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TASK 12 REPORT

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

REMEDIAL INVESTIGATION and FEASIBILITY STUDY

September 1990

U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE

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Prepared by

ADVANCED SCIENCES, INC
INTERNATIONAL TECHNOLOGY CORP.

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LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
AEC	Atomic Energy Commission
ARAR	applicable or relevant and appropriate requirement
AWQC	Ambient Water Quality Criteria
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COE	U.S. Army Corps of Engineers
CWA	Clean Water Act
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
FFCA	Federal Facility Compliance Agreement
FMPC	Feed Materials Production Center
FS	Feasibility Study
IT	International Technology, Inc.
μg/l	micrograms per liter
MCL	maximum contaminant level
mrem	milli roentgen equivalent man
MSL	mean sea level
MPRSA	Marine Protection Research and Sanctuaries Act
mtu	metric tons of uranium
NAAQS	National Ambient Air Quality Standard
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NLO	National Lead Company of Ohio
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency

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LIST OF ACRONYMS AND ABBREVIATIONS
(Concluded)

PCB	polychlorinated biphenyl
pCi	picoCurie
pCi/gm	picoCuries per gram
pCi/l	picoCurie per liter
ppm	parts per million
RAO	Remedial Action Objective
RCRA	Resource Compensation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
TBC	to be considered
TSCA	Toxic Substances Control Act
WMCO	Westinghouse Materials Company of Ohio

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Atomic Energy Commission (AEC), predecessor to the U.S. Department of Energy (DOE), established a production complex in the early 1950s for processing uranium and its compounds from natural uranium ore concentrates. This complex, known as the Feed Materials Production Center (FMPC), is located on 1050 acres in a rural area approximately 18 miles northwest of downtown Cincinnati, Ohio. The villages of Fernald, New Baltimore, Ross, Shandon, and New Haven are all located within a few miles of the plant.

On July 18, 1986, a Federal Facility Compliance Agreement (FFCA) pertaining to environmental impacts associated with the many years of operation of the FMPC was jointly signed by the DOE and the U.S. Environmental Protection Agency (EPA) . The FFCA is 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. The 1986 FFCA was amended by a Consent Agreement under Section 120 and 106(a) of CERCLA in order to achieve consistency with the operable unit concept and the current commitments of the Remedial Investigation/Feasibility Study (RI/FS) program without modifying the underlying objectives. The Consent Agreement was signed on April 9, 1990 and became effective on June 29, 1990.

In response to the FFCA, a Remedial Investigation and Feasibility Study (RI/FS) is in progress pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA).

The technical strategy adopted for the RI/FS is to issue distinct RI/FS reports for each of five operable units identified at the FMPC. One of the operable units identified for the RI/FS is Operable Unit 3, which addresses clean up of contamination (typically soil and perched groundwater) in the Production Area and other identified suspect areas. The Production Area covers approximately 136 acres near the center of the FMPC. The suspect areas include rubble

mounds, the K-65 slurry line, the main effluent line, the Clearwell to Manhole 175 line, the sewage treatment plant/incinerator area, an area in the east buffer zone, the fire training area, and an area around the flagpole.

The Operable Unit 3 study addresses surface and below surface radiological and hazardous chemical contamination of soils and perched groundwater attributable to Production Area activities, whether within or outside the area bounded by the Production Area security fence. It also includes the scrap metal piles and the miscellaneous discarded materials and equipment overlying the former drum baling area. A basic assumption of the Operable Unit 3 study is that WMCO's RCRA Closure, Spill Prevention Control and Countermeasure, and Best Management Practices plans will address any activities that are necessary for facilities, underground storage tanks, aboveground drums, and buildings, in addition to repairs of active underground piping.

In general, the Production Area consists of numerous buildings and other facilities utilized in processing the uranium ore concentrates. Also, there is now a large number of waste storage drums, some scrap metal piles, and miscellaneous discarded scrap materials and equipment located in the former drum baling area within the Production Area. For purposes of investigating the location of contaminants and the application of remedial action alternatives, the Production Area was divided into four quadrants. A description of these quadrants is contained in Chapter 1.0 (Section 1.4). Descriptions of the nature and extent of contamination within the quadrants is provided in Chapter 6.0.

The term "suboperable unit" (SU) has been used to identify a consolidation of contaminated areas into categories against which the remedial action alternatives can be screened. The environmental contamination within the Production Area has been categorized into seven

suboperable units. Chapter 6.0 contains detailed descriptions of these suboperable units as defined for Operable Unit 3. The suboperable units are briefly defined as follows:

- Suboperable Unit A - Open field areas with limited access to contaminated soils
- Suboperable Unit B - Open field areas with good access to contaminated soils
- Suboperable Unit C - Soil contamination under facilities
- Suboperable Unit D - Soil contamination under facilities designated for possible demolition
- Suboperable Unit E - Aboveground contaminants (e.g., drum baling area, scrap metal piles, rubble mounds)
- Suboperable Unit F - Perched groundwater contamination
- Suboperable Unit G - Soils surrounding transfer lines

This Feasibility Study (FS) may be viewed (for explanatory purposes) as occurring in three phases: the development of alternatives, the initial screening of the alternatives, and the detailed analysis of alternatives. Alternatives are typically developed concurrently with the Remedial Investigation (RI) site characterization. This report encompasses both the development of alternatives and the initial screening of alternatives. The approach utilized in this report is consistent with CERCLA guidance (EPA 1988a), except for two steps related to the development of alternatives and one step related to the initial screening of alternatives. These deviations were necessitated by the current progress on the Remedial Investigation Report and the Baseline Risk Assessment; both of which are on schedule for submittal to EPA on April 9, 1991, consistent with the Consent Agreement. The three steps that have been modified are: 1) evaluation of process options based on effectiveness, implementability, and relative cost; 2) assembling of alternatives based on process options; and 3) preparation of order of magnitude cost estimates for initial screening of alternatives.

In this report, the methodology utilized instead assembled alternatives based on technology types with the appropriate range of process options being carried forward into the detailed analysis of alternatives. Therefore, process options are evaluated only on the basis of technical implementability in the initial screening step. In addition, it is not yet considered appropriate to develop order of magnitude costs at this stage of the Feasibility Study due to the currently insufficient data available for nonradiological contaminants. This resulted in costs being identified as "high," "medium," or "low." Cost was not considered a legitimate criteria for eliminating an alternative at this stage of the screening process.

The remedial action objectives applicable to Operable Unit 3 are shown in Table ES-1. This report will be followed by the Detailed Analysis of Alternatives presentation.

Fourteen potential remedial action alternatives were developed, based on current site characterization data, for initial screening with respect to the seven suboperable units identified for Operable Unit 3. These 14 alternatives are:

- Alternative 1 - No Action
- Alternative 2 - Cap
- Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap
- Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap
- Alternative 5 - Mechanical Removal and On-Site Disposal
- Alternative 6 - Mechanical Removal and Off-Site Disposal
- Alternative 7 - Near Term: Temporary Cap; Far Term: Mechanical Removal and On-Site Disposal
- Alternative 8 - Near Term: Temporary Cap; Far Term: Mechanical Removal and Off-Site Disposal
- Alternative 9 - Groundwater Extraction, Treatment, and Discharge

TABLE ES-1

OPERABLE UNIT 3 REMEDIAL ACTION OBJECTIVES

Media	Remedial Action Objective
Solid Waste • Soils • Metals • Facilities	Prevent current and future radiation emissions from causing detectable chronic effects. Prevent current and future above-background airborne radiation doses from exceeding 2.5 milli roentgen equivalent man (mrem), and radon concentrations from exceeding risk levels of $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk. Prevent current and future airborne chemical concentrations from exceeding $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk and/or a hazard index of 0.25. Prevent direct contact with soils or other solid wastes containing uranium at levels greater than 35 picoCuries per gram (pCi/gm) [approximately 50 parts per million (ppm)]. Prevent erosion of soil that would contribute to inorganic and organic chemical surface water concentrations exceeding risk levels of $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk and/or a hazard index of 0.25. Prevent erosion of soils that would contribute to surface water concentrations of chemicals in Operable Unit 3 from reaching concentrations in excess of 25 percent of those reported in Tables 2-3 and 2-4. Prevent circumstances that may cause leaching of contaminants to groundwater. Prevent current and future radiation doses migrating from soils or wastes from exceeding 25 mrem/year.
Perched Groundwater	Prevent releases of radionuclides to the groundwater exceeding total uranium levels of 20 picoCuries per liter (pCi/l) [approximately 30 micrograms per liter (μg/l)]. Prevent releases of inorganic and organic chemicals in excess of concentrations shown in Tables 2-3 and 2-4.

- Alternative 10 - Groundwater Extraction, Monitoring, Treatment, and Discharge
- Alternative 11 - Subsurface Barrier
- Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge
- Alternative 13 - Facility Removal and On-Site Disposal
- Alternative 14 - Facility Removal and Off-Site Disposal

In this list of alternatives there is a slight difference between Alternatives 9 and 10. In Alternative 9, all perched groundwater that is extracted is routed to a treatment facility for treatment to levels consistent with Applicable or Relevant and Appropriate Requirements (ARARs). In Alternative 10, a monitoring system will regulate water flow, such that perched groundwater above ARARs-dictated levels will be routed to a treatment facility, but water below the allowable criteria will bypass the treatment facility en route to the Great Miami River for discharge. The availability and use of a monitoring system to determine Hazardous Substance List/volatile organic compounds content in groundwater (either continuously or in a batch system) is still under investigation; this alternative may require modification to be applicable to Hazardous Substance List/volatile organic compounds treatment.

All alternatives that involve on- or off-site disposal would also include volume reduction and packaging if necessary. In addition, alternatives that involve mechanical removal would also include scrap metal decontamination/salvage as appropriate. Decontamination and decommissioning of facilities/buildings is not considered a remedial action alternative for purposes of Operable Unit 3. However, removal of selected facilities and remediation of the underlying contaminated soils has been included as a process option in two of the alternatives (13 and 14).

The alternatives were assembled from screened technologies and process options, and using additional data gathered since the alternative development process. Technologies and process options judged nonapplicable were eliminated from the alternatives. Chapter 2.0 identifies the remedial action objectives and the general response actions applicable to Operable Unit 3. Chapter 3.0 describes, identifies, and evaluates technology types and technology process options. Chapter 4.0 describes the assembly of alternatives and defines the 14 alternatives used in the initial screening process.

After the preliminary evaluation, each remaining alternative was evaluated as described in Chapter 5.0, to ascertain if any could be eliminated from further consideration in the detailed analysis of alternatives. The alternatives were screened against three general criteria: effectiveness, implementability, and cost (described in Chapter 6.0), and each alternative was examined for applicability to each suboperable unit. The No Action Alternative was retained for each suboperable unit to achieve compliance with the requirements of CERCLA. Chapter 6.0 also provides details as to the location, extent, and volume of contamination.

The factors of the effectiveness criterion include: 1) short-term public health protection; 2) long-term public health protection; 3) short-term environmental protection; 4) long-term environmental protection; and 5) the degree to which toxicity, mobility, or volume of the contaminants would be reduced. Factors of implementability considered for the screening evaluation include: 1) constructability, 2) reliability, 3) maintainability, 4) likelihood of obtaining agency approvals, and 5) special engineering requirements.

The total cost of an alternative was the final criterion considered. Cost estimates for screening alternatives are typically based on a variety of cost-estimating data (e.g., generic unit costs, vendor information, and conventional cost-estimating guides) and similar prior estimates modified by site-specific information. Cost estimates for items common to all alternatives or indirect costs (e.g., engineering, financial, supervision, outside contractor support, contingencies) do not warrant substantial effort during the initial alternative screening phase. For Operable

Unit 3, it is not yet considered appropriate to develop order of magnitude costs at this stage of the Feasibility Study, due to the currently insufficient data available for nonradiological contaminants. This has resulted in identifying costs as "high," "medium," or "low" and not considering cost as a legitimate criteria for eliminating an alternatives at this stage of the screening process.

For each factor of each criterion, the alternatives were assigned numerical values of one through five. A ranking of "one" indicates a particular alternative is least favorable with respect to a specific factor (e.g., short-term environmental protection or constructability), while "five" represents an alternative that is most favorable for a particular factor relative to other alternatives. This provided a maximum score of 25 each for the effectiveness and implementability criteria. Chapter 7.0 provides a general summary of the overall screening process and a tabulation of the relative evaluation of the alternatives.

The Baseline Risk Assessment is not complete at this stage of the RI/FS. In the absence of a quantification of risks, the No Action Alternative was ranked lower in terms of environmental protection both in the short and long term. The Baseline Risk Assessment will be completed concurrent with the Detailed Analysis of Alternatives. Alternatives passing through the screening will be evaluated for risk to human health and environmental protection for direct comparison to the baseline condition.

Table ES-2 provides a summary cross reference of technology options with respect to the proposed alternatives in which the technologies are contained.

Table ES-3 provides a matrix representation of the alternatives and the suboperable units for which the alternatives were screened. The details of this screening are contained in Chapter 6.0. Chapter 7.0 provides a summary table and discussion of the results of the screening of alternatives developed in Chapter 6.0.

TABLE ES-2

OPERABLE UNIT 3 REMEDIAL ACTION ALTERNATIVES AND TECHNOLOGY TYPES

Technology Types	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Monitoring	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Maintenance	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Subsurface Barrier											●	●		
Cap		●	●	●			●	●						
Storm Water Management		●	●	●			●	●	●	●		●		
Groundwater Extraction									●	●		●		
Mechanical Removal			●	●	●	●	●	●					●	●
Facility Removal													●	●
Groundwater Treatment									●	●		●		
Soil Treatment					●	●	●	●					●	●
Thermal Treatment			●	●	●	●	●	●					●	●
Metals Decontamination			●	●	●	●							●	●
Stabilization		●	●	●	●	●	●	●					●	●
Waste Segregation and Volume Reduction			●	●	●	●	●	●					●	●
Transportation and Packaging			●	●	●	●	●	●					●	●
On-Site Waste Disposal			●		●		●						●	
Off-Site Waste Disposal				●		●		●						●
Discharge									●	●		●		

Alternative 1 - No Action

Alternative 2 - Cap

Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap

Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap

Alternative 5 - Mechanical Removal and On-Site Disposal

Alternative 6 - Mechanical Removal and Off-Site Disposal

Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal

Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal

Alternative 9 - Groundwater Extraction, Treatment, and Discharge

Alternative 10- Groundwater Extraction, Monitoring, Treatment, and Discharge

Alternative 11 - Subsurface Barrier

Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge

Alternative 13 - Facility Removal and On-Site Disposal

Alternative 14 - Facility Removal and Off-Site Disposal

TABLE ES-3

OPERABLE UNIT 3 PRELIMINARY SCREENING MATRIX CHART

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Suboperable Unit A	●	●			●	●								
Suboperable Unit B	●	●			●	●								
Suboperable Unit C	●				●	●	●	●						
Suboperable Unit D	●				●	●	●	●					●	●
Suboperable Unit E	●	●	●	●	●	●								
Suboperable Unit F	●								●	●	●	●		
Suboperable Unit G	●	●			●	●								

SU A: Open Field Areas with Limited Access to Contaminated Soils

SU B: Open Field Areas with Good Access to Contaminated Soils

SU C: Soil Contamination Under Facilities

SU D: Soil Contamination Under Facilities Designated for Possible Demolition

SU E: Aboveground Contaminants

SU F: Perched Groundwater Contamination

SU G: Soils Surrounding Transfer Lines

NOTE:
SU = Suboperable Unit

Alternative 1 - No Action

Alternative 2 - Cap

Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap

Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap

Alternative 5 - Mechanical Removal and On-Site Disposal

Alternative 6 - Mechanical Removal and Off-Site Disposal

Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal

Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal

Alternative 9 - Groundwater Extraction, Treatment, and Discharge

Alternative 10 - Groundwater Extraction, Monitoring, Treatment, and Discharge

Alternative 11 - Subsurface Barrier

Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge

Alternative 13 - Facility Removal and On-Site Disposal

Alternative 14 - Facility Removal and Off-Site Disposal

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Four alternatives have been eliminated from further analysis based on the results of the screening (described in Chapter 6.0). Primarily, the basis for retaining or deleting an alternative is the alternative's total ranking score relative to the No Action Alternative. If the total score of the alternative under consideration is less than or equal to the No Action Alternative score, then the alternative is deleted from further consideration. The exception to this rule is when considering a pair of similar alternatives with either on-site or off-site disposal options. If one alternative of the pair has a total score lower than the No Action Alternative, but the other has a score higher than the No Action Alternative, then both alternatives are retained for detailed analysis. This exception is included because at this time in the screening process, it is not possible to accurately quantify all factors involved in evaluating on-site versus off-site disposal options. Using this analysis, Alternatives 2, 3, 4, and 11 were screened out and will not be carried forward for detailed analysis. The 10 alternatives remaining for consideration during detailed analysis are:

- Alternative 1 - No Action
- Alternative 5 - Mechanical Removal and On-Site Disposal
- Alternative 6 - Mechanical Removal and Off-Site Disposal
- Alternative 7 - Near Term: Temporary Cap; Far Term: Mechanical Removal and On-Site Disposal
- Alternative 8 - Near Term: Temporary Cap; Far Term: Mechanical Removal and Off-Site Disposal
- Alternative 9 - Groundwater Extraction, Treatment, and Discharge
- Alternative 10 - Groundwater Extraction, Monitoring, Treatment, and Discharge
- Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge
- Alternative 13 - Facility Removal and On-Site Disposal
- Alternative 14 - Facility Removal and Off-Site Disposal

1.0

1.0 INTRODUCTION

The Feed Materials Production Center (FMPC) is a contractor-operated federal facility for the production of pure uranium metals for the U.S. Department of Energy (DOE). The FMPC is located on 1050 acres in a rural area approximately 18 miles northwest of downtown Cincinnati, Ohio. The Production Area is an approximate 136-acre fenced tract near the center of the FMPC. The villages of Fernald, New Baltimore, Ross, Shandon, and New Haven are all located within a few miles of the FMPC (Figure 1-1).

On July 18, 1986, a Federal Facility Compliance Agreement (FFCA) pertaining to environmental impacts associated with the operation of the FMPC was jointly signed by DOE and the U.S. Environmental Protection Agency (EPA). The FFCA was entered into pursuant to Executive Order 12088 (43CFR47707) to ensure compliance with existing environmental statutes and implementing regulations such as the Clean Air Act (CAA); Resource Conservation and Recovery Act (RCRA); and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). 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. The 1986 FFCA was amended by a Consent Agreement under Section 120 and 106(a) of CERCLA in order to achieve consistency with the operable unit concept and the current commitments of the Remedial Investigation/Feasibility Study (RI/FS) program without modifying the underlying objectives. The Consent Agreement was signed on April 9, 1990 and became effective on June 29, 1990.

In response to the FFCA, an RI/FS was initiated pursuant to CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA). All RI/FS activities are being conducted in conformance with the EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (EPA 1988a).

1.1 REPORT ORGANIZATION

This report is organized into seven chapters and one appendix. Chapter 1.0 discusses the background of the study, including the approach and objectives of the RI/FS for the FMPC;

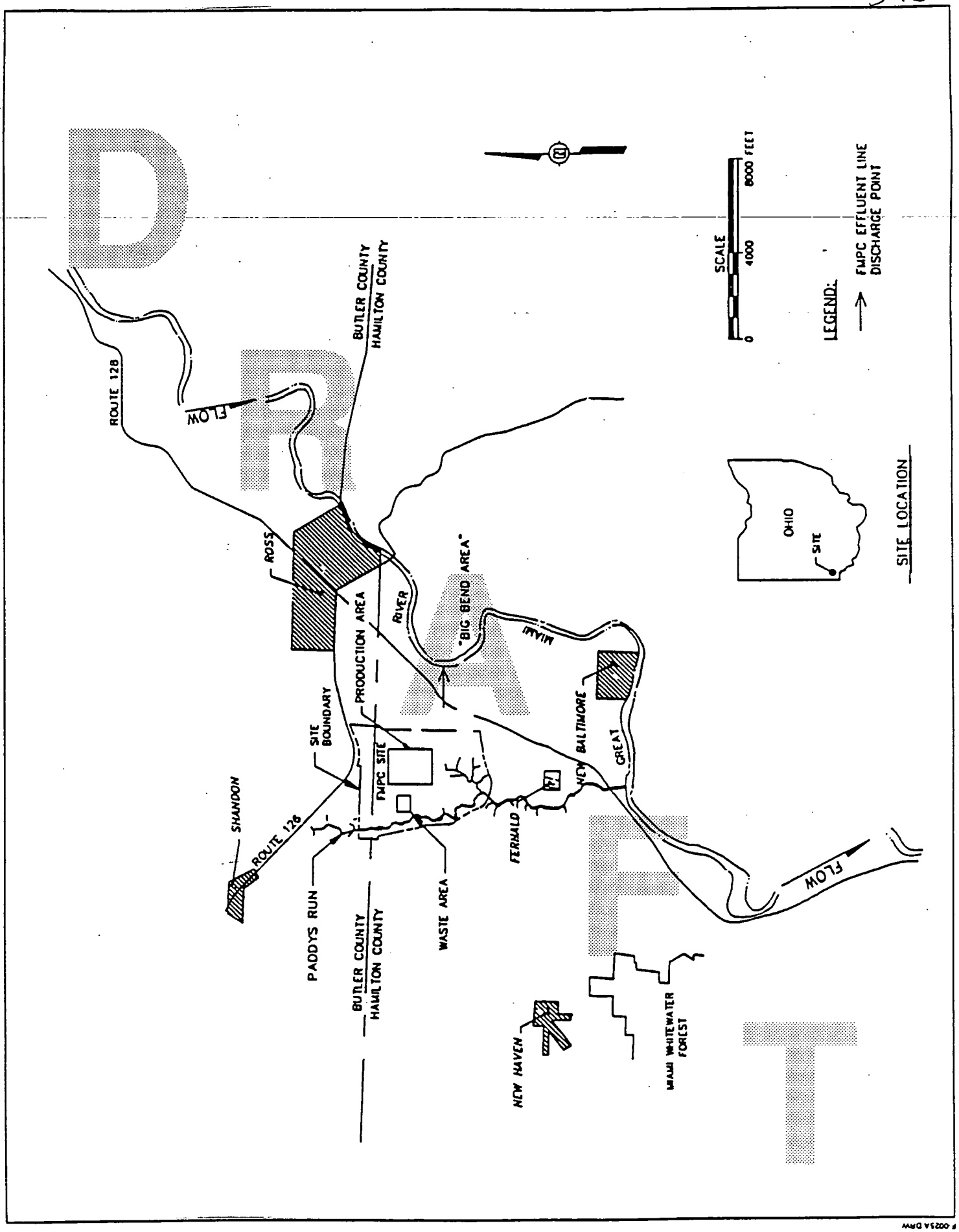

FIGURE 1-1. LOCATION OF THE FEED MATERIALS PRODUCTION CENTER

site historical, geological, climatic, hydrogeological, and environmental settings; Operable Unit 3 definition, facility descriptions, and scope; and a general description of contamination that was found within Operable Unit 3.

Chapter 2.0 discusses remedial action objectives and general response actions applicable to Operable Unit 3. Chapter 3.0 describes, identifies, and evaluates technology types and technology process options based on their applicability to the Operable Unit 3 remedial actions.

Chapter 4.0 describes the remedial action alternatives required to address the general response actions discussed in Chapter 2.0 and describes the 14 alternatives that are the basis for the remainder of the report. Chapter 5.0 identifies the methodology used in the alterative screening process. Chapter 6.0 gives details of the initial screening of alternatives, and Chapter 7.0 presents a summary of the alternatives to be retained for detailed analysis. Appendix A identifies a comprehensive list of potentially applicable or relevant and appropriate requirements (ARARs).

1.2 APPROACH AND OBJECTIVES

The RI/FS for the FMPC initially was designed to address the entire site and to focus on various environmental media that could be potentially impacted by past and present operations at the FMPC. The purpose of the Remedial Investigation (RI) is to determine the nature and extent of any release, or threat thereof, of hazardous or radioactive substances and to gather the necessary data to support the evaluation of remedial action alternatives in the Feasibility Study (FS).

The FS phase of the RI/FS is designed to develop and evaluate remedial action alternatives and to recommend the remedial actions to be taken to protect the public health or welfare, and the environment from releases or threatened releases of hazardous or radioactive substances, pollutants, or contaminants at or from the FMPC. The FS is comprised of the following tasks:

- Description of Current Situation
- Work Plan
- Development of Alternatives
- Initial Screening of Alternatives
- Detailed Analysis of Alternatives
- Evaluation and Selection of Preferred Alternatives
- Draft Feasibility Study Report
- Final Feasibility Study Report
- Additional Requirements

A Work Plan for the site-wide RI/FS, based on the requirements of the FFCA, was originally submitted to the EPA in December 1986. After a series of technical discussions, the Work Plan was modified and resubmitted in March 1988. It received EPA approval in May 1988.

The Work Plan prepared for the site-wide RI/FS provided the overall technical approach, identified a number of investigative areas, developed objectives for each of the specified investigations, and established overall objectives for the evaluation of the data collected during the RI activities. The Work Plan also involved the preparation of a number of detailed plans to establish specific procedures to be followed in the completion of the RI/FS for the FMPC. These plans included the following:

- Sampling Plan
- Health and Safety Plan
- Community Relations Plan
- Data Management Plan
- Quality Assurance Project Plan

The Sampling Plan, which was submitted in March 1988 in conjunction with the RI/FS Work Plan, contained objectives, sampling locations, and sampling procedures for:

- Radiation
- Surface soils
- Groundwater
- Subsurface soils
- Surface water and sediment
- Biological resources

The Work Plan identified 27 units of the FMPC to be investigated in the RI/FS. Several modifications to the list eventually increased this total to 39 units. In the course of the investigation, it became apparent that, for technical and program management purposes, these 39 units needed to be categorized and grouped together. The concept of operable units was introduced into the program to accommodate separate schedules for each operable unit, thereby allowing the remedial action process to proceed to completion for the most well-defined or problematical units, while data collection and analysis continued for other operable units.

There are five operable units:

- Operable Unit 1 - Waste Pits 1 through 6, Clearwell, and Burn Pit
- Operable Unit 2 - Other Waste Units
- Operable Unit 3 - Production Area and Suspect Areas
- Operable Unit 4 - Silos 1, 2, 3, and 4
- Operable Unit 5 - Environmental Media

Because the Work Plan, and more specifically, the Sampling Plan was developed prior to the formulation of the operable units for the FMPC, no operable-unit-specific sampling plans were prepared. Areas covered by Operable Units 1 through 4 are considered sources for possible contamination of the underlying aquifer (Figure 1-2). Although an RI report for one operable unit may indicate the presence of an adjacent operable unit as a potential contributing source, the focus of the RI report will be to present data identifying that source and define the vertical and lateral extent of contamination within the boundary of that operable unit.

The RI report for Operable Unit 5 will address the Great Miami Aquifer that underlies the source operable units, surface water drainages that may carry contamination from those operable units, and any remaining soil contamination not included in the other operable unit RI reports. The net effect of the five RI reports will be to provide a complete description of the extent of contamination and a detailed analyses of its various sources.

The scope of work for the RI at the FMPC was prepared to satisfy the following specific objectives:

- Identify and characterize any sources of potential radiological and chemical contamination.
- Determine the nature and extent of any radiological and chemical substances found in soils, sediments, surface water, and groundwater.
- Identify the migration pathways and mechanisms for transport of radiological and chemical substances found in soils, sediments, surface water, and groundwater.
- Characterize the occurrence of chemical or radiological substances in aquatic and terrestrial organisms both on and off site.

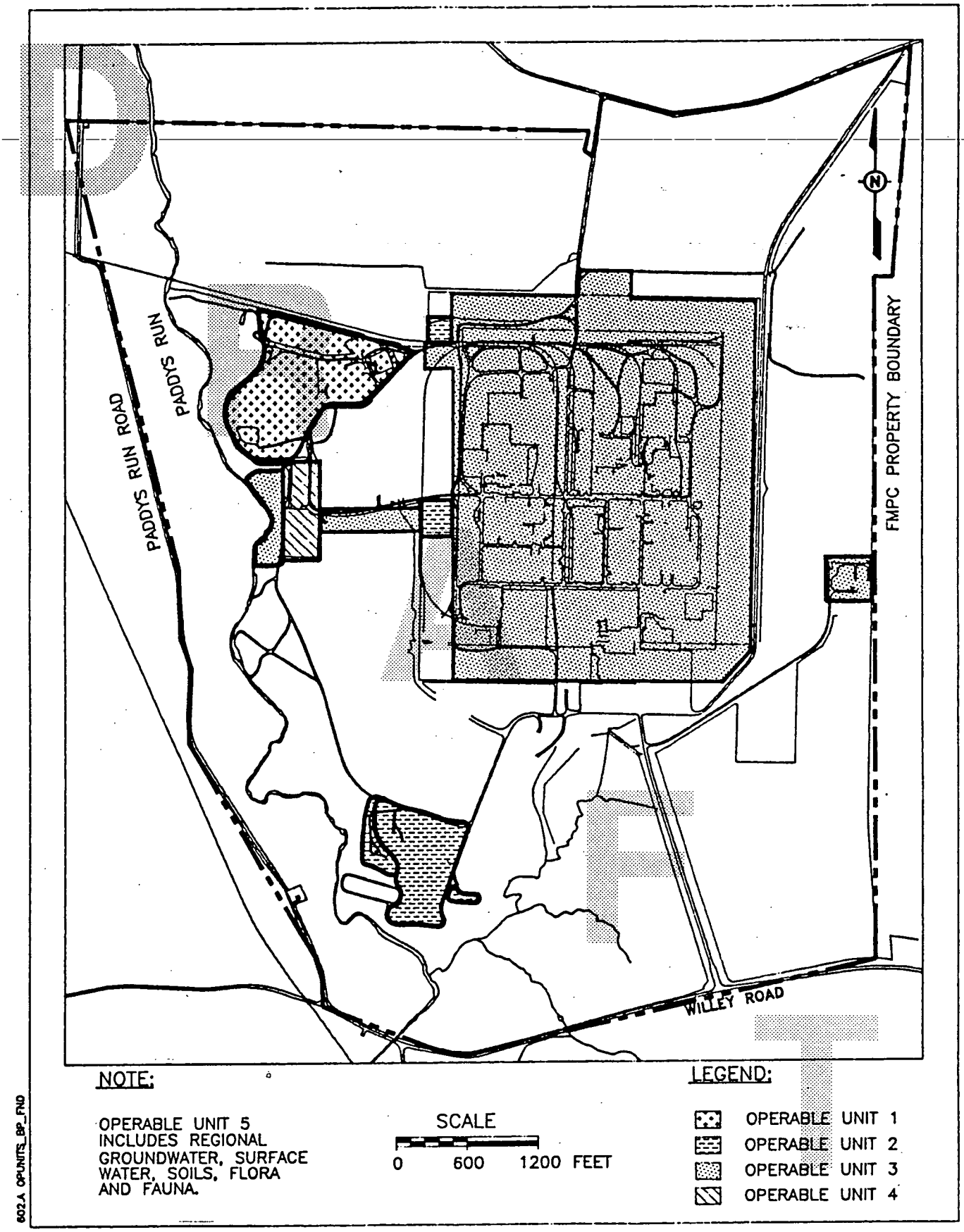

FIGURE 1-2. SOURCE OPERABLE UNITS

- Conduct health risk assessments and environmental impact studies to assess the risk associated with any confirmed contamination at or emanating from the site.
- Develop, validate, and apply various site models to augment the current understanding of the site environment.
- Provide the data necessary to perform the screening and detailed analysis of remedial alternatives during the FS.

The objectives of the FS are to use the Remedial Investigation information to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site. The objective of this Initial Screening of Alternatives report was to evaluate all remedial alternatives against specific criteria in order to select appropriate alternatives for the subsequent detailed analysis phase. The evaluation criteria used were effectiveness, implementability, and cost. This report is a primary deliverable under the Consent Agreement.

1.3 SITE BACKGROUND

Operable Unit 3 encompasses the soils and perched groundwater within and underlying the Production Area, as well as metal scrap piles within the Production Area and a limited number of Production Area facilities. This operable unit also encompasses 10 specific suspect areas. The following discussion relates specifically to facilities and processes affecting Operable Unit 3.

1.3.1 Site Description and History

The Atomic Energy Commission (AEC), predecessor to the DOE, established the FMPC for processing uranium and its compounds from natural uranium ore concentrates and recycled recoverable residues for U.S. Government needs. This integrated production complex began operations in conformance with AEC Orders in the early 1950s. In 1951, National Lead Company of Ohio (now NLO, Inc.) entered into a contract with AEC as the Operations and Maintenance Contractor. This contractual relationship lasted with AEC, and eventually, DOE, until January 1, 1986. Westinghouse Materials Company of Ohio (WMCO), a wholly owned subsidiary of Westinghouse Electric Corporation, then assumed management responsibilities of the site operations and facilities for a minimum of five years.

The pilot plant was completed in 1951 and was the first operational facility at the FMPC. Following completion of the pilot plant, the metals fabrication plant (Plant 6) began operations in 1952. Two metals production plants (Plants 5 and 6), the green salt plant (Plant 4), the recovery plant (Plant 8), the sampling plant (Plant 1), and the refinery (Plant 2/3) began operations in 1953. The hexafluoride reduction plant (Plant 7) and the special products plant (Plant 9) were operational in 1954. A diagram of the existing FMPC Production Area layout is provided in Figure 1-3.

Production peaked in 1960 at approximately 10,000 metric tons of uranium (mtu) per year. A product decline began in 1964, to a low in 1975 of about 1230 mtu. During the 1970s, consideration was given to closing the FMPC; therefore, capital improvements and staffing were minimized. The staffing level, which peaked at 2891 in 1956, slowly declined from 662 in 1972 to 538 in 1979. In 1981, the FMPC began planning to accommodate increased production requirements. Production levels significantly increased and there was a rapid staff buildup in many areas for several years. Implementation of a major facilities restoration program followed. Production ceased in the summer of 1989 to focus plant resources on the restoration program. Currently, the FMPC remains in an inactive status; however, the environmental studies and restoration activities continue.

A variety of chemical and metallurgical processes were utilized at the FMPC for the manufacture of uranium products. During the manufacturing process, high quality uranium compounds were introduced into the FMPC processes at several points. Impure starting materials were dissolved in nitric acid and the uranium was purified through solvent extraction to yield a solution of uranyl nitrate. Evaporation and heating converted the nitrate solution to uranium trioxide powder. This compound was reduced with hydrogen to uranium dioxide and then converted to uranium tetrafluoride by reaction with anhydrous hydrogen fluoride. Uranium metal was produced by reacting uranium tetrafluoride and magnesium metal in a refractory-lined vessel. This primary uranium metal was then remelted with scrap uranium metal to yield a purified uranium ingot.

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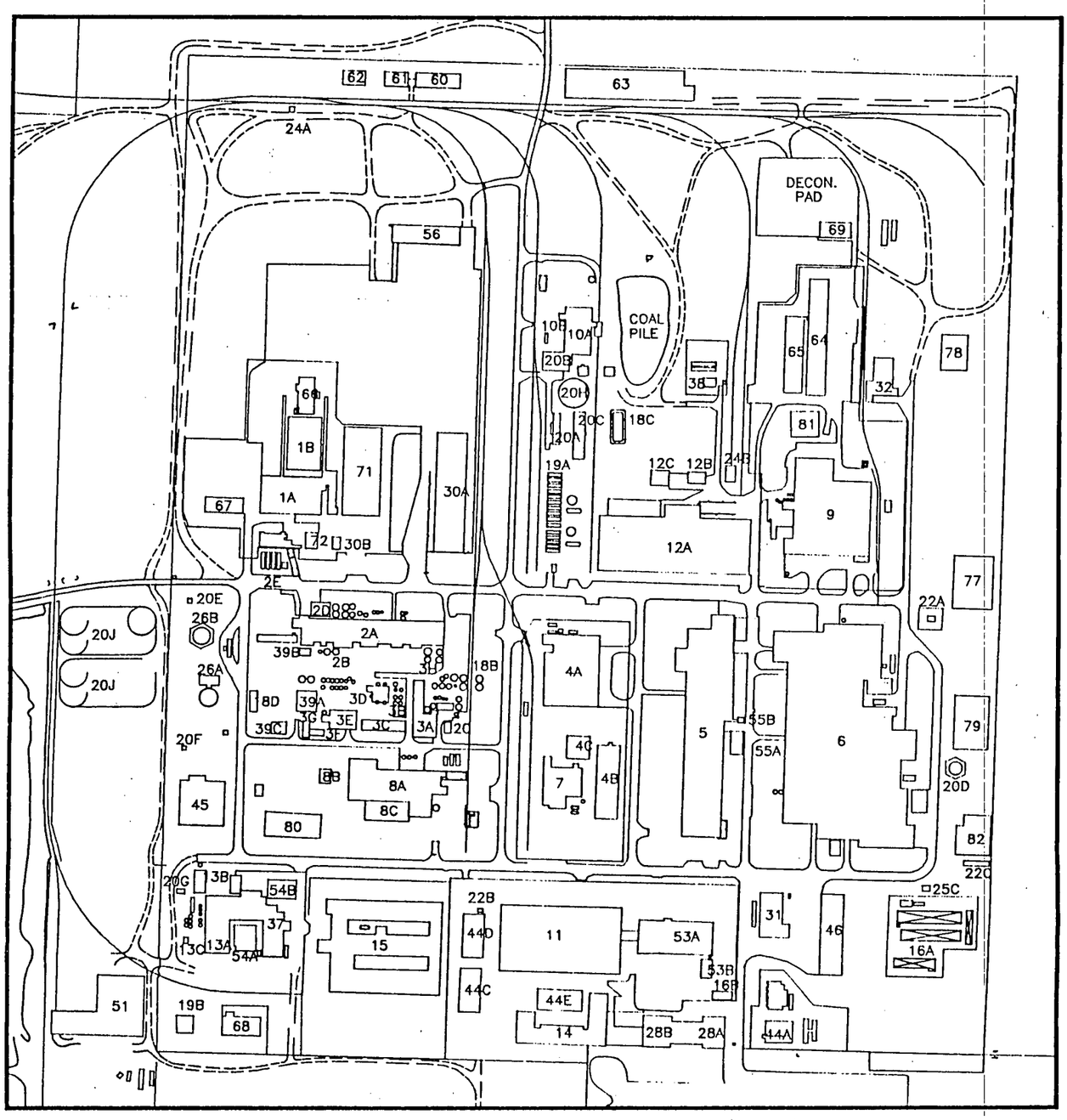
FIGURE 1-3.
FMPC LAYOUT

8-3-90 602.B__PRODAREA__BP__FND



1A	PREPARATION PLANT	15	LABORATORIES	39A	INCINERATOR BLDG.
1B	PLANT 1 STORAGE BLDG.	16A	MAIN ELECTRICAL STATION	39B	SHELTER STORAGE BLDG.
2A	ORE REFINERY PLANT	16B	ELECTRICAL SUBSTATION	39C	INCIN. BLDG. SPRINKLER RISER HOUSE
2B	LIME HANDLING BLDG.	18B	GENERAL SUMP	44A	TRAILER COMPLEX (6-PLEX)
2C	BULK LIME HANDLING BLDG.	18C	COAL PILE RUNOFF BASIN	44C	TRAILER COMPLEX (7 PLEX S)
2D	METAL DISSOLVER BLDG.	18D	BIODENITRIFICATION TOWERS	44D	TRAILER COMPLEX (7 PLEX N)
2E	MFS STORAGE AND PUMP HOUSE	19A	MAIN METAL TANK FARM	44E	TRAILER COMPLEX (NO PLEX)
3A	MAINTENANCE BLDG.	19B	PILOT PLANT AMMONIA TANK FARM	45	RUST ENG. BLDG.
3B	OZONE BLDG.	20A	VALVE/CONTROL BLDG	46	HEAVY EQUIPMENT BLDG.
3C	CONTROL HOUSE	20B	FILTER/CHEMICAL BLDG.	51	6 TO 4 REDUCTION FACILTY #2
3D	NAR TOWERS	20C	COOLING TOWERS	53A	O.S. & H. BLDG.
3E	HOT RAFFINATE BLDG.	20D	ELEVATER POTABLE STORAGE TANK	53B	IN-VIVO BLDG.
3F	DIGESTION FUME RECOVERY	20E	WELL HOUSE #1	54A	6 TO 4 REDUCTION FACILITY #1
3G	REFRIGERATION BLDG.	20F	WELL HOUSE #2	54B	PILOT PLANT WHSE.
3H	REFINERY SUMP	20G	WELL HOUSE #3	55A	SLAG RECYCLING BLDG.
4A	GREEN SALT PLANT	20H	PROGESS WATER STORAGE TANK	55B	SLAG RECYCLING PIT/ELEVATOR
4B	PLANT 4 WHSE.	20J	LIME SLURRY PITS	56	CP STORAGE WHSE.
4C	PLANT 4 MAINTENANCE BLDG.	22A	GAS METER BLDG.	60	QUONSET HUT #1
5	METALS PRODUCTION PLANT	22B	SEWER LIFT STATION	61	QUONSET HUT #2
6	METALS FABRICATION PLANT	22C	TRUCK SCALE	62	QUONSET HUT #3
7	PLANT 7	24A	RAILROAD SCALE HOUSE	63	KC-2 WHSE.
8A	RECOVERY PLANT	24B	RAILROAD ENGINE HOUSE	64	THORIUM WHSE.
8B	MAINTENANCE BLDG.	25C	SEWAGE LIFT STATION BLDG.	65	(OLD) PLANT 5 WHSE.
8C	ROTARY KILN/DRUM RECOND. BLDG.	25D	U.V. DISINFECTION BLDG.	66	DRUM RECONDITIONING BLDG.
9	SPECIAL PRODUCTS PLANT	25E	DIGESTER CONTROL BLDG.	67	PLANT 1 THORIUM WHSE.
10A	BOILER PLANT	26A	PUMP HOUSE-HP FIRE PROTECTION	68	PILOT PLANT WHSE.
10B	BOILER PLANT MAINTENANCE BLDG.	26B	ELEVATED WATER STORAGE TANK	69	DECONTAMINATION BLDG.
11	SERVICE BLDG.	28A	SECURITY BLDG.	71	GENERAL IN-PROCESS STORAGE WHSE.
12A	MAIN MAINTENANCE BLDG.	28B	HUMAN RESOURCES BLDG.	72	DRUM STORAGE BLDG.
12B	CYLINDER STORAGE BLDG.	30A	CHEMICAL WHSE.	77	FINISHED PRODUCT WHSE.
12C	LUMBER STORAGE BLDG.	30B	DRUM STORAGE WHSE.	78	D & D BLDG. (NOT CONSTR.)
13A	PILOT PLANT WET SIDE	31	ENGINE HOUSE/GARAGE	79	PLANT 6 WHSE.
13B	PILOT PLANT MAINTENANCE BLDG.	32	MAGNESIUM STORAGE BLDG.	80	PLANT 8 WHSE.
13C	SUMP PUMP HOUSE	37	PILOT PLANT ANNEX	81	PLANT 9 WHSE.
14	ADMINISTRATION BLDG.	38	PROPANE STORAGE	82	RECEIVING/INCOMING MTRLS. INSP. BLDG.

FIGURE 1-3
EXISTING PRODUCTION AREA LAYOUT

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From 1953 through 1955, the FMPC refinery processed pitchblende ore from the Belgian Congo. Pitchblende ore contains all daughter products of the uranium decay chains, and is particularly high in radium content. No chemical separation or purification was performed on the ore prior to arrival at the FMPC. Beginning in 1956, the refinery feedstock consisted of uranium concentrates (yellowcake) from Canada and the United States. Canadian concentrates were not processed after 1960. In the production of these concentrates, most of the uranium daughters had been removed. However, radium-226 remained in the yellowcake in amounts that varied with the process.

Small amounts of thorium were produced at the FMPC on several occasions from 1954 through 1975. Thorium operations were performed in the metals fabrication plant, the recovery plant, the special projects plant, and the pilot plant. The FMPC currently serves as DOE's thorium repository for a variety of thorium materials.

Solid waste materials associated with uranium metals production are currently stored on site in steel drums, awaiting further processing or off-site disposal at approved facilities. These wastes include oils, sludges, contaminated combustibles, filter cake, off-specification uranium tetrafluoride or thorium tetrafluoride, and reject uranium trioxide. The drums have been placed on various pads and in warehouses within the Production Area, and are inspected regularly. Contents of deteriorated drums are repackaged. Other waste materials, stored in drums on contained surfaces, include spent degreasing solvents and polychlorinated biphenyl (PCB)-contaminated material.

Leachate from the Production Area and other site areas can potentially migrate through a till layer of varying thickness to the regionally important Great Miami Aquifer, which underlies the site. This aquifer serves as a principal source of domestic, municipal, and industrial water throughout the region.

Liquid waste effluent generated from FMPC process operations is sent to a general plant sump for treatment and analysis prior to release to the Great Miami River through the main effluent line (Figure 1-1). The main effluent line to the Great Miami River is the permitted discharge

point for wastewater from the FMPC. The discharge is regulated by a National Pollutant Discharge Elimination System (NPDES) permit and DOE Orders, with compliance monitoring performed at Manhole 175 before the effluent leaves the site boundary.

