.4
Calcium	41,900	301,000	10,300	2430	3610	8570
Chromium	42.2	12.9	68.8	47.2	24.3	34.1
Cobalt	2430	6.2(B)	648	543	692	602
Copper	1790	ND	220	221	263	249
Iron	13,500	4010	37,800	26,900	8330	11,400
Lead	21,600	153	15,100	17,600	28,500	29,800
Magnesium	7390	8740	4200	4220	1520	2060
Manganese	403	335	170	160	74.2	83.2
Mercury	1.0	2.3	1.7	0.37	ND	0.34
Nickel	2200	14.6	878	787	1070	897
Potassium	207(B)	37.8(B)	271(B)	192(B)	118(B)	289(B)
Selenium	91.1	ND	117	95.9	118	105
Silver	22.8	ND	9.1	12.0	7.4	10.1
Sodium	4070	588(B)	912	226(B)	3100	857
Thallium	0.61(B)	ND	0.33(B)	0.39(B)	1.4(B)	0.82(B)
Vanadium	142	21.9	214	211	151	193
Zinc	154	11.2	31.6	70.8	25.8	25.7
Cyanide	1.1	ND	4.5	0.90	2.5	1.6

Inorganic Qualifiers
ND - Compound analyzed for but not detected above instrument detection level (IDL)
B - Compound found between IDL and CRQL

Note 1: S1 indicates Silo 1, S2 indicates Silo 2, 21-33 indicate Silo 3
Note 2: Data validation is currently in progress
Source: Winter 1989 WMCO sampling

TABLE B-2 (Continued)

CHEMICAL CONCENTRATION REPORT FOR SILOS 1, 2, AND 3
OPERABLE UNIT 4

Inorganics Analysis Data (mg/kg)
SILO 3

Sample Location	21	22	23	24	25	26	27
Aluminum	21,300	18,000	18,000	23,700	15,800	10,800	20,800
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	1380	2450	1610	6380	2200	532	1460
Barium	297	253	332	194	210	118	319
Beryllium	20.8	20.6	39.9	35.1	26.5	10.0	25.2
Cadmium	41.7	60.3	40.1	204	62.4	21.5	45.5
Calcium	39,500	33,100	32,600	23,300	25,800	21,300	39,900
Chromium	260	171	421	139	213	170	335
Cobalt	2580	1100	1340	1870	1340	ND	2190
Copper	2020	2430	1610	7060	2440	1620	2140
Iron	41,700	26,200	60,400	13,900	31,200	28,200	67,600
Lead	1700	1440	646	4430	1310	1510	1130
Magnesium	74,400	62,400	44,900	38,200	44,100	44,800	72,400
Manganese	5200	3610	6500	2420	.3980	2700	5790
Mercury	ND	ND	ND	0.30	ND	0.69	ND
Nickel	3280	1200	1810	2280	1760	6170	3150
Potassium	5310	3880	22800	4520	7360	3300	13600
Selenium	159	108	129	122	105	349	192
Silver	23.8	21.5	9.2	14.8	14.3	14.9	20.2
Sodium	30,100	43,100	44,100	38,100	31,200	22,900	39,500
Thallium	10.0	37.6	6.5	73.9	35.8	7.2	11.9
Vanadium	1180	2030	1420	4550	2030	499	1270
Zinc	497	361	637	387	380	301	563
Cyanide	ND	ND	ND	ND	ND	ND	ND

Inorganic Qualifiers
ND - Compound analyzed for but not detected above instrument detection level (IDL)
B - Compound found between IDL and CRQL

Note 1: S1 indicates Silo 1, S2 indicates Silo 2, 21-33 indicate Silo 3
Note 2: Data validation is currently in progress
Source: Winter 1989 WMCO sampling

TABLE B-2 (Continued)

CHEMICAL CONCENTRATION REPORT FOR SILOS 1, 2, AND 3
OPERABLE UNIT 4

Inorganics Analysis Data (mg/kg)
SILO 3

Sample Location	28	29	30	33
Aluminum	14,800	13,500	15,300	17,500
Antimony	ND	ND	ND	ND
Arsenic	1420	1010	1060	1980
Barium	142	118	215	185
Beryllium	31.2	13.9	16.6	26.4
Cadmium	69.8	24.2	35.1	52.7
Calcium	26,200	25,600	29,900	25,900
Chromium	560	443	236	221
Cobalt	2800	3520	2950	1350
Copper	2760	1640	2010	2280
Iron	45,000	40,000	37,800	23,800
Lead	1800	1960	1330	1750
Magnesium	71,400	80,900	58,100	52,800
Manganese	5940	5290	3970	2780
Mercury	ND	ND	0.30	ND
Nickel	3040	3830	4230	1970
Potassium	3740	1300	6690	7340
Selenium	204	186	254	101
Silver	13.3	9.5	17.4	16.1
Sodium	51,700	27,000	30,400	39,000
Thallium	5.5	4.0	13.7	3.1
Vanadium	2540	418	1040	3040
Zinc	672	449	397	306
Cyanide	ND	ND	ND	ND

Inorganic Qualifiers
ND - Compound analyzed for but not detected above instrument detection level (IDL)
B - Compound found between IDL and CRQL

Note 1: S1 indicates Silo 1, S2 indicates Silo 2, 21-33 indicate Silo 3
Note 2: Data validation is currently in progress
Source: Winter 1989 WMCO sampling