1.4 OPERABLE UNIT 3

1.4.1 Definition and Description

Operable Unit 3 encompasses several suspect areas and the Production Area, which is bounded by the security fence and buffer zone on the north, south, and east. It is bounded on the west by the single fence and does not generally include the waste pit or K-65 areas except for specific suspect areas.

The Operable Unit 3 study addresses surface and below surface radiological and hazardous chemical contamination of soils and perched groundwater attributable to Production Area activities, whether within or outside the area bounded by the Production Area security fence. It also includes the scrap metal piles and the miscellaneous discarded materials and equipment overlying the former drum baling area. A basic assumption of the Operable Unit 3 study is that WMCO's RCRA Closure, Spill Prevention Control and Countermeasure, and Best Management Practices plans will address any activities that are necessary for facilities, underground storage tanks, aboveground drums, and buildings, in addition to repairs of active underground piping.

The suspect areas encompassed by Operable Unit 3 are specific areas, outside the Production Area but within the FMPC property and/or right-of-way, where past activities may have led to an environmental release from facilities to the soils and perched groundwater, or to a facility itself if it is currently abandoned. These soils may be outside the FMPC property boundary, as in the case of the sewage treatment plant/incinerator area. The 10 suspect areas currently being addressed under Operable Unit 3 are:

- Area within the east buffer zone
- Clearwell to Manhole 175 pipeline
- Fire training area
- Flagpole area to the south of the administration building
- Sewage treatment plant/incinerator area
- K-65 slurry line

- Main effluent line
- Rubble mound west of the K-65 silos
- Rubble mound south of the K-65 slurry line
- Rubble mound in the northeast corner of the pit area

Because data on the concentrations of Hazardous Substance List constituents in Operable Unit 3 were limited at the time this report was written, lists of possible contaminants in Operable Unit 3 were made based on documented activities at the site, and not on actual analytical data. A more specific list of nonradiological and radiological contaminants at the site will be provided in the RI.

Due to the complexity of the various contaminated zones and surrounding structures, facilities, and utility lines, it is difficult to address alternative development and screening on an area-by-area basis. For this reason, contamination problems within Operable Unit 3 are categorized into seven distinct suboperable units (SUs). Similar contaminated areas are grouped into the appropriate suboperable unit and screening of alternatives was conducted based on the problem type, rather than on each specific area. This technique minimizes redundancy in assessing the effectiveness and implementability of an alternative addressing a specific suboperable unit. Costs will be addressed separately for each affected area, and then totaled on a suboperable-unit-specific basis. This procedure was necessary to obtain an overall cost comparison for each applicable alternative for a particular suboperable unit.

The seven suboperable units are:

- Suboperable Unit A: Open field areas with limited access to contaminated soils
- Suboperable Unit B: Open field areas with good access to contaminated soils
- Suboperable Unit C: Soil contamination under facilities
- Suboperable Unit D: Soil contamination under facilities designated for possible demolition
- Suboperable Unit E: Aboveground contaminants

- Suboperable Unit F: Perched groundwater contamination
- Suboperable Unit G: Soils surrounding transfer lines.

For each of these suboperable units, several specific areas have been identified. Details on contaminated areas and their relation to suboperable units is provided in Chapter 6.0.

1.4.2 Production Area Overview

The production of uranium metal products at the FMPC involved a series of chemical and metallurgical conversions that occurred in nine specialized plants within Operable Unit 3. A number of other buildings on the site housed support operations. Each of these facilities had a distinct purpose, resulting in significant differences in the process operations, chemical forms, and types of individual conveyance, storage, and containment units associated with each of the facilities.

To better focus the investigation of this complex production network into a manageable technical framework, the Production Area was separated into four distinct quadrants (Figure 1-4), which generally include the following principal facilities and operations:

- Southeast Quadrant (Plants 4, 5, 6, and 7) - Principal processes included uranium reduction, metals production, fabrication, machining, and local wastewater treatment.

  Main Substation and Garage - No processing activities were involved. Activities were limited to the central distribution station for petroleum products, vehicle maintenance, and the plant electrical substation.

- Southwest Quadrant (Plants 2/3, Plant 8, and General Sump) - Principal processes included uranium digestion in the refinery, uranium recovery and oxidation, and water/wastewater treatment.

  Pilot Plant and Laboratory - Principal activities included uranium reduction (uranium hexafluoride and uranium tetrafluoride), various types of pilot-scale operations, and sample testing and analysis.

- Northwest Quadrant (Plant 1 and Drum Storage Pad) - Principal activities included slightly enriched uranium processing; uranium compound milling; materials sampling, analysis, and storage; and drum reconditioning.

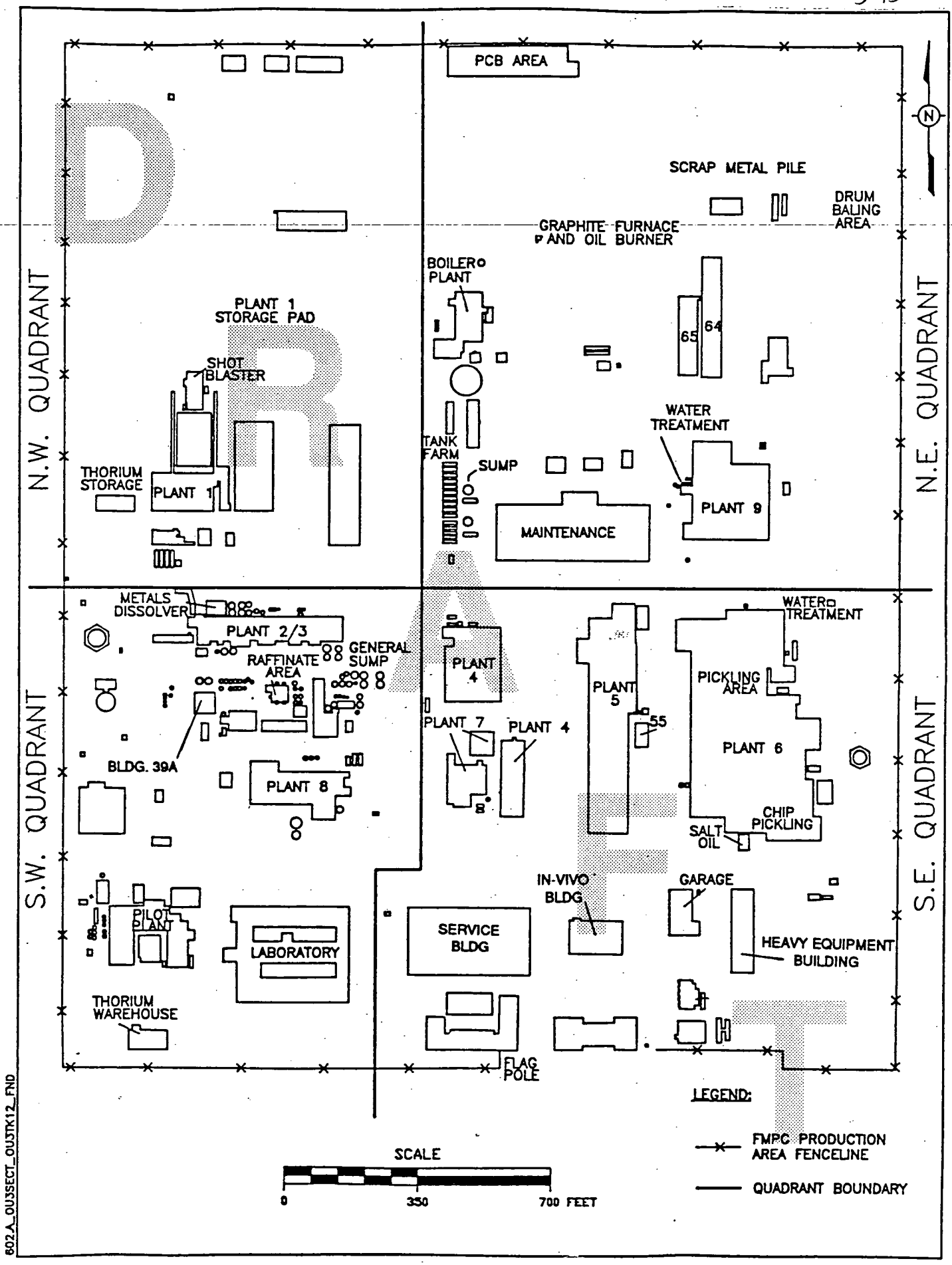

FIGURE 1-4. FMPC PRODUCTION AREA QUADRANT MAP

- Northeast Quadrant (Plant 9, Decontamination and Decommissioning Facility, Maintenance Building, Boiler Plant, Tank Farm, and Metal Scrap Pile) - Principal activities included special uranium products casting; uranium heat treating, machining, and decladding; thorium processing; decontamination and decommissioning of equipment; equipment maintenance; chemical storage and metal scrap storage; and site production of steam, air, and water.

1.4.3 Production Area Description

This section contains more detailed descriptions of each quadrant, as well as a listing of potential contaminants within each sector. This contaminant listing was developed from documented activities at the site and is meant to be representative of possible contamination. Preliminary nonradiological contamination data is presented where available. Complete details on contamination types and levels will be contained in the Operable Unit 3 RI Report. Existing data indicate that the dominant contamination is uranium. This information is summarized in Section 1.4.6 and details are given in Chapter 6.0.

1.4.3.1 Southeast Quadrant

The southeast quadrant (Figure 1-4) is located on the southeast side of the Production Area. It includes Plants 4 through 7, the main electrical substation, and the garage/heavy equipment building.

Plant 4, the green salt plant, produced uranium tetrafluoride (green salt) from uranium trioxide through a reduction-hydrofluorination process, and blended and packaged depleted green salt for transportation to the metals production plant. Plant 4 also reprocessed black oxide to enhance its reactivity for other processing.

Plant 5, the metals production plant, reduced uranium tetrafluoride with magnesium in an electrical resistance furnace to produce high-purity uranium metal derbies. Some derbies were remelted in vacuum induction furnaces, molded into ingots, and cropped into billets before transportation to Plant 6, the metals fabrication plant, or Plant 9, the special products plant. Other derbies were shipped directly to various DOE sites.

Plant 6, the metals fabrication plant, heat treated uranium metal billets to improve their strength and grain structure in preparation for extrusion into tubes at other sites. Extruded tubes of uranium were cut into blanks, heat treated, and machined into finished elements for inspection and shipment to other DOE production sites. Resultant chips and lathe turnings were crushed, pickled, briquetted, and recycled to the casting operations in Plant 5. Flat ingots were surface machined and inspected. Current sampling data shows chlorinated organics under Plant 6 from 4 to 4.5 feet below floor level.

Plant 7, the hexafluoride reduction plant, was designed for the conversion of uranium hexafluoride to uranium tetrafluoride in a gas-gas reaction, and was used for this purpose until it was shut down in 1956. It is currently classified as a surplus facility, and is used as a storage warehouse principally for drums of uranium tetrafluoride and a few drums of residue from Plant 4, the green salt plant.

This quadrant also includes the main electrical substation, the garage, the truck weigh station, a water tower, a new warehouse, a new receiving/inspection building, the service building, the in-vivo building, and the heavy equipment building. None of these facilities are production process operation or uranium handling facilities, and there are currently no production wastes stored or located in them. Current sampling data shows benzene, ethylbenzene, and xylenes around the garage and heavy equipment building.

Table 1-1 lists the expected or potential types of contamination based on the southeast quadrant's operations and history.

1.4.3.2 Southwest Quadrant

The southwest quadrant (Figure 1-4) is located on the southwest side of the Production Area. There are three general types of facilities within the southwest quadrant: operating plants, storage areas, and support areas. Plant 2/3, the refinery, is a large-scale chemical operation plant in which the following processes occurred: digesting enriched uranium scrap residues in nitric acid to produce a uranyl nitrate feed solution, solvent extraction and purification, concentration of the purified uranyl nitrate solution by evaporation, and thermal denitrification to uranium trioxide. Nitrogen oxides released during the dissolution and denitrification steps

were converted to nitric acid and reused in the process. Chlorinated organics have been found within Plant 2 from 6 to 7.5 feet below floor surface. In addition, soil samples have shown cadmium, di-n-propylnitrosamine, chlorinated organics, and polycyclic aromatic hydrocarbons from 5.5 to 6 feet below the drums north of Plant 2. Cadmium, silver, lead, PCBs, n-nitrosadiphenylamine, tributyl phosphate, and pthalates have been found in the same location in the first foot of samples.

TABLE 1-1

OPERABLE UNIT 3 POTENTIAL CONTAMINANTS - SOUTHEAST QUADRANT

Plant 4:
Uranium Dioxide
Uranium Trioxide
Hydrofluoric Acid
Ammonia
Uranium Tetrafluoride
Black Oxide
Calcium Fluoride

Plant 5:
Uranium Tetrafluoride
Magnesium Fluoride
Magnesium
Black Oxide
Graphite
Uranium
Hydraulic Oil
Degreasing Solvents
PCBs and Organics Associated with Machining and Cutting Oil

Plant 6:
Uranium Tetrafluoride
Thorium
Nitric Acid
Uranyl Nitrate
Black Oxide
Uranium
Hydraulic Oil
Sodium Hydroxide
Molten Salts
Degreasing Solvents
PCBs and Organics Associated with Machining and Cutting Oil

Plant 7:
Uranium Tetrafluoride
Hydrofluoric Acid
Calcium Fluoride
Uranium Hexafluoride
Ammonia
Freon
Thorium

Main Electrical Substation:
PCBs

Garage/Heavy Equipment Building:
Petroleum, Oils, and Organics
Uranium
Uranium Compounds
Paints
Solvents
Other Lubricants

At Plant 8, the recovery plant, enriched residues and scrap generated on site or received from off-site facilities were processed to remove moisture, oil, graphite, and metallic impurities before being sent to the refinery, Plant 2/3, for uranium extraction. Also, large volumes of low-level radioactive waste slurries were filtered within Plant 8. Residues were also dried in the Plant 8 furnaces, materials were milled and sorted, and extensive thorium processing was performed.

The pilot plant is the original FMPC process facility where many of the FMPC processes were pilot tested before scaling up for actual production. Process operations occurred principally in the pilot plant and the laboratory. Portions of the pilot plant were extensively refurbished for the production of uranium tetrafluoride from uranium hexafluoride.

The FMPC hazardous waste bulk storage tank container facility is also located in a portion of the pilot plant tank farm. The facility consists of two empty 10,000-gallon tanks that previously contained spent degreasing solvents.

Other key facilities in this quadrant are:

- Metal dissolver building
- Control building
- Storage building
- General sump
- Former waste solvent drum storage site immediately west of the laboratory
- Hydrogen fluoride/ hydrofluoric acid tank
- Uranium hexafluoride/ uranium tetrafluoride reduction area
- Argon tank
- Incinerator plant
- Biodenitrification building
- Plant 2/3 maintenance building
- Hot raffinate building
- Refinery sump
- Green salt warehouse
- Pilot plant/ammonia tank farm
- Underground tanks/drum storage area immediately south of pilot plant main building
- Pilot plant/thorium warehouse and radiographic facility
- Ammonia dissociator building

There are also approximately 85 aboveground tanks located throughout this quadrant. Most were used in conjunction with the operations in Plant 2/3 and the raffinate water treatment process.

Above background concentrations of cadmium, lead, nickel, zinc, and polycyclic aromatic hydrocarbons have been found in the first foot of soil samples taken east of the laboratory.

Around the pilot plant tank farm, chlorinated hydrocarbons, dibenzofuran, PCBs and polycyclic aromatic hydrocarbons have been found in the first foot of soil samples. In the same area, soil samples from 9.5 to 10.5 feet show polycyclic aromatic hydrocarbons, PCBs, and cadmiums.

Table 1-2 lists the expected or potential types of contamination based on the southwest quadrant's operations and history.

TABLE 1-2

OPERABLE UNIT 3 POTENTIAL CONTAMINANTS - SOUTHWEST QUADRANT

Plant 2/3:
Uranyl Nitrate
Nitric Acid
Tributyl Phosphate
Kerosene
Sodium Carbonate
Uranium Trioxide
Black Oxide
Sulfuric Acid
Oxides of Nitrogen

Plant 8:
Uranium Residues and Scrap
Thorium
Black Oxide
Graphite
Uranium
Uranium Compounds
Nitric Acid
Sulfuric Acid
Hydraulic Oil
Degreasing Solvents
PCBs
Organics associated with machining and cutting oil

K-65 Slurry Line:
Barium
Uranium
Thorium
Radium Compounds

Hot Raffinate Building:
Radium-226
Black Oxide
Uranyl Nitrate
Hydraulic Oil
Nitric Acid

Pilot Plant Warehouse:
Thorium
Barium Salts

Pilot Plant:
Uranium Hexafluoride
Uranium Tetrafluoride
Ammonia
Hydrofluoric Acid
Thorium
Argon
Graphite
Uranium and Uranium Compounds
Thorium and Thorium Compounds
Uranyl and Thorium Nitrates
Nitric Acid
Barium Salts
Magnesium and Magnesium Salts
Kerosene
Tributyl Phosphate
Sodium Hydroxide
Hydraulic Oil
Degreasing Solvents
PCBs
Organics associated with machining and cutting oils
Molten Salts

General Sump:
Sodium Hydroxide
Sodium Chloride
Lime
Ammonia
Thorium and Uranium Residues
Calcium Hydroxide
Magnesium Hydroxide
Calcium Carbonate
Flocculating Agents

Laboratory:
PCBs
Pesticides
Analytical Reagents
Process Chemicals
Out of Specification Plutonium

Pilot Plant Tank Farm:
Ammonia
Degreasing Solvents

1.4.3.3 Northeast Quadrant

The northeast quadrant (Figure 1-4) is located in the northeast corner of the Production Area. It contains a wide variety of facilities and storage pad areas, including the metal scrap pile, the former drum baling area, the graphite furnace/oil burner area, the special products plant (Plant 9), the maintenance building, the boiler plant, the tank farm, the decontamination and decommissioning building, and various storage pads and warehouses.

The decontamination and decommissioning building and pad areas were used primarily for decontamination and disposal activities. Materials were cleaned and reused, or salvaged if possible, or placed on the metal scrap pile. The metal scrap pile primarily consists of ferrous material, with some aluminum, copper, brass, and nickel. Within the drum baling area are various discarded scraps and materials, and abandoned vehicles and equipment. The graphite furnace/oil burner area includes both the abandoned oil burner and the graphite burner that were used to dispose of these contaminated items.

The maintenance building includes various nonprocess, storage, and support areas. In addition to the maintenance craft shops, this building housed the plant stores and receiving area. Drummed solvents, lubricants, and gas cylinders are stored on a pad located north of the maintenance building.

Soil samples taken north of the maintenance building show above background concentrations of polycyclic aromatic hydrocarbons, PCBs, cadmium, beryllium, magnesium, nickel, and straight chain chlorinated organics. Soil samples taken south of the maintenance building show above background concentrations of PCBs, straight chain chlorinated organics, cadmium, nickel, beryllium, mercury, zinc, molybdenum, and magnesium.

Soil samples from the general area north of the graphite furnace/oil burner area show surface soil above background concentrations of PCBs, straight chain chlorinated organics, polycyclic aromatic hydrocarbons, pthalates, dibenzofuran, lead, cadmium, nickel, zinc, silver, magnesium, mercury, benzyl alcohol, and beta-hexachlorocyclohexane.

Plant 9, the special products plant, accomplished the following functions: machining uranium metal ingots for extrusion, casting derbies into large-diameter ingots, and chemically decladding copper layers from unirradiated uranium fuel cores. The boiler plant area includes all equipment and distribution systems for the "process fluids" for the site (e.g., sanitary, process, and cooling water; plant and instrumentation air; fuel gas; and steam). Air is used for running instrumentation and processes in the plant. Fuel gas is used in the various plant furnaces. Steam is primarily used for heating, but also powers the backup turbines in case of a power or motor failure. These turbines supply emergency backup pumping of water throughout the plant. Water is pumped from sumps, tanks, and other retainers to the general sump and the water process facility for treatment. One soil sample outside the southeast corner of Plant 9 has shown elevated concentration of chlorinated organics.

Plant 9, the special products plant, originally had all the same processes as Plants 5 and 6, but on a smaller scale. It was converted over the years due to program changes to directly support site operations. Most recent activities included derby production and salt cleaning, remelt operations, machining uranium metal ingots for extrusion, and chemically decladding cover layers from unirradiated uranium fuel cores.

The tank farm originally consisted of 16 aboveground and buried storage tanks that contain ammonia, ammonium hydroxide, anhydrous hydrogen fluoride, hydrofluoric acid, potassium fluoride, kerosene, nitric acid, hydrochloric acid, calcium fluoride, potassium hydroxide, and tributyl phosphate. The original tank farm was expanded in the 1960s, with several modifications thereafter until 1985, when a major rebuild was started. The tank farm's modifications (to hold hydrofluoric acid) were completed and the tanks are presently empty. Also, functional checks were never run on the tanks.

Table 1-3 lists the expected or potential types of contaminants based on the northeast quadrant's operations and history.

TABLE 1-3

OPERABLE UNIT 3 POTENTIAL CONTAMINANTS - NORTHEAST QUADRANT

Plant 9:
Uranium Tetrafluoride
Nitric Acid
Hydrofluoric Acid
Thorium
Copper Compounds
Machine Oils and Solvents
Graphite
Uranium and Uranium Compounds
Thorium and Thorium Compounds
Magnesium and Magnesium Fluoride
Molten Salts
Zirconium
Hydraulic Oil

Maintenance Building:
PCBs
Solvents
Paints
Uranium and Uranium Compounds
Thorium and Thorium Compounds

Thorium Warehouses:
Thorium and Thorium Compounds

Tank Farm:
Ammonia
Potassium Hydroxide
Hydrochloric Acid
Hydrofluoric Acid
Potassium Fluoride
Ammonium Hydroxide
Nitric Acid
Kerosene and Other Organics

D&D Facility:
Uranium and Uranium Compounds
Thorium and Thorium Compounds
Sodium Hydroxide

Drum Baling Area
PCBs
Asbestos

1.4.3.4 Northwest Quadrant

This quadrant (Figure 1-4) is located in the northwest corner of the Production Area. The facilities within this quadrant are principally utilized for warehousing and storage. Plant 1, the sampling plant, and the Plant 1 drum storage pad are the principal facilities in this quadrant. In addition, the northwest quadrant contains two large scrap metal piles and a large rubble mound consisting of discarded construction rubble materials.

Current activities in the northwest quadrant include storage of approximately 68,000 drums and containers of thorium and uranium residue. However, due to major drum relocation activities,

the number of drums in a given area is subject to considerable variation. An inventory will be needed at some date to establish a new baseline. Prior activities included:

- Shipping, receiving, storing, milling, and classifying depleted, normal, and enriched uranium materials
- Reconditioning of steel drums for reuse and baling of deteriorated drums for salvage
- Open unirradiated fuel pins containing enriched uranium dioxide pellets
- Sampling and analysis of incoming materials and the storage of residues and other materials awaiting off-site shipment

A soil sample at 1 to 2 feet beneath surface level near the shot blaster area (immediately north of Plant 1) shows trichloroethene and cadmium concentrations above background level.

Table 1-4 lists the expected or potential types of contamination based on the northwest quadrant's operations and history.

TABLE 1-4

OPERABLE UNIT 3 POTENTIAL CONTAMINANTS - NORTHWEST QUADRANT

Plant 1:	Plant 1 Ore Silos:
Uranium Dioxide	Q-11 Ore
Lead	
Graphite	**Plant 1 Drum Storage Pad:**
Uranium and Uranium Compounds	Thorium and Thorium Compounds
Thorium and Thorium Compounds	Uranium and Uranium Compounds
Magnesium and Magnesium Fluoride	**Chemical Warehouse:**
Copper and Copper Compounds	Dry Bulk Chemicals
Hydraulic Oil	RCRA Sampling Activities
Paint	**Quonset Huts:**
Solvents	Thorium and Thorium Compounds
	Uranium and Uranium Compounds

1.4.4 Suspect Areas

Suspect areas are those areas suspected of having contamination due to past activities or that were identified as contaminated through field testing within the FMPC property boundary but outside the Production Area. Specifically, these areas are: three rubble mounds, the K-65 slurry line, the main effluent line, the Clearwell to Manhole 175 pipeline, the sewage treatment plant/incinerator area, one area in the buffer zone, the fire training area, and a small area around the flagpole. (Note: The K-65 slurry line and part of the Clearwell to Manhole 175 pipeline are enclosed in a covered trench at the location marked "6" on Figure 1-5.)

There are three locations where rubble has been placed on the land surface outside of the Production Area. One mound is west of the K-65 silos along the east bank of Paddys Run. The second rubble mound is located approximately halfway between the K-65 silos and the Production Area. The third mound is just outside the northwest corner of the Production Area. This third rubble mound is the only one that has shown uranium contamination; suspect rubble mound two was not located (no evidence of rubble at the suspected location) and samples from mound number one have shown no contamination in the rubble or the soils beneath the rubble.

The K-65 slurry line is placed within a 2.5-foot covered concrete trench 1500 feet long that runs from the K-65 silo site into the Production Area; the security fence is considered the east boundary. Soil and sediment samples from this line show the presence of radioactive materials. A portion of the Clearwell to Manhole 175 line also runs through this concrete trench.

The main effluent line connects Manhole 175 at the sewage treatment plant to the Great Miami River. Testing to date has indicated no contamination; however, additional testing along the entire length is ongoing.

The Clearwell to Manhole 175 pipeline was a pressurized process line, but now carries surface water runoff that enters the Clearwell. Testing has not been completed along this line.

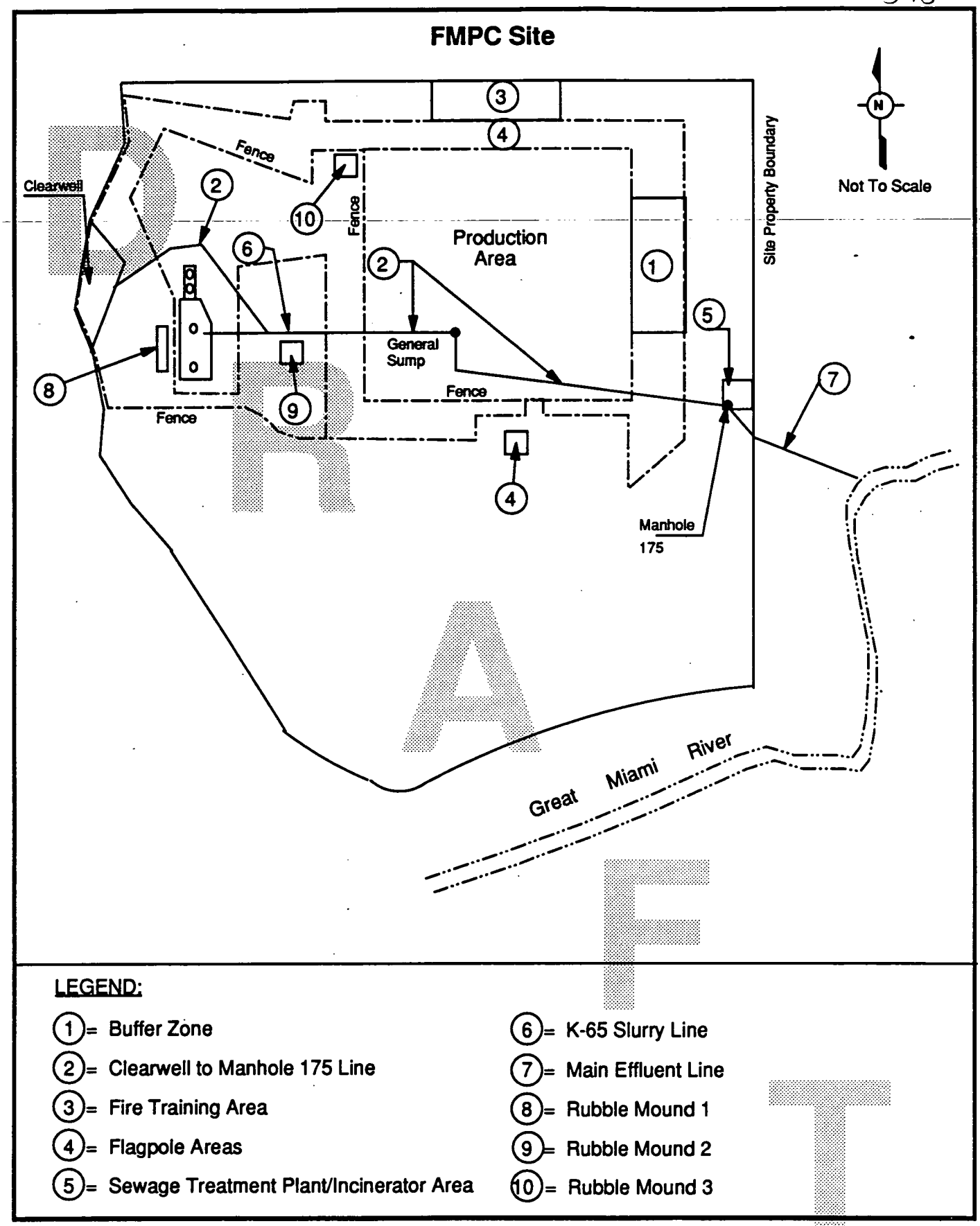

FIGURE 1-5. OPERABLE UNIT 3 SUSPECT AREAS

The sewage treatment plant/incinerator area is located due east of the southeast corner of the Production Area. Sample data have shown uranium contamination of the soil around the incinerator building and the east side of the sewage treatment plant. Surface soil samples around the incinerator building have shown low concentrations of 1,1,1-trichloroethane.

The buffer zone is the general area between the Production Area security fence and the FMPC site fence. An area approximately 500 feet by 250 feet in the buffer zone on the east side of the Production Area has shown uranium contamination in the soil.

The fire training area is approximately 400 feet by 125 feet and is located north of the Production Area between the security fence and the FMPC property boundary. Testing in this area indicates radioactive, as well as organic and hazardous waste list contaminants. Soil samples have shown straight chain chlorinated organics, 1,1,1-trichloroethane in concentrations of 2.88 mg/kg, and tetrachloroethane in concentrations of 2.15 mg/kg.

As originally identified, an area around the flagpole in front of the administration building was thought to have a buried container (large tank or vault) of radioactive wastes. It was determined that this area is not contaminated, nor has evidence of a buried container been discovered. The suspect location has now been identified as an area near the old administration building. This location is approximately 100 yards south of the fire training area. Testing is in progress to identify the actual site of the suspected buried vault and the extent and type, if any, of contamination. Both of these suspect flagpole areas are indicated by a number "4" on Figure 1-5, but only the flagpole area on the north side of the Production Area is still being investigated for possible contamination.

1.4.5 Production and Additional Suspect Areas Work Plan

The Production and Additional Suspect Areas Work Plan (ASI/IT 1989) detailed a soil and perched groundwater sampling plan. The plan specified both systematic boring, on a 250-foot grid pattern, and focused boring, which targets specific facilities such as tank enclosures and sumps. The systematic and initial focused boring activities are complete. The resultant data from the samples were used to identify and characterize the hazardous and radioactive materials contamination in Operable Unit 3.

The methodology consisted of collection of soil samples from each six-inch interval in the borings as they were drilled. The borings were advanced until they reached a depth of 20 feet or had penetrated a saturated sandy interval containing perched groundwater. When a saturated interval was found, the boring was terminated at the bottom of the saturated interval, and a two-inch diameter, polyvinyl chloride well screen and casing was installed as a piezometer in the boring. When a piezometer was installed, water samples were collected for total uranium analysis and monthly water level measurements are still being taken.

This Initial Screening of Alternatives for Operable Unit 3 report is based on current analytical results from sampling data. Additional sampling activities yet to be performed, or currently in progress, as part of the work plan (ASI/IT 1989) include:

- Soil and groundwater sampling adjacent to the process line between the Clearwell and the general sump
- Soil and groundwater sampling adjacent to other underground pressurized lines
- Soil and groundwater testing on the main effluent line between Manholes 179 and 180
- Additional Hazardous Substance List sampling as currently planned in the Facilities Test Program
- Characterization of facilities designated for possible demolition
- Contamination sampling of scrap metal piles and abandoned equipment

1.4.6 General Description of Contamination

Operable Unit 3 contamination is generally uranium contamination of soils and perched groundwater underlying site facilities. In addition, metal scrap piles and miscellaneous abandoned equipment and materials contain low levels of uranium contamination. Although other Hazardous Substance List contaminants are present within Operable Unit 3, uranium has been identified as the dominant contaminant to date. All contaminants, however, will be addressed through the RI/FS process.

1.4.6.1 Contamination of Soils

The majority of soils containing uranium exceeding acceptable residual concentration levels [50 parts per million (ppm), see Section 2.1)] are located in the top 1.5 feet of surficial material. With respect to surface area, approximately 50 percent of the Production Area soils contain contamination exceeding these levels.

Significantly high uranium concentration levels are found throughout the Production Area. These high concentrations are predominantly between 200 and 500 ppm. Two exceptions to this are the south-central and north areas of Plant 6 in the southeast quadrant. Within these areas, uranium concentrations approach 70,000 ppm in north Plant 6 and 17,000 ppm in south central Plant 6. Table 1-5 details locations, depths, and quantities (greater than or less than 200 ppm) of uranium concentrations in the Production Area.

Additional contaminants that are likely to be found in soils were discovered through RI/FS perched groundwater sampling at concentrations above background levels. These contaminants are magnesium, thorium, and manganese contained in the northeast quadrant; and magnesium and thorium contained in the northwest quadrant. Both the southwest and southeast quadrants contain thorium, with the southwest quadrant also containing radium-226, and the southeast quadrant containing technetium-99 at levels above background; however, nonradiological sampling data is not yet available in these areas. Full radiological testing has not been completed for all samples taken in Operable Unit 3. Sampling indicates that concentrations are significant in some areas. Table 1-6 shows available data on the isotopic distribution of those areas with significant amounts of contamination.

Contamination data currently available for suspect areas comes from the FMPC Sampling and Analysis Data Document (DOE 1988) and RI/FS soils data as follows: the fire training area contains surficial contamination above 200 ppm over a large area and 1,1,1-trichloromethane, 1,1-dichlorethane, 1,1-dichlorethene, ethylbenzene, tetrachloroethane, toluene, and xylenes at levels above background. The sewage treatment plant/incinerator area contains a large quantity of surficial soils with levels above 200 ppm to the northeast of the incinerator itself. Chapter 6.0 provides a detailed discussion of the extent of soils contamination and sources.

TABLE 1-5

OPERABLE UNIT 3 URANIUM CONTAMINATION IN SOIL WITHIN THE PRODUCTION AREA

Quadrant	Depths of Contamination (ft)				
	0 - 1.5	1.5 - 3	3 - 5.5	10 - 15	15 - 20
Open Areas					
Northeast Quadrant Graphite Furnace and Oil Burner Area	■	—	—	—	—
Northeast Quadrant - Area South and North of NE Scrap Metal Pile	▲	—	—	—	—
Northeast Quadrant Buffer Zone and Area East of Plant 9	■	—	—	—	—
Northwest Quadrant Plant 1 Drum Storage Pad	■	—	—	—	—
Northwest Quadrant Thorium Storage Area	■	—	—	▲	▲
Southwest Quadrant Area Between Plant 2/3 and 4	▲	—	—	—	—
Southwest Quadrant Plant 8 Area	■	—	▲	▲	▲
Southwest Quadrant Laboratory Area	■	—	—	—	—
Southeast Quadrant Area East and West of Plant 5	■	—	▲	—	▲
Southeast Quadrant Area South of Garage and In-Vivo Building	■	▲	—	—	—
Southeast and Southwest Quadrant Area Along First Street	■	▲	▲	▲	▲
Southeast and Northeast Quadrant Area South of Maintenance Bldg & Plant 9	▲	▲	■	—	■
Under Facilities					
Northeast Quadrant Plant 9	■	■	■	■	—
Southwest Quadrant Plant 2/3	■	■	■	■	■
Southwest Quadrant Building 39A, Incinerator	■	■	▲	▲	■
Southwest Quadrant Pilot Plant and Pilot Plant Tank Farm	■	▲	▲	■	—
Southeast Quadrant Plant 4	■	—	—	—	—
Southeast Quadrant Plant 6	■	■	■	■	■

LEGEND:

■ = Contamination Greater than 200 ppm

▲ = Contamination Between 50 and 200 ppm

— = Contamination Less Than 50 ppm

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TABLE 1-6

OPERABLE UNIT 3 ISOTOPIC DISTRIBUTION OF RADIOACTIVE ELEMENTS

Location	Isotope							
	U-234	U-235/23	U-238	TH-230	TH-228	TH-232	Ra-226	0THER
North of Plant 2/3	>200ppm	>200ppm	>200ppm	150-200ppm	—	—	—	—
East of Plant 8	>200ppm	—	>200ppm	—	—	—	—	—
West of Pilot Plant	>200ppm	—	>200ppm	50-100ppm	—	—	—	—
Northeast of Pilot Plant	100-150ppm	—	100-150ppm	>200ppm	—	—	—	—
North of Former Drum Storage Area	50-100ppm	—	50-100ppm	—	—	—	—	—
Graphite Furnace/ Oil Burner Area	>200ppm	—	>200ppm	—	—	—	—	—
Drum Baling Area	—	—	50-100ppm	—	50-100ppm	50-100ppm	150-200ppm	—
North of Maintenance Building	50-200ppm	—	150-200ppm	—	—	—	—	—
Southwest Corner of Plant 9	50-100ppm	—	50-100ppm	—	—	—	—	—
K-65 Slurry Line	—	—	>200ppm	>200ppm	—	—	—	50-100ppm Ru-106
K-65 Slurry Line Soil	—	—	150-200ppm	—	—	50-100ppm	>200ppm	>200ppm (Pb-210) (Tc-99)

— = No Radioactive Elements Identified

1.4.6.2 Contamination of Perched Groundwater

Approximately 80 percent of the groundwater samples taken from the Production Area contained measurable levels of uranium contamination. Plumes significantly exceeding uranium concentration levels greater than 1000 micrograms per liter (µg/l) have been recorded. These values are predominantly between 1000 µg/l and 50,000 µg/l, but two exceptions exist. The exceptions are located east of Plant 6 and at the south end of Plant 9, with uranium concentrations of 146,000 µg/l and 696,000 µg/l, respectively. Table 1-7 details locations and ranges of uranium contamination in the perched groundwater.

Other chemicals that have been detected in perched groundwater, in addition to uranium are:

- Dichloroethene and trichloroethene near Plant 2/3 and Plant 9
- Chlorinated organics and benzene related compounds at concentrations less that 40 µg/l, total xylenes estimated at concentrations of 300 - 400 µg/l, and vinyl acetate and 4-methyl-2-pentanane at concentrations less than 10 µg/l east of the garage
- Above background level concentrations of magnesium, manganese, molybdenum, aluminum, and vanadium northeast of the decontamination pad
- Low levels of selenium east of B Street.

Both the southwest and southeast quadrants contain thorium, with the southwest quadrant also containing radium-226, and the southeast quadrant containing technetium-99 at levels above background; however, nonradiological sampling data is not yet completed in these areas. Chapter 6.0 provides a detailed discussion of perched groundwater contamination and sources.

1.4.6.3 Contamination Related to Scrap Metal and Discarded Equipment/Materials

Miscellaneous scrap metals are contained in both the northeast and northwest quadrants. Reported uranium contamination levels are relatively low. Additional testing is targeted for these piles.

TABLE 1-7

OPERABLE UNIT 3
PERCHED GROUNDWATER URANIUM CONTAMINATION WITHIN THE PRODUCTION AREA

Area	Contamination
Southeast Quadrant East of Plant 6	■
Southwest Quadrant Southeast of Plant 2 / 3	●
Southwest Quadrant Surrounding Plant 2 / 3	●
Southwest Quadrant Surrounding Plant 8	●
Southwest Quadrant Incinerator, Building 39A	▲
Southwest Quadrant West of Plant 8	▲
Southwest Quadrant Northeast of Plant 2 / 3	▲
Southwest Quadrant West of Pilot Plant	●
Northeast Quadrant South of Plant 9	■

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LEGEND:

■ = Contamination Greater than 50,000 µg/l

▲ = Contamination Between 10,000 µg/l and 50,000 µg/l

● = Contamination Less than 10,000 µg/l

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Miscellaneous discarded scrap material and equipment is located within the northeast quadrant, primarily in the former drum baling area. A detailed inventory of these materials has not been performed, but preliminary inspections have identified vehicles and scrap construction equipment contaminated with low levels of uranium, as well as asbestos and possibly PCB-contaminated scrap transformer carcasses and capacitors.

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2.0

2.0 INTRODUCTION TO SCREENING OF ALTERNATIVES

The identification and screening of alternatives consists of seven general steps. The first step is to develop remedial action objectives specifying the contaminants and media of interest, exposure pathways, and preliminary remediation goals that permit a range of treatment and containment alternatives to be developed. The preliminary remediation goals are developed on the basis of chemical-specific ARARs, when available; other available information; and site-specific, risk-related factors.

The second step is to develop general response actions for each medium of interest defining containment, treatment, excavation, pumping, or other actions, singly or in combination, that may be taken to satisfy the remedial action objectives, as well as the location and action-specific ARARs for the site.

The third step is to identify and screen the technologies applicable to each general response action to eliminate those that cannot be implemented technically at the site.

The fourth step is to identify and evaluate technology process options to select a representative process for each technology type retained for consideration. Although specific processes are selected for alternative development and evaluation, these processes are intended to represent the broader range of process options within a general technology type. Because the site is yet to be fully characterized (e.g., types, quantities, and levels of contaminants) it was infeasible to screen process options, except for general effectiveness, and apply them to the alternative development. Therefore, the alternatives developed were based upon technology types rather than process options.

Next, alternatives are developed to protect human health and the environment by reducing the radiological and hazardous substances from the site to as low as reasonably achievable, treating to reduce concentrations of radiological and hazardous substances to acceptable health-based levels, preventing exposure to radiological and hazardous substances, or some combination of these measures.

A sixth step involves identifying and describing volumes or areas of media to which general response actions might be applied, taking into account the requirements as identified in the remedial action objectives and the chemical and physical characterization of the site.

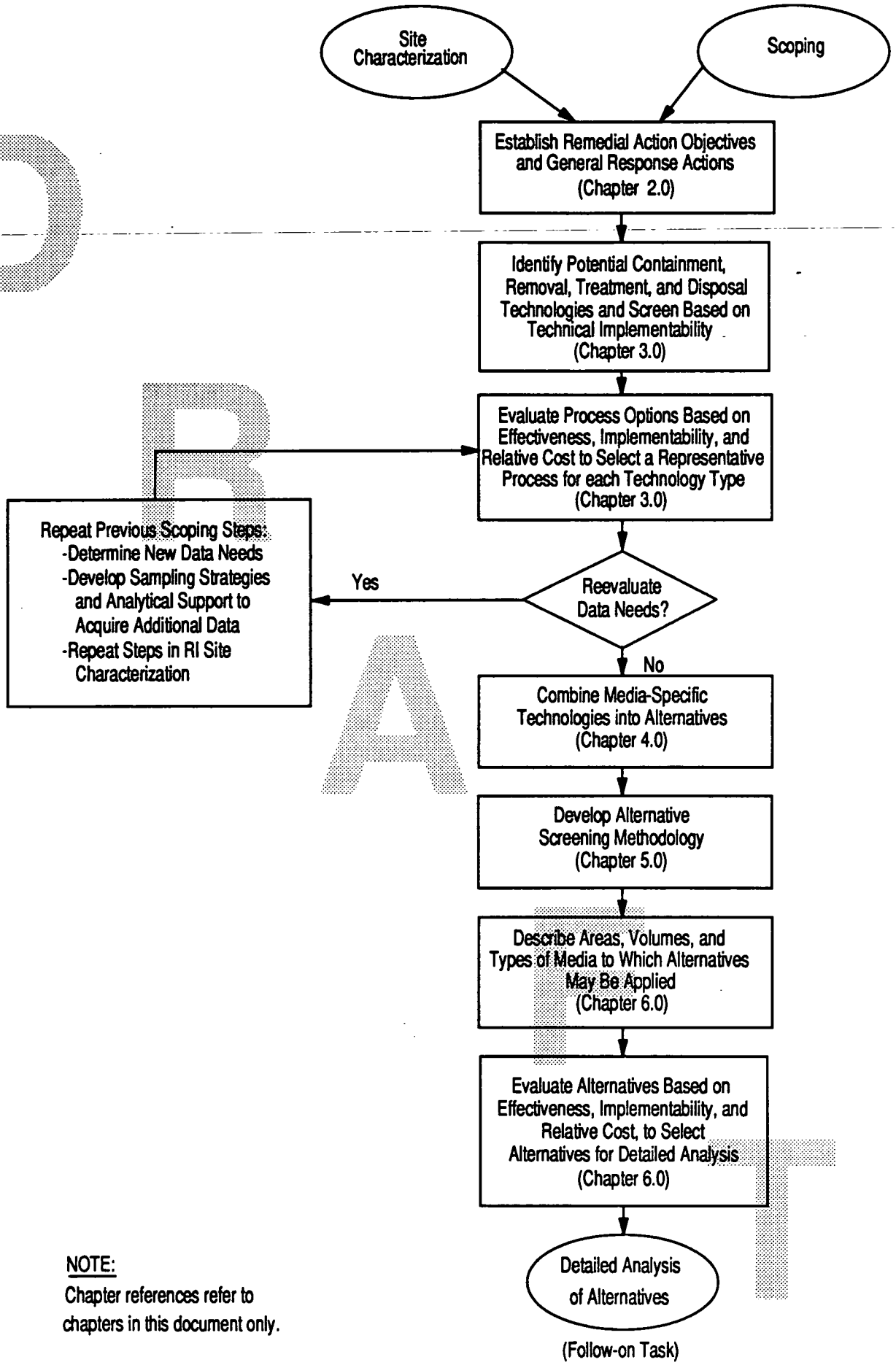
The final step is to screen the alternatives applicable to the Production Area and suspect areas to eliminate those that are not suitable for detailed analysis.

These steps (Figure 2-1) outline the approach used throughout this document. This chapter discusses remedial action objectives and general response actions for Operable Unit 3. Chapter 3.0 identifies and screens the technology types and process options, Chapter 4.0 describes the alternatives, Chapter 5.0 defines the screening methodology, and Chapter 6.0 screens the alternatives.

2.1 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) are media and operable-unit-specific cleanup goals for protecting human health and the environment (EPA 1988a,c). The objectives must address the contaminants of concern and the exposure routes and receptors identified in the Operable Unit 3 RI 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 would not 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 should address this issue.



NOTE:
Chapter references refer to chapters in this document only.

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FIGURE 2-1. OPERABLE UNIT 3 ALTERNATIVE DEVELOPMENT AND SCREENING PROCESS

As stated in the preamble to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (EPA 1990a), chemical-specific 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 are developed as suggested by the EPA (EPA 1990a; and EPA 1988c).

It is important to note that the information presented is based on preliminary data that will be revised as additional data becomes available.

2.1.1 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 3 identifies two major human exposure categories: current land-use exposures and future potential land-use exposures. The current exposure setting at the site includes 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 5820.2A. After 100 years, it is assumed that no active controls can be relied on for protection of human health.

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 3, it must be demonstrated that remedial alternatives meet airborne and direct radiation RAOs for the radionuclides of potential concern and meet drinking water RAOs for both radionuclides and nonradioactive chemicals of potential concern.

2.1.2 Remedial Action Objectives Based on ARARs

The development of RAOs is concurrent with the identification of frequently used standards or ARARs (see Appendix A). As is the case with the FMPC, these standards may need to be altered to ensure sufficient health protection based on multiple sources and pathways. As stated previously, 25 percent of the chemical-specific ARAR is the RAO for a single operable unit. The 25 percent may require alteration if a single operable unit contains multiple sources or exposure pathways or if other operable units do not contain the contaminant.

Chemical-specific ARARs have been identified for the control of radionuclide concentrations in air and groundwater and for chemical concentrations in drinking water. These chemical-specific ARARs are listed in Table 2-1.

2.1.3 Remedial Action Objectives Based on Risk Criteria

For several of the constituents in Operable Unit 3, no MCLs have been developed. 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) to determine acceptable intake levels in water (EPA 1988c). The method is similar to the manner used to develop MCLs (EPA 1989c). Briefly, the RAO is estimated using the following steps:

- Determine the acceptable daily intake (the RfD) based on dose response data and appropriate safety factors.

- Determine the acceptable water concentration (c) in milligrams per liter (mg/l) based on the assumption that a 70-kilogram (kg) 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.

2.1.4 Summary of Operable Unit 3 Remedial Action Objectives

RAOs for relevant media associated with Operable Unit 3 are summarized in Table 2-2. As shown, many of the RAOs for Operable Unit 3 are chemical-specific ARARs-based. Risk-based RAOs had to be developed for two inorganic metals and 13 organic compounds for the

TABLE 2-1

CHEMICAL-SPECIFIC ARARs APPLICABLE TO OPERABLE UNIT 3 REMEDIATION

Chemical-Specific	Standard	ARAR/TBC	Regulation
Radionuclide Emission (Except Airborne Rn-222)	Public Dose <10 mrem/yr	Relevant and Appropriate	40CFR61, Subpart H
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 Silver <0.05 mg/l Radium <5 pCi/l Aroclor-1254 <0.0005 mg/l Aroclor-1260 <0.0005 mg/l 1,1-Dichloroethene <0.007 mg/l Benzene <0.005 mg/l Trichloroethene <0.005 mg/l 1,1,1-Trichloroethane <0.2 mg/l	Applicable	40CFR141.11

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TABLE 2-2

OPERABLE UNIT 3 REMEDIAL ACTION OBJECTIVES

Media	Remedial Action Objective
Solid Waste • Soils • Metals • Facilities	Prevent current and future radiation emissions from causing detectable chronic effects.
	Prevent current and future above-background airborne radiation doses from exceeding 2.5 mrem, and radon concentrations from exceeding risk levels of $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk.
	Prevent current and future airborne chemical concentrations from exceeding $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk and/or a hazard index of 0.25.
	Prevent direct contact with soils or other solid wastes containing uranium at levels greater than 35 picoCuries per gram (pCi/gm) (approximately 50 ppm).
	Prevent erosion of soil that would contribute to inorganic and organic chemical surface water concentrations exceeding risk levels of $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk and/or a hazard index of 0.25.
	Prevent erosion of soils that would contribute to surface water concentrations of chemicals in Operable Unit 3 from reaching concentrations in excess of 25 percent of those reported in Tables 2-3 and 2-4.
	Prevent circumstances that may cause leaching of contaminants to groundwater.
	Prevent current and future radiation doses migrating from soils or wastes from exceeding 25 mrem/year.
Perched Groundwater	Prevent releases of radionuclides to the groundwater exceeding total uranium levels of 20 picoCuries (pCi/l) (approximately 30 μg/l).
	Prevent releases of inorganic and organic chemicals in excess of concentrations shown in Table 2-3 and 2-4.

perched 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}.

2.1.4.1 Solid Wastes

Remedial actions encompassing Operable Unit 3 prevent direct contact with and inhalation of soils and other solid wastes that contain chemicals and radionuclides at concentrations that do not meet RAOs, human health, or environmental criteria. The goal is to prevent contact with chemicals in the solid wastes 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 must also follow limits specified in DOE Order 5400.5, which limits the radiation dose to 100 mrem/yr (or an operable unit limit of 25 mrem/yr). An additional remediation goal of Operable Unit 3 is to prevent penetrating radiation doses to the public from exceeding 25 percent of the 100 milli roentgen equivalent man (mrem) annual dose limit, as specified in DOE Order 5400.5. This order has been identified as to be considered (TBC) for Operable Unit 3. 40CFR61 Subpart H allows for a 10 mrem/yr limit to the public for all airborne nuclides except Radon-222. Twenty-five percent of this limit is 2.5 mrem/yr for Operable Unit 3.

The acceptable residual concentration for total uranium in surface soil is assumed to be 35 pCi per gram (approximately 50 ppm). This concentration was developed from the Nuclear Regulatory Commission (NRC) Branch Technical Position, "Disposal or On-Site Storage of Residual Thorium or Uranium (Either as Natural Ores or Without Daughters Present) From Past Operations" (1981) and has been adapted for numerous sites throughout the United States.

Most areas of organic and inorganic contamination discovered in the Production Area also contain uranium. Existing restrictions on handling, storing, and transporting uranium contaminants will be used. In the event that hazardous chemical contamination of soils is discovered without radiological contamination, it would typically be found in small quantities that could be packaged in 55-gallon drums and transported off or on site. Verification that the material contains no radiological contamination would be required before shipment.

2.1.4.2 Perched Groundwater

Of great concern is the potential for the constituents of the Production Area and suspect areas to enter the underlying Great Miami Aquifer sometime in the future. Remedial action objectives developed for perched groundwater specify that future releases should not exceed MCLs (specified in 40CFR141), and for chemicals without MCLs, future releases should not exceed risk-based derived cleanup levels. Specific perched groundwater RAOs for Operable Unit 3 chemicals are listed in Tables 2-3 and 2-4.

In the absence of an MCL for uranium in community water systems (aside from radium, which has a promulgated MCL), and with the approval of an MCL not expected until 1992, the DOE is proposing that a "functional MCL" in the form of acceptable residual concentration levels be approved for use at the FMPC. This proposed concentration for uranium (in natural isotopic proportions) is 20 pCi/l and corresponds to a mass concentration of 30 μg/l of uranium. Remedial actions at the FMPC will be based on compliance with the "functional MCL" and will be reviewed, as necessary, when the final MCL for uranium is approved by EPA.

Various methods and criteria were considered for determining an acceptable concentration for uranium in drinking water (or groundwater that could be used as a drinking water supply). A concentration limit of 100 μg/l (67 pCi/l) was recommended by Wrenn et al. (1985). A limit of 105 μg/l for adults is derived from the reference dose of 3 μg/kg per day for uranium. Both of these limits are based on chemical toxicity considerations.

An acceptable concentration for uranium in groundwater can also be derived from radiation risk considerations. In the proposed standards for the control of residual radioactive materials from inactive uranium processing sites, EPA has proposed a concentration limit of 30 pCi/l or 45 μg/l for combined uranium-234 and uranium-238 to present the same level of risk as for radium at its MCL or 5 pCi/l (52FR36001 and EPA 1987).

The allowable concentration (20 pCi/l) is derived from a radiation dose limit of 4 millirems (mrem) per year. This is the dose limit used for beta- and gamma-emitting radionuclides in 40CFR141.16.

TABLE 2-3

GROUNDWATER REMEDIAL ACTION OBJECTIVE FOR INORGANIC CHEMICALS IN OPERABLE UNIT 3

Chemical	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[b]	0.05	0.0125
Barium	1.0 mg/l MCL	1.0	0.25
Cadmium	0.01 mg/l MCL	0.01	0.0025
Chromium	0.05 mg/l MCL	0.05	0.0125
Lead	0.05 mg/l MCL	0.05	0.0125
Manganese	0.2 mg/kg/d RfD[c]	7.0	1.75
Mercury	0.002 mg/l MCL	0.002	0.0005
Silver	0.05 mg/l MCL	0.05	0.0125
Zinc	0.2 mg/kg/d RfD	7.0	1.75

[a]Twenty-five percent of ARAR or risk-based standard (may require alteration if a single operable unit contains multiple sources or exposure pathways or if other operable units do not contain this contaminant)

[b]Maximum Contaminant Levels reported in 40CFR141 - National Primary Drinking Water Regulations

[c]Reference dose reported in United States Environmental Protection Agency. 1990b. Integrated Risk Information System (IRIS).

TABLE 2-4

OPERABLE UNIT 3
GROUNDWATER REMEDIAL ACTION OBJECTIVE FOR ORGANIC CHEMICALS

Chemical	Basis for Remedial Objective	Acceptable Water Concentration (mg/l)	FMPC Action Level for a Single Operable Unit[a] (mg/l)
Acetone	0.1 (mg/kg/d) RfD[b]	3.5	0.9
Anthracene	0.3 (mg/kg/d) RfD	10.5	2.6
Aroclor-1254	0.0005 mg/l MCL[c]	0.0005	0.00012
Aroclor-1260	0.0005 mg/l MCL	0.0005	0.00012
Bis (2-ethylhexyl) phthalate	0.014 $(mg/kg/d)^{-1}$ CPF[d]	2.5×10^{-3}	6.3×10^{-4}
Benzyl alcohol	0.3 (mg/kg/d) RfD	10.5	2.6
Beta-BHC	1.8 $(mg/kg/d)^{-1}$ CPF	1.9×10^{-5}	4.8×10^{-6}
1,1-Dichloroethene	0.007 mg/l MCL	0.007	0.0018
Benzene	0.005 mg/l MCL	0.005	0.0012
1,1-Dichloroethane	0.091 $(mg/kg/d)^{-1}$ CPF	3.8×10^{-4}	9.5×10^{-5}
Fluoranthene	0.04 (mg/kg/d) RfD	1.4	0.35

[a]Twenty-five percent of ARAR or risk-based standard. (May require alteration if a single operable unit contains multiple sources or exposure pathways or if other operable units do not contain the contaminant)

[b]Reference dose (Rfd) reported in United States Environmental Protection Agency. 1990b. Integrated Risk Information System (IRIS).

[c]Maximum Contaiminant Levels reported in 40CFR141 - National Primary Drinking Water Regulations.

[d]Cancer Potency Factor (CPF) reported in United States Environmental Protection Agency. 1990b. Integrated Risk Information System (IRIS).

TABLE 2-4
(Concluded)

Chemical	Basis for Remedial Objective	Acceptable Water Concentration (mg/l)	FMPC Action Level for a Single Operable Unit[a] (mg/l)
Fluorene	0.04 (mg/kg/d) RfD	1.4	0.35
Naphthalene	0.004 (mg/kg/d) RfD	0.14	0.035
Phenol	0.6 (mg/kg/d) RfD	21.0	5.3
Pyrene	0.03 (mg/kg/d) RfD	1.05	0.263
4-methyl-2-pentanone (methyl isobutyl ketone)	0.05 (mg/kg/d) RfD	1.75	0.44
Trichloroethene	0.005 mg/l MCL	0.005	0.00125
1,1,1-Trichloroethane	0.2 mg/l MCL	0.2	0.05
N-nitro-sodiphenylamine	0.0049 $(mg/kg/d)^{-1}$ CPF	.0071	.0018

[a]Twenty-five percent of ARAR or risk-based standard. (May require alteration if a single operable unit contains multiple sources or exposure pathways or if other operable units do not contain the contaminant)

[b]Reference dose (Rfd) reported in United States Environmental Protection Agency. 1990b. Integrated Risk Information System (IRIS).

[c]Maximum Contaiminant Levels reported in 40CFR141 - National Primary Drinking Water Regulations.

[d]Cancer Potency Factor (CPF) reported in United States Environmental Protection Agency. 1990b. Integrated Risk Information System (IRIS).

Derivation of the allowable concentration assumes an annual ingestion rate of 730 liters of drinking water (two liters per day, 365 days per year). This is the standard value used for the average water consumed per person (EPA 1989a).

In the absence of definitive chemical solubility information for uranium in groundwater at the FMPC, it is assumed that uranium in drinking water is relatively soluble with five percent of ingested uranium passing into the blood. The radiation dose conversion factor corresponding to this solubility is given in the Federal Guidance Report No. 11 (EPA 1988b). The radiation dose (50-year committed effective dose equivalent) per unit ingested quantity of uranium (natural isotopic proportions) is 2.69×10^{-4} mrem/pCi. The allowable concentration is calculated by dividing the annual radiation dose limit (4 mrem) by the annual intake (730 liters) and the radiation dose conversion factor (2.69×10^{-4} mrem/pCi). The resultant calculated concentration of uranium in drinking water is 20.4 pCi/l, which is rounded to 20 pCi/l.

The use of this concentration limit will be applied under a "sum" rule in conjunction with other radionuclides not specifically listed in 40CFR141. This rule requires that the sum of the radiation dose from all radionuclides (excluding radium-226, radium-228, and radon) via the drinking water pathway cannot exceed 4 mrem per year.

Activities conducted as part of the RI/FS at the FMPC that are impacted by the choice of this allowable concentration of uranium in water will be reviewed when the final MCL for uranium is approved by the EPA.

2.2 GENERAL RESPONSE ACTIONS

General response actions are identified for contaminants of concern to satisfy the remedial action objectives. The response actions considered applicable for Operable Unit 3 are no action, containment/treatment, excavation/treatment/disposal, collection/treatment/disposal, and near-term containment, far-term excavation/treatment/disposal.

The above response actions can generally be described as follows:

- No Action: Represents no further remedial action at the site in addition to what is currently proposed as part of other operational or regulatory compliance programs, such as monitoring and security controls.

- Containment/Treatment: Represents a minimum action scenario that is intended to isolate (by containment technologies) the wastes and to minimize the mobility of the contaminants and the vertical and horizontal infiltration of rainfall into and through the solid wastes to the underlying soils and perched groundwater. In situ treatment of contaminated materials to reduce the toxicity, mobility, and/or volume of contaminants will be considered.

- Excavation/Treatment/Disposal: Involves the removal of waste material to an on-site or approved licensed off-site treatment or disposal facility that will restrict contaminant migration and exposure. This action involves removal technologies, post removal actions, waste disposal options, and treatment options to reduce the toxicity, mobility, and/or volume of the contaminants.

- Collection/Treatment/Disposal: Involves the containment, collection, and treatment of contaminated water. This action includes collection/treatment of water from perched groundwater pumping and other actions (e.g., equipment cleanup and dust suppression activities).

- Near-Term Containment, Far-Term Excavation/Treatment/Disposal: Involves a near-term contamination containment action followed by a long-term excavation/treatment after the decontamination, decommissioning, and dismantling of facilities. It is designed specifically to address contaminated soils under facilities. In situ treatment of contaminated media to reduce the toxicity, mobility, and/or volume of contaminants will be considered.

DRAFT

3.0

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The general response actions discussed in Chapter 2.0 will be defined further in this chapter to specify remedial technology types. This chapter will identify and evaluate technology process options to select one or more representative processes for each technology type selected for evaluation. Due to the lack of site characterization data and information, it was not possible to determine whether or not specific technology types and/or process options could be effectively implemented at the site. Therefore, effectiveness was the main factor considered during this screening of technology types and process options. Implementability and cost played limited roles in the screening process, as well. At this stage, the entire screening process focused on: 1) potential effectiveness of process options in handling the estimated areas or volumes of media and meeting the remediation goals identified in the remedial action objectives, 2) the potential impacts to human health and the environment, and 3) how proven and reliable the process is with respect to the known contaminants on site.

For Operable Unit 3, 16 general technology types were considered. These technology types consist of capping, subsurface barriers, storm water management, groundwater extraction, groundwater treatment, soil treatment, packaging and transportation, thermal treatment, on-site waste disposal, off-site waste disposal, discharge, mechanical removal, facility removal, waste segregation and volume reduction, metals decontamination, and stabilization. The technology process options that apply to these technology types are listed in Table 3-1.

The technology process options, and rationale for elimination of selected process options are discussed in the following sections. In most cases, several process options are retained for each technology type. This is done because in most cases either two or more processes are sufficiently different in their performance and/or two or more process options together serve as a possibly viable solution. Also, because of the various types of contamination (e.g., radioactive, organic, inorganic), it was necessary to retain a number of process options for each technology type. The technology types and technology process options retained for evaluation are listed in Figure 3-3 (at the end of this chapter). Where possible, innovative technologies also have been retained for further consideration (e.g., hydrocyclonic separation). In accordance with CERCLA

TABLE 3-1

INITIAL IDENTIFICATION OF TECHNOLOGY TYPES AND PROCESS OPTIONS FOR OPERABLE UNIT 3

DRAFT

Capping

Single-Layer Cap
Multilayer Cap
Temporary Cap
Sump Repair/Replacement

Subsurface Barrier

Slurry Wall
Grout Curtains

Storm Water Management

Diversion and Collection
Grading
Revegetation

Groundwater Extraction

Interceptor Trenches: Horizontal Drains, Open Ditches
Dedicated Well System
Wellpoint System
Jet-Eductor System
Vertical Sand Drains
Electro-Osmosis

Groundwater Treatment

Ion Exchange
Flocculation
Clarification
Centrifugation
Filtration
Flotation
Evaporation
Reverse Osmosis
Denitrification
Adsorption
Stripping
Ultraviolet Radiation/Oxidation

Soil Treatment

Gravimetric Separation
Soil Washing
Chemical Extraction
Hydrocyclonic Separation

Off-Site Transportation and Packaging

Limited Quantities
Low Specific Activity Material
Type A Quantities
Type B Quantities
Rail and Truck Transportation

Thermal Treatment

Multiple Hearth
Circulating Bed Combustion
Plasma Arc

On-Site Waste Disposal

Permanent On-Site Disposal Facility

Off-Site Waste Disposal

Approved (Licensed) Off-Site Disposal Facility
Landfilling

Discharge

Discharge to the Great Miami River

Mechanical Removal

Heavy Construction Equipment

Facility Removal

Demolition

Waste Segregation and Volume Reduction

Sorting
Shredding
Compaction

Metals Decontamination

Liquid Abrasive Blasting
Freon Cleaning
Electropolishing
Physical and Chemical Separation
Pelletized Carbon Dioxide

Stabilization

Surcharging
Vitrification
In Situ Vitrification
Cement-Based Stabilization
Thermoplastic Stabilization

guidance, innovative technologies may be retained for evaluation if they are judged to be implementable and if available information indicates that they will provide better treatment, fewer or less adverse effects, or lower costs than other options.

3.1 CAPPING

Caps can be used to cover known areas of soil contamination. Capping involves the installation of a barrier over the surface of the contaminated area to control erosion and prevent leachate generation and migration from surface water infiltration. Capping is an effective, relatively inexpensive technology type that prevents vertical mobility of contaminants from surface water infiltration due to precipitation. Capping can control erosion and reduce or eliminate the direct and indirect exposure pathways due to contact, inhalation, and ingestion of contaminants. Existing subsurface contamination is not directly controlled or otherwise remediated by capping.

Caps can be of single or multiple layers and can consist of asphalt, chemical sealant/stabilizer, natural clay-rich soils, fortified clay, concrete, synthetic membrane, or multimedia containing two or more layers of these materials. Single-layer caps are constructed of the low-permeability materials mentioned above. Natural soil and admixes are not recommended because they are susceptible to freeze/thaw cycles and because exposure to drying can cause shrinking and cracking.

A properly designed capping system confines the materials in place, thereby eliminating handling and possible exposure problems encountered in alternatives in which a combination of excavation and removal are used. Sump repair is similar to the temporary cap process. Possible technology process options from the capping technology type category include single layer cap, multilayer cap, temporary cap, and sump repair.

3.1.1 Single-Layer Caps

Single-layer caps can control erosion and reduce or eliminate the direct and indirect exposure pathways due to contact, inhalation, and ingestion of contaminants. Also, they can prevent or impede leachate generation due to surface water infiltration. At the FMPC, surface areas of soil contamination typically are considerably smaller than those of groundwater. For this

reason, single-layer caps are considered a viable alternative for immobilizing soil contamination at the FMPC. Caps are not viable as a groundwater control measure at the FMPC due to the large surface area and interference caused by existing facilities creating difficulties for implementation. Single layer caps are retained for further evaluation as a containment option.

3.1.2 Multilayer Caps

Multilayer caps are generally designed in accordance with EPA guidelines under RCRA (see Figure 3-1). These guidelines recommend a three-layer system that consists of:

- An approximately 2-foot thick upper vegetative layer
- An approximately 2-foot thick combined filter and drainage layer
- A synthetic membrane liner overlying low permeability soil bottom layer

The vegetative layer would be supported by a topsoil cover. The drainage layer would consist of sand with a filter between the sand drainage layer and the upper vegetative layer. The low permeability layer would consist of a compacted clay layer placed just beneath a membrane layer. This design would divert infiltrating liquids away from the enclosed contaminated materials. The multilayer cap will be retained for further evaluation.

3.1.3 Temporary Caps

A temporary cap can also be utilized for floors of contaminated facilities as appropriate. The temporary capping process consists of placing an epoxy-base or polyurethane coating on the floor of the facility. Prior to coating, the floor would be shotblasted and cleaned. This surface preparation method would be used in conjunction with radiological detection instruments to remove radiologically contaminated concrete, as well as to provide an acceptable profile for proper adherence of the coating to the existing concrete. The shotblasted material and any contaminated concrete rubble would be removed and disposed of as contaminated waste. This coating would diminish penetration of radioactive emissions from the underlying contaminated soils through the floor and serve as a barrier to downward movement of liquids that may temporarily collect on the floor. The temporary cap is retained for further evaluation.

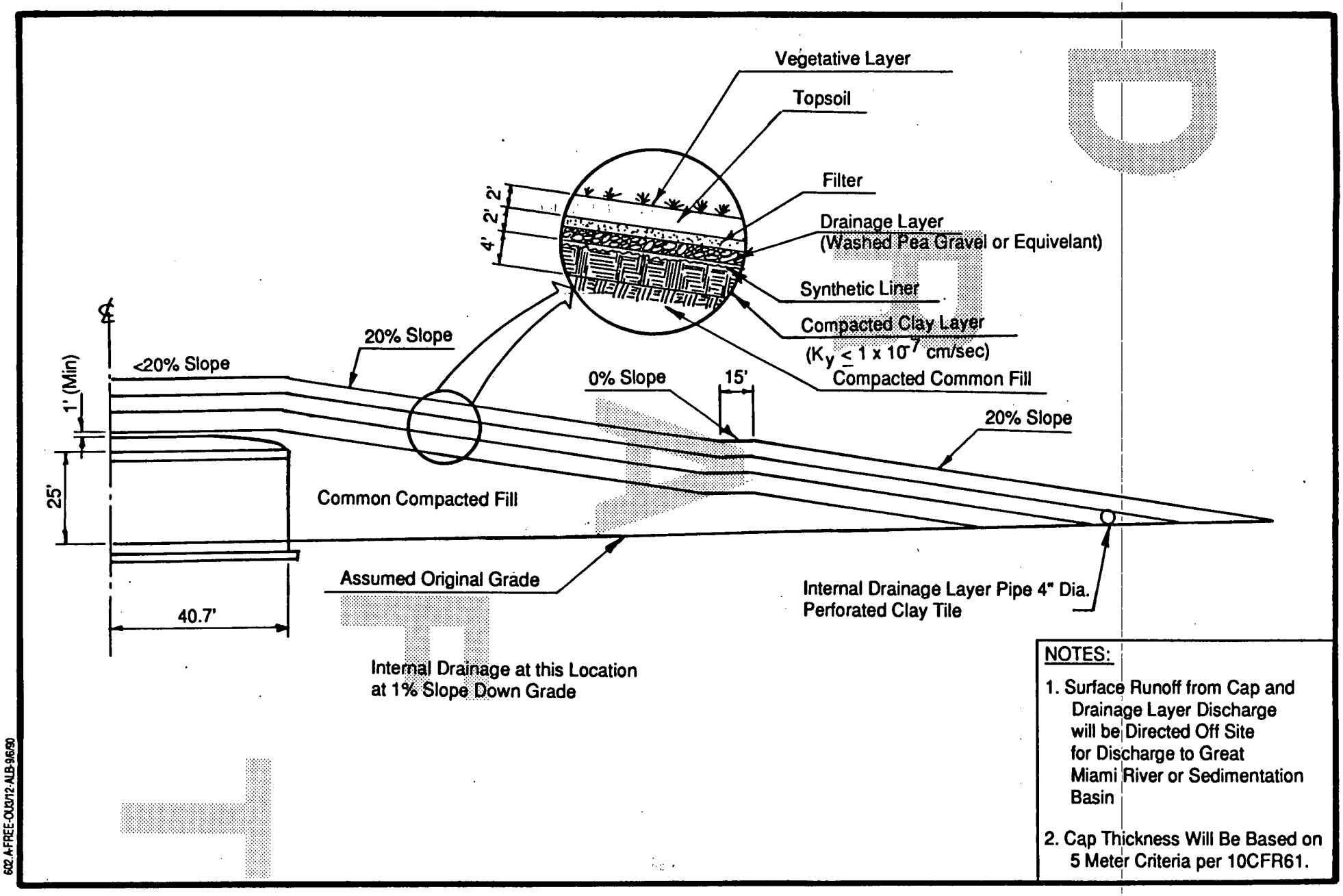

FIGURE 3-1. RCRA CAP

3.1.4 Sump Repair/Replacement

Sumps at the FMPC have been identified as contamination sources. Sumps are usually located within or near facilities. Sumps will either be repaired or removed and replaced, depending on whether they are repairable. Epoxy-based or polyurethane coating coupled with pressure injection where there are seeping cracks in the concrete will be used to repair sumps as appropriate. The process is similar to the temporary cap process and is retained for further evaluation.

3.2 SUBSURFACE BARRIERS

The term subsurface barriers refers to a variety of methods whereby low permeability cut-off walls or diversions are installed below ground to contain, capture, or redirect groundwater flow in the vicinity of a site. The most commonly used subsurface barriers are slurry walls, particularly soil-bentonite slurry walls. Less common are cement-betonite or concrete (diaphragm) slurry walls and grouted curtains. These types of subsurface barriers are discussed in the following sections.

3.2.1 Slurry Walls

Slurry walls are vertical, low permeability barriers that impede horizontal movement of contaminants in groundwater. Slurry walls are a commonly used form of containment because they are a relatively inexpensive means of reducing groundwater flow in unconsolidated earth materials. Slurry walls are often used in conjunction with groundwater extraction systems (see Figure 3-2), and have a proven history of success. Soil-bentonite walls have been used for years for groundwater control in conjunction with large dam projects and, more recently, hazardous waste sites. There is ample evidence of their success in these applications.

There are various types of slurry walls. The types are differentiated by the materials used to backfill the slurry trench. Portland cement, bentonite, and water are used to construct a cement bentonite slurry wall. The slurry is placed in a trench, where it forms a barrier to water flow. The only difference between the cement-bentonite and the soil-bentonite slurry wall is the addition of portland cement. Also, cement-bentonite slurry sets up into a semirigid (inflexible) solid and is therefore usable in areas where the topography varies. In addition, the mixing process does not require a large on-site mixing facility.

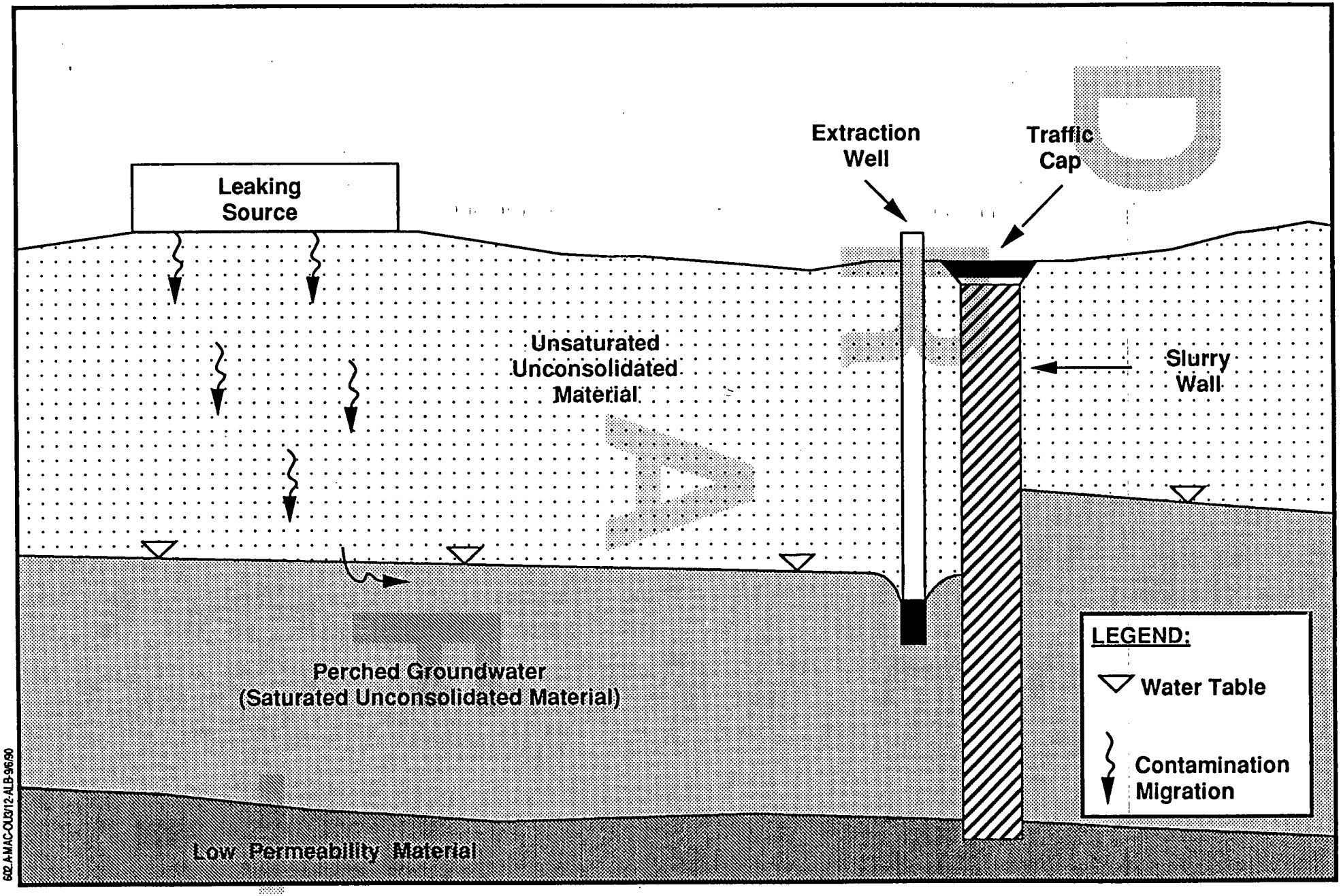

FIGURE 3-2. SLURRY WALL AND EXTRACTION WELL

Usually, construction of these barriers is relatively straightforward. However, at the FMPC, overhead and underground structures, buildings, utilities, and other surface features, including concrete pads, render construction extremely difficult. A continuous impermeable layer must also be present below the zone of contamination to provide an underlying barrier to migration. They can be used alone or in conjunction with caps and/or groundwater treatment systems, such as extraction wells. Slurry walls alone help reduce horizontal migration. In conjunction with other treatment systems, they help prevent the generation of leachate. Slurry walls are a viable containment process option. Due to the nature of existing facilities, they should be considered where construction could be more readily employed, such as around the periphery of the site. Slurry walls will be retained for further evaluation. The RI also will examine the extent and permeability of the underlying horizontal layers in the glacial overburden at the FMPC.

3.2.2 Grout Curtains

Grout curtains are subsurface barriers created in unconsolidated materials by pressure injection. Grout barriers can be many times more costly than slurry walls and are generally incapable of attaining truly low permeabilities because the complete integrity of the curtain cannot be confirmed by remote construction. While they require no operation and little or no maintenance, grout curtains may require more monitoring than other barriers. This is because even if a very small gap is left in the barrier, it can enlarge quite rapidly by piping or tunneling if a sufficient hydraulic gradient develops across the wall. Grout curtains are a specialty technology process option seldom applied to hazardous waste sites. For the reasons stated above, the grout curtain will not be carried forward for further evaluation.

3.3 STORM WATER MANAGEMENT

Capping is associated with storm water management technology process options such as collection ditches and sedimentation basins. Surface water control structures are designed to accept rainwater runoff from the cap and run-on from adjacent areas. Surface water diversion and collection techniques are useful support techniques that may be used either in combination with each other or with other selected process options. Some of these techniques can be used during site work and can be effective in preventing worker contact with surface runoff of

contaminated water. Sedimentation basins will be used as a form of diversion/collection. Sedimentation basins contain site surface water and runoff for a specific period of time to allow the settlement of suspended soil sediments, prior to off-site discharge.

Two other storm water management technology process options, grading and revegetation, are incorporated into the design of caps when appropriate. Grading and revegetation, in combination with capping, are viable technology process options for containment. Diversion and collection, grading, and revegetation will be retained for further evaluation.

3.3.1 Diversion and Collection

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

Surface water diversion and collection techniques are useful support technology category techniques that may be either used in combination with each other or with other selected process option technologies. Some of these techniques are commonly used during site work and can be effective in minimizing the contact of surface runoff with contaminated water and waste material.

Surface water diversion and collection is a viable technology process option when used in conjunction with other remedial action technologies and is therefore retained for further evaluation.

3.3.2 Grading

Grading is a general term for techniques used for managing surface water runoff and for helping control 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 ground surface to permit more efficient movement of water across the ground surface at nonerosive velocities whenever possible. Where the potential for erosion is present, protection is provided for the soil surface by vegetation.

For covered disposal sites, a properly designed and constructed grading program can be an economical method of helping control infiltration, diverting runoff, and minimizing erosion. Grading assists in preparing a suitable soil cover that can support beneficial plant species. It is also an important factor in proper cap design, performance, and reliability. Revegetation plays a key role in grading and is easy to implement (see Section 3.3.3).

Grading/regrading is inexpensive if suitable cover materials are available on site or close to the disposal site. The techniques and equipment used in grading operations are well established and are widely used. It is usually possible to find contractors and equipment locally.

Grading is useful in ponding, runoff velocities/soil erosion, differential settlement infiltration, and leaching of wastes; it also roughens and loosens soils, thereby preparing them for revegetation. For grading to be effective, it is essential to remove depressions and to repair slumped or badly eroded slopes.

Grading, in combination with capping, surface sealing, and revegetation, is a viable technology process option for containment of materials in a suitably designed and constructed facility. It is, however, a support technology process option and will be retained for further evaluation.

3.3.3 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 to develop a stable and naturally fertile surface environment. Revegetation can be useful for upgrading the appearance of a possible disposal site. Planning involves the selection of suitable plant species, seed bed preparation, seeding/planting, mulching and/or chemical stabilization, fertilization, and maintenance. Revegetation has application for both short-term stabilization (including intermediate covers at waste disposal sites) and long-term site reclamation.

The selection of suitable grasses, legumes, shrubs, and trees is a very important aspect of successful revegetation. Additional factors include the use of mulches and stabilizers, the application of required doses of lime/fertilizers, and optimum timing in seeding. Revegetation should be incorporated in design/construction of any disposal facility considered for short-term or long-term storage of materials. It can stabilize the surface of the disposal facility and reduce erosions and, thus, contribute to the effectiveness and reliability of a cap.

With proper planning, design, and implementation, a revegetation plan can reduce erosion and stabilize the surface of a covered disposal site. A multilayered capping system with properly graded slopes, in combination with suitable vegetative cover (e.g., grasses, legumes, and shrubs), is capable of isolating buried wastes from surface water input.

Vegetative covers require frequent maintenance, but may prevent more costly maintenance from erosion of surface soils. However, with the proper revegetation, maintenance can be minimal. Revegetation is also important to the integrity and performance of dikes, waterways and sedimentation basins. Revegetation is a viable component of a storm water management system and is retained for further evaluation.

3.4 GROUNDWATER EXTRACTION

All of the proposed groundwater extraction systems will require the water to be transported to either a treatment plant or to the discharge location. Two options are available for this transportation: trucking on a daily basis or a water conveyance system. If a trucking option is selected, surge tanks will be located at all pumps or drains. The surge tanks would be emptied into tanker trucks as necessary and the water would be transported to the water treatment plant. If the option of a conveyance system is selected, piping will be installed from all pumps and drains to the water treatment plant.

Contaminated groundwater located in shallow, perched, relatively sandy layers at the site can be removed by several technology options. Water extraction systems may include interceptor trenches, wellpoint systems, jet-educator systems, dedicated well systems, vertical sand drains, and electro-osmosis. A brief description and explanation of the relative applicability of each technology process option follows.

3.4.1 Interceptor Trenches

Trench systems include both open ditches and horizontal drains. An open, sloping ditch, when excavated to a depth lower than the water table, will conduct water from earth materials because the total gravity head in the formations will be higher than the head in the ditch. Consequently, water flows from higher to lower pressure. Open ditches are not advised because they impede surface traffic and represent a long-term hazard to personnel at the FMPC.

Horizontal drains are usually placed in a temporary excavation that remains open only for the duration of drain construction. Horizontal drains are usually constructed with perforated pipe placed in a medium of sand or gravel. The perforated pipe is placed beneath or at the base of the strata to be drained, with sand or gravel placed contiguously with that strata. The remainder of the excavation is typically filled with native materials. The system is generally sloped to a common collection point or sump, where the water is pumped to the surface. Horizontal drains work well in thin, less permeable materials, but do not perform well in thick, highly permeable materials because of the relative slowness in draining these formations by this method, and dangers in excavating thick, saturated zones caused by instability of sidewalls during construction. Horizontal drains are retained for evaluation in conjunction with other technology process options.

3.4.2 Dedicated Well System

A dedicated well system is a network of independent wells, each with a dedicated pump installed within the well. This system is particularly well suited to extracting large quantities of water from thick layers of permeable materials. Proper component sizing and interwell spacing allows dedicated wells to be adapted to thin, less permeable materials. At the FMPC, the saturated thickness of the more permeable sandy materials is typically less than five feet. Considering the aquifer thickness and apparent, relatively low hydraulic conductivity of these materials, this type of system is rendered marginally adequate to function for the entire site. Individual wells located where greater aquifer thickness, lateral extent, and permeability are encountered are viable for local removal of contaminated water.

Descriptions from boring logs of the saturated materials in the perched groundwater zones indicate that the sandy materials have a silt component, and may grade laterally into sandy silts. The sandy zones do not appear to be continuous over a wide area, generally do not exceed 5 feet in thickness, and are usually less than 20 feet beneath the surface. For these reasons, dedicated well systems have limited applicability for removing contaminated water from the perched groundwater zone, but they will be retained for further evaluation for appropriate applications.

3.4.3 Wellpoint System

A wellpoint system consists of small-diameter riser pipes, usually installed in a linear or circular configuration, with the risers connected to a common header and pumped by one or more wellpoint pumps. Spacing between wellpoints is generally determined by the depth of placement and the cone of depression generated by the pumping system. Wellpoints may be surface-driven, water-jetted, or placed in predrilled holes, with filter pack placed around the screen (Department of Army, Navy and Air Force 1971).

Wellpoints are suitable for water extraction in shallow groundwater environments typical of the perched groundwater conditions at the FMPC, providing that the hydraulic conductivity of the aquifer exceeds approximately 1×10^{-3} centimeters per second (the approximate limit of gravity drainage). A comparison of installation techniques indicates that installation by surface driving produces the least effective wellpoint because minimal filter pack is provided, and clogging or damage to the screen and riser can occur during installation. This is accommodated by installing wellpoints at a closer spacing, or by testing individual wellpoints and reinstalling as necessary. Water-jetted wellpoint installation is not recommended at hazardous waste sites because of the relatively large volumes of water used and the high water pressure employed. Both conditions may, in the short term, adversely affect the contaminant plume. Wellpoints installed in predrilled holes are the most effective because a large filter pack can be accommodated and because installation can be easily controlled and verified. This is also the most expensive method of installation.

In soils classified as sandy silts and silty sands, the hydraulic conductivity may range between 1×10^{-3} and 1×10^{-5} centimeters per second; drainage cannot be readily achieved by gravity

alone, but may be aided by using a vacuum wellpoint system. This system is essentially a conventional wellpoint system in which a partial vacuum is maintained at the well screen and filter pack, increasing the hydraulic gradient and consequently improving flow to the wellpoint. Saturated soils at the FMPC may have permeability values below 1×10^{-3} centimeters per second; consequently, this is a viable groundwater extraction method at the FMPC and will be retained for further evaluation.

3.4.4 Jet-Eductor System

A jet-eductor system consists of wellpoint screens attached to jet-eductors installed at the end of double riser pipes. One pipe is a pressure pipe to supply the jet-eductor pump; the other pipe is for discharge from the jet-eductor pump. A jet-eductor system is installed in a similar manner to that of a conventional well system, but it has the advantage of being able to pump small quantities of water from low-permeability materials at depths as great as 100 feet. This system is not necessary at the FMPC because the shallow, perched groundwater resides primarily at depths less than 20 feet. For this reason, this technology process option will not be carried forward for further evaluation.

3.4.5 Vertical Sand Drains

Vertical sand drains consist of a column of sand placed in a cased hole that has been driven or drilled through soil. Once the sand has been emplaced, the casing is removed and the surface plugged and capped. Vertical drains can be used to connect several thin, relatively permeable strata that are separated by zones of low permeability materials. Water can be drained from the upper permeable zones into a lower permeable zone, where it can be extracted by one of the other technologies described for the extraction of groundwater. This technology process option is retained for evaluation in conjunction with other technology options.

3.4.6 Electro-Osmosis

Water cannot be readily extracted from soils such as silts, clay-rich silts, and clay-rich sands by pumping alone. These soils can be drained with wells or wellpoints used in conjunction with electrical current. Water contained in soil voids migrates away from a positive electrode and toward a negative electrode. If the negative electrode is also a wellpoint, the water can be effectively removed from low permeability soils by pumping. Because other less sophisticated

technology process options are available to effectively remove the contaminated water from perched strata at the FMPC, and because electric potential may cause polarization of dissolved constituents, electro-osmosis will not be carried forward for further evaluation.

3.5 GROUNDWATER TREATMENT

Groundwater treatment may be required because water may contain metal contamination, low-level radioactivity, organics, and/or high nitrates. Due to the complex composition of the perched groundwater at the FMPC, no single treatment technology process option is capable of removing all contaminants present to desired concentrations. Therefore, all of the following technology process options have been retained for consideration as components in a treatment train that would be designed to effectively reduce groundwater contaminant concentrations to or below the required levels. The following section discusses those treatment processes for treating the relatively concentrated contaminated waters beneath the FMPC. Residue resulting from the treatment process is in the form of sludge. This by-product of the treatment process would be retained for on-site or off-site disposal.

3.5.1 Ion Exchange

Ion exchange is a chemical treatment process in which certain dissolved ions are removed from water by exchanging them with other (counter) ions held by electrostatic forces to charged groups on the surface of an insoluble solid (resin) with which the solution is contacted. Ion exchange resins are typically polymer beads that have been modified by the addition of chemical groups that attract various ionic species. The resins can be regenerated for reuse with a strong solution of the exchangeable counter ion. Resin types range from general purpose demineralization resins that remove nearly all salts to selective chelating resins that have high affinities for specific ions.

Ion exchange may be used as a final treatment to remove trace metals and radionuclides from diluted wastewater. Uranium removal by ion exchange is a feasible technology process option that has been implemented in the field. Laboratory and field trials for removing uranium from drinking water supplies have identified a high absorption capacity and selectivity of resins for this radionuclide. The resins may be used once and disposed of, or they may be regenerated, which will produce a concentrated waste stream for treatment and disposal; the concentrated

regenerant can be treated with the sludge. Ion exchange is an easily implemented and reliable commercial technology process option. Treatment cost is moderately expensive and will depend on the type of resin employed and the quantity of the various ionic species removed from the wastewater.

Ion exchange can remove specific inorganic ionic materials and may be a component of the overall wastewater treatment system and is therefore retained for further evaluation.

3.5.2 Flocculation

Flocculation is the coagulation of small colloidal suspended solids into larger particles to allow relatively easy separation from the wastewater. Primarily a physical process, flocculation will help remove only the suspended solids and will not affect dissolved species. In addition, this technology process option will not reduce the hazard associated with solids, but it will facilitate their subsequent treatment and disposal. Typically, laboratory-scale bench settling tests would be required to select type and dosage of flocculent. Flocculation could be a component of a wastewater treatment system and is therefore retained for further evaluation.

3.5.3 Clarification

Clarification is a density separation treatment for removal of organic or inorganic contaminants. Clarification, frequently known as sedimentation, involves the separation of suspended solids from a liquid by gravity. It has no effect on dissolved species. Clarification can be performed in large tanks or pits (preferably with a sloped bottom) or in packaged equipment supplied by vendors.

Clarification can either be used as a pretreatment technique to remove organic or inorganic contaminants prior to downstream processing, or as a final polishing step to produce a high quality effluent suitable for direct discharge. Solids separation is usually enhanced by flocculation. Clarification can remove the suspended solids from wastewater. Clarification is an effective first stage treatment for large particles that settle quickly. It is a common process that can be included in the wastewater treatment system and is therefore retained for further evaluation.

3.5.4 Centrifugation

Centrifugation is a density separation treatment. Centrifugation is a process in which the solid and liquid components of a mixture are separated by the application of centrifugal force. The process of centrifugation is analogous to sedimentation (settling) in which solids are separated from liquids as a result of gravitational force; however, centrifugation increases the applied force by several times the force of gravity.

Centrifuges offer some advantage over filtration or clarification for solids removal from the wastewater in that centrifuges can thicken sludges and handle some solids at a relatively high throughput. Decontamination of a centrifuge at the end of the remediation activities could pose a problem due to the complexity of the equipment, but is a viable treatment process for removing solids from the wastewater and is therefore retained for further evaluation.

3.5.5 Filtration

Filtration is a method for separating solids from a liquid. The stream to be filtered passes through a medium that allows the liquid to pass through while trapping the solids. Filtration is commonly used in water treatment plants for solids removal. Pressure filtration is typically used for dewatering sludges, which, in turn, reduces transportation and disposal costs.

Filtration usually provides a better separation of solids from water when compared with clarification. Filtration will not reduce the hazard associated with the insoluble wastewater constituents, but it will reduce their volume and further treatment may be necessary.

There are no environmental concerns associated with filtration except the disposal of any hazardous sludge generated. Filtration is a commonly used unit operation that may be used as part of a waste treatment process and is therefore retained for further evaluation.

3.5.6 Flotation

Flotation is a density separation treatment for removal of finely divided suspended solids. Air is bubbled through a waste solution, which causes small particles to rise to the surface with the air bubbles. This process is effective for the removal of finely divided suspended solids from liquid waste streams. Flotation is typically carried out in an open tank or basin. Flotation

could be a component of a uranium-contaminated wastewater treatment system and facilitate subsequent treatment and disposal. As a support step for solids settling, flotation is potentially applicable and is therefore retained for further evaluation.

3.5.7 Evaporation

Evaporation is the process of separating wastewater from salts and solids by vaporizing or evaporating the wastewater. Evaporation could be used to concentrate the salts and solids in wastewater. However, evaporation will not reduce the hazards associated with these wastes. It will only facilitate their subsequent treatment and disposal. Condensate treatment may be required as a support step of this waste treatment process. This process will be retained for further evaluation.

3.5.8 Reverse Osmosis

Reverse osmosis involves diffusion of water through a semipermeable membrane with applied pressure. It is a separation process that can retain particles (including dissolved species) as small as 1 to 10 angstroms (10^{-8} to 10^{-7} centimeters).

Historically, reverse osmosis has been associated with removal of salts and inorganic compounds from brackish water. Unlike water, salts and other contaminants cannot pass through the semipermeable membrane and therefore are concentrated. The degree of concentration depends on the pressures and membranes employed. One of the significant limitations of reverse osmosis is related to the tendency of membranes to foul and reduce the flux or product flow. This happens if the solubility limit of the salt species in wastewater is exceeded. A stabilizing agent (one that chemically bonds with ions in solution to form a stable compound) can be added to reduce this effect (MacDonnell et al. 1989).

Although typical removal efficiency for uranium by this process is approximately 70 percent, the same data indicate that 90 percent removal efficiencies can be achieved. Reverse osmosis can concentrate the salts and solids in wastewater and may be part of a wastewater treatment. Some pretreatment of the water to the reverse osmosis units may be required. Reverse osmosis could be a component of a wastewater treatment system and is therefore retained for further evaluation.

3.5.9 Denitrification

Denitrification is a microbial wastewater process by which nitrates and nitrites are reduced to molecular nitrogen. Denitrification is a respiratory mechanism in which nitrate/nitrite replaces molecular oxygen in bioassimilation. The process requires the availability of a carbon source that is usually satisfied by the addition of methanol to the wastewater. Denitrification takes place in an anoxic (no oxygen) environment. In the absence of molecular oxygen, facultative bacteria use the nitrates or nitrites as a source of molecular oxygen for metabolizing organic matter for energy. Denitrification should have no adverse environmental effects, is easily implementable, and is a reliable technology process option for wastewater treatment. Denitrification is therefore retained for further evaluation.

3.5.10 Adsorption

Adsorption is a physical-chemical process that involves the removal of dissolved solids from liquid waste by adsorption onto a treatment medium (e.g., activated carbon or activated alumina). Adsorption is commonly used as a polishing step to remove refractory organics (i.e., those that resist biological degradation) from treated waters and wastewaters prior to discharge. The suspended solids content of the influent to an adsorption process step must typically be restricted to less than 50 milligrams per liter, or system clogging and treatment failure could result. This condition could be met by implementing solids-removal processes, such as clarification and/or filtration, prior to the adsorption step in the overall treatment system for the contaminated water. Two adsorption processes are potentially applicable to the proposed action: activated carbon adsorption and activated alumina adsorption.

The most common type of adsorption in water and wastewater treatment operations is activated carbon adsorption. Thermal activation creates sites on carbon particles for the adsorption (physical and chemical) of solution contaminants. The number of these adsorption sites on activated carbon is significant compared with other adsorbents, based on a large surface-to-mass ratio that is typically 1000 square meters per gram. There are two types of activated carbon: granular and powdered. Granular activated carbon adsorption is usually carried out in a column or tank, whereas powdered activated carbon is usually added to the waste solution in a process reactor. Because granular activated carbon can typically be regenerated, whereas powder

activated carbon cannot, the former is most commonly used in treatment systems. The effectiveness and reliability of carbon adsorption for the removal of dilute organics and some inorganics from aqueous waste streams have been demonstrated in the field. Adsorption could be part of a wastewater treatment system. This process is retained for further evaluation.

3.5.11 Stripping

Stripping can remove dissolved contaminants, primarily volatile compounds, from liquid waste steams using air or steam. Air stripping (using aeration towers, spray aeration, diffused air aeration, or air lift pumps) is typically used to treat ammonia and certain organics such as acetone, carbon tetrachloride, benzene, and toluence. The removal is achieved by transferring the targeted compound from solution to air, whereupon treatment of the air generally becomes necessary. Steam stripping is essentially a steam distillation process in which the targeted contaminants (e.g., volatile organics) become the distillate. The process can be used to remove phenols, chlorohydrocarbons, ammonia, or hydrogen sulfide from solution. Stripping could be part of a wastewater treatment system and is therefore retained for further evaluation.

3.5.12 Ultraviolet (UV) Radiation/Oxidation

The ultraviolet (UV) radiation/oxidation process uses UV radiation, ozone, and hydrogen peroxide to destroy toxic organic compounds. The process oxidizes compounds that are toxic or refractory (resistant to biological oxidation) in concentrations of parts per million/billion.

Contaminated groundwater containing PCBs, organics, and volatile organics, are suitable for this treatment process and it will be retained for further evaluation.

3.6 SOIL TREATMENT

The soil treatment technology process options identified for consideration are gravimetric separation, soil washing, chemical extraction, and hydrocyclonic separation.

3.6.1 Gravimetric Separation

Gravimetric separation is a physical treatment process that involves the separation of materials by density through stratification in a fluid media. This is accomplished by placing the soils/sediments into a pulsating bed of stainless steel shot that is acted upon by a flow of water

that dilates and then contracts the bed. The material settles over the bed, and stratifies by particle density and grain size. The higher density particles that are small enough in size tend to make their way through the interstitial spaces and are deposited in the bottom sedimentation trap. In most cases, uranium will become concentrated with the most dense fraction, and what is left behind is generally "clean" material.

This technology process option has been widely used in the mineral/mining industry, but is of questionable value for nonhomogeneous materials with high clay or organic content. It is not effective in removal of material chemically bonded in the soil/sediment matrix.

The process is available commercially and has been tested on soils from the FMPC with little success. The process requires substantial disposal of residual fraction as contaminated.

Gravimetric separation has not proven successful in treating the type of materials expected from the FMPC and, therefore, is not retained for further evaluation.

3.6.2 Soil Washing

Soil washing is a physiochemical treatment process that involves the extraction of organic and inorganic compounds from soils or sediments by leaching. This is accomplished by passing an appropriate leaching solution through the soils using an injection/recirculation process. These solutions may include water, water surfactant mixtures, acids or bases (for inorganics), chelating agents, and oxidizing or reducing agents. This process is used on excavated soils or sediments that are fed into a washing unit.

In general, this technology process option has been demonstrated to remove metallic compounds of lead, cadmium, chromium, and copper. Use of nitric acid as a leaching agent is a commonly used commercial production technique for removal from soils or sediments; however, it is not proven.

Only a few mobile units necessary for this process are commercially available. The process also requires removal of contaminants from the washing fluid. Soil washing is a potentially viable option and is retained for further evaluation.

3.6.3 Chemical Extraction

Chemical extraction uses chemicals to remove organic and volatile inorganic compounds from soils. The process removes toxic/hazardous organics and inorganics from soils by extracting contaminants by partitioning. The site is flooded with an appropriate flushing solution and the extracted material is collected. Chemical extraction is a potentially viable option and is retained for further evaluation.

3.6.4 Hydrocyclonic Separation

Hydrocyclonic separation is a soil reclamation process that separates the contaminant from soil particles greater than three micron in diameter, and generates reusable soil, and concentrates the contaminant. The process is based on a novel application of gas-sparged centrifugal separation using operating conditions/equipment specifications tailored to optimize the separation of the particular contaminant.

When a suspension of solid particles in a fluid is fed tangentially into the top of a conical chamber, it acquires a spinning trajectory. The tangential velocity of the particles tends to carry them toward the periphery of the chamber. The result is a downward spiral path of increasing radius until the particles reach the boundary. The particles then continue their spiraling descent down the wall while the fluid moves upward in the central core. Because at high tangential velocities the outward force on a particle is many times greater than the force of gravity, cyclones accomplish more rapid and effective separation than gravitational settling chambers.

When the particles of the slurry vary in size, the denser particles have greater kinetic energy for a given tangential velocity and, therefore, reach the boundary more quickly than the lighter particles. By appropriately designing its geometry and operating conditions, a cyclone can thus be used to separate particles by size or specific gravity. When the fluid in the feed is liquid, this separation can be further aided by the technique of sparging gas bubbles into the cyclone vortex from the interior of the cyclone wall. It has been found that these bubbles tend to create turbulence at the boundary layer with the liquid in the vortex, thereby increasing the probability of collisions with particles in suspension, the lighter fraction of which may adhere to

and be entrained by the bubbles to form a foam that migrates to the center of the cyclone because of its relatively lighter weight. Therefore, gas sparging may enhance the classification properties of cyclones. The hydrocyclonic process is a potentially viable process and is retained for further evaluation as an innovative technology.

3.7 OFF-SITE TRANSPORTATION AND PACKAGING

The U.S. 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, four may apply to Operable Unit 3 sites:

- Limited quantities
- Low specific activity material
- Type A package quantities
- Type B package quantities

Under each of these categories, the Operable Unit 3 residues will be specified as "normal form" because they have not been tested to meet the requirements of 49CFR173.469.

3.7.1 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 Operable Unit 3 materials 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 radioactivity found in the wastes, it would require an inordinate number of packages to ship the wastes. The logistics of inventorying and accounting for this number of packages renders this shipping classification unsuitable for the shipping of the materials; therefore, this technology process option will not be carried forward for further evaluation.

3.7.2 Low Specific Activity Material

The advantage to shipping radioactive material categorized as low specific activity is to gain exemptions from using specification packaging (e.g., Type A, Type B, etc). Whereas the other

packaging and shipping classifications place a limit on the curie content of a package, the low specific activity classification places a limit on the specific activity of the contents of each package.

In other words, all contaminated waste will be divided into three categories: 1) those with a specific activity value equal to or less than 0.05 curie, 2) those with a specific activity value greater than 0.05 but not more than one curie, and 3) those with a specific activity value greater than one curie. These categories are then used to determine packaging requirements. This technology process option is retained for further evaluation.

3.7.3 Type A Quantities

Operable Unit 3 residues can be shipped in Type A packaging, which requires that the activity level in each package does not exceed the A2 value for the radionuclide of concern listed in 49CFR173.435. The design and performance specifications for Type A packaging are listed in 49CFR173.412. Type A packages are designed to meet more stringent requirements than low specific activity packages and are typically used for packaging materials with greater levels of radioactivity. Type A containers are generally more expensive than low specific activity containers.

Due to the activity levels and the package activity level restrictions for Type A packages, the wastes would require an inordinate number of packages. As with the limited quantities classification, the logistics for storing and accounting for a large quantity of Type A packages would be prohibitive, and therefore, this technology process option will not be carried forward for further evaluation.

3.7.4 Type B Quantities

Type B packaging is required for all wastes that exceed Type A packaging requirements. The design and performance requirements for Type B packages are listed in 49CFR173.431 and 10CFR71.51. Type B packaging is constructed to much higher standards than either Type A or low specific activity packaging and is much more expensive.

Generally, shipments of Type B quantities are made in a 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 or rail trips, and difficulty in obtaining Type B overpacks. This technology process option is retained for further evaluation.

3.7.5 Rail and Truck Transportation

There are currently two options being considered for transporting radiological and hazardous waste: transportation by rail and by interstate trucking. There is presently a side track that runs through the FMPC and links up with a main railroad system. This would be convenient for loading the waste; highway transportation would not be required to get waste to the rail system. Rail transportation is less expensive (in dollars-per-rail-mile) than highway transportation. There are fewer accidents per mile and public resistance to rail transportation would not be expected to be as great. The railroads that presently operate out of Fernald are Union Pacific and CSX Transportation. Both transportation options, rail and truck, will be retained for further evaluation.

3.8 THERMAL TREATMENT

Thermal destruction is a treatment method that uses high temperature oxidation under controlled conditions to degrade a substance. Thermal destruction methods can be used to destroy organic contaminants in liquid, gaseous, and solid waste streams. The hazardous products of thermal treatment require air pollution control equipment to be used to prevent release of undesirable species into the atmosphere. As required by the Clean Air Act, all air quality and emission requirements will be complied with throughout the course of the proposed action by implementing mitigative measures as necessary (e.g., wetting surfaces to minimize dust generation and controlling vehicular traffic, as well as wearing personal protective equipment). Monitoring will be conducted to ensure compliance and, prior to treatment, necessary permits will be obtained.

3.8.1 Multiple Hearth

A multiple hearth incinerator consists of refractory lined steel, a rotating central shaft, a series of solid flat hearths, a series of rabble arms with teeth for each hearth, an air blower, waste feeding and ash removal systems, and fuel burners mounted on the walls (U.S. Department of Commerce 1985). It can also be equipped with an afterburner, liquid waste burners, and side ports. Residence time may be very long.

The multiple hearth incinerator can be used for the disposal of all forms of combustible industrial waste materials including sludges, tars, solids, liquids, and gases. The incinerator is best suited for hazardous sludge destruction. Solid waste often requires pretreatment such as shredding and sorting. It can treat the same wastes as the rotary kiln, provided that pretreatment of solid waste is applied. The principal advantages of multiple hearth incineration include high residence time for sludge and low volatile materials, ability to handle a variety of sludges, ability to evaporate large amounts of water, high fuel efficiency, and the utilization of a variety of fuels. The greatest disadvantages of the technology process option include susceptibility to thermal shock, inability to handle wastes containing ash (which fuses into large rock-like structures), and wastes requiring very high temperatures. Also control of the firing of supplemental fuels is difficult. The multiple hearth incinerator will be retained for further evaluation.

3.8.2 Circulating Bed Combustion

Circulating bed combustion is an outgrowth of conventional fluidized bed incineration. However, the fluid bed operates with higher velocities than conventional fluid beds and it recirculates the fluidized material within the system, returning it back to the feed section (U.S. Department of Commerce 1985).

Circulating bed combustion is suitable for burning solid, liquid, sludge, or gaseous waste streams. The advantages of this incinerator are similar to those of a conventional fluidized bed system with lower susceptibility to corrosion of the boiler, a less complicated scrubbing system, close temperature control, and dry solid waste recovery. Circulating bed combustion will be retained for further evaluation.

3.8.3 Plasma Arc

Plasma Arc is a thermal treatment technology that uses the heat from a plasma torch to create a molten bath used to detoxify contaminated soil. Organic contaminants are vaporized and react at very high temperatures to form innocuous products. Solids melt and are incorporated into the molten bath. Metals are retained in this phase, and when cooled, the material is a nonleachable matrix. This process is most appropriate for soils contaminated with metals and organic compounds. This process is most useful for difficult to handle wastes. It is effective with almost any toxic material, but because electric energy is expensive, it is most beneficial for wastes with high solids content containing heavy metals and/or organics. Mixed radioactive wastes can readily be handled. Plasma Arc will be retained for further evaluation.

3.9 ON-SITE WASTE DISPOSAL

A permanent on-site disposal facility will be retained for evaluation for the disposal of waste material on site. The primary consideration of an on-site disposal facility is to store the low-level radioactive waste in a manner that renders it both secure and retrievable for an extended period of time without employing extraordinary measures.

3.9.1 Permanent On-Site Disposal Facility

The permanent on-site disposal facility will provide a permanent pre-engineered environment to restrict containment migration. The facility will be designed in accordance with 10CFR61 and 40CFR264. The major concern to be addressed is the possible migration off site of long-lived radionuclides potentially transported via groundwater to the shallow aquifer beneath the site. This concern will be addressed by minimizing the potential for groundwater to reach the waste storage pile; to mitigate the effects of the groundwater should it reach the low-level waste storage; and to provide intercepting barriers to aid in the collection, sampling, and proper treatment of any leachate emanating from the area in close proximity to the storage containers.

The concept of the permanent on-site disposal facility is intended for the containment of low-level radioactive wastes, but the facility would also be usable as a RCRA or mixed waste storage facility under the CERCLA agreement and related ARARs (WMCO 1990a). The permanent on-site disposal facility is retained for further evaluation.

3.10 OFF-SITE WASTE DISPOSAL

Disposal in an approved (licensed) off-site disposal facility and landfilling are two off-site waste disposal process options. Compatibility testing would be performed prior to bulking wastes for off-site transport to ensure that consolidation will not result in incompatible waste reaction or in large volumes of waste that are unacceptable for off-site disposal. Compatibility testing refers to simple, rapid, and cost-effective testing procedures that are used to segregate wastes into broad categories.

3.10.1 Landfilling

Off-site disposal includes landfilling and incineration. Landfilling of radiological and hazardous materials is not considered an option due to federal land ban regulations that will likely have eliminated hazardous waste landfilling by the time remedial actions would be implemented. Therefore, wastes that are amenable to treatment or incineration should be segregated from wastes for which no treatment alternative is known. Landfilling is not considered as an option for a site clean-up action, and therefore, is not retained for further evaluation.

3.10.2 Approved (Licensed) Off-Site Disposal Facility

Contaminated waste can be permanently disposed of at an approved (licensed) disposal facility. After volume reduction, treatment, and packaging the waste would be transported to an approved (licensed) off-site disposal facility in compliance with 40CFR, Subchapter C, Part 262 and NRC (10CFR71). No untreated wet, raw waste, or free liquids will be accepted at most approved (licensed) disposal facilities. Mixed and/or low-level radioactive waste will be accepted. If identified as mixed waste, it will be accepted only in a solidified form. An approved (licensed) off-site disposal facility is retained for further evaluation.

3.11 DISCHARGE

Discharge refers to the release of treated or untreated groundwater to either a surface water body via a permitted outfall, or to the subsurface environment via deep well injection. The options of discharge to the Great Miami River via an existing or new pipeline has been retained for further evaluation.

3.12 MECHANICAL REMOVAL

Soils and aboveground contaminants will be removed mechanically using heavy construction equipment. Contaminated soils will be removed from underneath buildings and from open field areas. Aboveground contaminants will be removed from open field areas and pad areas.

3.12.1 Heavy Construction Equipment

Techniques for remediating contaminated soils generally involve removal. During the removal of contaminated soils, it is important to minimize the threat of further environmental harm. Heavy construction equipment will be modified or altered for work in contaminated areas (i.e., appropriate equipment components such as shields, enclosures, etc. will be used). Depending on the extent, type, and location of contamination (i.e., under facilities, limited access, open areas, etc.), equipment such as backhoes, endloaders, mining equipment, and/or automated excavation equipment can be used. Heavy construction equipment will be retained for further evaluation.

In addition to the mechanical removal of contaminated soils throughout Operable Unit 3, other contaminated materials may also be removed. A variety of contaminated vehicles and miscellaneous waste must be addressed. For example, scrap metal piles composed of various ferrous metal types may need to be mechanically removed to avoid further contact and/or exposure.

The task of removing contaminated soils from underneath a building or other structure without compromising the structural integrity of such buildings/structures will require techniques such as those used in augmenting sinking foundations and underground mining operations.

Before such an activity would commence, a thorough study of the existing building/structure would have to be made to ascertain design capabilities versus the current situation. As with most structures, the structure's load-bearing capability may have been reduced because of differential settlement, rust/corrosion, concrete deterioration, and/or random failures caused by inadvertent modification of structural members that may have caused changes in design load paths. Also, the original structural design concept must be thoroughly understood prior to activity commencement.

This structural analysis would yield information relative to where grade beams and columns or other vertical supports could be emplaced (also their necessary strength and other design characteristics) to provide sufficient shoring of the above-grade structure to permit the removal of subgrade contaminated soils. This would be necessary to ensure that no extensive load displacements occur during the excavation. Such displacements could lead to partial or complete collapse of the above-grade structure.

A thorough analysis of the subsurface soils and water table will be performed in the near future. This will be required to determine the number and locations of beams/columns and their design. Such an analysis should also reveal whether or not piling would be required. If the strength of soils is sufficient to enable support of the building through simple columns (posts), there is no problem. However, if the bearing strength will not support the posts or shorings, then piling must be emplaced to a sufficient depth where the bearing strength/friction offsets the induced loads.

Once these analyses have been completed, all mechanical equipment in the building should be deactivated and a methodical plan for excavation would be implemented.

3.13 FACILITY REMOVAL

Facility removal addresses the demolition of selected contaminated facilities. The demolition of facilities will be continued until the facilities are taken down to their respective slabs, pads, footers, and/or piers. Once this is accomplished, the pads and contaminated soils would then be removed.

3.13.1 Demolition

Demolition techniques to be employed at the FMPC will be performed in compliance with DOE Order 5820.2A. Moreover, complete characterization of the facility and ways to ensure the safety of the personnel and the environment will be implemented. Certain intrinsic characteristics of FMPC facilities may require a few deviations from a standard demolition approach. Foremost is the relatively high-level contamination known to exist in specific areas of the facilities. Also, although most levels of contamination within and around the subject

buildings have been charted, there is always a possibility that random pockets of considerable contamination may exist in remote or hard to reach areas (e.g., under eaves, in far corners of lofts, on ledges, etc.). These possibilities dictate that the facilities be initially and periodically surveyed during demolition to ensure personnel safety and identify additional decontamination necessary for disposal.

Because demolition of old structures has a tendency to stir up dust and dirt, means must be employed to reduce such effects and the likelihood of creating a localized cloud of radioactive particulates that could migrate to and fallout on other areas of the FMPC, adjacent farms, and residential or other populated areas. Means to be employed would vary by case and could include spraying with water to settle and suppress the formation of dust or the use of temporary enclosures that could be placed over the entire facility if necessary.

In some FMPC facilities and tank farms, residual nitric acid and other acids may have collected in tankage and transfer lines to such an extent that it could pose a hazard to demolition crews if not approached cautiously. Finally, transite (asbestos) siding was used liberally in original construction of the facilities. Some of this siding is in bad repair, and has already been condemned, and must therefore be handled carefully during demolition and transportation. Disposal of these and other hazardous materials must be carefully considered along with radiation hazards.

Before the start of demolition activity, a thorough study or survey of the existing buildings will have to be made to ascertain original design capabilities versus their current state. As has happened in many old structures, the load bearing capability may have lessened because of differential settlement, rust and corrosion attacking main structural members, concrete deterioration, and inadvertent modification of members that may have since caused changes in design load paths. Random noncritical, localized failures of some structural elements may have already occurred that could become critical as other members are removed.

During the study, a structural failure analysis should be made to ascertain where in the structure chances are greatest for a serious failure as demolition progresses. Such an analysis may reveal the need to augment certain structures with temporary supports until the demolition process progressed to that particular area.

These analyses will yield information to help determine the sequence of structure takedown and is vital in avoiding a progressive collapse or serious failure during demolition.

Although there could be some concurrency, the actual demolition of the facility would occur in five steps. First, the associated utility and transfer lines, ducting, and cables would be disconnected. Second, all equipment within the facility would be disconnected and removed. Third, the roof and sidings would be removed. Fourth, the miscellaneous structural members would be cut and removed. And fifth, the main structural members would be cut and removed. As a facility removal process option, demolition will be retained for further evaluation.

3.14 WASTE SEGREGATION AND VOLUME REDUCTION

Waste segregation and volume reduction are parts of remedial action alternatives that involve treatment and/or disposal of the wastes. Reducing the volume of waste may reduce costs associated with containerization, transportation, and disposal. Volume reduction technologies have no effect upon the hazards associated with metals, organic compounds, or radioactive substances in the waste. Volume reduction technology process options include compaction and shredding. The technology process options for segregation include magnetic and manual sorting.

If some of the wastes stored in Operable Unit 3 could be reutilized (e.g., metal scrap), volume reduction would facilitate handling of the materials. Volume reduction could be used in conjunction with waste segregation technology process options as an intermediate step between removal of the wastes and their ultimate disposal or reutilization.

3.14.1 Sorting

A combination of magnetic sorting and manual sorting may be required to sort or segregate the waste material for better handling and disposal. Manual sorting involves the "hands-on" separation of the different physical types of waste material. As metals or other types of debris

different from the primary waste forms are encountered, they would be evaluated and removed by the safest method. Magnetic sorting would further identify areas of ferrous materials. The drum baling area, for example, which is being used as a temporary disposal area for abandoned vehicles and equipment, consists of large structures such as cranes, vehicles, construction materials, and unshredded metal. A waste segregation technology process option would be appropriate for this area for better handling and disposal. Sorting is retained as a waste segregation technology process option because of the aboveground contamination in Operable Unit 3. Further evaluation also will consider the viability of sorting by continuous and/or batch analysis.

3.14.2 Shredding

Shredding is another frequently used and widely available technology process option for reducing the volume of waste before disposal or reutilization. Shredding technology process options are generally applicable to the same types of wastes as compaction technology process options. Shredding is retained as a volume reduction technology process option.

3.14.3 Compaction

Compaction is a commonly used technology process option for reducing the volume of a wide variety of wastes. A compaction technology such as crushing could be applied to both contaminated and decontaminated wastes prior to disposal or reutilization. Compaction of the waste facilitates handling and optimizes the use of space in a disposal facility. Compacting equipment is readily available. The volume reduction technology process option described here could be implemented without major difficulties. The compactor/baler and mobile high force compactor used to compact process waste and trash might be utilized for compacting wastes in Operable Unit 3. Volume reduction technology process options may be cost-effective pretreatments for many of the wastes. Compaction is retained as a volume reduction technology process option.

3.15 METALS DECONTAMINATION

Prior to sorting, volume reduction, and packaging, it may be possible to decontaminate some of the low-level radioactive waste. Decontaminated metals may be of use at this or other DOE

facilities, possibly through reshaping metal materials through a high heat process. The resultant materials could be used for purposes such as shielding blocks. The decontamination processes currently available include liquid abrasive blasting, freon cleaning, electropolishing, physical and chemical separation, and pelletized carbon dioxide processes.

3.15.1 Liquid Abrasive Blasting

Liquid abrasive blasting, sometimes referred to as "liquid honing," is a cleaning technique used for particle removal. Radioactive decontamination using liquid abrasive blasting is performed in an enclosed booth. The user of the equipment designs the enclosed booth size to meet the space limitations and the size of items planned for decontamination. A sump at the bottom of the booth contains a water/abrasive mixture known as a slurry. This slurry, normally about 50 gallons, is continuously recirculated through a blasting nozzle that accelerates the slurry onto the surface being decontaminated. The nozzle can be held or mounted on a holder inside the booth. Liquid abrasive blasting will generate a contaminated water/abrasive slurry as an additional waste. This contaminated slurry will be treated along with other contaminated waste. Liquid abrasive blasting performs decontamination relatively fast, at a low cost per item, and with little damage to the items being decontaminated. It appears to be the most promising decontamination process in terms of cost effectiveness, operating technician exposure, and general volume of secondary waste. Liquid abrasive blasting is therefore retained for further evaluation.

3.15.2 Freon Cleaning

Freon cleaning is a decontamination process that reduces loose surface contamination on a multitude of materials. However, freon cleaning does not remove the surface layer of a contaminated item. Therefore, freon cleaning frequently cannot decontaminate to below unrestricted release limits. When compared with freon cleaning, liquid abrasive blasting for all equipment except electrical items is superior. The large range of control available to the operating technician of liquid abrasive blasting equipment allows complete scrubbing of other items without damage. Therefore, this technology process option will not be carried forward for further evaluation.

3.15.3 Electropolishing

Electropolishing is a process that removes fixed contamination from metallic objects. It is a slow process that requires highly skilled operating technicians. Part of the electropolishing set-up time involves precleaning removal of grease, paint, tape, and other surface materials that act as insulators to the electropolishing process. It also possesses inherent safety hazard potential, and creates a difficult secondary waste disposal problem. Therefore, this technology process option will not be carried forward for further evaluation.

3.15.4 Physical and Chemical Separation

Employing physical and chemical separation techniques, it may be possible to decontaminate soils to low radiation levels by separating the highly contaminated particles on the basis of particle sizes. While the coarse soil particle fractions might still contain radiation above acceptable levels, removal of radioactive contaminants from them might allow return of the soil to the place of origin or placement in a nonhazardous waste landfill. While applying further physical separation techniques would not lower the radiation levels, chemical separation technologies applied to the separated coarse particles might bring the treated soil radiation to acceptable levels. This technology will therefore be retained for further evaluation.

3.15.5 Pelletized Carbon Dioxide

A pelletized carbon dioxide (CO_2) cleaning system utilizes pelletized CO_2 fluidized in a compressed air stream as an abrasive or nonabrasive to remove surface coatings and contamination from materials. The degree of abrasion is controlled by varying the operating parameters (e.g., pressure and standoff distance). Liquid CO_2 is compressed into pellets, approximately the size of grains of rice, at -110°F that are fed by gravity into a compressed air stream. The mixture of air and solid CO_2 continuously flows through a nozzle at high velocity, and strikes on the article being cleaned. The collision between the pellets and the article causes the kinetic energy of the pellets to be rapidly converted to heat, which causes the CO_2 to pass from the solid to the vapor state and condense back to the solid form. The CO_2 decontamination technology has been successfully demonstrated for the removal of both fixed and smearable radioactive contamination. The pelletized CO_2 decontamination technology is viable, and therefore, will be retained for further evaluation.

3.16 STABILIZATION

The stabilization technology process options identified for consideration are surcharging, vitrification, in situ vitrification cement-based stabilization, and thermoplastic stabilization.

3.16.1 Surcharging

Surcharging typically induces compaction of soils by covering the area with a soil mound for a long period of time. After the compaction goal is achieved, the soil overburden may be removed and discarded or utilized for surcharging another area. This inexpensive and simple stabilization technique will achieve long-term soil/waste stability and adequate cap-bearing capacity (after the overburden is removed), but delays completion of the overall action due to the typically long completion time required. This technology process option is a viable stabilization method and is therefore retained for further evaluation.

3.16.2 Vitrification

Vitrification converts contaminated solids into a glass (amorphous) and a crystalline mineral matrix that has mechanical and chemical durability properties similar to granite. Vitrification, at melting temperatures between 1100°C and 1600°C, will destroy organics and fix metals into the nonleachable solidified melt. In vitrification, the waste mixture must have sufficient mineral content to form the glassy/crystalline matrix. If the waste is low in silica or alumina compounds, they may be added in the form of sand or soil.

The vitrification process requires a large and efficient vented off-gas collection system. In the event of vent system failure, the super-heated gases would be released to the environment and workers would be exposed to various radiochemical and chemical contaminants. While all precautions (backup systems) would be taken to prevent this, the risk must be noted. Moving the contaminated waste and placing it in trenches before vitrification will improve cost effectiveness and allow greater control over the process.

Glass melting equipment (both continuous and batch) can be used to vitrify wastes. Conventional equipment, including "cold cap" and "drop tube electro" melters, have been studied

for vitrifying radioactive waste. Batch (in can) melting of radioactive waste has also been studied. A stirred tank melter has been proposed, but not extensively studied. Gas-fired melters are not appropriate because of air pollutant emission control requirements.

The cold cap, drop tube, or stirred tank melters would be fed a mix of waste, sand, and fluxing agents and would produce a glass melt that would be "pulled" off. This melt could be cast as blocks or frit (the fused or partially fused materials used in making glass) and would probably resemble a bottle glass. This product could be entombed or buried as required for final disposal.

Vitrification of FMPC sludges, soils, and other solid wastes would significantly reduce the hazards associated with these materials. The radionuclides and metals would be fixed in a glass/crystalline matrix that has extremely high resistance to leaching and good mechanical integrity. The vitrified product would, in most situations, be stable for exceptionally long periods, exceeding the service life of other solidified waste forms.

Vitrification is an appropriate technology process option for many of the FMPC solid or semisolid waste materials. Vitrification forms a high strength leach-resistant solid that does not rely on a container, an engineered facility, or institutional control for long-term stability. This technology process option will be retained for further evaluation.

3.16.3 In Situ Vitrification

In the in situ vitrification process, electricity is applied to electrodes placed in the ground over the waste mass. The ground and waste mass heat and melt, and the melting zone grows downward. A hood to catch gases is placed over the zone, and the gases are treated or removed to prevent air pollution. There is difficulty in confirming that stabilization is achieved at depths and a lack of assurance that this technology process option would provide adequate long-term protection of public health and the environment. An additional problem can result from a vent system failure, in which case the super-heated gases would be released to the environment and workers would be exposed to various radiochemical and chemical contaminants. It is an unverified technology option, and to date, it has been unverifiable in field practice. However, this technology process option may be useful in conjunction with

technology process options such as capping and/or subsurface barriers in order to stabilize contaminated soils for containment. This is an emerging process and will be retained for further evaluation.

3.16.4 Cement-Based Stabilization

Cement-based stabilization is a form of stabilization prior to disposal. A slurry of excavated soil and water are mixed with portland cement to form a stable solid. This technology process option will be retained for further evaluation.

3.16.5 Thermoplastic Stabilization

Thermoplastic stabilization is a form of stabilization prior to disposal. Dried excavated soil is heated and dispensed through a heated plastic matrix of asphalt, bitumen, paraffin, or polyethylene to form a stable solid. This technology process option will be retained for further evaluation.

The technology process options retained for further evaluation for Operable Unit 3 are listed in Figure 3-3.

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Groundwater General Response Actions	Remedial Technology Types	Process Options	Description	Screening Comments
No Action	Fencing	None	Fence Security Control	Required for Consideration by National Oil and Hazardous Substances Contingency Plan (NCP)
	Monitoring	Groundwater Monitoring	Ongoing Monitoring of Wells	Required for Consideration by NCP
Containment	Subsurface Barriers	Slurry Wall	Subsurface Trench around Areas of Contamination Filled with a Soil or Cement Bentonite Slurry	Potentially Applicable
		Grout Curtain	Pressure Injection of Grout in a Regular Pattern of Drilled Holes	Not Applicable Because they are Specialty Options Seldom Applied to Hazardous Waste Sites
Treatment	Stabilization	In Situ Vitrification	In Situ conversion of Contaminated Solids into Glass and Crystalline Mineral Matrix	Not Applicable to Groundwater
		Vitrification	Process that converts Contaminated Solids into Glass and Crystalline Mineral Matrix	Not Applicable to Groundwater
		Surcharging	Process that Induces Compaction of Soils by Covering the Area with a Soil Mound	Not Applicable to Groundwater
		Cement-Based Stabilization	A Slurry of Excavated Soil and Water are mixed with Portland Cement to form a Stable Solid	Not Applicable to Groundwater
		Thermoplastic Stabilization	Dried Excavated Soil is Heated and Dispensed Through a Heated Plastic Matrix to Form a Stable Solid	Not Applicable to Groundwater

LEGEND:

= Technology Types or Process Options that were Screened Out.

602-A-3101-OU3/12-NLB-9/19/90

FIGURE 3-3.

OPERABLE UNIT 3 INITIAL SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Groundwater General Response Actions	Remedial Technology Types	Process Options	Description	Screening Comments
Collection / Treatment / Disposal	Groundwater Extraction	Horizontal Drain	Perforated Pipe in a Medium to Collect Contaminated Groundwater	Potentially Applicable
		Open Ditches	Open, Sloping Ditch Excavated to a Depth Lower than the Water Table	Not Applicable Because they Impede Surface Traffic and Represent a Long-term Hazard to Personnel
		Dedicated Well System	A Network of Independent Wells each with a Dedicated Pump Installed Within the Well	Potentially Applicable
		Wellpoint System	Small Diameter Rise Pipes Connected to a Common Header and Pumped by One or More Wellpoint Pumps	Potentially Applicable
		Jet-Eductor System	Wellpoint Screens Attached to Jet Eductors Installed at the end of Double Rise Pipes	Not Applicable Because of the Shallow, Perched Groundwater
		Vertical Sand Drains	Columns of Sand Placed in Cased Holes Allowing Water to be Drained	Potentially Applicable
		Electro-Osmosis	Wells or Wellpoints used in Conjunction with Electrical Current	Not Applicable to Silts, Clay-rich Silts, or Clay-rich Sands
	Groundwater Treatment	Ion Exchange	Chemical Process where Contaminated Water is Passed Through a Resin Bed where Ions are Exchanged	Potentially Applicable
		Flocculation	Physical Process to Help Remove Suspended Solids	Potentially Applicable
		Clarification	Density Separator Process that Involves the Separation of Suspeded Solids from a Liquid by Gravity	Potentially Applicable
		Centrifugation	Density Separation Process in which the Solid and Liquid Components of a Mixture are Separated by Gravitational Force	Potentially Applicable
		Filtration	Physical Process for Solids Removal	Potentially Applicable
		Flotation	A Density Separation Process for Removal of Finely Divided Suspended Solids	Potentially Applicable
		Evaporation	Process of Separating Wastewater from Salts and Solids by Vaporizing the Wastewater	Potentially Applicable
		Reverse Osmosis	Use of High Pressure to Force Water Through a Membrane Leaving Contaminants Behind	Potentially Applicable
		Denitrification	Microbial Wastewater Process by which Nitrates/ Nitrites are Reduced to Molecular Nitrogen	Potentially Applicable
		Adsorption	Physical/Chemical Process that Involves the Removal of Dissolved Solids by Adsorption into a Treatment Medium	Potentially Applicable
		Stripping	Mixing Large Volumes of Air with Water in a Packed Column to Promote Transfer of VOCs to Air	Potentially Applicable
		Ultraviolet Radiation/Oxidation	Process Using Ultraviolet Radiation to Destroy Toxic Organic Compounds	Potentially Applicable
	On-Site Waste Disposal	Permanent On-Site Disposal Facility	Permanent On-Site Disposal Facility	Potentially Applicable
	Off-Site Waste Disposal	Approved (Licensed) Disposal Facility	Permanent Off-Site Disposal Facility	Potentially Applicable
		Landfilling	Off-Site Disposal Option	Not Applicable Due to the Federal Land Ban Regulations
	Discharge	Discharge to Great Miami River	Extracted Water Discharged to Great Miami River	Potentially Applicable

LEGEND:

= Technology Types or Process Options that were Screened Out.

602-A-3102-OU3/12-ALB-9/19/90

FIGURE 3-3. (Continued)

OPERABLE UNIT 3 INITIAL SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Solid Waste General Response Actions	Remedial Technology Types	Process Options	Description	Screening Comments
No Action	Fencing	None	Security Control Fence	Required for Consideration by NCP
	Monitoring	Groundwater Monitoring	On-going Monitoring of Wells	Required for Consideration by NCP
Containment	Capping	Multilayer Cap	Three-Layer System Covering Contaminated Areas	Potentially Applicable
		Single-layer Cap	Single-layer Application over Contaminated Areas	Potentially Applicable
		Temporary Cap	Epoxy-based or Polyurethane Coating on Facility Floors	Not Applicable for Soil Containment
		Sump Repair/Replacement	Sealing and Prevention of Leakage from Sumps	Not Applicable for Soil Containment
	Storm Water Management	Diversion and Collection	Surface Water Control	Potentially Applicable
		Grading	Modification to Ground Surface Contours	Potentially Applicable
		Revegatation	Providing a Vegetative Cover	Potentially Applicable
Treatment	Stabilization	Surcharging	In Situ Soil Compaction	Potentially Applicable
		Vitrification	Conversion of Solids into a Glass and Crystalline Mineral Matrix	Not Applicable for In Situ Soil Containment
		Cement-Based Stabilization	Mixture of Soil, Water, and Cement to Promote Stability	Not Applicable for In Situ Soil Containment
		Thermoplastic Stabilization	Extruded Soil Through a Heated Plastic Matrix to Promote Stability	Not Applicable for In Situ Soil Containment
		In Situ Vitrification	In Situ Conversion of Solids into a Glass and Crystalline Mineral Matrix	Potentially Applicable

LEGEND:

= Technology Types or Process Options that were Screened Out.

602.A-3103-OU3/12-ALB-9/19/90

FIGURE 3-3. (Continued)

OPERABLE UNIT 3 INITIAL SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Solid Waste General Response Actions	Remedial Technology Types	Process Options	Description	Screening Comments
Excavation, Treatment, Disposal	Mechanical Removal of Soil	Heavy Construction Equipment	Heavy Construction Equipment (e.g., End Loader)	Potentially Applicable
	Facility Removal	Facility Demolition	In Compliance with DOE Order 5820.2A	Potentially Applicable
	Mechanical Removal of Aboveground Contaminants	Heavy Construction Equipment	Heavy Construction Equipment (e.g., End Loader)	Potentially Applicable
	Soil Treatment	Gravimetric Separation	Density Separation of Materials	Not Applicable for Contaminant Type
		Chemical Extraction	Chemical Treatment	Potentially Applicable
		Soil Washing	Treatment Through Leaching	Potentially Applicable
		Hydrocyclonic Separation	Treatment Through Cyclone Separation	Potentially Applicable
	Thermal Treatment	Multiple Hearth	Incineration of Contaminants	Potentially Applicable
		Circulating Bed Combustion	Fluidized Bed Incineration	Potentially Applicable
		Plasma Arc	Plasma Torch Incineration	Potentially Applicable
	Metals Decontamination	Liquid Abrasive Blasting	Particle Removal Through Liquid Blasting	Potentially Applicable
		Physical & Chemical Separation	Separation by Particle Size	Potentially Applicable
		Pelletized Carbon Dioxide	Abrasive Particle Removal	Potentially Applicable
		Freon Cleaning	Reduces Loose Surface Contamination	Not Applicable for Action Limit
		Electropolishing	Removes Fixed Contamination	Not Applicable due to Safety Hazards
	Stabilization	Surcharging	In Situ Soil Compaction	Not Applicable for Excavated Soils
		Vitrification	Conversion of Solids into Glass	Potentially Applicable
		In Situ Vitrification	In Situ Conversions of Solids into Glass	Not Applicable for Excavated Soils
		Cement-Based Stabilization	Soil, Water, and Cement Mixture	Potentially Applicable
		Thermoplastic Stabilization	Heated Plastic and Soil Matrix	Potentially Applicable
	Waste Segregation and Volume Reduction	Sorting	Magnetic and Manual Sorting	Potentially Applicable
		Compaction	Volume Reduction	Potentially Applicable
		Shredding	Volume Reduction	Potentially Applicable
	Packaging & Transportation	Limited Quantities	Smallest Quantity of Radioactive Material Packaging	Not Applicable: Too Restrictive
		Type A	Radioactive Material Packaging	Not Applicable: Too Restrictive
		Type B	Radioactive Material Packaging	Potentially Applicable
		Low Specific Activity Material	Nonspecific Radioactive Material Packaging	Potentially Applicable
		Rail Transportation	Off-Site Transportation	Potentially Applicable
		Truck Transportation	On-Site and Off-Site Transportation	Potentially Applicable
	On-Site Waste Disposal	Permanent On-Site Disposal Facility	Permanent Site-wide Disposal Facility	Potentially Applicable
	Off-Site Waste Disposal	Approved (Licensed) Disposal Facility	Permanent Off-Site Disposal Facility	Potentially Applicable
		Landfilling	Off-Site Disposal Facility	Not Applicable Due to the Federal Land Ban Regulations

LEGEND:

= Technology Types or Process Options that were Screened Out.

602.A-3104-OU3/12-ALB-9/19/90

FIGURE 3-3. (Continued)

OPERABLE UNIT 3 INITIAL SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Solid Waste General Response Actions	Remedial Technology Types	Process Options	Description	Screening Comments
Near Term: Containment; Far Term: Excavation; Treatment; Disposal	Capping	Multilayer Cap	Three-Layer System Covering Contaminated Areas	Not Applicable For Temporary Cap
		Single-layer Cap	Single-Layer Application over Contaminated Areas	Potentially Applicable
		Temporary Cap	Epoxy-Based or Polyurethane Coating on Facility Floors	Potentially Applicable
		Sump Repair/Replacement	Sealing & Prevention of Leakage from Sumps	Potentially Applicable
	Storm Water Management	Diversion and Collection	Surface Water Control	Potentially Applicable
		Grading	Modification to Surface Ground Contours	Potentially Applicable
		Revegetation	Providing a Vegetative Cover	Not Applicable for Temporary Cap
	Mechanical Removal of Soil	Heavy Construction Equipment	Heavy Construction Equipment (e.g., End Loader)	Potentially Applicable
	Facility Removal	Facility Demolition	In Compliance with DOE Order 5820.2A	Not Applicable for Soils
	Mechanical Removal of Aboveground Contaminants	Heavy Construction Equipment	Heavy Construction Equipment (e.g., End Loader)	Not Applicable for Soils
	Soil Treatment	Gravimetric Separation	Density Separation of Materials	Not Applicable for Contaminant Type
		Chemical Extraction	Chemical Treatment	Potentially Applicable
		Soil Washing	Treatment Through Leaching	Potentially Applicable
		Hydrocyclonic Separation	Treatment Through Cyclone Separation	Potentially Applicable
	Thermal Treatment	Multiple Hearth	Incineration of Contaminants	Potentially Applicable
		Circulating Bed Combustion	Fluidized Bed Incineration	Potentially Applicable
		Plasma Arc	Plasma Torch Incineration	Potentially Applicable
	Metals Decontamination	Liquid Abrasive Blasting	Particle Removal Through Liquid Blasting	Not Applicable to Soils
		Physical & Chemical Separation	Separation by Particle Size	Not Applicable to Soils
		Pelletized Carbon Dioxide	Abrasive Particle Removal	Not Applicable to Soils
		Freon Cleaning	Reduces Loose Surface Contamination	Not Applicable to Soils
		Electropolishing	Removes Fixed Contamination	Not Applicable to Soils
	Stabilization	Surcharging	In Situ Soil Compaction	Potentially Applicable
		Vitrification	Conversion of Solids into Glass	Potentially Applicable
		In Situ Vitrification	In Situ Conversions of Solids into Glass	Not Applicable for Excavated Soils
		Cement-Based Stabilization	Soil, Water, and Cement Mixture	Potentially Applicable
		Thermoplastic Stabilization	Heated Plastic and Soil Matrix	Potentially Applicable
	Waste Segregation and Volume Reduction	Sorting	Magnetic and Manual Sorting	Potentially Applicable
		Compaction	Volume Reduction	Potentially Applicable
		Shredding	Volume Reduction	Potentially Applicable

(See next page)

LEGEND:

= Technology Types or Process Options that were Screened Out.

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FIGURE 3-3. (Continued)

OPERABLE UNIT 3 INITIAL SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Solid Waste General Response Actions	Remedial Technology Types	Process Options	Description	Screening Comments
(See Preceeding Page)				
Near Term: Containment				
Far Term: Excavation				
Treatment				
Disposal	Packaging & Transportation	Limited Quantities	Smallest Quantity of Radioactive Material Packaging	Not Applicable: Too Restrictive
		Type A	Radioactive Material Packaging	Not Applicable: Too Restrictive
		Type B	Radioactive Material Packaging	Potentially Applicable
		Low Specific Activity Material	Nonspecific Radioactive Material Packaging	Potentially Applicable
		Rail Transportation	Off-Site Transportation	Potentially Applicable
		Truck Transportation	On-Site and Off-Site Transportation	Potentially Applicable
	On-Site Waste Disposal	Permanent On-Site Disposal Facility	Permanent Site-wide Disposal Facility	Potentially Applicable
	Off-Site Waste Disposal	Approved (Licensed) Disposal Facility	Permanent Off-Site Disposal Facility	Potentially Applicable
		Landfilling	Off-Site Disposal Facility	Not Applicable Due to the Federal Land Ban Regulations

LEGEND:

= Technology Types or Process Options that were Screened Out.

602.A.3105A-OU3/12-ALB-9/19/90

FIGURE 3-3. (Concluded)

OPERABLE UNIT 3 INITIAL SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

4.0

4.0 DESCRIPTION OF ALTERNATIVES

"In assembling alternatives, general response actions and the process options chosen to represent the various technology types for each medium or operable unit are combined to form alternatives for the site as a whole" (EPA 1988a). The CERCLA guidance defines technology types as "general categories or technologies, such as chemical treatment, thermal treatment, [or] capping. The term 'technology process options' refers to specific processes within each technology type."

By CERCLA guidance, alternatives should be assembled with process options rather than technology types. But in Operable Unit 3, the RI site characterization is still in progress, consistent with Consent Agreement dates. Because the site has not been fully characterized, particularly relative to nonradiological contamination (e.g., types, quantities, and levels of contamination), process options have to be retained to address additional radiological and chemical contamination. The possible screening of the process options prior to the full characterization of the site could significantly restrict the development of appropriate remedial action alternatives.

To this end, the alternatives for Operable Unit 3 were assembled with technology types rather than process options. Another factor involved in the selection of this approach was the diversity and magnitude of the contamination types (e.g., aboveground contaminants, facility demolition, process lines, etc.) within Operable Unit 3.

4.1 ASSEMBLY OF ALTERNATIVES

Operable Unit 3 was separated into two categories of media: solid waste and perched groundwater. These media were separated to assist in the complete remediation of the groundwater. Four perched groundwater alternatives were developed. These alternatives consist of one containment and three collection alternatives. Collection is defined as groundwater extraction.

Analysis of the solid waste media highlighted three separate categories: soils, metals, and facilities. Due to the diversity of these three categories, specific alternatives were developed for

each, resulting in nine alternatives consisting of one containment, six excavation, and two near-term containment/far-term excavation alternatives. The containment alternative is a capping option. Among the six excavation alternatives, two are designed to address aboveground contaminants only. The soils underneath the aboveground wastes appear to have minimal contamination; therefore, capping of these soils after the removal of the aboveground waste appears feasible. The next two excavation alternatives address all soils and aboveground contaminants with removal, treatment, and disposal. This includes the excavation of soils from underneath facilities. The final two excavation alternatives are designed for selected facility removal over areas of contaminated soils. The two interim alternatives are designed to address contamination underneath facilities and have a two-phased approach: The first phase is a temporary action to contain the contamination until the facilities are decontaminated, decommissioned, and dismantled; In the second phase, the soils would be excavated, treated, and disposed, after the facilities have been removed.

Finally, the last alternative, No Action, is required by the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) and results in a total of 14 alternatives being developed for Operable Unit 3. These 14 alternatives are (See Figure 4-1):

- Alternative 1 - No Action
- Alternative 2 - Cap
- Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap
- Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap
- Alternative 5 - Mechanical Removal and On-Site Disposal
- Alternative 6 - Mechanical Removal and Off-Site Disposal
- Alternative 7 - Near Term: Temporary Cap; Far Term: Mechanical Removal and On-Site Disposal
- Alternative 8 - Near Term: Temporary Cap; Far Term: Mechanical Removal and Off-Site Disposal
- Alternative 9 - Groundwater Extraction, Treatment, and Discharge

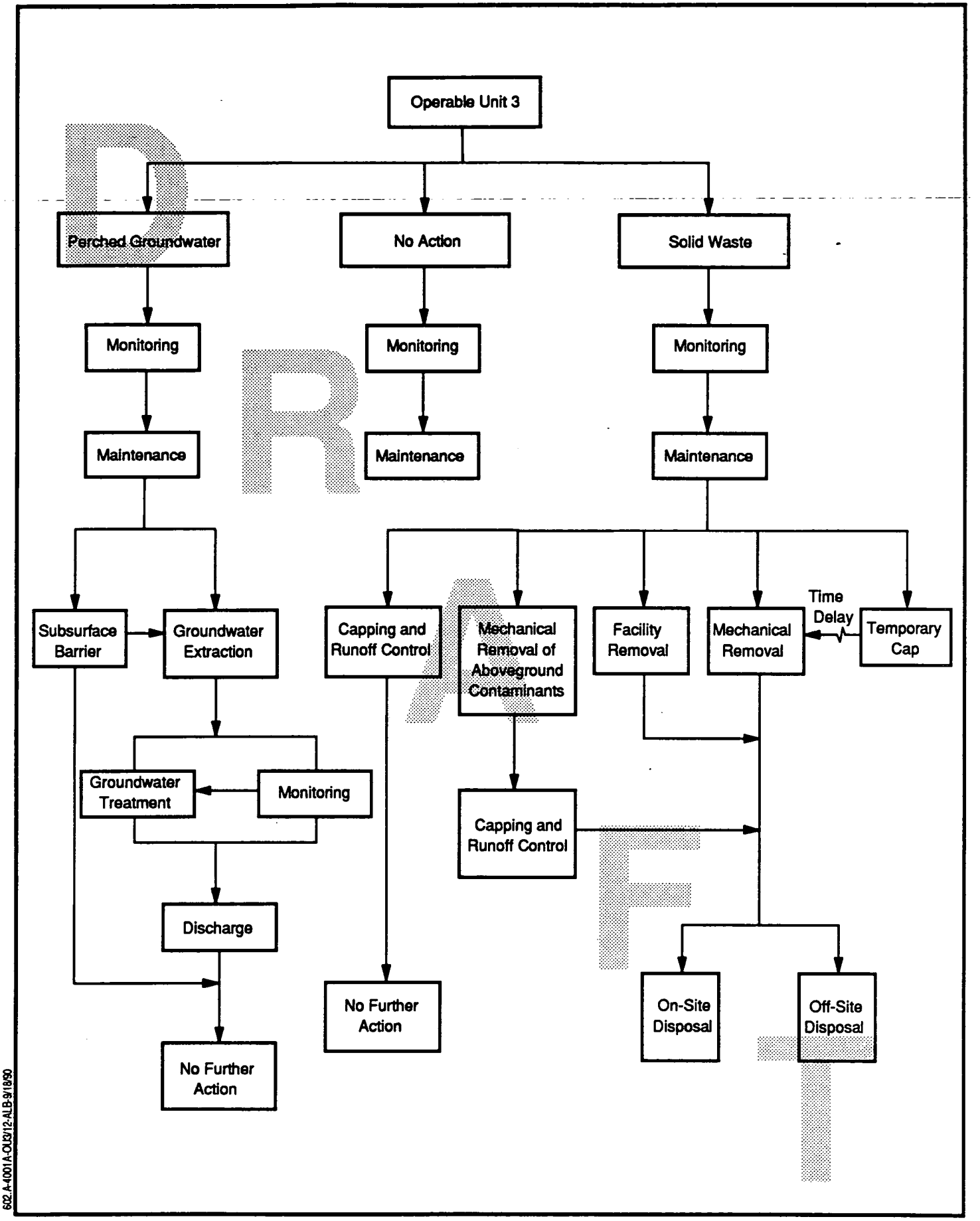

FIGURE 4-1. OPERABLE UNIT 3 REMEDIAL ACTION ALTERNATIVES

- Alternative 10 - Groundwater Extraction, Monitoring, Treatment, and Discharge
- Alternative 11 - Subsurface Barrier
- Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge
- Alternative 13 - Facility Removal and On-Site Disposal
- Alternative 14 - Facility Removal and Off-Site Disposal

In this list of alternatives there is a slight difference between Alternatives 9 and 10. In Alternative 9, all perched groundwater extracted is sent to a treatment facility for treatment to the allowable uranium criteria (20 pCi/l). In Alternative 10, a monitoring system will regulate the water flow. Perched groundwater with uranium contamination above the ARARs-dictated criteria will go to the treatment facility. Water with uranium contamination below the ARARs-dictated criteria will bypass the treatment facility en route to the Great Miami River for discharge. Extraction time will vary, depending on several factors: Interconnection of perched zones, recharge rates, total reservoir area, and permeability must be known to estimate extraction duration. This issue is undergoing further evaluation in the RI to establish this time frame. An order of magnitude extraction time of 10 years will be assumed for these alternatives for cost estimating purposes. The discharge of all water from Manhole 175 to the Great Miami River will be regulated to prevent the level of contamination in the river (including contamination already present) from exceeding the ARARs-dictated criteria. In both Alternatives 9 and 10, some processes for the treatment of Hazardous Substance List/volatile organic compounds contaminants may be needed (if such contaminants are identified), as well as a mechanism for monitoring Hazardous Substance List/volatile organic compounds concentration levels in Alternative 10.

All alternatives that involve on-site or off-site disposal would also include volume reduction and packaging if necessary. Alternatives that involve mechanical removal would also include scrap metal decontamination/salvage, as appropriate. When contaminated soils are removed, soil treatment will also be performed. This will decrease the quantities and/or toxicity of waste for transportation and disposal. The final processes used for the soil treatment will be analyzed and selected in the detailed analysis of alternatives. In situ treatment processes also will be

evaluated at that time. In addition, all alternatives will require monitoring and maintenance, both during construction of the remedial action and after the remedial action is in place. Alternatives 1, 9, 10, and 12 will include groundwater monitoring. Alternatives 2 through 8 and Alternative 11 will also include groundwater monitoring, unless they are used in conjunction with Alternatives 1, 9, 10, or 12. Table 4-1 shows the technology process options applicable to each alternative. In addition, Table 4-2 shows the connections between media, remedial action objectives, general response actions, remedial technology types, and process options.

The Initial Screening of Alternatives (described in Chapter 6.0) was conducted based on the above list of alternatives.

4.2 DEFINITION OF ALTERNATIVES

4.2.1 Alternative 1 - No Action

The No Action Alternative, as required by the National Oil and Hazardous Substance Pollution Contingency Plan (NCP 1990), is carried forward throughout this document. This alternative includes monitoring and security controls that presently exist, but no source control measures will be implemented. The No Action Alternative is used as a baseline to compare other remedial alternatives developed for Operable Unit 3.

4.2.2 Alternative 2 - Cap

This containment alternative represents a minimum action scenario that is intended to isolate the wastes and to minimize the vertical infiltration of rainfall into and through the solid wastes to the underlying soils and perched groundwater. This alternative consists of capping and storm water management.

The waste areas to be capped will be contour-graded with clean, compacted fill to provide drainage prior to cap placement. In many cases, this work will occur around buildings, which will require coordination with the cap as discussed in Chapter 3.0. All cap elements and layers

TABLE 4-1

OPERABLE UNIT 3 REMEDIAL ACTION ALTERNATIVES AND TECHNOLOGY TYPES

Technology Types	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Monitoring	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Maintenance	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Subsurface Barrier											●	●		
Cap		●	●	●			●	●						
Storm Water Management		●	●	●			●	●	●	●		●		
Groundwater Extraction									●	●		●		
Mechanical Removal			●	●	●	●	●	●					●	●
Facility Removal													●	●
Groundwater Treatment									●	●		●		
Soil Treatment					●	●	●	●					●	●
Thermal Treatment			●	●	●	●	●	●					●	●
Metals Decontamination			●	●	●	●							●	●
Stabilization		●	●	●	●	●	●	●					●	●
Waste Segregation and Volume Reduction			●	●	●	●	●	●					●	●
Transportation and Packaging			●	●	●	●	●	●					●	●
On-Site Waste Disposal			●		●		●						●	
Off-Site Waste Disposal				●		●		●						●
Discharge									●	●		●		

Alternative 1 - No Action

Alternative 2 - Cap

Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap

Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap

Alternative 5 - Mechanical Removal and On-Site Disposal

Alternative 6 - Mechanical Removal and Off-Site Disposal

Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal

Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal

Alternative 9 - Groundwater Extraction, Treatment, and Discharge

Alternative 10- Groundwater Extraction, Monitoring, Treatment, and Discharge

Alternative 11 - Subsurface Barrier

Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge

Alternative 13 - Facility Removal and On-Site Disposal

Alternative 14 - Facility Removal and Off-Site Disposal

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TABLE 4-2

OPERABLE UNIT 3 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS

Media	Remedial Action Objectives	General Response Actions	Remedial Technology Types	Process Options
Perched Groundwater	• Prevent releases of radionuclides to the groundwater exceeding total uranium levels of 20 pCi/l (approximately 30 mg/l). • Prevent releases of inorganic and organic chemicals in excess of concentrations shown in Tables 2-3 and 2-4.	<u>No Action</u> No action Monitoring Site access restrictions <u>Containment/Treatment</u> Containment <u>Collection/Treatment/Disposal</u> Collection/Treatment/Disposal Collection/Monitoring/Treatment/Disposal Containment/Collection/Treatment/Disposal	<u>No Action</u> Fencing <u>Containment</u> Subsurface barrier <u>Collection</u> Groundwater extraction Storm water management <u>Treatment</u> Groundwater treatment (physical/chemical)	None Slurry Wall Horizontal drains, dedicated well systems, wellpoint systems, and/or vertical sand drains Diversion and collection Ion exchange, flocculation, clarification, centrifugation, filtration, flotation, evaporation, reverse osmosis, denitrification, adsorption, stripping, and/or UV oxidation

TABLE 4-2
(Continued)

Media	Remedial Action Objectives	General Response Actions	Remedial Technology Types	Process Options
Perched Groundwater (concluded)			Disposal On-site disposal	Permanent on-site disposal facility
			Off-site disposal	Approved (licensed) disposal facility
			Discharge	Discharge via Manhole 175 to Great Miami River

TABLE 4-2
(Continued)

Media	Remedial Action Objectives	General Response Actions	Remedial Technology Types	Process Options
Solid Waste • Soils • Metals • Facilities	• Prevent current and future radiation emissions from causing detectable chronic effects. • Prevent current and future above-background airborne radiation doses from exceeding 2.5 mrem, and radon concentrations from exceeding risk levels of $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk. • Prevent current and future airborne chemical concentrations from exceeding $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk and/or a hazard index of 0.25. • Prevent direct contact with soils or wastes containing uranium at levels greater than 35 pCi/gm (approximately 50 ppm).	<u>No Action</u> No action Monitoring Site access restrictions <u>Containment/Treatment</u> Containment • Soils • Metals <u>Excavation/Treatment/Disposal</u> Removal/Treatment/Disposal • Soils • Metals • Facilities Removal/Treatment/Disposal/Containment • Metals Facility Removal/Excavation/Treatment/Disposal • Facilities <u>Near-Term Containment, Far-Term Excavation/Treatment/Disposal</u> Containment/Removal/Treatment/Disposal • Soils	<u>No Action</u> Fencing <u>Containment</u> Capping Storm water management <u>Removal</u> Mechanical removal of soils and/or aboveground contaminants Facility removal	None Multilayer cap, single-layer cap, temporary cap, and/or sump repair/replacement Diversion and collection, grading, and/or revegetation Solid excavation by backhoes, end loaders, mining equipment, and/or other heavy construction equipment Facility demolition

TABLE 4-2
(Concluded)

Media	Remedial Action Objectives	General Response Actions	Remedial Technology Types	Process Options
Solid Waste (Concluded)	• Prevent erosion of soil that would contribute to inorganic and organic chemical surface water concentrations exceeding risk levels of 2.5×10^{-5} to 2.5×10^{-7} cancer risk and/or a hazard index of 0.25.		Treatment Soil treatment	Chemical extraction, soil washing, and/or hydrocyclonic separation
			Thermal treatment	Multiple hearth, circulating bed combustion, and/or plasma arc
	• Prevent erosion of soils that would contribute to surface water concentrations of chemicals in Operable Unit 3 from reaching concentrations in excess of 25 percent of those reported in Tables 2-3 and 2-4.		Metals decontamination	Liquid abrasive blasting, physical and chemical separation, and/or pelletized carbon dioxide
			Stabilization	Surcharging, vitrification, in situ vitrification, cement-based stabilization, and/or thermoplastic stabilization
	• Prevent circumstances that may cause leaching of contaminants to groundwater.		Waste segregation and volume reduction	Sorting, compaction, and/or shredding
			Transportation and packaging	Low specific activity, type B, and rail and truck
	• Prevent current and future radiation doses migrating from soils or wastes from exceeding 25 mrem/year.		On-site waste disposal	Permanent on-site disposal facility
			Off-site waste disposal	Approved (licensed)

will be contoured to grades that promote drainage while minimizing the effects of waste subsidence and storm water erosion. Runoff control features will safely remove storm water from the waste area while run-on control features will direct storm water away from the closed area.

In addition to capping soils, this alternative will be considered for capping the aboveground contaminants. The aboveground waste would be graded and stabilized before cap emplacement.

Runoff/run-on control will be accomplished using one or more of the following: site contour grading, vegetation, diversion ditches, collection ditches, weirs, baffles, or lined sedimentation basins.

4.2.3 Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap

This alternative was designed to address only aboveground contaminants such as the metal scrap piles. The intent of this alternative is to offer the full spectrum of options for the remediation of the aboveground waste.

This alternative will remediate the soil through capping, single-layer or multilayer, once the aboveground waste is removed, which will be achieved through the use of heavy construction equipment.

After removal of the aboveground waste, the metals will be decontaminated for salvage. The process used for the decontamination will be liquid abrasive blasting, physical and chemical separation, or pelletized carbon dioxide. These process options will be evaluated further during the detailed analysis of alternatives.

The remaining packaged low-level radioactive waste that cannot be salvaged will be stored in a permanent on-site disposal facility. This facility will have a very long life due to its conservative design criteria and the stability of its location. This facility is expected to remain intact for several hundred years and prevent migration of hazardous constituents to the accessible environment.

After disposal of the aboveground contaminants, the remaining soil will be capped to minimize the vertical infiltration of water into the contaminated soils. In situ vitrification will be evaluated during the detailed analysis of alternatives for possible application to soils treatment.

4.2.4 Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap

As detailed above, this alternative was designed to address only aboveground contaminants such as metal scrap piles. After removal by heavy construction equipment, the aboveground waste will be decontaminated for salvage by liquid abrasive blasting, physical and chemical separation, or pelletized carbon dioxide. These process options will be evaluated further during the detailed analysis of alternatives.

The remaining low-level radioactive waste that cannot be salvaged will be transported and disposed at an approved off-site location. After volume reduction and packaging, the FMPC waste will be transported to a federally approved (licensed) off-site disposal facility in compliance with 40CFR, Subchapter C, Part 262 and NRC (10CFR71). A temporary storage structure will be required at the FMPC in support of the effort. The transport technology. process options selected for further consideration include transport by rail, truck, or rail with a truck transfer station at the disposal site. Any special conditions the disposal facility imposes (e.g., no free liquids, no respirable particulate fines) will be satisfied before shipping.

After disposal of the aboveground contaminants, the remaining soil will be capped with either a single-layer or multilayer cap to minimize the vertical infiltration of water into the contaminated soils. In situ vitrification will be evaluated during the detailed analysis of alternatives for possible application to soils treatment.

4.2.5 Alternative 5 - Mechanical Removal and On-Site Disposal

This alternative is designed for three situations: the removal of surface soils, the removal of aboveground contaminants and surface soils, and the removal of surface soils underneath a facility. For soils underneath a facility, excavation will be performed in a fashion similar to mining operations as detailed in section 3.9.1.1. The aboveground contaminants will be removed by heavy construction equipment and decontaminated for salvage by liquid abrasive blasting, physical and chemical separation, or pelletized carbon dioxide. Contaminated soils in

accessible areas will be removed by heavy construction equipment and treated. The treatment options carried forward for further evaluation are soil washing, chemical extraction, and hydrocyclonic separation. After packaging, the remaining wastes that cannot be treated or salvaged will be sent to a permanent on-site disposal facility. If packaging is not necessary, the waste will be disposed of in bulk within the on-site disposal facility.

4.2.6 Alternative 6 - Mechanical Removal and Off-Site Disposal

As with Alternative 5, this alternative is designed for three situations: the removal of surface soils, the removal of aboveground contaminants and surface soils, and the removal of surface soils underneath a facility. For soils underneath a facility, excavation will be performed in a fashion similar to mining operations and is detailed in section 3.9.1.1. The aboveground contaminants will be removed by heavy construction equipment and decontaminated for salvage by liquid abrasive blasting, physical and chemical separation, or pelletized carbon dioxide. Contaminated soils in accessible areas will be removed by heavy construction equipment and treated. The treatment options carried forward for further evaluation are soil washing, chemical extraction, and hydrocyclonic separation. The remaining wastes that cannot be treated or salvaged will be disposed at an approved (licensed) disposal facility off site. After volume reduction and packaging, the waste will be transported to an approved (licensed) off-site disposal facility in compliance with 40CFR, Subchapter C, Part 262 and NRC (10CFR71). A temporary storage structure will be required at the FMPC in support of the effort. The transport technology options selected for further consideration include transport by rail, truck, or rail with a truck transfer station at the disposal site. Any special conditions the disposal facility imposes (e.g., no free liquids, no respirable particulate fines) will be satisfied prior to shipping.

4.2.7 Alternative 7 - Near Term: Temporary Cap; Far Term: Mechanical Removal and On-Site Disposal

This alternative consists of a near-term action (temporary cap), followed by a far-term excavation process after decontamination, decommissioning, and dismantling of the facilities. It was designed to address contaminated soils under facilities while allowing continued operation of the particular facility. Because the facility itself restricts access to the contaminated soil until it is removed, this alternative is divided into two parts: near term and far term.

In the near term, the facility floors will be covered with a temporary cap to prevent further migration of contaminants into the soils under the facilities. A temporary cap is an epoxy-based or polyurethane coating applied to the floors of the facility. In situations where contamination from the facility has migrated to the open area surrounding the building, the open area will be remediated in conjunction with the facility. These areas will be addressed in this fashion because these soils are part of the facility foundation. To prevent contact with these soils prior to final remediation, a single-layer cap will be applied over the surficial contamination. The cap will consist of a concrete and/or bituminous asphalt layer and will be removed with the soils after the facilities are removed.

In the far term, this alternative is based on the assumption that the facilities overlying contaminated soils will eventually be decommissioned, decontaminated, and dismantled. Once the facilities have been removed, the soils will be excavated by heavy construction equipment and the soils will be treated by soil washing, chemical extraction, or hydrocyclonic separation. The remaining waste will be packaged, if necessary, and disposed in a permanent on-site disposal facility. There is no firm date set for decommissioning of the FMPC.

4.2.8 Alternative 8 - Near Term: Temporary Cap; Far Term: Mechanical Removal and Off-Site Disposal

This alternative, designed in two sections, will temporarily cap the facility floors and the surrounding areas as necessary and then the soils will be excavated after facility removal. The temporary cap will be an epoxy-based or polyurethane coating for the facility floors and a concrete and/or bituminous asphalt layer for the soils around the facility.

In the far term, this alternative is based upon the assumption that the facilities overlying contaminated soils will eventually be decommissioned, decontaminated, and dismantled. Once the facilities have been removed, the soils will be excavated by heavy construction equipment and the soils will be treated by soil washing, chemical extraction, or hydrocyclonic separation. The remaining waste will be disposed at an approved (licensed) off-site disposal facility in compliance with 40CFR, Subchapter C, Part 262 and NRC (10CFR71). After volume reduction and packaging, the waste will be transported to the disposal facility. A temporary storage structure will be required at the FMPC in support of this effort. The transport technology options selected for further consideration include transport by rail, truck, or rail with a truck

transfer station at the disposal site. Any special conditions imposed by the disposal facility (e.g., no free liquids, no respirable particulate fines) will be satisfied prior to shipping. There is no firm date set for decommissioning of the FMPC.

4.2.9 Alternative 9 - Groundwater Extraction, Treatment, and Discharge

The groundwater for the Production Area is addressed in sections, but the entire area will be remediated as a unit. Groundwater extraction will be accomplished by horizontal drains, dedicated well systems, well point systems, and/or vertical sand drains. It is assumed that extraction will continue for a minimum of 10 years with continuous monitoring to establish the date of completion. Once collected, the water will be routed to a treatment facility and discharged into the Great Miami River after treatment. The exact process flow used in the treatment facility will be evaluated in the detailed analysis of alternatives. The residue from the treatment facility will be disposed on or off site.

4.2.10 Alternative 10 - Groundwater Extraction, Monitoring, Treatment, and Discharge

The types of groundwater extraction systems used for this alternative will be evaluated in the detailed analysis of alternatives. In addition to the groundwater extraction system, a continuous monitoring system will regulate the water flow after extraction. Perched groundwater with uranium contamination above the allowable uranium concentration levels (20 pCi/l, see Section 2.1) will be routed to the treatment facility. Water with uranium contamination below this criteria will be sent directly to the Great Miami River for discharge.

If additional data on the perched groundwater contamination identifies contamination other than radiological, then the monitoring system will be modified to ensure that no contamination above allowable limits is released to the Great Miami River. The monitoring system will be evaluated in the detailed analysis of alternatives.

4.2.11 Alternative 11 - Subsurface Barrier

This alternative proposes to place a subsurface barrier around the lower half of the Production Area. The barrier would be 6000 feet in length and would encompass the east, south, and west

sides of the FMPC. With this alternative, the water would be contained within the Production Area, but would not be removed or treated. The barrier would minimize horizontal migration of the contamination out of the Production Area.

4.2.12 Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge

This alternative is a combination of both Alternatives 9 and 11. A subsurface barrier would be placed around the lower half of the Production Area and the groundwater would be extracted via a dedicated well system, wellpoint system, horizontal drains, or vertical sand drains. All water would be transported to a treatment facility prior to discharge to the Great Miami River. The exact process flow used in the treatment facility will be evaluated in the detailed analysis of alternatives. The residue from the treatment facility will be disposed on or off site.

4.2.13 Alternative 13 - Facility Removal and On-Site Disposal

This alternative proposes to remove specific designated facilities at the FMPC that cover contaminated soils. The demolition of the facilities, in accordance with DOE Order 5820.2A, will occur in a phased process:

- Disconnect utilities and associated lines, ducting, etc.
- Remove machinery and equipment.
- Remove roof and siding.
- Remove miscellaneous structural members.
- Remove main structural members.

Once the facility has been removed, the concrete pad and contaminated soils will be excavated. Salvageable materials will be decontaminated by liquid abrasive blasting, physical and chemical separation, or pelletized carbon dioxide, and then processed through salvage companies for recycling. The excavated soils will be treated by soil washing, chemical extraction, or hydrocyclonic separation. Any unsalvageable materials, including concrete and contaminated soils, will be packaged and disposed at a permanent on-site disposal facility.

4.2.14 Alternative 14 - Facility Removal and Off-Site Disposal

This alternative proposes to remove specific designated facilities at the FMPC that cover contaminated soils. This demolition will be in accordance with DOE Order 5820.2A. Once the facilities are removed, heavy construction equipment will excavate the remaining materials.

Salvageable materials will be decontaminated by liquid abrasive blasting, physical and chemical separation, or pelletized carbon dioxide. Soils will be treated by soil washing, chemical extraction, or hydrocyclonic separation. The remaining waste will be disposed at an approved (licensed) off-site disposal facility in compliance with 40CFR, Subchapter C, Part 262 and NRC (10CFR71). A temporary storage structure will be required at the FMPC in support of transportation to the disposal facility. Any special conditions imposed by the disposal facility (e.g., no free liquids, no respirable particulate fines) will be satisfied prior to shipping.

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5.0

5.0 ALTERNATIVE SCREENING METHODOLOGY

In the previous chapter, 14 alternatives were developed from the technology types remaining from the initial technology screening. Next, these alternatives will be subjected to a screening based on three criteria: effectiveness, implementability, and cost. The major focus of this evaluation is the effectiveness and implementability of each option, with less emphasis on cost.

Specifically, the following information was developed, or is currently being developed, for the various technologies used in the alternatives, and will be considered as part of the initial screening process in Chapter 6.0:

- Areas, types, and levels of contamination
- Size and configuration of on-site extraction and containment systems
- Flow rates for groundwater extraction systems
- Special requirements for constructing treatment or containment systems
- Distances for disposal technologies

The current status of this information development step is as follows: 1) Chapter 6.0 includes a listing of the various contaminated areas within each suboperable unit (Table 6-1). Chapter 6.0 also provides details about uranium contamination levels and depths, as well as maps showing approximate configurations and locations of radiological contamination. Little progress has yet been made in determining the magnitude of chemical contamination present; 2) size and configuration of the on-site extraction and containment systems are currently being developed; 3) flow rates for groundwater extraction systems have been determined; 4) special requirements for constructing treatment or containment systems are currently being developed; and 5) although an approved (licensed) disposal facility has not been located for receipt of the radiologically contaminated waste, transportation distances to a generic western site in Nevada have been computed.

5.1 ALTERNATIVE EVALUATION PROCESS

5.1.1 Effectiveness Evaluation

Each alternative was evaluated for effectiveness in protecting human health and the environment in both the short term and the long term. Short-term effectiveness is a measure of the technical effectiveness of the alternative to protect human health and the environment over the short term. The short-term effectiveness assessment will consider the effectiveness of each alternative in protecting human health and the environment from the initiation of remedial action activities up to the time when the response objectives are achieved. The short-term effectiveness of each alternative will be evaluated on the basis of the following four analysis factors:

- Protection of the community during remedial action
- Protection of workers during remedial action
- Environmental impacts associated with implementation of the remedial action
- Time frame for achievement of the remedial response objectives

Long-term effectiveness is a measure of the technical effectiveness of the alternative to protect human health and the environment after achievement of the remedial response objectives. The long-term effectiveness assessment will focus on the effectiveness of each alternative in protecting human health and the environment from residuals or untreated materials remaining on site. The long-term effectiveness and permanence of each alternative will be evaluated on the basis of the following three analysis factors:

- Magnitude of remaining risk
- Adequacy of controls
- Reliability of controls

Protection of human health for on-site activities involves site workers and nearby residents in the short term, and nearby residents in the long term. Off-site activities will affect residents along the shipment routes in the short term. Short term refers to the construction and implementation period, when disturbing contaminated soils, creating dust, and changing surface

water runoff routes could affect people, flora, fauna, and site physical characteristics (e.g., surface erosion, sedimentation). Long term refers to the period after remedial actions are complete, and includes the effects of treatment processes on contaminated materials, siltation factors, recharge rates to the aquifer, and removal versus nonremoval actions on contaminated material.

In addition, each alternative was evaluated for its effectiveness in reducing the toxicity, mobility, or volume of contaminants through treatment. Treatment includes a wide range of technologies, but only a limited number can be implemented where radioactive contamination is present. Treatments considered applicable include chemical, physical, and/or biological processes. Chapter 3.0 discusses those considered applicable in detail. Typically, these treatments are used to reduce volume; no process options have yet been identified that will reduce toxicity. Physical shielding (or containment) is also considered to be a treatment that reduces migration, but not toxicity or volume. For example, a permanent storage facility is considered a containment treatment that will reduce mobility, but not toxicity or volume.

5.1.2 Implementability Evaluation

Implementability refers to the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Implementability includes five factors: constructability, reliability, maintainability, agency approvals, and special engineering. Constructability involves the actual field activities necessary to build the remedial action structures after design challenges have been met, consideration of site conditions, and the impact of geological factors and existing structures/utilities.

Reliability and maintainability factors address how well a remedial action activity or process will maintain its performance requirements over time and how much effort is necessary to maintain the remedial action in a fully operational status. These factors also include operation, replacement, maintenance, and monitoring of the technical components of an alternative.

Agency approvals rely on the ability to comply with the substantive requirements of permits consistent with section 121(e) of CERCLA and specific provisions of Interagency Agreements (such as the FMPC FFCA, State of Ohio Consent Decrees, and the CERCLA 120 Consent Agreement).

Special engineering refers to special equipment or design factors for the remedial action activity. For example, special design factors for permanent storage facilities, identification of unique quality control monitoring activities for the permanent on-site disposal facility, and the design of a cap within a congested area are included in the special engineering factor.

5.1.3 Cost Evaluation

Cost estimates for screening alternatives are typically based on a variety of cost-estimating data (e.g., generic unit costs, vendor information, and conventional cost-estimating guides) and similar prior estimates modified by site-specific information. Cost estimates for items common to all alternatives or indirect costs (e.g., engineering, financial, supervision, outside contractor support, contingencies) do not warrant substantial effort during the initial alternative screening phase. For Operable Unit 3, it is not yet considered appropriate to develop order of magnitude costs at this stage of the Feasibility Study, due to the currently insufficient data available for nonradiological contaminants. This has resulted in identifying costs as "high," "medium," or "low" and not considering cost as a legitimate criteria for eliminating an alternative at this stage of the screening process.

5.1.4 Innovative Technologies

Technologies are classified as innovative if they are fully developed, but lack sufficient cost or performance data for routine use at cleanup sites. Any innovative technologies identified in Chapter 3.0 will be evaluated further in the detailed analysis of alternatives.

5.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

CERCLA requires that remedial actions at federal facilities achieve a level of cleanup or standard of control of radiological and hazardous substances, pollutants, or contaminants that, at a minimum, assures the protection of human health and the environment. With respect to

those radiological and hazardous substances, pollutants, and contaminants that will remain on-site. CERCLA further defines this level as the remedial action that at least attains legally applicable or relevant and appropriate requirements (ARARs), standards, criteria, or limitations.

ARARs are classified as chemical specific, location specific, or action specific. Chemical-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. Action-specific ARARs relate to technology- or activity-based requirements or limitations on the specific response actions taken with respect to the type of wastes. 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 (i.e., on the nature of the contamination, the location of the site, and the general scope of the identified remedial action alternatives). A list of the potential ARARs for Operable Unit 3 is included in Appendix A.

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6.0

6.0 INITIAL SCREENING OF ALTERNATIVES

This chapter describes the initial screening of alternatives for Operable Unit 3 alternatives. Due to the complexity of the various contaminated zones and surrounding structures, facilities, and utility lines, it is difficult to address alternative screening on an area-by-area basis. For this reason, contamination problems within Operable Unit 3 are categorized into seven distinct suboperable units (SUs). Similar contaminated areas are grouped into the appropriate suboperable unit and screening of alternatives was conducted based on this methodology. This technique minimizes redundancy in assessing the effectiveness and implementability of an alternative addressing a specific suboperable unit. Costs are addressed separately for each affected area, and then totaled on a suboperable unit-specific basis. This procedure was necessary to obtain an overall cost comparison for each applicable alternative for a particular suboperable unit.

The seven suboperable units are:

- Suboperable Unit A: Open field areas with limited access to contaminated soils
- Suboperable Unit B: Open field areas with good access to contaminated soils
- Suboperable Unit C: Soil contamination under facilities
- Suboperable Unit D: Soil contamination under facilities designated for possible demolition
- Suboperable Unit E: Aboveground contaminants
- Suboperable Unit F: Perched groundwater contamination
- Suboperable Unit G: Soils surrounding transfer lines

For each of these suboperable units, several specific areas are identified. Table 6-1 lists the contamination areas by suboperable unit, and more complete descriptions of the contaminated areas are included in the following sections of this chapter.

TABLE 6-1

OPERABLE UNIT 3 CONTAMINATED AREAS LISTED BY SUBOPERABLE UNIT

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Suboperable Unit A: Open Field Areas With Limited Access to Contaminated Soils

Area Between Plant 4 and Plant 5
Area South of the Maintenance Building and Plant 9
Area Between Plant 2/3 and Plant 4
Plant 8 Hydrachloric Acid Metals Dissolver
Area Along 1st Street
Area North of Plant 8
Plant 8 Loading Dock
Area Between Laboratory and Pilot Plant
Area South and East of Laboratory
Plant 1 Drum Storage Pad
Area South of Garage and Heavy Equipment Building
Plant 5, Metals Production Plant
Thorium Storage Area
Area Between the Service Building and the In-Vivo Building

Suboperable Unit B: Open Field Areas With Good Access to Contaminated Soils

Graphite Furnace and Oil Burner Area
Fire Training Area
Buffer Zone and Area East of Plant 9
Area Around Incinerator (Plume) and Northeast Area
Area South of Northeast Scrap Metal Pile
Area North of Northeast Scrap Metal Pile

Suboperable Unit C: Soil Contamination Under Facilities

Plant 2/3, Refinery
Plant 4, Green Salt Plant
Incinerator

Suboperable Unit D: Contamination Under Facilities Designated for Possible Demolition

Plant 6, Pickling Area
Plant 6, Chip Pickling Area
Plant 9, Special Products Plant
Building 39A Incinerator
Pilot Plant and Pilot Plant Tank Farm

Suboperable Unit E: Aboveground Contaminants

Drum Baling Area
Scrap Metal Pile (Northeast Quadrant)
Scrap Metal Piles (Northwest Quadrant)
Construction Rubble Mound

Suboperable Unit F: Perched Groundwater Contamination

Southwest Quadrant
Northeast and Southeast Quadrants
Northeast and Northwest Quadrants

Suboperable Unit G: Soils Surrounding Transfer Lines

Main Effluent Line
K-65 Slurry Line
Clearwell Process Water Line

After separating the various areas into the appropriate suboperable units, a prescreening of the 14 alternatives found applicable to this operable unit was completed. This preliminary screening process identifies those alternatives applicable to a given suboperable unit (Table 6-2). Chapter 3.0 defines and evaluates the applicable technology types and technology process options. Chapter 4.0 describes and defines the remedial action alternatives. The alternatives developed for Operable Unit 3 remedial action are as follows:

Alternative 1 - No Action

Alternative 2 - Cap

Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap

Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap

Alternative 5 - Mechanical Removal and On-Site Disposal

Alternative 6 - Mechanical Removal and Off-Site Disposal

Alternative 7 - Near Term - Temporary Cap;
Far Term - Mechanical Removal and On-Site Disposal

Alternative 8 - Near Term - Temporary Cap;
Far Term - Mechanical Removal and Off-Site Disposal

Alternative 9 - Groundwater Extraction, Treatment, and Discharge

Alternative 10 - Groundwater Extraction, Monitoring, Treatment, and Discharge

Alternative 11 - Subsurface Barrier

Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge

Alternative 13 - Facility Removal and On-Site Disposal

Alternative 14 - Facility Removal and Off-Site Disposal

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TABLE 6-2
OPERABLE UNIT 3 PRELIMINARY SCREENING MATRIX CHART

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Suboperable Unit A	●	●			●	●								
Suboperable Unit B	●	●			●	●								
Suboperable Unit C	●				●	●	●	●						
Suboperable Unit D	●				●	●	●	●					●	●
Suboperable Unit E	●	●	●	●	●	●								
Suboperable Unit F	●								●	●	●	●		
Suboperable Unit G	●	●			●	●								

SU A: Open Field Areas with Limited Access to Contaminated Soils

SU B: Open Field Areas with Good Access to Contaminated Soils

SU C: Soil Contamination Under Facilities

SU D: Soil Contamination Under Facilities Designated for Possible Demolition

SU E: Aboveground Contaminants

SU F: Perched Groundwater Contamination

SU G: Soils Surrounding Transfer Lines

NOTE:
SU = Suboperable Unit

Alternative 1 - No Action

Alternative 2 - Cap

Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap

Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap

Alternative 5 - Mechanical Removal and On-Site Disposal

Alternative 6 - Mechanical Removal and Off-Site Disposal

Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal

Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal

Alternative 9 - Groundwater Extraction, Treatment, and Discharge

Alternative 10 - Groundwater Extraction, Monitoring, Treatment, and Discharge

Alternative 11 - Subsurface Barrier

Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge

Alternative 13 - Facility Removal and On-Site Disposal

Alternative 14 - Facility Removal and Off-Site Disposal

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After the preliminary screening, each remaining alternative was evaluated as described in Chapter 5.0. For each alternative, each factor of the criteria was ranked from one to five, based on how well the alternative satisfied the factor (i.e., "five" indicates that the alternative best satisfies the factor, and "one" indicates that the alternative least satisfies the factor). This ranking process was applied to each factor of the effectiveness and implementability criteria. Thus, because effectiveness has five separate factors (short-term public health; short-term environmental protection; long-term public health; long-term environmental protection; and reduction in toxicity, mobility, or volume of contaminants), the best possible ranking score that an alternative can receive for the effectiveness criterion is 25. Similarly, implementability has five factors (constructability, reliability, maintainability, agency approvals, and special engineering), and the highest ranking score an alternative could receive for this criterion is also 25. When evaluating cost, each alternative is assigned a value of low, medium, or high. Cost estimates for the alternatives were based on a variety of cost estimating data such as vendor information, conventional cost estimate guides, commercial remedial costs, and prior similar estimates.

Screening summary charts are found at the end of each of the seven suboperable unit discussions in this chapter. These summary charts show the relative ranking of each applicable alternative to the suboperable unit. The alternative cost ranking is based on the total cost of the alternative (sum of the costs of the regions). Specific assumptions used in the screening process are discussed in the following paragraphs.

When considering short-term public health and environmental protection, the effectiveness of each alternative in protecting human health and the environment from the initiation of remedial action activities up to the time when the response objectives are achieved is considered. The greater the nature, magnitude, and duration of the remedial activity, the greater the environmental risk associated with the implementation of the action. In cases where contamination has migrated off the FMPC property, any actions that do not remove the contamination have been downgraded in ranking.

The short-term public health and environmental protection has been ranked the lowest for off-site transportation and disposal due to traffic flow through the local community. It is assumed that this action would likely represent the greatest potential short-term impact to the community. In addition, disturbing the contamination will affect both workers and the public immediately off site. Engineered dust controls are assumed in use, but cannot reasonably be assumed one hundred percent effective.

Long-term public health and environmental protection risk of each alternative has been evaluated on the basis of the magnitude of remaining risk, adequacy of control, and reliability of controls. In addition, assessment will focus on the effectiveness of each alternative in protecting human health and the environment from residuals or untreated materials. These factors assume that the long-term effects of on-site disposal are equivalent to off-site disposal.

For reduction of toxicity, mobility, or volume through treatment, all remedial actions that do not include treatment have been downgraded in ranking. Although the cap prevents further vertical penetration of rainfall and runoff, continual horizontal infiltration may occur. Once horizontal infiltration has penetrated the contaminated waste, further migration can occur. All excavation actions assume treatment of the soils prior to disposal. Containment is considered to be physical treatment, and thus, reduces the mobility, but not the toxicity or volume of the contaminants.

Constructability evaluation considers not only the developmental status of any physical process units, but also any site-specific constraints such as subsurface conditions, space limitations, and/or site obstructions. The difficulty of the construction (e.g., facility removal or excavation under a facility) impacts the ranking of this factor. The more difficult the construction, the lower the ranking. Due to the working conditions within the Production Area, a loss of efficiency has been considered in the ranking.

Reliability of alternatives has been evaluated based on the ability of a given process option to meet specified efficiencies or performance goals and how well it will maintain its performance

requirements over time. In many situations, the reliability of the operation has been designed into the system through engineering requirements. If complex technologies are required for the alternative, the ranking has been lowered.

The maintainability of alternatives has been evaluated based on the ability to monitor and maintain the effectiveness of the remedial action. Most maintenance requirements will be routine, but if complex technologies are required of the alternative, the ranking has been lowered.

Agency approvals have been evaluated on the basis of agency and permit requirements. For areas outside the FMPC property, alternatives that do not remove the contamination are ranked low. In addition, if a delay is involved with the remedial action, the ranking has been lowered.

Special engineering has been evaluated based on any special design or implementation factors, including the need for specially trained or experienced personnel to set up or operate equipment or to implement a specific component of an alternative. The design of the permanent storage facility requires significantly more special engineering than a temporary storage facility; therefore, alternatives requiring special equipment or design factors or complex technologies have been ranked lower than the simpler alternatives.

Cost estimates for screening alternatives were based on a variety of cost-estimating data (e.g., generic unit costs, vendor information, and conventional cost estimating) and similar prior estimates modified by site-specific information. For this cost evaluation, each alternative is evaluated as to whether costs are low, medium, or high relative to other alternatives. The cost ranking was prepared for each alternative to allow a comparison of costs among similar alternatives. The data uncertainties present at this stage of the RI/FS for Operable Unit 3 force estimates to be approximated. The costs are estimates for comparison purposes only and it is considered premature to eliminate an alternative based exclusively on cost.

For purposes of this report, the following approximate cost ranges are used:

- Costs greater than $250 million are considered high.
- Costs between $50 million and $250 million are considered medium.
- Costs less than $50 million are considered low.

6.1 SUBOPERABLE UNIT A: OPEN FIELD AREAS WITH LIMITED ACCESS TO CONTAMINATED SOILS

Suboperable Unit A is defined as open field areas with limited access to contaminated soils (i.e., overhead obstructions, surrounding buildings) in the Production Area. Figure 6-1 illustrates the Suboperable Unit A areas. Due to the limited access, these alternatives will require coordination between construction equipment and the aboveground structures. In addition to aboveground structures, many of the areas are covered with concrete pads or roads. Because the concrete pads may be contaminated, they will be addressed similar to contaminated surface soils or replaced as necessary and will be included in the volume calculations of contaminated soils. Table 6-3 lists the areas and sizes of the uranium contamination. The volumes in this table were calculated by taking the sum of the volumes at various depths. For example, the volume of contaminated soil at uranium concentrations of 50 to 200 ppm in the area along 1st Street was calculated by taking the sum of the volumes at 0 to 1.5 feet, 1.5 to 3 feet, 3 to 5.5 feet, 10 to 15 feet, and 15 to 20 feet (Table 6-3). Thus, the calculation looks like this:

$$\text{Total volume} = (1500' \times 300' \times 1.5') + (400' \times 100' \times 1.5') + [\pi\,(50')^2 \times 2.5'] + [\pi\,(25')^2 \times 5'] + [\pi\,(25')^2 \times 5'] = 784{,}100 \text{ cubic feet}$$

There are five 25-foot diameter areas of uranium contamination greater than 200 ppm between 0 and 1.5 feet. However, these two areas are completely enclosed within the larger contaminated area, with uranium concentrations between 50 and 200 ppm, and thus, do not affect the total volume of contaminated soil. In addition, the table does not include a column for 5.5 to 10 feet because the facility sampling program did not identify any contamination at those depths. Sources for the contamination types and levels are discussed in Chapter 1.0.

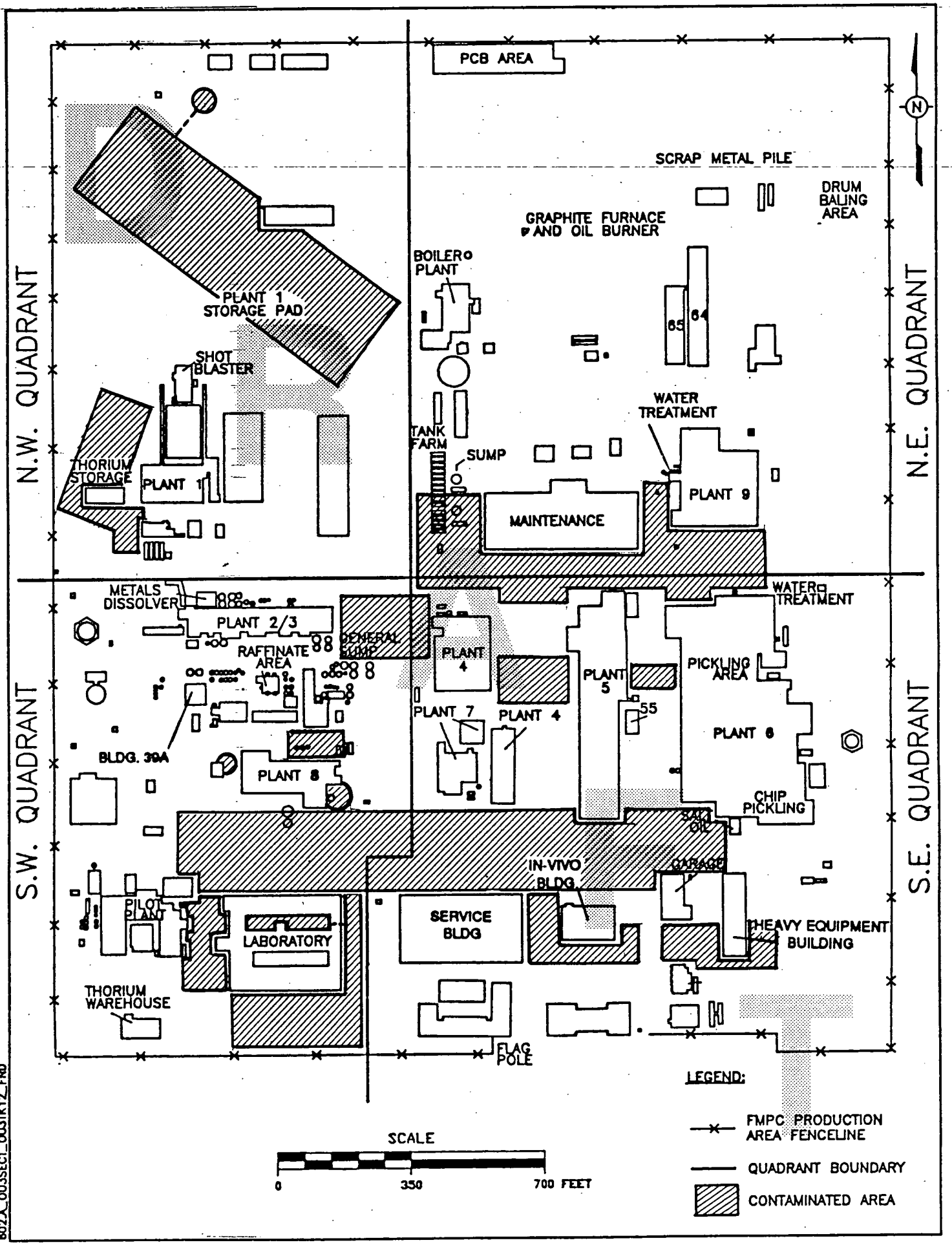

FIGURE 6-1. OPERABLE UNIT 3 CONTAMINATED AREAS - SUBOPERABLE UNIT A

TABLE 6-3

OPERABLE UNIT 3 URANIUM CONTAMINATED SOILS - SUBOPERABLE UNIT A

Area	Depth (Feet) 0.0 - 1.5	1.5 - 3.0	3.0 - 5.5	10 - 15	15 - 20	Volume (ft^3)
Area Between Plant 4 and 5	– / 250'x150'	– / –	– / –	– / –	– / –	56,250
Area South of Maintenance Building and Plant 9	– / 900'x250'	– / 100'x100'	50' Dia / 150' Dia	– / –	100' Dia / 150' Dia	485,050
Area Between Plant 2/3 and 4	– / 250'x200'	– / –	– / –	– / –	– / –	75,000
Plant 8 Hydrochloric Acid Metals Dissolver	– / –	– / –	– / 50'Dia	– / 75' Dia	– / 50' Dia	36,800
Area Along 1st Street	5@50' Dia / 1500'x300'	– / 400'x100'	– / 100' Dia	– / 50' Dia	– / 2@50' Dia	784,100
Area North of Plant 8	25' Dia / 150'x150'	– / –	– / 75'Dia	– / 25' Dia	– / –	47,250
Plant 8 Loading Dock	– / –	– / –	– / –	50' Dia / 100' Dia	– / 100' Dia	78,550
Area Between Laboratory and Pilot Plant	2@50' Dia / 200'x250'	– / –	– / –	– / –	– / –	75,000
Area South and East of Laboratory	2@50' Dia / 300'x300'	– / –	– / –	– / –	– / –	135,000
Plant 1 Drum Storage Pad	2@50' Dia / 50' Dia / 1000'x300'	– / –	– / –	– / –	– / –	452,950
Area South of Garage and Heavy Equipment Building	50' Dia / 150'x375'	75'x100'	– / –	– / –	– / –	95,650
Plant 5, Metals Production Plant	50' Dia / 175'x75'	– / –	– / 50' Dia	– / –	– / 50' Dia	34,400
Thorium Storage Area	2@50' Dia / 400'x200'			100' Dia	50' Dia	169,100
Area Between the Service Building & In-Vivo Building	50' Dia / 200'x150'					45,000
					Total Volume (ft^3)	2,570,100

NOTE:

Measurement= Dimension of Contaminated Material with Uranium Concentrations between 50 and 200ppm	Measurement= Dimension of Contaminated Material with Uranium Concentrations >200ppm

– = Uranium Concentrations Less than 50 ppm

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6.1.1 Area Descriptions

6.1.1.1 Area Between Plant 4 and Plant 5

Uranium soil contamination appears to have developed in this region from rainwater runoff from the Plant 5 area. The total volume of uranium contamination is approximately 56,250 cubic feet. The uranium concentration is between 50 and 200 ppm.

6.1.1.2 Area South of the Maintenance Building and Plant 9

Uranium soil contamination in this area appears to have developed from rainwater runoff from the Plant 9 area. The total volume of uranium contamination is approximately 485,050 cubic feet. The uranium concentration is generally between 50 and 200 ppm. There is one area approximately 50 feet in diameter between 3.0 and 5.5 feet in depth with uranium concentrations in excess of 200 ppm. There is another area approximately 100 feet in diameter between 15 and 20 feet in depth with uranium concentrations in excess of 200 ppm. This is an area of concern because mobile forms of uranium contamination are moving from Plant 6 and 9 into the perched water.

6.1.1.3 Area Between Plant 2/3 and Plant 4

Uranium soil contamination in this area appears to be the result of rainwater runoff from Plants 2/3 and 4. This water flows to the storm sewer between these plants. The total volume of uranium contamination is approximately 75,000 cubic feet. The uranium concentration is between 50 and 200 ppm.

6.1.1.4 Plant 8 Hydrochloric Acid Metals Dissolver

This area was originally used to dissolve uranium and magnesium scrap metals. On this diked pad, two 1000-gallon wooden tanks containing hydrochloric acid were used to dissolve the metals prior to separation in Plant 8. The contamination in this area appears to be leakage from the pad into the soils (WMCO 1989). The total volume of uranium contamination is approximately 36,800 cubic feet. The uranium concentration is between 50 and 200 ppm.

6.1.1.5 Area Along 1st Street

This area encompasses portions of both the southeast and southwest quadrants. The source of the uranium contamination appears to be liquid containing radioactive material leaking into the soils from the south end of Plant 6 (which is addressed under Suboperable Unit D), and from rainwater runoff from the adjacent roadways that are contaminated by material movements and air deposition from Plants 4, 5, 7, and 8 (WMCO 1989). This area begins south of Plant 6 and continues to south of Plant 8. The uranium contamination does not reach any facilities, but follows both sides of 1st Street. The total volume of uranium contamination is approximately 784,100 cubic feet. Within this zone, there are five areas 50 feet in diameter, between 0- and 1.5-foot depth, with uranium concentrations in excess of 200 ppm. The remainder of the zone contains uranium concentrations between 50 and 200 ppm.

6.1.1.6 Area North of Plant 8

The uranium soil contamination in this area is just west of the sump at the northeast corner of Plant 8. The area is most likely contaminated by rainwater runoff from the adjacent roadways that were contaminated by material movements and air deposition from Plants 2/3 and 8. The total volume of uranium contamination is approximately 47,250 cubic feet. There is one area 25 feet in diameter, between 0- and 1.5-foot depth, with uranium concentrations in excess of 200 ppm.

6.1.1.7 Plant 8 Loading Dock

This area is located underneath the concrete loading pad east of Plant 8 and appears to be contaminated by rainwater washing radioactive material into the soil around and beneath the pad. The total volume of uranium contamination is approximately 78,550 cubic feet. There is an area 50 feet in diameter where the uranium concentration is greater than 200 ppm between 10 and 15 feet in depth.

6.1.1.8 Area Between Laboratory and Pilot Plant

This open area includes a former waste solvent drum storage site between the pilot plant and laboratory and an open field south of the laboratory. There are two areas approximately 50 feet in diameter with uranium concentrations in excess of 200 ppm between 0- and 1.5-foot depth between the pilot plant and laboratory. This uranium contamination appears to be

rainwater that washed radioactive material into the soil around and beneath the pad. The total volume of uranium contamination is approximately 75,000 cubic feet. WMCO is currently conducting a removal action on this contaminated material. Once this action is complete, the contaminated material will be placed in storage boxes and maintained on site pending final disposition.

6.1.1.9 Area South and East of Laboratory

The uranium soil contamination in this area occurs south and east of the laboratory. A small section within the laboratory is also included in this area. The total volume of uranium contamination is approximately 135,000 cubic feet. There are two areas approximately 50 feet in diameter with uranium concentrations in excess of 200 ppm between 0- and 1.5-foot depth.

6.1.1.10 Plant 1 Drum Storage Pad

Plant 1 storage pad is used to store drummed low-level radioactive materials and contaminated copper scrap awaiting further processing or shipment off site. WMCO has 68,000 drums and containers currently on site. Of these drums, approximately 32,000 drums contain uranium residue, approximately 5000 drums contain mixed waste, and approximately 13,000 containers (the equivalent of approximately 7500 55-gallon drums) store thorium. An additional 18,000 drums containing uranium residue are suspected to contain mixed waste (WMCO 1990b). This includes drum storage areas on the east and south side of Building 56 and a 50-foot diameter storage area northwest of Building 56. Most of the drums currently stored on the pad exhibit evidence of corrosion and deterioration, and are in the process of being overpacked. WMCO is currently pursuing removal actions on the Plant 1 pad. These removal actions include concrete surface repair, storm water run-on/runoff control, and a planned phase A/B storage facility. These actions call for the repair of cracked, or leaking surfaces through a process of scarifying existing concrete, placement of an impermeable membrane, and placement of new concrete over the membrane. Also, the creation of storm water runoff routes, and the construction of a storage facility adjacent to the Plant 1 pad is planned. In addition, WMCO is currently moving drums on site, and plans to store approximately 30,000 within Plant 6, Plant 9, and other indoor areas by September 30, 1990.

There are two areas approximately 50 feet in diameter, between 0 and 1.5 feet in depth, with uranium concentrations in excess of 200 ppm. The total volume of uranium soil contamination for this area is approximately 452,950 cubic feet. Uranium contamination appears to have developed in this area from rainwater runoff from the Plant 1 area and the drums stored on the pad, which washed radioactive material into the soil around and beneath the concrete pads.

6.1.1.11 Areas South of Garage and Heavy Equipment Building

Continuous, area-wide uranium soil contamination greater than 50 ppm exists in the open areas south of the garage and heavy equipment building. The total volume of uranium soil contamination is approximately 95,650 cubic feet. One area 50 feet in diameter, with uranium concentrations greater than 200 ppm, exists from 0 to 1.5 feet adjacent to the southern half of the heavy equipment building. The uranium contamination sources for these two concentrations appear to have been previously removed.

6.1.1.12 Plant 5, Metals Production Plant

Uranium contamination from rainwater runoff is found around and beneath the pad immediately east of Plant 5. The total volume of uranium contamination for this area is approximately 34,400 cubic feet. One area with uranium concentrations greater than 200 ppm is found within a 50-foot diameter area at a depth from 0 to 1.5 feet.

6.1.1.13 Thorium Storage Area

Uranium soil contamination appears to have developed in this region from rainwater runoff from the Plant 1 area. The total volume of uranium soil contamination is approximately 169,100 cubic feet. The uranium concentration is between 50 and 200 ppm. There are two areas approximately 50 feet in diameter, at 0 to 1.5 feet in depth, with uranium concentrations in excess of 200 ppm.

6.1.1.14 Area Between the Service Building and the In-Vivo Building

Uranium soil contamination in this area occurs south of 1st Street and between the service building and the in-vivo building. The total volume of uranium contamination is approximately 45,000 cubic feet. There is one area 50 feet in diameter, at 0 to 1.5 feet in depth, with uranium concentrations in excess of 200 ppm.

6.1.2 Alternatives

Alternatives 3 and 4 are eliminated regarding Suboperable Unit A because no aboveground contaminants exists. Similarly, because there are no buildings over the contaminated soils, Alternatives 7 and 8 are eliminated. Alternatives 9 through 12 are eliminated because they apply only to perched groundwater contamination. Alternatives 13 and 14 are eliminated because they apply to facilities designated for possible demolition. Therefore, the alternatives that will be screened for Suboperable Unit A are Alternatives 1, 2, 5, and 6. Table 6-4 shows the screening summary for those alternatives. Details of the initial screening are given below.

6.1.2.1 Alternative 1 - No Action

This alternative scored 34 out of a possible 50.

6.1.2.1.1 Effectiveness

In the short term, risks to on-site workers and the public immediately off site are considered low; therefore, the ranking of the short-term public health and environmental protection is high (factors scored a 5) because all material remains in place and is undisturbed. Long-term public health and environmental protection are ranked unfavorably because this alternative does not provide for the mitigation of existing contamination (factors scored a 1). In addition, the potential for further environmental contamination exists, because this alternative does not remove or contain the soil contamination. This alternative does not reduce the toxicity, mobility, or volume of the waste (factor scored a 1).

Overall effectiveness of this alternative scored 13 out of a possible 25.

6.1.2.1.2 Implementability

The No Action Alternative requires no implementation; therefore, constructability, reliability, maintainability, and special engineering ranked high (factors scored a 5). However, agency approvals may be required for this alternative (factor scored a 1).

Overall implementability of this alternative scored 21 out of a possible 25.

TABLE 6-4

OPERABLE UNIT 3 SCREENING SUMMARY - SUBOPERABLE UNIT A
OPEN FIELD AREAS WITH LIMITED ACCESS TO CONTAMINATED SOILS

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Effectiveness														
Short-term public health	5	4			3	1								
Short-term environmental protection	5	4			3	2								
Long-term public health	1	3			5	5								
Long-term environmental protection	1	3			5	5								
Reduction in toxcity, mobility, or volume	1	1			5	5								
Subtotal	13	15			21	18								
Implementability														
Constructability	5	4			3	3								
Reliability	5	4			4	4								
Maintainability	5	4			4	4								
Agency approvals	1	2			4	3								
Special engineering	5	4			3	3								
Subtotal	21	18			18	17								
Cost	L	L			H	H								
Total	34	33			39	35								

Alternative 1 - No Action
Alternative 2 - Cap
Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap
Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap
Alternative 5 - Mechanical Removal and On-Site Disposal
Alternative 6 - Mechanical Removal and Off-Site Disposal
Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal
Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal
Alternative 9 - Groundwater Extraction, Treatment, and Discharge
Alternative 10 - Groundwater Extraction, Monitoring, Treatment And Discharge
Alternative 11 - Subsurface Barrier
Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge
Alternative 13 - Facility Removal and On-Site Disposal
Alternative 14 - Facility Removal and Off-Site Disposal

Cost:	Ranking (1 to 5):
L=Low	5-Best Satisfies Criteria
M=Medium	
H=High	1-Least Satisfies Criteria

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6.1.2.1.3 Cost

There is no incremental cost for this alternative; thus, cost is low.

6.1.2.2 Alternative 2 - Cap

This alternative scored 33 out of a possible 50.

6.1.2.2.1 Effectiveness

This nonremoval alternative represents a minimum action scenario intended to isolate waste and minimize vertical infiltration of rainfall/runoff into and through the soil. A cap will affect the saturation of contaminated materials and will reduce leaching of contaminants to the groundwater. Capping has low short-term worker health and environmental risks because of the limited construction required and associated exposure time (factors scored a 4). There are little or no expected risks to the public immediately off site. With respect to the long-term public health and environmental protection, the cap will prevent direct contact exposure to individuals from contaminants and will reduce the risks of wind dispersion of the materials. However, this alternative does not address the removal, treatment, or containment of the contaminated soil (factors scored a 3). This alternative does not have any provisions for reducing the toxicity and volume of the contamination, but would diminish the mobility by reducing vertical infiltration of precipitation. Even though the cap minimizes rainfall from penetrating the contaminated soils, accumulated water at the edges of the cap will penetrate vertically, and ultimately, horizontally, into the soils (factor scored a 1).

Overall effectiveness of this alternative scored 15 out of a possible 25.

6.1.2.2.2 Implementability

The constructability factors for a cap are relatively simple. The technology, equipment, manpower, and materials exist and are readily available; however, working conditions can make construction at the FMPC difficult (factor scored a 4). Capping is also reliable (factor scored a 4), and test methods exist to verify adequate construction.

Maintainability factors for a cap include periodic maintenance (factor scored a 4). If left unattended, natural biological succession will occur and the cap will deteriorate. Eventually,

insects and small burrowing animals will penetrate the cap and reach the soil. This opens pathways for precipitation to infiltrate first the cap liner and subsequently the soil itself. Periodic maintenance involves regrading the cap and revegetating the surface.

There are no local agency approvals needed for the implementation of this alternative; however, state and federal agencies are unlikely to accept a cap alone as a long-term remedial action (factor scored a 2). One special engineering requirement is the coordination of the cap design and construction with the aboveground structures within the area (factor scored a 4).

Overall implementability of this alternative scored 18 out of a possible 25.

6.1.2.2.3 Cost

The total relative cost for this alternative is low.

6.1.2.3 Alternative 5 - Mechanical Removal and On-Site Disposal

This alternative scored 39 out of a possible 50.

6.1.2.3.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated soil (factors scored a 3). On-site workers will be impacted by dust from the removal activity, but there are little or no expected risks to the public immediately off site.

Long-term public health and environmental protection are ranked high due to the permanent storage of the soil (factors scored a 5). The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative scored 21 out of a possible 25.

6.1.2.3.2 Implementability

Constructability factors for this alternative include the capability to use construction equipment for the mechanical removal of the waste and construction of the on-site disposal facility (factor scored a 3). The necessary items such as manpower, technology, equipment, and materials are

available; however, working conditions at the FMPC can make construction difficult. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the on-site disposal facility will include periodic long-term maintenance (factor scored a 4).

There are no local agency approvals needed for this alternative, and state and federal agencies are likely to accept this alternative as a long-term remedial action (factor scored a 4).

Special engineering requirements include the coordination of the mechanical removal equipment with the underground utilities and the aboveground structures within the region, in addition to the design of the on-site disposal facility (factor scored a 3).

Overall implementability of this alternative scored 18 out of a possible 25.

6.1.2.3.3 Cost

The total relative cost for this alternative is high.

6.1.2.4 Alternative 6 - Mechanical Removal and Off-Site Disposal

This alternative scored 35 out of a possible 50.

6.1.2.4.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated waste. On-site workers will be impacted by dust from the soil removal, but there are little or no expected risks to the public immediately off site. The local community will be affected by the traffic flow of the contaminated waste to the off-site disposal facility. Public road transport of contaminated waste is more likely to affect public health than the environment; therefore, the short-term public health risk (factor scored a 1) is higher than the short-term environmental risk (factor scored a 2). Long-term public health and environmental protection are ranked high (factors scored a 5) due to the permanent storage of the waste off site. The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative scored 18 out of a possible 25.

6.1.2.4.2 Implementability

Constructability factors for this alternative include the capability to use construction equipment for the mechanical removal of the waste and construction of a temporary on-site storage structure to house the waste (factor scored a 3). The necessary items such as manpower, technology, equipment, and materials are available; however, working conditions at the FMPC can make construction more difficult. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the off-site disposal facility will include periodic long-term maintenance (factor scored a 4).

Transportation of contaminated wastes off site will be in compliance with NRC40CFR and 49CFR. State hazard permits will be required from all transportation route states that have this requirement. These permits will be obtained by the company transporting the waste (factor scored a 3). Special engineering requirements include the coordination of the mechanical removal equipment with the underground utilities and the aboveground structures, facilities, and utility lines within the area, in addition to the design of the off-site disposal facility (factor scored a 3).

Overall implementability of this alternative scored 17 out of a possible 25.

6.1.2.4.3 Cost

The total relative cost for this alternative is high.

6.2 SUBOPERABLE UNIT B: OPEN FIELD AREAS WITH GOOD ACCESS TO CONTAMINATED SOILS

Suboperable Unit B is defined as open field areas with good access to contaminated soils (i.e., no confined spaces). Figures 6-2, 6-3, and 6-4 illustrate the Suboperable Unit B areas. This description is applicable to the suspect areas and some areas within the Production Area. Some of the areas discussed in this problem are covered with concrete pads or roads. Because the concrete pads may be contaminated, they will be addressed as contaminated surface soils or replaced as necessary. Table 6-5 lists the areas and the size of the contamination zones. The

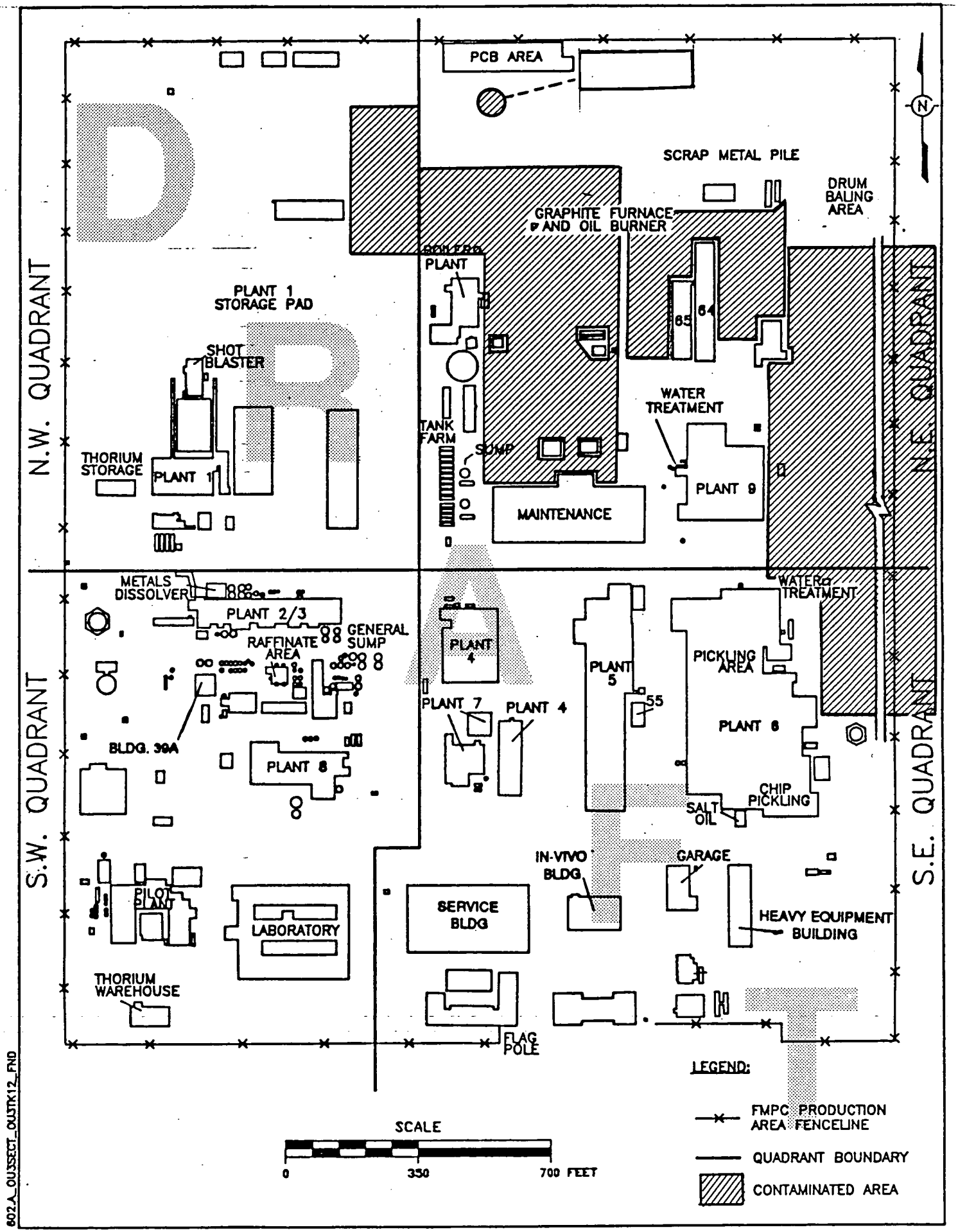

FIGURE 6-2. OPERABLE UNIT 3 CONTAMINATED AREAS - SUBOPERABLE UNIT-B

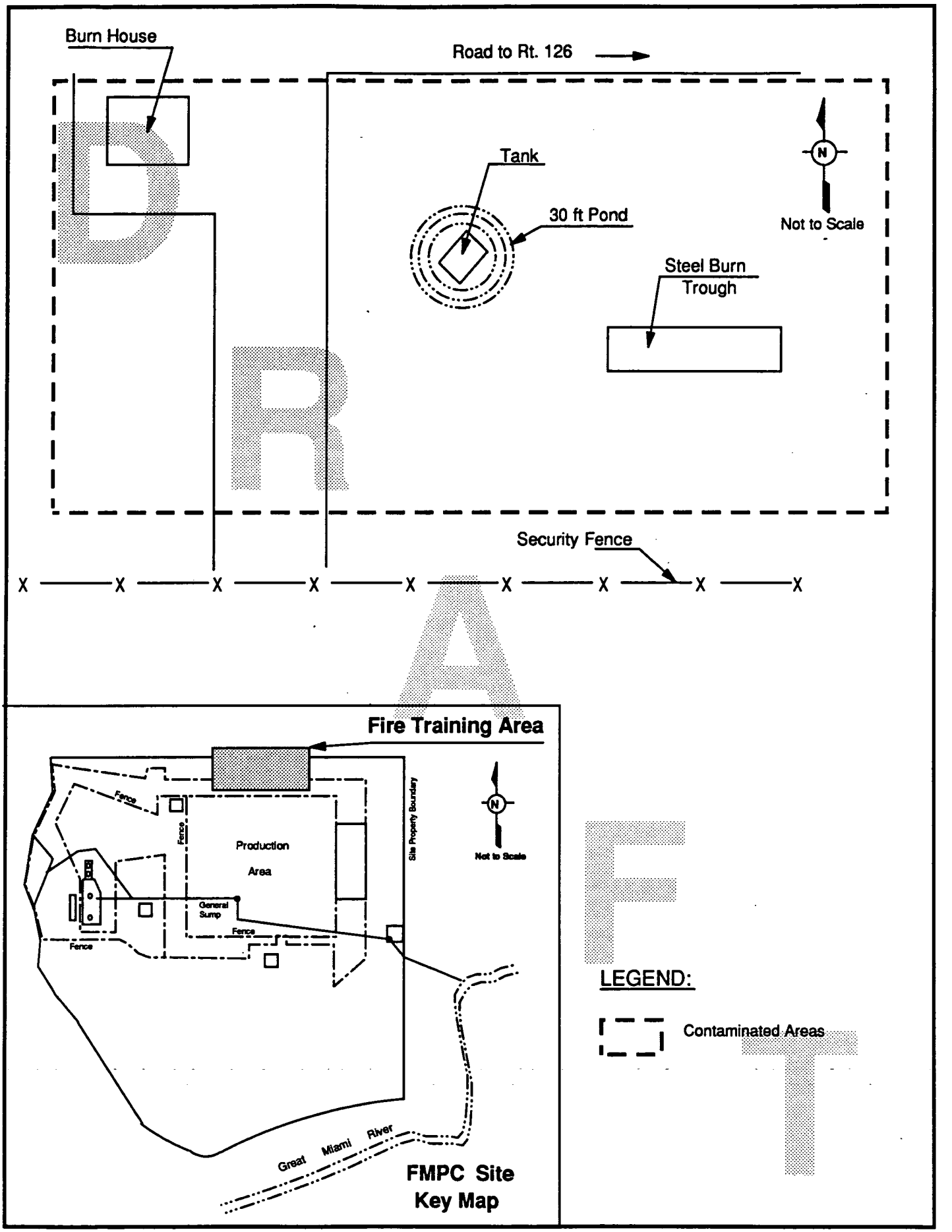

FIGURE 6-3. OPERABLE UNIT 3 FIRE TRAINING AREA

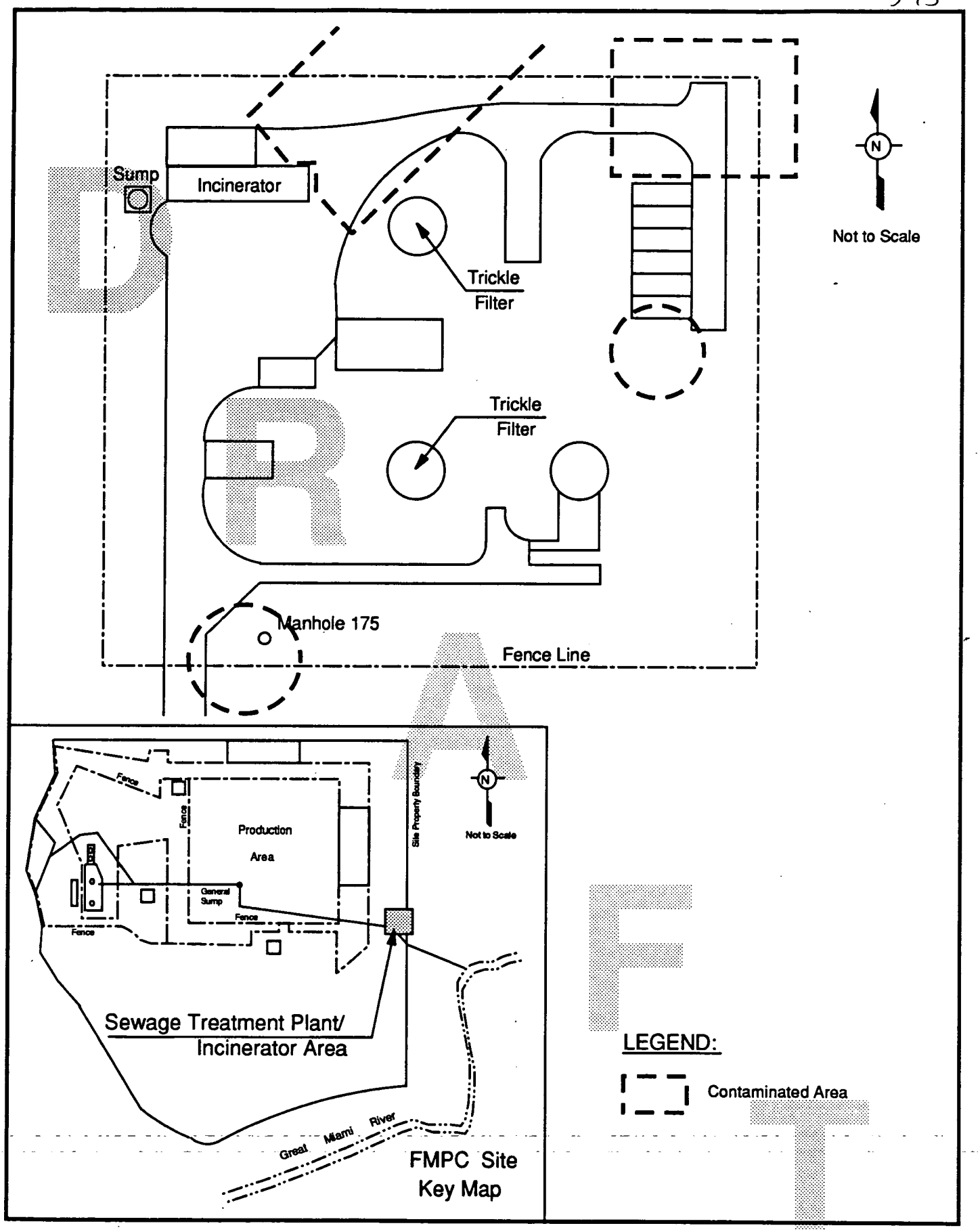

FIGURE 6-4. OPERABLE UNIT 3 SEWAGE TREATMENT PLANT/INCINERATOR AREA

TABLE 6-5

OPERABLE UNIT 3 URANIUM CONTAMINATED SOILS - SUBOPERABLE UNIT B

Area	Depth (Feet)					Volume (ft^3)
	0.0 - 1.5	1.5 - 3.0	3.0 - 5.5	10 - 15	15 - 20	
Graphite Furnace and Oil Burner Area	3@50' Dia / 600'x800'	– / –	– / –	– / –	– / –	720,000
Fire Training Area	2@50' Dia / 250'x150'	– / –	– / –	– / –	– / –	56,250
Buffer Zone and Area East of Plant 9	500'x250'x2' / 1250'x525'	– / –	– / –	– / –	– / –	1,234,400
Area Around Incinerator (Plume) and Northeast Area	300'x300'x2' 100'x100'x2' 50' Dia / 50' Dia	– / –	– / –	– / –	– / –	205,900
Area South of Northeast Scrap Metal Pile	– / 400'x350'	– / –	– / –	– / –	– / –	210,000
Area North of Northeast Scrap Metal Pile	– / 350'x150' 100' Dia	– / –	– / –	– / –	– / –	90,550
					Total Volume (ft^3)	2,517,100

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NOTE:

Measurement= Dimension of Contaminated Material with Uranium Concentrations between 50 and 200ppm

Measurement= Dimension of Contaminated Material with Uranium Concentrations >200ppm

-- = Uranium Concentrations Less than 50 ppm

volumes in this table were calculated by taking the sum of the volumes at the various depths as discussed in the Section 6.1 example. The volumes of contaminated material include the concrete pads.

6.2.1 Area Descriptions

6.2.1.1 Graphite Furnace and Oil Burner Area

This area includes the graphite furnace/oil burner area and the areas around the maintenance building and boiler plant. The total volume of uranium soil contamination is approximately 720,000 cubic feet. There is one area approximately 50 feet in diameter, between 0 and 1.5 feet in depth, with uranium concentrations in excess of 200 ppm. Within this area, samples also indicate the presence of PCB-contaminated material.

With the exception of the PCB values, contamination levels are low. Presumably, the source of PCBs in the northwest and the northeast corner of the boiler plant coal pile is spillage of oil during transport to the graphite/oil burner. Chloroform contamination has also been detected in very low quantities.

The area north of the maintenance building is of concern due to the machine oils and solvents in the vicinity. Hazardous Substance List organics were detected in two samples located on the north side of the maintenance building north of a storage pad where solvents and lubricants are kept in drums.

The concentrations of contamination are lower at greater depths. The contamination appears to be concentrated at the surface, indicating that the source of the problem is surface spillage. The maximum depth of the problem has not been determined. The penetration depth of trichloroethene, a solvent that is heavier than water, is expected to be greater than other Hazardous Substance List contaminants detected.

Lead, arsenic, and uranium are the metals of concern north of the maintenance building. Background levels for lead and arsenic have not been rigorously established for the site; however, a review of the data from the Hazardous Substance List analyses (ASI/IT 1989) indicates that typical lead values are on the order of a few tens of ppm and arsenic is a few ppm in the soil. The lead values are above background values in both of these samples, although arsenic is elevated in only surface samples.

Uranium is present in the surface sample; however, a sample from 2 feet to 2.5 feet has less than 50 ppm uranium, indicating that the depth extent of soils contaminated with uranium is less than 2 feet. A small concentration of uranium contamination (less than 50 ppm) has also been detected in a gravel-covered area near the southeast corner of the maintenance building. Concentrations of uranium are found just outside the maintenance building, with one area approximately 50 feet in diameter, between 0 and 1.5 feet in depth, that has uranium concentrations greater than 200 ppm.

The boiler plant is located on the west side of the northeast quadrant and just northwest of the maintenance building. There are small amounts of uranium contamination (less than 50 ppm) down to 1.5 feet in the area northwest of the boiler plant. There is one area northwest of the boiler plant approximately 50 feet in diameter, between 0 and 1.5 feet in depth, with uranium concentrations in excess of 200 ppm. Also, there are traces of PCBs in the area. Presumably, the source of PCBs is oil spillage as it was taken to the oil burner.

6.2.1.2 Fire Training Area

The fire training area is located 50 feet north of the buffer zone fence. The area consists of a burn house, tank, a 30-foot diameter pond, and a steel burn trough. A security fence lines the south side of this area. The total approximate volume of uranium-contaminated soil at concentrations greater than 200 ppm is 56,250 cubic feet. There are two areas approximately 50 feet in diameter, between 0 and 1.5 feet in depth, with uranium concentrations in excess of 200 ppm. There is evidence from test samples that PCBs and other Hazardous Substance List

materials are present. Data also indicate organic and radionuclide contamination, such as 1,1,1-trichlorethane, 1,1-dichloroethane, 1,1-dichloroethene, ethyl benzene, tetrachloroethane, and toluene in the area at concentrations greater than 200 ppm, more than likely obtained from coal tar.

6.2.1.3 Buffer Zone and Area East of Plant 9

Uranium soil contamination in this area occurs east of Plant 9 and includes a portion of the buffer zone. The total volume of uranium contamination is approximately 1,234,400 cubic feet. There is an area in the buffer zone of approximately 125,000 square feet, between 0 and 1.5 feet in depth, with uranium concentrations in excess of 200 ppm.

6.2.1.4 Area Around Incinerator (Plume) and Northeast Area

The incinerator is located in the northwest corner of the sewage treatment plant area, which is east of the Production Area, and has uranium soil contamination in excess of 200 ppm within a surface soil plume of a width of 300 feet and a length of 300 feet. This plume probably resulted from stack emission of uranium-contaminated materials from the incinerator. Uranium contamination is assumed to have migrated downward at least six inches below the surface. For estimating purposes, cleanup would involve extraction of soil to 2 feet below surface, giving a total volume of approximately 180,000 cubic feet. In addition, a sump is located at the southwest corner of the incinerator. Samples taken at this sump indicate total uranium concentrations of less than 25 ppm. In the upper northeast corner of this suspect area, sample data indicates uranium concentrations of more than 200 ppm to a depth of approximately 2 feet, giving a volume of approximately 20,000 cubic feet. There is an area in the vicinity of Manhole 175 approximately 50 feet in diameter with uranium concentrations in excess of 200 ppm. Data also show organic and radionuclide contamination in this area. The total volume of contaminated material in the incinerator area is approximately 205,900 cubic feet.

6.2.1.5 Area South of the Northeast Scrap Metal Pile

This open area between the scrap metal pile and Buildings 64 and 65 appears to be contaminated from rainwater runoff from the scrap metal pile (northeast quadrant). The total volume of uranium contamination is approximately 210,000 cubic feet. The uranium concentration is between 50 and 200 ppm.

6.2.1.6 Areas North of the Northeast Scrap Metal Pile

There are two areas north of the scrap metal pile (northeast quadrant) with uranium concentrations between 50 and 200 ppm. One area approximately 52,500 square feet is due north of the scrap metal pile and the other, approximately 100 feet in diameter, is just northwest of the scrap metal pile. The total volume is approximately 90,550 cubic feet.

6.2.2 Alternatives

For this suboperable unit, Alternatives 3 and 4 are eliminated because no aboveground contaminants exists. Similarly, because there are no buildings over the contaminated soils, Alternatives 7 and 8 are eliminated. Alternatives 9 through 12 are eliminated because they apply only to perched groundwater contamination. Alternatives 13 and 14 are eliminated because they apply to facilities designated for possible demolition. Therefore, the alternatives that will be screened for Suboperable Unit B are Alternative 1, 2, 5, and 6. Table 6-6 shows the screening summary for those alternatives that apply to this suboperable unit. Details of the initial screening are given below.

6.2.2.1 Alternative 1 - No Action

This alternative scored 32 out of a possible 50.

6.2.2.1.1 Effectiveness

In the short term, risks to on-site workers and the public immediately off site are considered low, since all material remains in place and undisturbed. However, there is some risk to short-term public health and environmental protection (factors scored a 4) because both the fire training area and the area around the incinerator are outside the FMPC security fence.

Long-term public health and environmental protection are ranked unfavorably since this alternative does not provide for the mitigation of existing contamination (factors scored a 1). In addition, the potential for environmental contamination exists because this alternative does not remove or contain the soil contamination. This alternative does not reduce the toxicity, mobility, or volume of the waste (factor scored a 1).

Overall effectiveness of this alternative scored 11 out of a possible 25.

TABLE 6-6

OPERABLE UNIT 3 SCREENING SUMMARY - SUBOPERABLE UNIT B
OPEN FIELD AREAS WITH GOOD ACCESS TO CONTAMINATED SOILS

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Effectiveness														
Short-term public health	4	4			3	1								
Short-term environmental protection	4	4			3	2								
Long-term public health	1	3			5	5								
Long-term environmental protection	1	3			5	5								
Reduction in toxcity, mobility, or volume	1	1			5	5								
Subtotal	11	15			21	18								
Implementability														
Constructability	5	4			3	3								
Reliability	5	4			4	4								
Maintainability	5	4			4	4								
Agency approvals	1	1			4	3								
Special engineering	5	4			3	3								
Subtotal	21	17			18	17								
Cost	L	L			H	H								
Total	32	32			39	35								

Alternative 1 - No Action
Alternative 2 - Cap
Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap
Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap
Alternative 5 - Mechanical Removal and On-Site Disposal
Alternative 6 - Mechanical Removal and Off-Site Disposal
Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal
Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal
Alternative 9 - Groundwater Extraction, Treatment, and Discharge
Alternative 10 - Groundwater Extraction, Monitoring, Treatment And Discharge
Alternative 11 - Subsurface Barrier
Alternative 12 - Subsurface Barrier and Groundwater Extraction Treatment, and Discharge
Alternative 13 - Facility Removal and On-Site Disposal
Alternative 14 - Facility Removal and Off-Site Disposal

Cost:	Ranking (1 to 5):
L=Low	5-Best Satisfies Criteria
M=Medium	
H=High	1-Least Satisfies Criteria

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6.2.2.1.2 Implementability

The No Action Alternative requires no implementation; therefore, constructability, reliability, maintainability, and special engineering ranked high (factors scored a 5). However, agency approvals may be required for this alternative (factor scored a 1).

Overall implementability of this alternative scored 21 out of a possible 25.

6.2.2.1.3 Cost

There is no incremental cost for this alternative; thus, cost is low.

6.2.2.2 Alternative 2 - Cap

This alternative scored 32 out of a possible 50.

6.2.2.2.1 Effectiveness

This nonremoval alternative represents a minimum action scenario intended to isolate waste and minimize vertical infiltration of rainfall/runoff into and through the soil. A cap will affect the saturation of contaminated materials and will reduce leaching of the contaminants to the groundwater. Capping has low short-term public health and environmental protection risks to the on-site workers because of limited construction and associated exposure time (factors scored a 4). There are little or no expected risks to the public immediately off site. With respect to the long-term public health and environmental protection, the cap will prevent direct contact exposure to individuals from contaminants and will reduce the risks of wind dispersion of the materials. However, this alternative does not address the removal, containment, or treatment of the contaminated soil (factors scored a 3). This alternative does not have any provisions for reducing the toxicity and volume of the contamination. However, this alternative diminishes the mobility by reducing vertical infiltration of precipitation. Even though the cap minimizes rainfall from penetrating the contaminated soils, excess water at the edges of the cap will penetrate vertically, and ultimately, horizontally, into the soils (factor scored a 1).

Overall effectiveness of this alternative scored 15 out of a possible 25.

6.2.2.2.2 Implementability

The constructability factors for a cap are relatively simple. The technology, equipment, manpower, and materials exist and are readily available; however, working conditions at the FMPC can make construction more difficult (factor scored a 4). Capping is also reliable (factor scored a 4), and test methods exist to verify adequate construction.

Maintainability factors for a cap include periodic maintenance (factor scored a 4). If left unattended, natural biological succession will occur and the cap will deteriorate. Eventually, insects and small burrowing animals will penetrate the cap and reach the soil. This opens pathways for precipitation to infiltrate first the cap liner and subsequently the soil itself. Periodic maintenance involves regrading the cap and revegetating the surface.

There are no local agency approvals needed for the implementation of this alternative; however, state and federal agencies are unlikely to accept a cap alone as long-term remedial action. This differs from Problem 1 (confined space) because there is less pedestrian and vehicular traffic and there are sections under this problem area that are not located on the FMPC property (factor scored a 1). There are no special engineering requirements needed for the implementation of this alternative (factor scored a 4).

Overall implementability of this alternative scored 17 out of a possible 25.

6.2.2.2.3 Cost

The total relative cost for this alternative is low.

6.2.2.3 Alternative 5 - Mechanical Removal and On-Site Disposal

This alternative scored 39 out of a possible 50.

6.2.2.3.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated soil (factors scored a 3). On-site workers will be impacted by dust from the removal activity, but there are little or no expected risks to the public immediately off site.

Long-term public health and environmental protection are ranked high due to the permanent storage of the soil (factors scored a 5). The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative scored 21 out of a possible 25.

6.2.2.3.2 Implementability

Constructability factors for this alternative include the capability to use construction equipment for the mechanical removal of the waste and construction of the on-site disposal facility (factor scored a 3). The necessary items such as manpower, technology, equipment, and materials are available; however, working conditions at the FMPC can make construction more difficult. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the on-site disposal facility will include long-term maintenance (factor scored a 4).

There are no local agency approvals needed for this alternative, and state and federal agencies are likely to accept this alternative as a long-term remedial action (factor scored a 4). A special engineering requirement is the design of the on-site disposal facility (factor scored a 3).

Overall implementability of this alternative scored 18 out of a possible 25.

6.2.2.3.3 Cost

The total relative cost for this alternative is high.

6.2.2.4 Alternative 6 - Mechanical Removal and Off-Site Disposal

This alternative scored 35 out of a possible 50.

6.2.2.4.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated soil. On-site workers will be impacted by dust from the removal activity, but there are little or no expected risks to the public immediately off site. The local community will be affected by the traffic flow of the contaminated waste to the off-site disposal facility. Public road transport of contaminated waste is more likely to affect public health than

the environment; therefore, the short-term public health risk (factor scored a 1) is higher than the short-term environmental risk (factor scored a 2). Long-term public health and environmental protection are ranked high (factors scored a 5) due to the permanent storage of the waste off site. The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative scored 18 out of a possible 25.

6.2.2.4.2 Implementability

Constructability factors for this alternative include the capability to use construction equipment for the mechanical removal of the soil and construction of a temporary on-site storage structure; however, working conditions at the FMPC can make construction difficult (factor scored a 3). The necessary items such as manpower, technology, equipment, and materials are available. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the off-site disposal facility will include periodic long-term maintenance (factor scored a 4).

Transportation of contaminated wastes off site will be in compliance with NRC40CFR and 49CFR. State hazard permits will be required from all transportation route states that have this requirement. These permits will be obtained by the company transporting the waste (factor scored a 3). Special engineering requirements include anticipated design of the off-site disposal facility (factor scored a 3).

Overall implementability of this alternative scored 17 out of a possible 25.

6.2.2.4.3 Cost

The total relative cost for this alternative is high.

6.3 SUBOPERABLE UNIT C: SOIL CONTAMINATION UNDER FACILITIES

Suboperable Unit C is defined as soil contamination under facilities. Unlike Suboperable Unit D, these facilities have not been designated for possible demolition. Figures 6-5 and 6-6 illustrate the Suboperable Unit C areas. The alternatives considered for this suboperable unit consist of nonremoval or interim actions. It is assumed for the nonremoval actions that the

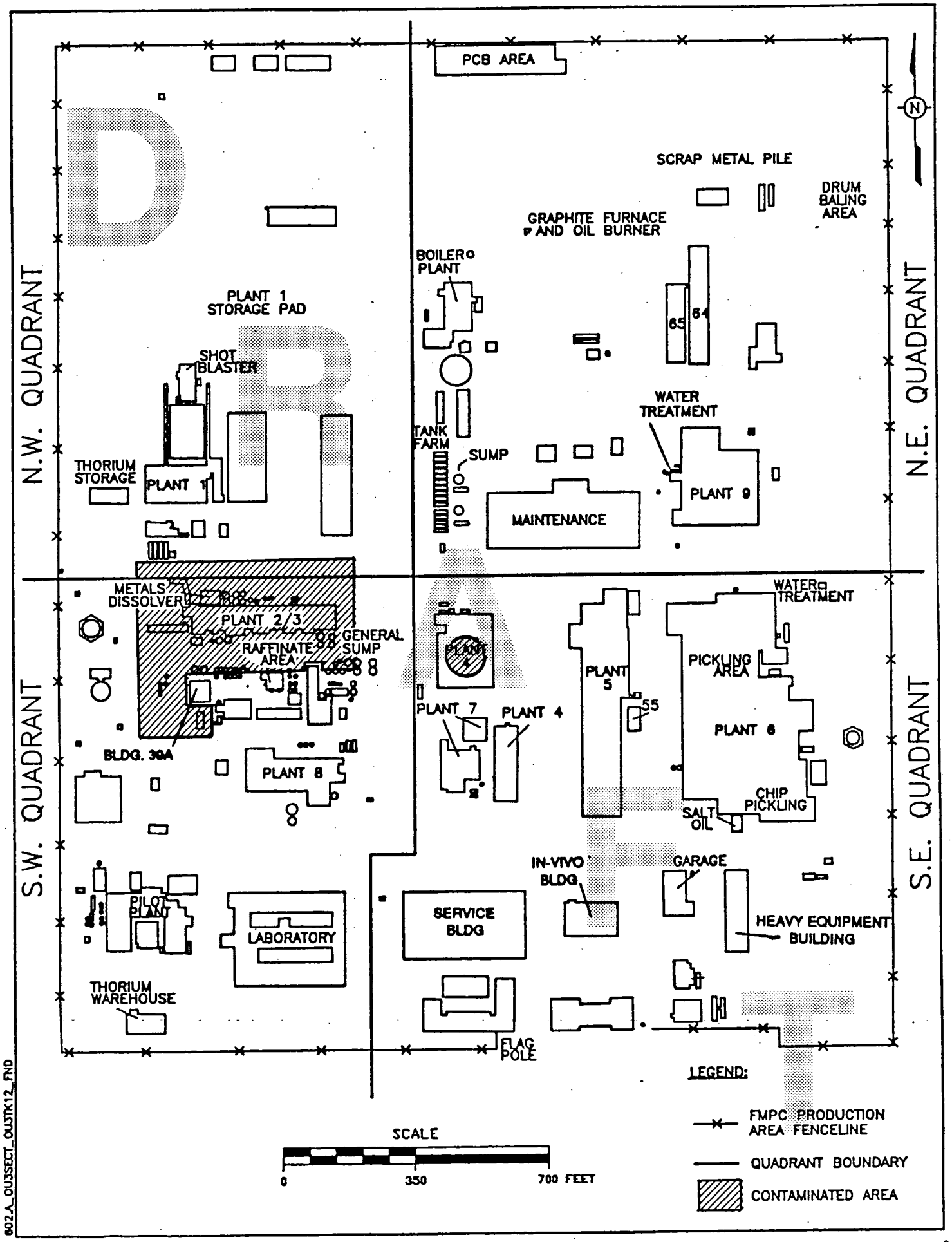

FIGURE 6-5. OPERABLE UNIT 3 CONTAMINATED AREAS - SUBOPERABLE UNIT C

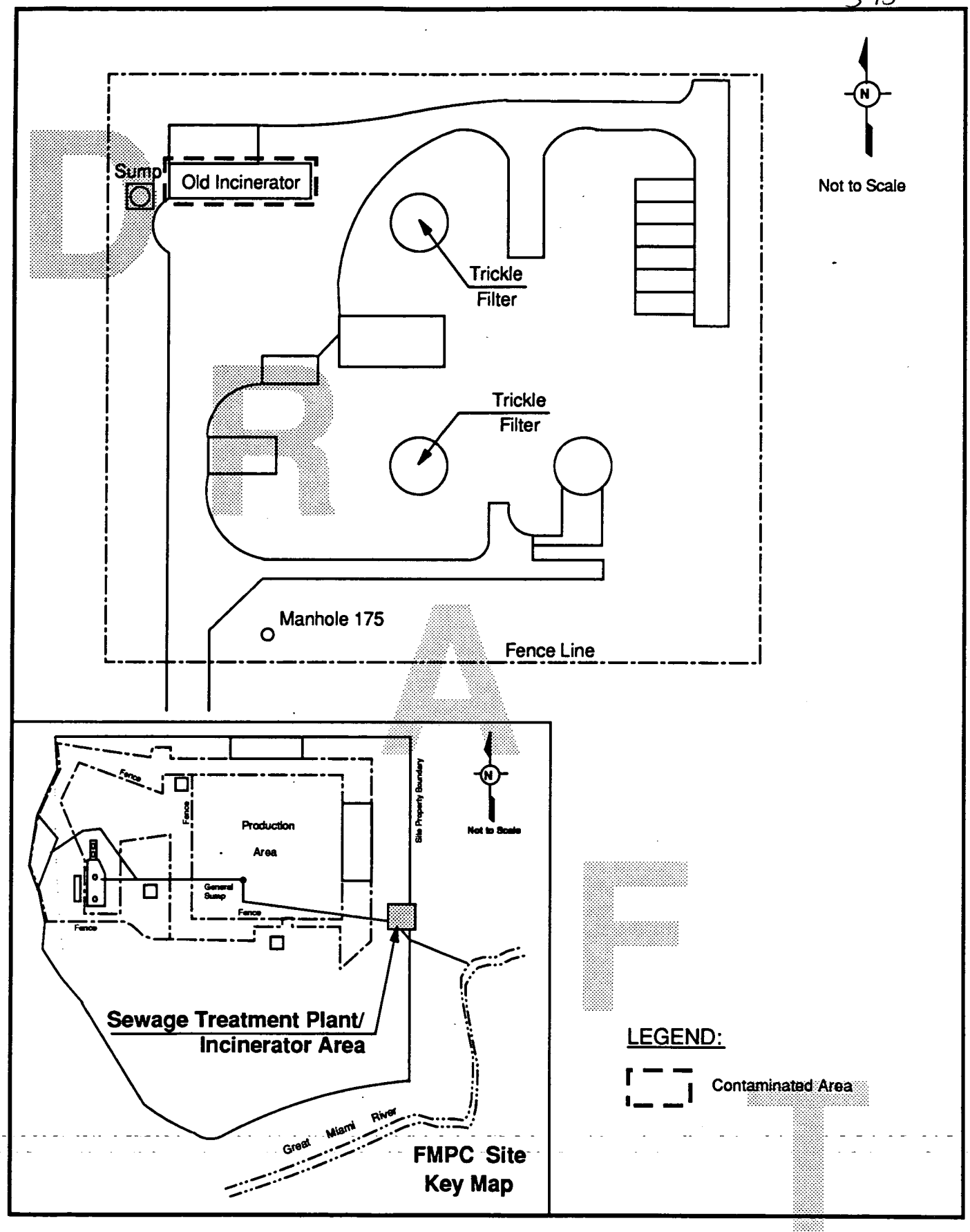

FIGURE 6-6. OPERABLE UNIT 3 SEWAGE TREATMENT PLANT/INCINERATOR AREA

facility will not be removed. Under the interim action scenario, the facility will be removed at some undetermined time in the future. Until that time, the facility will remain and be one part of the interim remedial action. Table 6-7 lists the areas and sizes of the contamination zones. The volumes in this table were calculated by taking the sum of the volumes at the various depths as discussed in the Section 6.1 example.

6.3.1 Area Descriptions

6.3.1.1 Plant 2/3, Refinery

This area is contained within the boundaries of Plant 2/3, the general sump, and the raffinate area. The total volume of uranium-contaminated soil is approximately 1,182,500 cubic feet. The sources of uranium contamination leakage are the sumps in three areas: southeast of Plant 2/3, southwest of Plant 2/3, and northwest of Plant 2/3 (WMCO 1989). Contamination from these three sources has dispersed throughout the area, resulting in contamination as deep as 20 feet. The mobile forms of uranium contamination are moving into the perched water, which is addressed in Suboperable Unit F. The uranium concentration in these sections is well in excess of 200 ppm, and is higher than 1000 ppm in the sumps southwest of Plant 2/3.

6.3.1.2 Plant 4, Green Salt Plant

Within Plant 4, there are two sumps: the Plant 4 sump and the tank farm sump. Uranium contamination is suspected to have leaked into the soil from these sumps (WMCO 1989). The total volume of uranium contamination is approximately 11,800 cubic feet. Most uranium concentrations are between 50 and 200 ppm, but there is one area 50 feet in diameter (centered around the Plant 4 sump) that exceeds 200 ppm.

6.3.1.3 Incinerator

The incinerator building is approximately 75 feet long by 25 feet wide. It is located in the northwest corner of the sewage treatment plant/incinerator area east of the Production Area. The total volume of the uranium contamination under the facility is approximately 2800 cubic feet. Sampling shows uranium contamination to be in excess of 200 ppm. Soil samples indicate that there is uranium contamination only under part of the facility.

TABLE 6-7

OPERABLE UNIT 3 URANIUM CONTAMINATED SOILS - SUBOPERABLE UNIT C

Area	Depth (Feet) 0.0 - 1.5	1.5 - 3.0	3.0 - 5.5	10 - 15	15 - 20	Volume (ft^3)
Plant 2/3, Refinery	300'x100' / 50' Dia / 500'x350'	25' Dia / 300'x100'	150'x25' / 300'X200'	2@25' Dia / 400'x200'	2@50' Dia / 200'x100' / 300'X150'	1,182,500
Plant 4, Green Salt Plant	50' Dia / 100' Dia	– / –	– / –	– / –	– / –	11,800
Incinerator	75'x25' / –	– / –	– / –	– / –	– / –	2800
					Total Volume (ft^3)	1,197,100

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NOTE:

Measurement= Dimension of Contaminated Material with Uranium Concentrations between 50 and 200ppm	Measurement= Dimension of Contaminated Material with Uranium Concentrations >200ppm

– = Uranium Concentrations Less than 50 ppm

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6.3.2 Alternatives

Because this suboperable unit addresses contamination under facilities, Alternatives 2, 3, and 4 have been eliminated from consideration. Alternatives 9 through 12 are eliminated because they apply only to perched groundwater contamination. Alternatives 13 and 14 are eliminated because they apply to facilities designed for possible demolition. Alternatives 1, 5, 6, 7, and 8 apply. Table 6-8 shows the screening summary for those alternatives that apply to this suboperable unit. Details of the initial screening are given below.

6.3.2.1 Alternatives 1 - No Action

This alternative scored 34 out of a possible 50.

6.3.2.1.1 Effectiveness

In the short term, risks to on-site workers and the public immediately off site are considered low; therefore, the ranking of the short-term public health and environmental protection is high (factors scored a 5) because all material remain in place and undisturbed. Long-term public health and environmental protection are ranked unfavorably because this alternative does not mitigate existing contamination (factors scored a 1). In addition, the potential for environmental contamination exists because this alternative does not remove or contain the soil contamination. This alternative does not reduce the toxicity, mobility, or volume of the waste (factor scored a 1).

Overall effectiveness of this alternative scored 13 out of a possible 25.

6.3.2.1.2 Implementability

The No Action Alternative requires no implementation; therefore, constructability, reliability, maintainability, and special engineering ranked high (factors scored a 5). However, agency approvals may be required for this alternative (factor scored a 1).

Overall implementability of this alternative scored 21 out of a possible 25.

6.3.2.1.3 Cost

There is no incremental cost for this alternative; thus, cost is low.

TABLE 6-8

OPERABLE UNIT 3 SCREENING SUMMARY - SUBOPERABLE UNIT C
SOIL CONTAMINATION UNDER FACILITIES

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Effectiveness														
Short-term public health	5				3	1	3	1						
Short-term environmental protection	5				3	2	2	2						
Long-term public health	1				5	5	5	5						
Long-term environmental protection	1				5	5	5	5						
Reduction in toxcity, mobility, or volume	1				5	5	4	4						
Subtotal	13				21	18	19	17						
Implementability														
Constructability	5				2	2	3	3						
Reliability	5				4	4	4	4						
Maintainability	5				4	4	4	4						
Agency approvals	1				4	3	2	1						
Special engineering	5				2	2	3	3						
Subtotal	21				16	15	16	15						
Cost	L				H	H	H	H						
Total	34				37	33	35	32						

Alternative 1 - No Action
Alternative 2 - Cap
Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap
Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap
Alternative 5 - Mechanical Removal and On-Site Disposal
Alternative 6 - Mechanical Removal and Off-Site Disposal
Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal
Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal
Alternative 9 - Groundwater Extraction, Treatment, and Discharge
Alternative 10 - Groundwater Extraction, Monitoring, Treatment And Discharge
Alternative 11 - Subsurface Barrier
Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge
Alternative 13 - Facility Removal and On-Site Disposal
Alternative 14 - Facility Removal and Off-Site Disposal

Cost:	Ranking (1 to 5):
L=Low	5-Best Satisfies Criteria
M=Medium	
H=High	1-Least Satisfies Criteria

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6.3.2.2 Alternative 5 - Mechanical Removal and On-Site Disposal

This alternative scored 37 out of a possible 50.

6.3.2.2.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated waste (factors scored a 3). On-site workers will be impacted by dust from the removal action, but there is little or no expected risk to the public immediately off site. Long-term public health and environmental protection are ranked high due to the permanent storage of the soil (factors scored a 5). The treatment of the soil will reduce the volume and mobility of contaminants (factor scored a 5).

Overall effectiveness of this alternative is 21 out of a possible 25.

6.3.2.2.2 Implementability

Prior to any activities, the facility will be evacuated and isolated. Constructability factors for this alternative include the capability to use construction equipment to mechanically remove the soil in a technique similar to mining operations. The foundation of the facility will be physically supported throughout the removal of the contaminated soils and the reinsertion of the clean soil. Difficulties to excavate under the facility are anticipated. An on-site disposal facility to house the waste can be constructed. Manpower, technology, equipment, and materials are available; however, working conditions at the FMPC can make construction difficult (factor scored a 2). The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the on-site disposal facility will include periodic long-term maintenance (factor scored a 4).

Sumps highlighted in the area descriptions can be addressed as a potential source of contamination into the soils and groundwater. The source of the leak within the sump will be isolated. If the sump is repairable, then a spot decontamination and repair action will be performed. If the sump is not repairable, then it will be removed and replaced. Monitoring of the sump will continue through its life span.

There are no local agency approvals needed for this alternative, state and federal agencies are likely to accept this alternative as a long-term remedial action (factor scored a 4).

Significant special engineering will be required to design the on-site disposal facility and, especially, to design the shoring and excavation program for removal of contaminants under existing buildings. In addition, construction logistics problems are expected to be very difficult for contaminated soils removal under existing buildings (factor scored a 2).

Overall implementability of this alternative scored 16 out of a possible 25.

6.3.2.2.3 Cost

The total relative cost for this alternative is high.

6.3.2.3 Alternative 6 - Mechanical Removal and Off-Site Disposal

This alternative scored 33 out of a possible 50.

6.3.2.3.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated waste. On-site workers will be impacted by dust from the removal action, but there is little or no expected risk to the public immediately off site. The local community will be affected by the traffic flow of the contaminated waste to the off-site disposal facility. Public road transport of contaminated waste is more likely to affect public health than the environment; therefore, the short-term public health risk (factor scored a 1) is higher than the short-term environmental risk (factor scored a 2). Long-term public health and environmental protection are ranked high (factors scored a 5) due to the permanent disposal of the waste off site. The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative is 18 out of a possible 25.

6.3.2.3.2 Implementability

Prior to any activities, the facility will be evacuated and isolated. Constructability factors for this alternative include the capability to use construction equipment to mechanically remove the soil in a technique similar to mining operations. The foundation of the facility will be physically supported throughout the removal of the contaminated soils and the reinsertion of the clean

soil. A temporary on-site storage structure can be constructed. Manpower, technology, equipment, and materials are available; however, working conditions at the FMPC can make construction difficult (factor scored a 2). The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the off-site disposal facility will include long-term maintenance (factor scored a 4).

The sumps highlighted in the area descriptions can be addressed as a potential source of contamination into the soil and groundwater as detailed in Alternative 5.

Transportation of contaminated wastes off site will be in compliance with NCR40CFR and 40CFR. State hazard permits will be required from all transportation route states that have this requirement. These permits will be obtained by the company transporting the waste (factor scored a 3). Significant special engineering will be required to design the temporary on-site disposal facility, the off-site disposal facility, and, especially, to design the shoring and excavation program for removal of contaminants under existing buildings. In addition, construction logistics problems are expected to be very difficult for contaminated soils removal under existing buildings (factor scored a 2).

Overall implementability of this alternative scored 15 out of a possible 25.

6.3.2.3.3 Cost

The total relative cost for this alternative is high.

6.3.2.4 Alternative 7 - Near Term: Temporary Cap; Far Term: Mechanical Removal and On-Site Disposal

This alternative scored 35 out of a possible 50.

6.3.2.4.1 Effectiveness

For short-term public health, this alternative limits contact with surficial contamination. Once the facilities are removed, workers will be exposed to hazardous materials during removal and handling. There is little or no expected increase in risk, in the short term, to the public immediately off site (factor scored a 3). Short-term environmental risk is increased because the contaminated material remains in place (factor scored a 2). There are fewer problems

associated with long-term public health and environmental protection because the material will be isolated from the public in a permanent facility (factors scored a 5). The soils will remain in place until after the facilities are demolished, but after mechanical removal, treatment of the soils will reduce the volume and mobility of the contaminants (factor scored a 4).

Overall effectiveness of this alternative scored 19 out of a possible 25.

6.3.2.4.2 Implementability

Constructability factors for this alternative include construction of a temporary cap of an epoxy-based or polyurethane coating on the floor of the facility. For regions with contaminated open areas surrounding the facility, a single-layer cap will be applied to prevent contact with surficial contamination. The cap will consist of a concrete and/or bituminous asphalt layer and will be removed with the soils, after the facilities are removed.

Once the facilities are removed, the contaminated soil will be removed with construction equipment. The on-site disposal facility can be constructed; however, working conditions at the FMPC can make construction more difficult (factor scored a 3). The necessary items such as manpower, technology, equipment, and materials are available. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the on-site disposal facility will include periodic long-term maintenance (factor scored a 4).

The sumps highlighted in the area descriptions can be addressed as a continual source of contamination into the soil and groundwater as described in Alternative 4.

No local agency approvals are needed; however, state and federal agencies are unlikely to accept this alternative for near-term remedial action due to the delays in time required for the remediation of the site under this alternatives (factor scored a 2).

Special engineering requirements are the coordination of the mechanical removal equipment with the underground utilities and the aboveground structures within the region, and the design of the on-site disposal facility (factor scored a 3).

Overall implementability of this alternative scored 16 out of a possible 25.

6.3.2.4.3 Cost

The total relative cost for this alternative is high.

6.3.2.5 Alternative 8 - Near Term: Temporary Cap; Far Term: Mechanical Removal and Off-Site Disposal

This alternative scored 32 out of a possible 50.

6.3.2.5.1 Effectiveness

For short-term public health and environmental protection, this alternative limits contact with surficial contamination. Once the facilities are removed, workers will be exposed to hazardous materials during removal and handling, but there is no expected increase in risk to the public immediately off site. The local community will be affected by the traffic flow of contaminated waste to the off-site disposal facility. Public road transport of contaminated waste is more likely to affect public health than the environment; therefore, the short-term public health risk (factor scored a 1) is higher than the short-term environmental risk (factor scored a 2). There are less risks associated with the long-term public health and environmental protection because the material will be isolated from the public in a permanent facility off site (factors scored a 5). The soils will remain in place until after the facilities are demolished, but after mechanical removal, treatment of the soils will reduce the volume and mobility of the contaminants (factor scored a 4).

Overall effectiveness of this alternative scored 17 out of a possible 25.

6.3.2.5.2 Implementability

Constructability factors for this alternative include construction of a temporary cap consisting of an epoxy based or polyurethane coating on the floor of the facility. For regions with contaminated open areas surrounding the facility, a single-layer cap will be applied to minimize contact with surficial contamination. The cap will consist of a concrete and/or bituminous asphalt layer that will be removed with the soils after the facilities are removed.

Once the facilities are removed, the contaminated soil will be removed with construction equipment. A temporary on-site storage structure can be readily constructed (factor scored a 3). The necessary items such as manpower, technology, equipment, and materials are available; however, working conditions at the FMPC can make construction more difficult.

The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the off-site disposal facility will include periodic maintenance (factor scored a 4).

The sumps highlighted in the area descriptions can be addressed as a continual source of contamination into the soil and groundwater as described in Alternative 4.

Transportation of contaminated wastes off site will be in compliance with NRC40CFR and 49CFR. State hazard permits will be required from all transportation route states that have this requirement. These permits will be obtained by the company transporting the waste. State and federal agencies are unlikely to accept this alternative for near-term remediation due to delays in time required for remediation (factor scored a 1). Special engineering requirements are the coordination of the construction equipment with the underground utilities and the aboveground structures within the region (factor scored a 3).

Overall implementability of this alternative scored 15 out of a possible 25.

6.3.2.5.3 Cost

The total relative cost for this alternative is high.

6.4 SUBOPERABLE UNIT D: SOIL CONTAMINATION UNDER FACILITIES DESIGNATED FOR POSSIBLE DEMOLITION

Suboperable Unit D is defined as soil contamination under facilities designated for possible demolition. Figure 6-7 illustrates the Suboperable Unit D areas. The alternatives considered for this problem consist of nonremoval, interim, and excavation actions. It is assumed for the nonremoval actions that the facility will not be removed. Under the interim action scenario, the facility will be removed at some undetermined time in the future. Until that time, the facility will remain and be one part of the interim remedial action. For the excavation action,

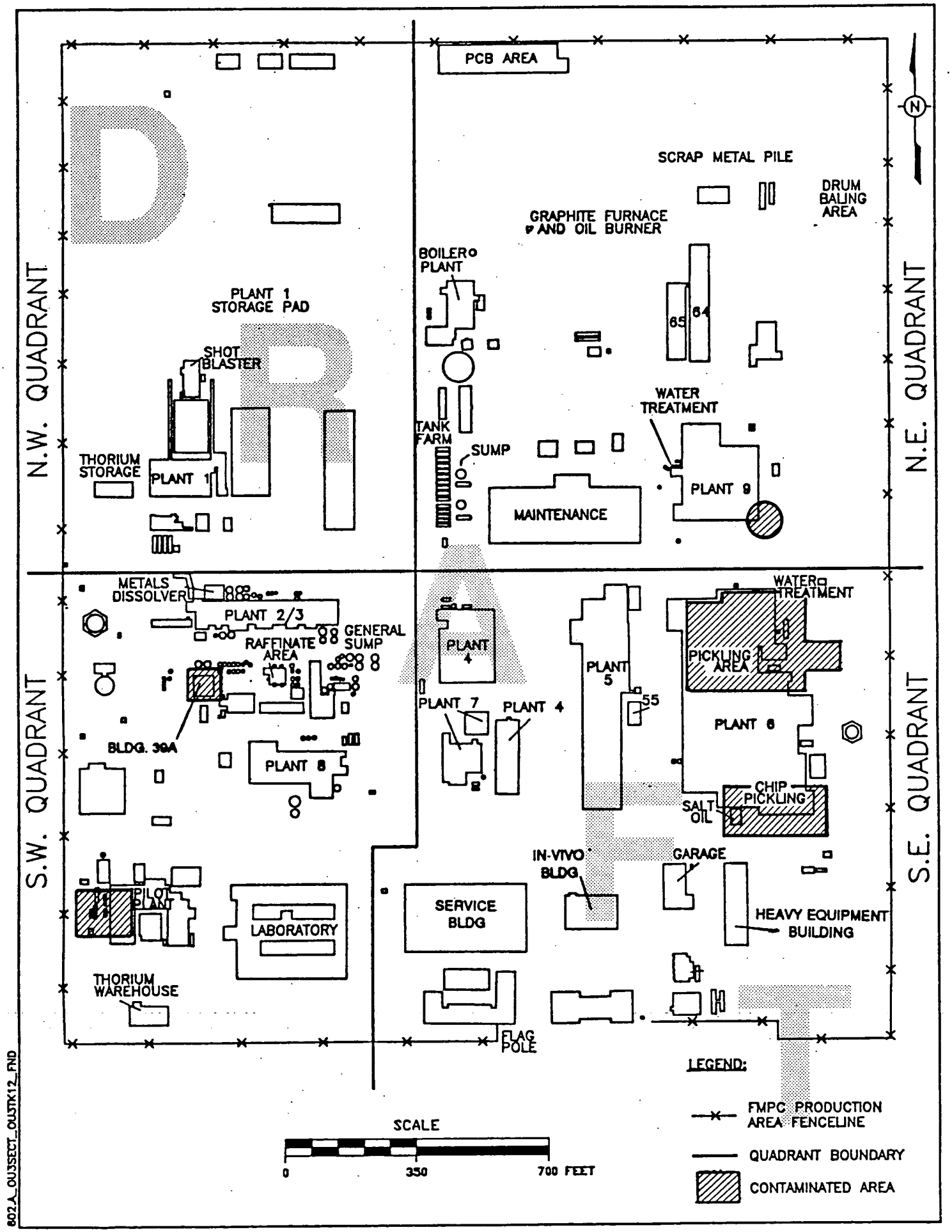

FIGURE 6-7. OPERABLE UNIT 3 CONTAMINATED AREAS - SUBOPERABLE UNIT D

both the facility and contaminated soils will be removed Table 6-9 lists the areas and sizes of the contamination zones. The volumes in this table were calculated by taking the sum of the volumes at the various depths as discussed in the Section 6.1 example.

6.4.1 Area Description

6.4.1.1 Plant 6 Pickling Area

This area consist of the pickling area and the water treatment area in Plant 6. The sump on the east side of the pickling area and the sump in the water treatment area appear to be sources of uranium contamination (WMCO 1989). The total volume of uranium-contaminated soil is approximately 1,627,500 cubic feet. Hazardous Substance List organics were found in this same area in only one six-inch interval. The source of the organics has not been identified. Areas with uranium concentrations in excess of 200 ppm permeate the entire depth.

6.4.1.2 Plant 6 Chip Pickling Area

Uranium contamination has spread from the chip pickling area through the salt oil area. The total volume of uranium-contaminated soil in this region is approximately 127,500 cubic feet. One area of contamination with uranium concentrations greater than 200 ppm is located on the surface with a size of 150 feet by 50 feet continuing to a depth of 5.5 feet with a size of 20 feet in diameter. The uranium contamination is suspected to have leaked from the sump and trench in the chip pickling room and the catch basin for the salt oil (WMCO 1989).

With respect to Alternatives 13 and 14, both areas of Plant 6, the Pickling Area and Chip Pickling Area, will be addressed as a unit.

6.4.1.3 Plant 9, Special Products Plant

Plant 9 is a metal production plant. The uranium contamination in the soil appears to be located primarily near the sump outside the southeast corner of Plant 9 (WMCO 1989). There is also a small area of uranium contamination under the southeast corner of the plant. The total volume of uranium contamination is approximately 39,250 cubic feet. There is also a

TABLE 6-9

OPERABLE UNIT 3 URANIUM CONTAMINATED SOILS - SUBOPERABLE UNIT D

Area	Depth (Feet) 0.0 - 1.5	1.5 - 3.0	3.0 - 5.5	10 - 15	15 - 20	Volume (ft^3)
Plant 6 Pickling Area	150'x25' / 25' Dia / 350'x300'	3@25' Dia / 350'x300'	1@25' Dia / 100' Dia / 350'x300'	2@25' Dia / 350'x300'	1@100' Dia / 350'x300'	1,627,500
Plant 6 Chip Pickling Area	150'x50' / 200'x125'	1@20' Dia / 150'x150'	1@20' Dia / 150'x150'	-- / --	-- / --	127,500
Plant 9, Special Products Plant	25' Dia / 100' Dia	25' Dia / 75' Dia	25' Dia / 75' Dia	25' Dia / 50' Dia	-- / --	39,250
Building 39A, Incinerator	100'x50' / 100'x100'	25' Dia / 175'x100'	-- / 100'x100'	-- / 100' Dia	50' Dia / 150'x100'	180,500
Pilot Plant and Pilot Plant Tank Farm	25' Dia / 225'x200'	-- / 50' Dia	-- / 50'x75'	30' Dia / 125'x75'	-- / --	126,700
					Total Volume (ft^3)	2,101,450

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NOTE:

Measurement= Dimension of Contaminated Material with Uranium Concentrations between 50 and 200ppm	Measurement= Dimension of Contaminated Material with Uranium Concentrations >200ppm

-- = Uranium Concentrations Less than 50 ppm

25-foot diameter area, between 0 and 1.5 feet in depth, with uranium concentrations greater than 200 ppm. The uranium contamination in the area emanates from a sump at the southeast corner of Plant 9. Sample testing has also shown very high levels of chlorinated solvents in the soil at a depth of 5 feet.

6.4.1.4 Building 39A, Incinerator

Building 39A contains two separate incinerators: a Kelly incinerator and a Trane incinerator. These incinerators were used for the destruction of solid and liquid wastes. The total volume of uranium contamination is approximately 180,500 cubic feet. There is one area of approximately 5000 square feet, extending from 0 to 1.5 feet in depth, with uranium concentrations exceeding 200 ppm. A second area approximately 25 feet in diameter, between 1.5 and 3.0 feet in depth, contains uranium concentrations in excess of 200 ppm. A third area approximately 150 feet in diameter, between 15 and 20 feet in depth, shows uranium concentrations in excess of 200 ppm.

6.4.1.5 Pilot Plant and Pilot Plant Tank Farm

At the western edge of the pilot plant main building, sampling shows uranium concentration in excess of 200 ppm that extend under the pilot plant main building and tank farm structures. A small rectangular area adjacent to the south side of the pilot plant main building was identified as an underground tank storage site that leaked radioactive material into the soil. Uranium contamination appears to be liquids leaking into the soil (WMCO 1989). Soil samples at 0- to 1.5- and 10- to 15-foot depths indicate significant levels of uranium contamination with concentrations greater than 200 ppm. The total volume of uranium-contaminated soil in this area is approximately 126,700 cubic feet.

6.4.2 Alternatives

Since Suboperable Unit D addresses contamination under facilities, Alternatives 2, 3, and 4 have been eliminated from consideration. Alternatives 9 through 12 are also eliminated because they apply only to perched groundwater contamination. Alternatives 1, 5, 6, 7, 8, 13, and 14 apply. Table 6-10 shows the screening summary for those alternatives that apply to this suboperable unit. Details of the initial screening are given below.

TABLE 6-10

OPERABLE UNIT 3 SCREENING SUMMARY - SUBOPERABLE UNIT D
SOIL CONTAMINATION UNDER FACILITIES DESIGNATED FOR POSSIBLE DEMOLITION

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Effectiveness														
Short-term public health	5				3	1	3	1					2	1
Short-term environmental protection	5				3	2	2	2					2	2
Long-term public health	1				5	5	5	5					5	5
Long-term environmental protection	1				5	5	5	5					5	5
Reduction in toxcity, mobility, or volume	1				5	5	4	4					5	5
Subtotal	13				21	18	19	17					19	18
Implementability														
Constructability	5				2	2	3	3					2	2
Reliability	5				4	4	4	4					4	4
Maintainability	5				4	4	4	4					4	4
Agency approvals	1				4	3	2	1					4	3
Special engineering	5				2	2	3	3					3	3
Subtotal	21				16	15	16	15					17	16
Cost	L				H	H	H	H					H	H
Total	34				37	33	35	32					36	34

Alternative 1 - No Action
Alternative 2 - Cap
Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap
Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap
Alternative 5 - Mechanical Removal and On-Site Disposal
Alternative 6 - Mechanical Removal and Off-Site Disposal
Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal
Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal
Alternative 9 - Groundwater Extraction, Treatment, and Discharge
Alternative 10 - Groundwater Extraction, Monitoring, Treatment And Discharge
Alternative 11 - Subsurface Barrier
Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge
Alternative 13 - Facility Removal and On-Site Disposal
Alternative 14 - Facility Removal and Off-Site Disposal

Cost:	Ranking (1 to 5):
L=Low	5-Best Satisfies Criteria
M=Medium	1-Least Satisfies Criteria
H=High	

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195

545

6.4.2.1 Alternative 1 - No Action

This alternative scored 34 out of a possible 50.

6.4.2.1.1 Effectiveness

In the short term, risks to on-site workers and the public immediately off site are considered low. Therefore, the ranking of the short-term public health and environmental protection is high (factors scored a 5) because all material remains in place and undisturbed. Long-term public health and environmental protection are ranked unfavorably because this alternative does not mitigate existing contamination (factors scored a 1). In addition, the potential for environmental contamination remains as it is because this alternative does not remove or contain the soil contamination. This alternative does not reduce the toxicity, mobility, or volume of the waste (factor scored a 1).

Overall effectiveness scored 13 out of a possible 25.

6.4.2.1.2 Implementability

The No Action Alternative requires no implementation; therefore, constructability, reliability, maintainability, and special engineering ranked high (factors scored a 5). However, agency approvals may be required for this alternative (factor scored a 1).

Overall implementability of this alternative scored 21 out of a possible 25.

6.4.2.1.3 Cost

There is no incremental cost for this alternative; thus, cost is low.

6.4.2.2 Alternative 5 - Mechanical Removal and On-Site Disposal

This alternative scored 37 out of a possible 50.

6.4.2.2.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated waste (factors scored a 3). On-site workers will be impacted by dust from the removal action, but there is little or no expected risk to the public immediately off site.

Long-term public health and environmental protection are ranked high due to the permanent storage of the soil (factors scored a 5). The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative is 21 out of a possible 25.

6.4.2.2.2 Implementability

Prior to any activities, the facility will be evacuated and isolated. Constructability factors for this alternative include the capability to use construction equipment to mechanically remove the soil in a technique similar to mining operations. The foundation of the facility will be physically supported throughout the removal of the contaminated soils and the reinsertion of the clean soil. Difficulties to excavate under the facility are anticipated. An on-site disposal facility can be constructed; however, working conditions at the FMPC can make construction difficult (factor scored a 2). Manpower, technology, equipment, and materials are available. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the on-site disposal facility will include periodic long-term maintenance (factor scored a 4). There are no local agency approvals needed for this alternative, and state and federal agencies are likely to accept this alternative as a long-term remedial action (factor scored a 4).

Significant special engineering will be required to design the on-site disposal facility and, especially, to design the storing and excavation program for removal of contaminants under existing buildings. In addition, construction logistics problems are expected to be very difficult for contaminated soils removal under existing buildings (factor scored a 2).

Overall implementability of this alternative scored 16 out of a possible 25.

6.4.2.2.3 Cost

The total relative cost for this alternative is high.

6.4.2.3 Alternative 6 - Mechanical Removal and Off-Site Disposal

This alternative scored 33 out of a possible 50.

6.4.2.3.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated waste. On-site workers will be impacted by dust from the removal action, but there is little or no expected risk to the public immediately off site. The local community will be affected by the traffic flow of the contaminated waste to the off-site disposal facility. Public road transport of contaminated waste is more likely to affect public health than the environment; therefore, the short-term public health risk (factor scored a 1) is higher than the short-term environmental risk (factor scored a 2). Long-term public health and environmental protection are ranked high (factors scored a 5) due to the permanent disposal of the waste off site. The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative is 18 out of a possible 25.

6.4.2.3.2 Implementability

Prior to any activities, the facility will be evacuated and isolated. Constructability factors for this alternative include the capability to use construction equipment to remove the soil in a technique similar to mining operations. The foundation of the facility will be physically supported throughout the removal of the contaminated soil and the reinsertion of the clean soil. A temporary on-site storage structure can be constructed; however, working conditions at the FMPC can make construction difficult (factor scored a 2). Manpower, technology, equipment, and materials are available. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the off-site disposal facility will include long-term maintenance (factor scored a 4).

Transportation of contaminated wastes off site will be in compliance with NRC40CFR and 49CFR. State hazard permits will be required from all transportation route states that have this requirement. These permits will be obtained by the company transporting the waste (factor scored a 3). Significant special engineering will be required to design the temporary on-site

disposal facility, the off-site disposal facility, and, especially, to design the shoring and excavation program for removal of contaminants under existing buildings. In addition, construction logistics problems are expected to be very difficult for contaminated soils removal under existing buildings (factor scored a 2).

Overall implementability of this alternative scored 15 out of a possible 25.

6.4.2.3.3 Cost

The total relative cost for this alternative is high.

6.4.2.4 Alternative 7 - Near Term: Temporary Cap; Far Term: Mechanical Removal and On-Site Disposal

This alternative scored 35 out of a possible 50.

6.4.2.4.1 Effectiveness

For short-term public health this alternative limits contact with surficial contamination. Once the facilities are removed, workers will be exposed to hazardous materials during removal and handling. There is little or no expected increase in risk to the public immediately off site (factor scored a 3). Short-term environmental risk is increased because the contaminated material remains in place (factor scored a 2). There are fewer problems associated with long-term public health and environmental protection because the material will be isolated from the public in a permanent facility (factors scored a 5). the soils will remain in place until after the facilities are demolished, but after mechanical removal, treatment of the soils will reduce the volume and mobility of the contaminants (factor scored a 4).

Overall effectiveness of this alternative scored 19 out of a possible 25.

6.4.2.4.2 Implementability

Constructability factors for this alternative include construction of a temporary cap consisting of an epoxy-based or polyurethane coating on the floor of the facility. For regions with contaminated open areas surrounding the facility, a single-layer cap will be applied to prevent contact with surficial contamination. The cap will consist of a concrete and/or bituminous asphalt layer and will be removed with the soils, after the facilities are removed. Once the

facilities are removed, the contaminated soil will be removed with construction equipment. An on-site disposal facility can be constructed (factor scored a 3); however, working conditions at the FMPC can make construction more difficult. The necessary items such as manpower, technology, equipment, and materials are available. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the on-site disposal facility will include periodic long-term maintenance (factor scored a 4).

No local agency approvals are needed; however, state and federal agencies are unlikely to accept this alternative for near-term remedial action due to delays in time required for the remediation of the site under this alternative (factor scored a 2).

Special engineering requirements are the coordination of the mechanical removal equipment with the underground utilities and the aboveground structures within the region, and the design of the on-site disposal facility (factor scored 3).

Overall implementability of this alternative scored 16 out of a possible 25.

6.4.2.4.3 Cost

The total relative cost for this alternative is high.

6.4.2.5 Alternative 8 - Near Term: Temporary Cap; Far Term: Mechanical Removal and Off-Site Disposal

This alternative scored 32 out of a possible 50.

6.4.2.5.1 Effectiveness

For short-term public health and environmental protection, this alternative limits contact with surficial contamination. Once the facilities are removed, workers will be exposed to hazardous materials during removal and handling, but there is no expected increase in risk to the public immediately off site. The local community will be affected by the traffic flow of contaminated waste to the off-site disposal facility. Public road transport of contaminated waste is more likely to affect public health than the environment; therefore, the short-term public health risk (factor scored a 1) is higher than the short-term environmental risk (factor scored a 2). There are less

problems associated with the long-term public health and environmental protection because the material will be isolated from the public in a permanent facility off site (factors scored a 5). The soils will remain in place until after the facilities are demolished, but after mechanical removal, treatment of the soils will reduce the volume and mobility of the contaminants (factor scored a 4).

Overall effectiveness of this alternative scored 17 out of a possible 25.

6.4.2.5.2 Implementability

Constructability factors for this alternative include construction of a temporary cap consisting of an epoxy-based or polyurethane coating on the floor of the facility. For regions with contaminated open areas surrounding the facility, a single-layer cap will be applied to prevent contact with surficial contamination. The cap will consist of a concrete and/or bituminous asphalt layer and will be removed with the soils, after the facilities are removed.

Once the facilities are removed, the contaminated soil will be removed with construction equipment. A temporary on-site storage structure can be readily constructed; however, working conditions at the FMPC can make construction difficult (factor scored a 3). The necessary items such as manpower, technology, equipment, and materials are available. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the off-site disposal facility will include periodic maintenance (factor scored a 4).

Transportation of contaminated wastes off site will be in compliance with NRC40CFR and 49CFR. State hazard permits will be required from all transportation route states that have this requirement. These permits will be obtained by the company transporting the waste. State and federal agencies are unlikely to accept this alternative for near-term remediation due to delays in time required for remediation (factor scored a 1). Special engineering requirements are the coordination of the construction equipment with the underground utilities and the aboveground structures within the region (factor scored a 3).

Overall implementability of this alternative scored 15 out of a possible 25.

6.4.2.5.3 Cost

The total relative cost for this alternative is high.

6.4.2.6 Alternative 13 - Facility Removal and On-Site Disposal

This alternative scored 36 out of a possible 50.

6.4.2.6.1 Effectiveness

Short-term public health and environmental protection are impacted by the actual excavation of the facility and the underlying soil. On-site workers will be impacted by dust from the removal action, but there is little or no expected risk to the public immediately off-site. For on-site activities, airborne releases would have the most direct potential impact on the community in the short-term (factors scored a 2). Long-term public health and environmental protection is ranked high (factors scored a 5) because residuals or untreated material will be isolated from the community in the on-site disposal facility. Because all contaminated waste (soil and facility) will be disposed of, the remaining risk is low. The volume and toxicity are not significantly reduced because the waste will remain in an on-site disposal facility, but the contaminated waste will be isolated. The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored 1 5).

Overall effectiveness of this alternative scored 19 out of a possible 25.

6.4.2.6.2 Implementability

The facility will be evacuated and isolated prior to any activities. Constructability factors for this alternative include the capability to use construction equipment to mechanically remove the soil and the actual facility. The difficulties and uncertainties related to construction will be evaluated. Also, disconnecting utilities and associated lines, ducting, etc. will be considered. This will require special techniques similar to mining operations. Once the facilities are removed, the contaminated soil will be removed with heavy construction equipment. Finally, an on-site disposal facility can be constructed. The necessary items such as manpower, technology, equipment, and materials are available; however, working conditions at the FMPC can make construction difficult (factor scored a 2). The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability

factors for the on-site disposal facility will include periodic long-term maintenance. No foreseen problems with failure detection of various components or activities are anticipated (factor scored a 4).

There are no local agency approvals needed for the implementation of this alternative. State and federal agencies are likely to accept this alternative as a long-term remedial action (factor scored a 4). Special engineering requirements are the coordination of the construction equipment with the underground utilities and the aboveground structures within the region (factor scored a 3).

Overall implementability of this alternative scored 17 out of a possible 25.

6.4.2.6.3 Cost

The total relative cost for this alternative is high.

6.4.2.7 Alternative 14 - Facility Removal and Off-Site Disposal

This alternative scored 34 out of a possible 50.

6.4.2.7.1 Effectiveness

Short-term public health and environmental protection are impacted by the actual excavation of the facility and the underlying soil. On-site workers will be impacted by dust from the removal action, but there is little or no expected risk to the public immediately off-site. For on-site activities, airborne releases would have the most direct potential impact on the community in the short-term. The local community will be affected by the traffic flow of contaminated waste to the off-site disposal facility. Any action involving off-site transport and disposal would likely represent the greatest potential impact to the community. Public road transport of contaminated waste is more likely to affect public health than the environment; therefore, the short-term public health risk (factor scored 1) is higher than the short-term environmental risk (factor scored a 2). Long-term public health and environmental protection (factors scored a 5) is ranked the same as the on-site alternative because residuals or untreated material will be isolated away from the community in the off-site disposal facility. Because all contaminated waste (soil and facility) will be isolated, any remaining risk is low. The volume and toxicity are not significantly reduced because the waste will remain in an off-site disposal facility, but the

contaminated waste will be isolated. The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative scored 10 out of a possible 25.

6.4.2.7.2 Implementability

The facility will be evacuated and isolated prior to any activities. Constructability factors for this alternative include the capability to use construction equipment to mechanically remove the soil and the actual facility. The difficulties and uncertainties related to construction will be evaluated. Also, disconnecting utilities and associated lines, ducting, etc. will be considered. This will require special techniques similar to mining operations. Once the facilities are removed, the contaminated soil will be excavated with heavy construction equipment. Finally, an off-site disposal facility can be constructed. The necessary items such as manpower, technology, equipment, and materials are available; however, working conditions at the FMPC can make construction difficult (factor scored a 2). The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the off-site disposal facility will include periodic long-term maintenance. No foreseen problems with failure detection of various components or activities are anticipated (factor scored a 4).

Transportation of contaminated wastes off site will be in compliance with NRC40CFR and 49CFR. State hazard permits will be required from all transportation route states that have this requirement. These permits will be obtained by the company transporting the waste (factor scored a 3), in addition to the numerous regulatory requirements necessary prior to shipment off site. Special engineering requirements are the coordination of the construction equipment with the underground utilities and the aboveground structures (e.g., steamlines) within the region (factor scored a 3).

Overall implementability of this alternative scored 16 out of a possible 25.

6.4.2.7.3 Cost

The total relative cost for this alternative is high.

6.5 SUBOPERABLE UNIT E: ABOVEGROUND CONTAMINANTS

Suboperable Unit E is defined as aboveground contaminants. Figure 6-8 illustrates the Suboperable Unit E areas. In most cases, the aboveground contaminant is scrap metal or equipment that has been abandoned or piles of construction rubble. Both types of waste are contaminated with uranium. In addition to the waste, sampling results indicate the underlying ground is also contaminated. In areas where a concrete pad exists, the pad will be addressed as contaminated surface soils and will be included in the volume calculation for the area. Table 6-11 lists the areas and sizes of the contamination zones. The volumes in this table were calculated by taking the sum of the volumes at the various depths as discussed in the Section 6.1 example.

6.5.1 Area Descriptions

6.5.1.1 Drum Baling Area

The drum baling area consists of discarded scraps, materials, and structures. It has recently come into use as an on-site storage area for abandoned vehicles, cranes, construction equipment, unshredded scrap metal, asbestos, and various rubble. This material is piled approximately 10 feet high. Many of these items are quite large and will require sorting and removal. Scattered meter readings indicate radioactivity is associated with the various scrap material. The total volume of uranium-contaminated aboveground material is approximately 400,000 cubic feet. There is one area, approximately 50 feet in diameter, with uranium concentrations in the underlying soil greater than 200 ppm. The total volume or uranium-contaminated soil is approximately 540,000 cubic feet.

6.5.1.2 Scrap Metal Piles

The FMPC currently has three separate piles of metallic scrap with uranium concentrations above background levels. One pile of material is stored on a controlled curbed pad in the northeast quadrant of the Production Area. This 25-foot high scrap metal pile consists primarily of ferrous material, with the remainder being a mixture of aluminum, stainless steel, copper, brass, and nickel. The total volume of the aboveground uranium contamination is

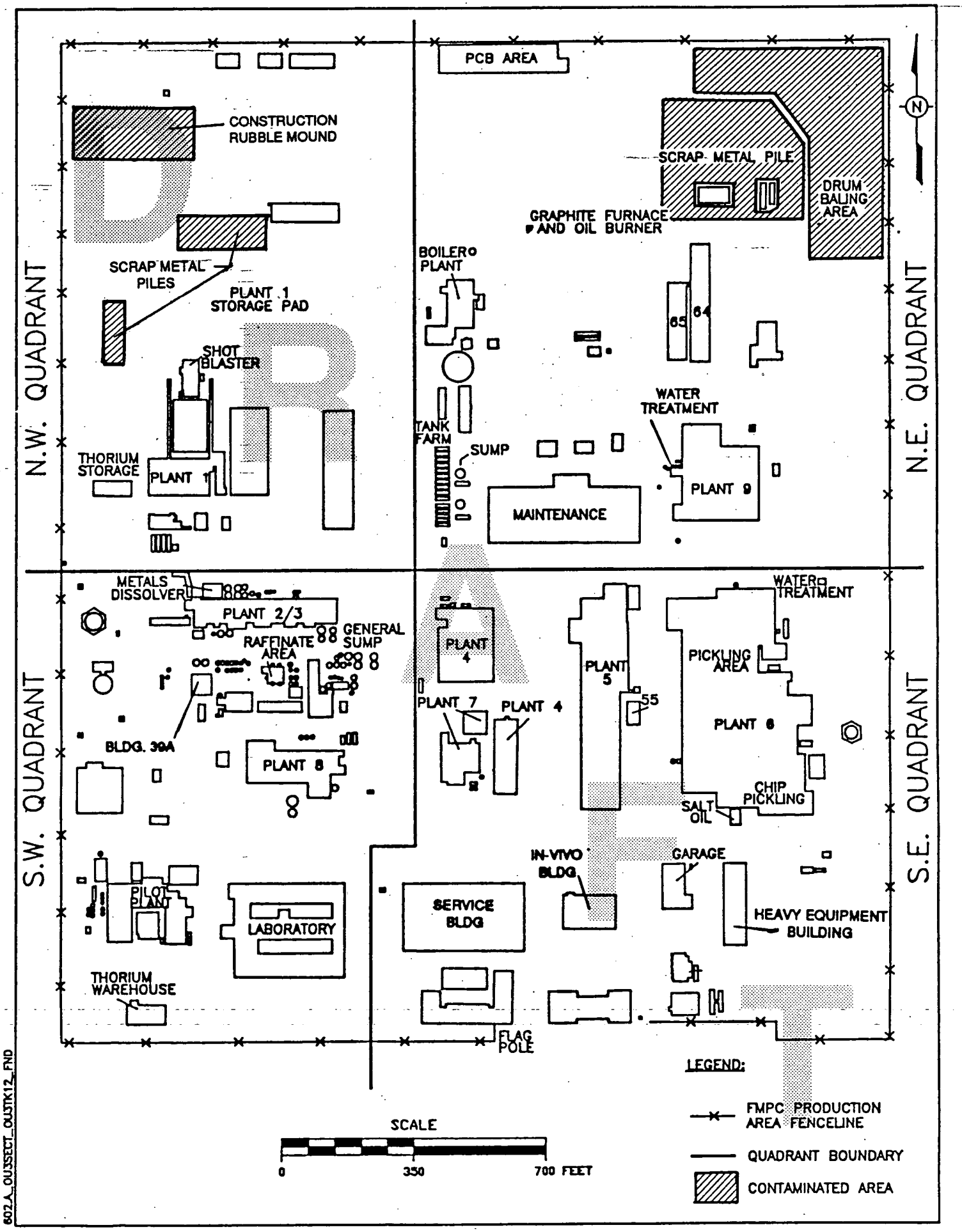

FIGURE 6-8. OPERABLE UNIT 3 CONTAMINATED AREAS - SUBOPERABLE UNIT E

TABLE 6-11

OPERABLE UNIT 3 URANIUM CONTAMINATED SOILS AND MATERIALS - SUBOPERABLE UNIT E

Area	Depth (Feet)					Volume (ft^3)
	0.0 - 1.5	1.5 - 3.0	3.0 - 5.5	10 - 15	15 - 20	
Drum Baling Area	50' Dia 600'x600'	Aboveground Contaminant Piles 200' x 200' x 10'				Material: 400,000 Soil:540,000
Scrap Metal Pile (Northeast Quadrant)	2@50' Dia 350'x350'	Aboveground Contaminant Piles 200' x 200' x 25'				Material: 1,000,000 Soil:183,750
Scrap Metal Piles (Northwest Quadrant)	--	--	Aboveground Contaminant Piles 300' x 300' x 30' 300'x300'	--	--	Material: 2,700,000 Soil:225,000
Construction Rubble Mound	350'x150'	--	Aboveground Contaminant Piles 100' x 100' x 30' --	--	--	Material: 300,000 Soil: 78,750

Total Volume (ft^3)		Material:	4,400,000
Total Volume (ft^3)		Soil:	1,027,500

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NOTE:

Measurement= Dimension of Contaminated Material with Uranium Concentrations between 50 and 200ppm	Measurement= Dimension of Contaminated Material with Uranium Concentrations >200ppm

-- = Uranium Concentrations Less than 50 ppm

approximately 1,000,000 cubic feet. Uranium-contaminated soils underlie a portion of the area. Two areas, approximately 50 feet in diameter, have uranium concentrations in the soil greater than 200 ppm. The total volume of uranium-contaminated soil is approximately 183,750 cubic feet.

The other two scrap metal piles are located in the northwest quadrant of the Production Area on the north end of the Plant 1 storage pad. These 30-foot high scrap piles also contain some asbestos material. The approximate total volume of the aboveground contaminants is 2,700,000 cubic feet. The total volume of uranium-contaminated soil is approximately 225,000 cubic feet.

6.5.1.3 Construction Rubble Mound

This area is a large rubble mound created from soil excavated during construction activities at the FMPC. At present, few data are available for this area. However, because this area was established in accordance with WMCO's standard operating procedures for soils management, uranium levels are expected to range from 50 to 150 ppm. The acceptable residual uranium level for Operable Unit 3 is 50 ppm.

The total volume of the aboveground uranium contamination is approximately 300,000 cubic feet. In addition, the total volume of uranium-contaminated soil is approximately 78,750 cubic feet.

6.5.2 Alternatives

Alternatives 7 and 8 have been eliminated because no facilities exist within these regions. Alternative 9 through 12 are also eliminated because they apply only to groundwater contamination. Alternatives 13 and 14 are eliminated because they apply to facilities designated for possible demolition. Alternatives 1, 2, 3, 4, 5, and 6 apply. Table 6-12 shows the screening summary for those alternatives that apply to this suboperable unit. Details of the initial screening are given below.

6.5.2.1 Alternative 1 - No Action

This alternative scored 34 out of a possible 50.

TABLE 6-12

OPERABLE UNIT 3 SCREENING SUMMARY - SUBOPERABLE UNIT E
ABOVEGROUND CONTAMINANTS

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Effectiveness														
Short-term public health	5	3	3	1	3	1								
Short-term environmental protection	5	3	3	2	3	2								
Long-term public health	1	3	4	4	5	5								
Long-term environmental protection	1	3	4	4	5	5								
Reduction in toxcity, mobility, or volume	1	1	3	3	5	5								
Subtotal	13	13	17	14	21	18								
Implementability														
Constructability	5	3	3	3	3	3								
Reliability	5	3	4	4	4	4								
Maintainability	5	3	4	4	4	4								
Agency approvals	1	1	2	2	4	3								
Special engineering	5	4	3	3	3	3								
Subtotal	21	14	16	16	18	17								
Cost	L	L	H	H	H	H								
Total	34	27	33	30	39	35								

Alternative 1 - No Action
Alternative 2 - Cap
Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap
Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap
Alternative 5 - Mechanical Removal and On-Site Disposal
Alternative 6 - Mechanical Removal and Off-Site Disposal
Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal
Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal
Alternative 9 - Groundwater Extraction, Treatment, and Discharge
Alternative 10 - Groundwater Extraction, Monitoring, Treatment And Discharge
Alternative 11 - Subsurface Barrier
Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge
Alternative 13 - Facility Removal and On-Site Disposal
Alternative 14 - Facility Removal and Off-Site Disposal

Cost:	Ranking (1 to 5):
L=Low	5-Best Satisfies Criteria
M=Medium	
H=High	1-Least Satisfies Criteria

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6.5.2.1.1 Effectiveness

In the short term, the contaminated waste remains in place and undisturbed. The short-term risks to the on-site workers are great due to aboveground contamination. There is little or no expected risk to the public immediately off site (factors scored a 5). Long-term public health and environmental protection are ranked unfavorably because this alternative does not mitigate existing contamination (factors scored a 1).

The potential for environmental contamination exits because this alternative does not remove or contain the soil contamination. This alternative does not reduce the toxicity, mobility, or volume of the waste (factor scored a 1).

Overall effectiveness of this alternative scored 13 out of a possible 25.

6.5.2.1.2 Implementability

The No Action Alternative requires no implementation; therefore, constructability, reliability, maintainability, and special engineering ranked high (factors scored a 5). However, agency approvals may be required for this alternative (factor scored a 1).

Overall implementability of this alternative scored 21 out of a possible 25.

6.5.2.1.3 Cost

There are no incremental costs for this alternative; thus, cost is low.

6.5.2.2 Alternative 2 - Cap

This alternative scored 27 out of a possible 50.

6.5.2.2.1 Effectiveness

This nonremoval alternative represents a minimum action scenario intended to isolate waste and minimize vertical infiltration of rainfall or runoff into and through the soil. A cap will affect the saturation of contaminated materials and will reduce leaching of contaminants to the groundwater. Capping poses low short-term environmental protection risk to the on-site workers because of limited construction and associated exposure time (factor scored a 3). The

short-term public health is ranked lower than short-term environmental protection due to the exposure of aboveground contamination (factor scored a 3). There is little or no expected risk to the public immediately off site. With respect to the long-term public health and environmental protection, the cap will prevent direct contact exposure to individuals from contaminants and will reduce the risk of wind dispersion of the materials. However, this alternative does not remove, contain, or treat the contaminated waste (factors scored a 3). This alternative does not reduce the toxicity and volume of the contamination, but it does diminish the mobility of the contamination by reducing vertical infiltration of precipitation. Even though the cap minimizes rainfall from penetrating the contaminated soils, excess water at the edges of the cap will penetrate vertically and ultimately, horizontally, into the contaminated soils (factor scored a 1).

Overall the effectiveness of this alternative scored a 13 out of a possible 25.

6.5.2.2.2 Implementability

Constructability requirements would include grading of aboveground contaminants to a level surface. Because the level surface would be some height above ground level, construction of a cap on unstable piles of contaminated materials would be difficult (factor scored a 3). Once the cap is constructed, it is reliable (factor scored a 3) and test methods exist to verify adequate construction.

Maintainability factors for a cap include periodic maintenance (factor scored a 3). If left unattended, natural biological succession will occur and the cap will deteriorate. Eventually, insects and small burrowing animals will penetrate the cap and reach the soil. This opens pathways for precipitation to infiltrate first the cap liner and subsequently the soil itself. Periodic maintenance involves regrading the cap and revegetating the surface.

There are no local agency approvals needed for this alternative (contaminated metals and soils remain in place); however, state and federal agencies are unlikely to accept a cap alone as a long-term remedial action (factor scored a 1). There is no special engineering required to implement this alternative (factor scored 1 4).

Overall implementability of this alternative scored 14 out of a possible 25.

6.5.2.2.3 Cost

The total relative cost for this alternative is low.

6.5.2.3 Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap

This alternative scored 33 out of a possible 50.

6.5.2.3.1 Effectiveness

The short-term public health and environmental protection for the on-site workers is ranked average because of the removal of the aboveground contaminants (factors scored a 3). There is little or no expected increase in risk to the public immediately off site. The cap will affect the saturation of contaminated materials and will reduce leaching of contaminants to the groundwater. In the long term, two sites must be addressed: the original capped region and the on-site disposal facility (factors scored a 4). The original capped region will contain the soil, minimize further vertical infiltration of precipitation, prevent direct contact to individuals from contaminants, and reduce the risk of wind dispersion of materials. The on-site disposal facility would fully enclose the waste materials. The mobility of the waste is contained, but the volume and toxicity of the soils remain the same (factor scored a 3).

Overall effectiveness of this alternative scored 17 out of a possible 25.

6.5.2.3.2 Implementability

Constructability factors include the capability to use construction equipment for the mechanical removal of the aboveground material and construction of the on-site disposal facility. Construction of a waste compaction facility is also a consideration (factor scored a 3); however, working conditions at the FMPC can make construction more difficult. The necessary items such as manpower, technology, equipment, and materials are available. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for a cap include periodic maintenance (factor scored a 4).

Because there are no facilities, aboveground structures, or utilities in the immediate area, there should be no maneuverability constraints. All waste will be compacted prior to disposal on site.

There are no local agency approvals needed for the implementation of this alternative; however, state and federal agencies are unlikely to accept removal of aboveground contaminants without removing underlying soil (factor scored a 2). Special engineering requirements include the design of the on-site disposal facility (factor scored a 3).

Overall implementability of this alternative scored 16 out of a possible 25.

6.5.2.3.3 Cost

The total relative cost for this alternative is high.

6.5.2.4 Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal and Cap

This alternative scored 30 out of a possible 50.

6.5.2.4.1 Effectiveness

The short-term public health (factor scored a 1) and environmental protection (factor scored a 2) will be ranked low, because of the transportation of contaminated material off site. The cap will offset the saturation of contaminated material and will reduce leaching of contaminants to the groundwater. For long-term public health and environmental protection, the original capped region will contain the soil, thus reducing mobility by minimizing further vertical infiltration of precipitation, prevent direct contact exposure to individuals from contaminants, and reduce the risk of wind dispersion of the materials (factors scored a 4). The volume and toxicity of the soils remain the same, but the aboveground contaminants are moved off site (factor scored a 3).

Overall effectiveness of this alternative scored 14 out of a possible 25.

6.5.2.4.2 Implementability

Constructability factors include the capability to use construction equipment for the mechanical removal of the aboveground contaminants and construction of the temporary on-site storage facility; however, working conditions at the FMPC can make construction difficult (factor scored a 3).

The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for a cap include periodic maintenance (factor scored a 4).

Because no facilities, aboveground structures, or utilities are situated in the area, there should be no maneuverability constraints. All waste will be compacted prior to disposal off site.

Transportation of contaminated waste off site will be in compliance with NCRC40CFR and 49CFR. State hazard permits will be required from all transportation route states that have this requirement. These permits will be obtained by the company transporting the waste (factor scored a 2). No special engineering is required to implement this alternative (factor scored a 3).

Overall implementability of this alternative scored 16 out of a possible 25.

6.5.2.4.3 Cost

The total relative cost for this is high.

6.5.2.5 Alternative 5 - Mechanical Removal and On-Site Disposal

This alternative scored 39 out of a possible 50.

6.5.2.5.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated materials. On-site workers will be impacted by dust from the removal, but there is little or no expected risk to the public immediately off site (factors scored a 3). Long-term public health and environmental protection are ranked high due to the permanent storage of the waste (factors scored a 5). The treatment of the soil and decontamination of the scrap metals will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative scored 21 out of a possible 25.

6.5.2.5.2 Implementability

Constructability factors include the capability to use construction equipment to mechanically remove the aboveground contaminants and construction of the on-site disposal facility. Construction of a waste compaction facility is also a consideration (factor scored a 3). Manpower, technology, equipment, and materials are available; however, working conditions at the FMPC can make construction difficult. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the on-site disposal facility will include periodic long-term maintenance (factor scored a 4).

There are no local agency approvals needed for this alternative (factor scored a 4). Special engineering will be required to coordinate the maneuverability of construction equipment with underground utilities and aboveground structures within the region and to design the on-site disposal facility (factor scored a 3).

Overall implementability of this alternative scored 18 out of a possible 25.

6.5.2.5.3 Cost

The total relative cost for this alternative is high.

6.5.2.6 Alternative 6 - Mechanical Removal and Off-Site Disposal

This alternative scored 35 out of a possible 50.

6.5.2.6.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated material. On-site workers will be impacted by dust from the removal, but there is little or no expected risk to the public immediately off site. The local community will be affected by the traffic flow of the contaminated waste to the off-site disposal facility. Public road transport of contaminated waste is more likely to affect public health than the environment; therefore, the short-term public health risk (factor scored a 1) is higher than the short-term environmental risk (factor scored a 2). Long-term public health and environmental

protection are ranked high due to the permanent storage of the waste off site (factors scored a 5). The treatment of the soil and decontamination of the scrap metals will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative scored 18 out of a possible 25.

6.5.2.6.2 Implementability

Constructability factors for this alternative include the capability to use construction equipment to mechanically remove the material. Construction of an off-site disposal facility and a waste compaction facility would need to be considered (factor scored a 3). Manpower, technology, equipment, and materials are available; however, working conditions at the FMPC can make construction difficult. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the off-site disposal facility will include long-term maintenance (factor scored a 4).

Transportation of contaminated wastes off site will be in compliance with NRC40CFR and 49CFR. State hazard permits will be required from all transportation route states that have this requirement. These permits will be obtained by the company transporting the waste (factor scored a 3). Special engineering is required to coordinate the maneuverability of construction equipment with underground utilities and aboveground structures within the area, and the design of the off-site disposal facility (factor scored a 3).

Overall implementability of this alternative scored 17 out of a possible 25.

6.5.2.6.3 Cost

The total relative cost for this alternative is high.

6.6 SUBOPERABLE UNIT F: PERCHED GROUNDWATER CONTAMINATION

All known perched groundwater contamination within Operable Unit 3 is included in Suboperable Unit F. Uranium is the most widespread and dominant contaminant at the FMPC, varying from 0 to greater than 100,000 μg/l. Consequently, uranium contamination is a principal factor in the screening process, although other contaminants are discussed. Figure 6-9 depicts

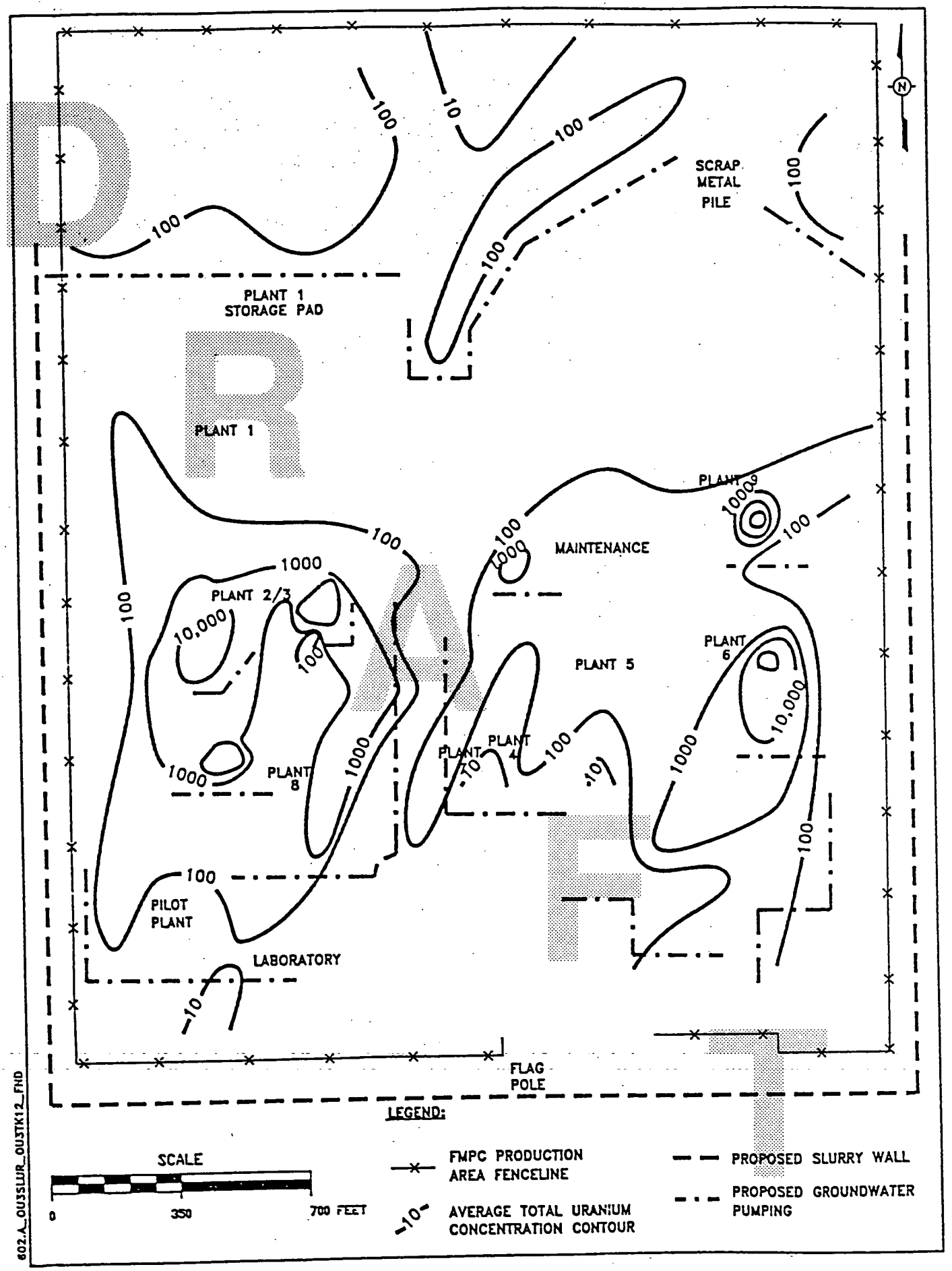

FIGURE 6-9. OPERABLE UNIT 3 PERCHED GROUNDWATER CONTAMINATION AND REMEDIAL ACTIONS, SUBOPERABLE UNIT E

groundwater contamination contours, proposed slurry wall locations, and proposed groundwater extraction locations. There is currently insufficient information from the RI for Operable Unit 3 to provide an estimate of the total volume of contaminated groundwater at the FMPC.

6.6.1 Area Descriptions

6.6.1.1 Southwest Quadrant

Uranium concentrations in perched groundwater exceeding 100 μg/l appear to extend continuously from Plant 1 and the thorium storage area, south to the laboratory and pilot plant. Within this apparent widespread plume of perched groundwater contamination, zones of higher uranium contamination occur. This area is subdivided into four sub-areas of relatively higher uranium concentrations described in the following paragraphs. All concentrations cited in the following paragraphs refer to uranium levels in the perched groundwater; the regional aquifer underlying the Production Area will be addressed under Operable Unit 5.

Uranium concentrations as high as 9444 μg/l have been detected in the perched groundwater immediately west of the pilot plant. At the northwest corner of the laboratory, 888 μg/l uranium was detected in the perched groundwater. The perched groundwater flow in this vicinity appears to be in the south to southwest direction.

West of the recovery plant, Plant 8, uranium concentrations between 19,000 and 31,200 μg/l were detected at three locations. Uranium concentrations exceeding 1000 μg/l surround this contamination area and extend both north and south of Plant 8. The perched groundwater flow in this vicinity is generally to the south.

Between the raffinate area and the southwest corner of Plant 2/3, water samples from five locations showed uranium concentrations exceeding 10,000 μg/l. Surrounding this area are several wells with concentrations exceeding 1000 μg/l. The perched groundwater flow in this vicinity is generally to the south.

Near the northeast corner of Plant 2/3, four piezometers indicated uranium values exceeding 10,000 μg/l. Uranium concentrations exceeding 1000 μg/l extend southward through the general sump area to the water treatment plant. Concentrations exceeding 100 μg/l extend northward to Plant 1 and the thorium storage area and southward toward the laboratory. The perched groundwater flow in this vicinity is generally to the south.

6.6.1.2 Northeast and Southeast Quadrants

Uranium concentrations in perched groundwater exceeding 100 μg/l extend from Plant 9 and the maintenance area, southward past the garage and substation. Within this area are two areas where uranium contamination exceeds 100,000 μg/l: at the southeast corner of Plant 9 and east of the Plant 6 pickling area. Between Plant 6 and 9, Hazardous Substance List organic compounds, including dichloroethene and trichloroethene, were detected in the perched groundwater. North of the maintenance area, Hazardous Substance List volatile and semivolatile organic compounds, as well as PCBs and lead, were encountered in one water sample. Perched groundwater contamination of similar compounds in this area are unknown at this time. The perched groundwater flow in this vicinity appears to be westward on the west side and southward over the rest of the area.

6.6.1.3 Northeast and Northwest Quadrants

The highest value of uranium detected in the perched groundwater in this area is 516 μg/l in the vicinity of the graphite furnace and oil burner and 689 μg/l near the northwest corner of the Plant 1 storage pad.

A possible continuous plume of perched groundwater uranium contamination exceeding 100 μg/l extends from the northwestern corner of the scrap metal pile, southwest through the graphite furnace, and south of the boiler plant. The perched groundwater flow in this vicinity is generally to the south, but may be to the southeast or southwest.

Possibly continuous with the uranium contamination detected at the northwest corner of the Plant 1 storage pad is an area extending essentially east-west across the north part of the storage pad. Immediately south of this area, uranium concentrations were detected at values ranging from 28 to 53 μg/l. The perched groundwater flow appears to be to the south or to the southwest in this area.

Uranium contamination exceeding 100 μg/l was also detected in two wells adjacent to the drum baling area. Uranium concentrations in the area between the drum baling area, the graphite furnace, and Plant 9 ranged from 53.4 to 36.1 μg/l. The perched groundwater flow in the vicinity of the drum baling area varies from southward to westward.

6.6.2 Alternatives

Alternatives 2 through 8 are eliminated because they apply only to soil contamination. Alternatives 13 and 14 are eliminated because they apply to facilities designated for possible demolition. Alternatives 1, 9, 10, 11, and 12 apply. Table 6-13 shows the screening summary for those alternatives. Details of the initial screening are given below.

6.6.2.1 Alternative 1 - No Action

This alternative scored 32 out of a possible 50.

6.6.2.1.1 Effectiveness

In the short term, public health risks to on-site workers and the public immediately off site are considered low (factor scored a 4) because contact with contaminated perched groundwater is unlikely. In addition, short-term risks to the environment are considered to be low (factor scored a 4). Long-term public health and environmental protection are ranked unfavorably (factors scored a 1) because this alternative does not mitigate existing contamination. This alternative does not reduce the toxicity, mobility, or volume of the contamination (factor scored a 1).

Overall effectiveness of this alternative scored 11 out of a possible 25.

6.6.2.1.2 Implementability

The No Action Alternative requires no implementation; therefore, constructability, reliability, maintainability, and special engineering ranked high (factors scored a 5). However, agency approvals may be required for this alternative (factor scored a 1). Groundwater monitoring will continue to be used to track the contamination plume.

TABLE 6-13

OPERABLE UNIT 3 SCREENING SUMMARY - SUBOPERABLE UNIT F
PERCHED GROUNDWATER CONTAMINATION

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Effectiveness														
Short-term public health	4								4	4	3	3		
Short-term environmental protection	4								4	4	3	3		
Long-term public health	1								5	5	2	5		
Long-term environmental protection	1								5	5	2	5		
Reduction in toxcity, mobility, or volume	1								5	5	3	5		
Subtotal	11								23	23	13	21		
Implementability														
Constructability	5								3	3	3	3		
Reliability	5								4	3	4	4		
Maintainability	5								4	3	4	4		
Agency approvals	1								5	5	1	5		
Special engineering	5								4	4	4	3		
Subtotal	21								20	18	16	19		
Cost	L								M	M	L	H		
Total	32								43	41	29	40		

Alternative 1 - No Action
Alternative 2 - Cap
Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap
Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap
Alternative 5 - Mechanical Removal and On-Site Disposal
Alternative 6 - Mechanical Removal and Off-Site Disposal
Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal
Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal
Alternative 9 - Groundwater Extraction, Treatment, and Discharge
Alternative 10 - Groundwater Extraction, Monitoring, Treatment And Discharge
Alternative 11 - Subsurface Barrier
Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge
Alternative 13 - Facility Removal and On-Site Disposal
Alternative 14 - Facility Removal and Off-Site Disposal

Cost:	Ranking (1 to 5):
L=Low	5-Best Satisfies Criteria
M=Medium	
H=High	1-Least Satisfies Criteria

Overall implementability of this alternative scored 21 out of a possible 25.

6.6.2.1.3 Cost

The total relative cost for Alternative 1 is low.

6.6.2.2 Alternative 9 - Groundwater Extraction, Treatment, and Discharge

This alternative scored 43 out of a possible 50.

6.6.2.2.1 Effectiveness

Under Alternative 9, perched groundwater from the FMPC area will be extracted or delivered to a central treatment facility and then discharged into the Great Miami River. For short-term public health and environmental protection, this alternative is ranked high because only wellpoints will be driven into the soils (factors scored a 4). Long-term public health and environmental protection are ranked high (factors scored a 5) because this alternative provides for removal and treatment of contaminated perched groundwater. This alternative reduces the mobility and volume of the contaminants because groundwater is extracted, treated, and discharged (factor scored a 5).

Overall effectiveness of this alternative scored 23 out of a possible 25.

6.6.2.2.2 Implementability

The constructability of the extraction well system and treatment system is significant, but the technology, equipment, and materials are available; however, working conditions at the FMPC can make construction difficult (factor scored a 3). Once the extraction well system and treatment system are in place, reliability and maintainability factors become relatively insignificant (factors scored a 4).

Agency approvals are needed to discharge treated groundwater into the Great Miami River (factor scored a 5). Special engineering factors required to implement this alternative include the design and placement of wellpoints and the coordination with existing structures and facilities (factor scored a 4).

Overall implementability of this alternative scored 20 out of a possible 25.

6.6.2.2.3 Cost

The total relative cost for this alternative is medium.

6.6.2.3 Alternative 10 - Groundwater Extraction, Monitoring, Treatment, and Discharge

This alternative scored 41 out of a possible 50.

6.6.2.3.1 Effectiveness

For short-term public health and environmental protection, Alternative 10 is ranked high because only wellpoints will be driven into the soils (factors scored a 4). In the long term, this alternative extracts and monitors all the perched groundwater from the FMPC area, treats any groundwater with uranium contamination above the allowable uranium content criteria, and discharges it to the Great Miami River. This will likely result in less groundwater to be treated than Alternative 9; however, currently there is insufficient data to determine quantities of water that will require treatment. Long-term public health and environmental protection (factors scored a 5) are ranked high because of the removal and treatment of the contaminated perched groundwater. This alternative reduces the mobility and volume of the contaminants by extracting, treating, and discharging the perched groundwater (factor scored a 5).

Overall effectiveness of this alternative scored 23 out of a possible 25.

6.6.2.3.2 Implementability

The constructability and maintainability of the extraction well, monitoring, and treatment systems are significant, but the technology, equipment, and materials are available; however, working conditions at the FMPC can make construction difficult (factors scored a 3). Continual maintenance of the monitoring system will be required to guarantee precise operation of the system. The reliability of the extraction and monitoring system will be designed in; however, this system would be less reliable than the extraction system used in Alternative 9 because of the additional monitoring equipment (factor scored a 3).

Agency approvals are needed to discharge treated groundwater into the Great Miami River (factor scored a 5). Special engineering factors required to implement this alternative include

the design and placement of wellpoints and the coordination with existing structures and facilities (factor scored a 4).

Overall implementability of this alternative scored 18 out of a possible 25.

6.6.2.3.3 Cost

The total relative cost for this alternative is medium.

6.6.2.4 Alternative 11 - Subsurface Barrier

This alternative scored 29 out of a possible 50.

6.6.2.4.1 Effectiveness

The construction and trenching associated with this alternative increases potential exposure to on-site workers. Therefore, in the short term, these actions increase risks to the public health and environment (factors scored a 3). There is little or no expected increase in risk to the public immediately off site. For long-term public health and environmental protection, this alternative contains the perched groundwater and reduces further horizontal migration of contaminants, but does not remove or treat the contaminated perched groundwater (factors scored a 2). While the volume and toxicity are not reduced and the vertical mobility of the contaminated groundwater is not affected, the subsurface barrier will limit (to some extent) the horizontal mobility of the groundwater (factor scored a 3).

Overall effectiveness of this alternative scored 13 out of a possible 25.

6.6.2.4.2 Implementability

Constructability factors for this alternative include trenching and placement of the subsurface barrier; however, working conditions at the FMPC can make construction difficult (factor scored a 3). The containment system will encompass the Production Area as one unit. Reliability and maintainability factors for a subsurface barrier in place are relatively insignificant (factors scored a 4).

Agency approvals are necessary and will likely be difficult to obtain because the contaminated perched groundwater is not removed or treated (factor scored a 1). Special engineering is

required to coordinate the barrier design and construction with the underground utilities within the area (factor scored a 4).

6.6.2.4.3 Cost

The total relative cost for this alternative is low.

6.6.2.5 Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge

This alternative scored 40 out of a possible 50.

6.6.2.5.1 Effectiveness

The construction of the extraction system and the subsurface barrier trenching action will increase potential exposure of on-site workers, thereby increasing short-term public health (factor scored a 3) and environmental risks (factor scored a 3). There is little or no expected increase in risk to the public immediately off site. For long-term public health and environmental protection, this alternative contains and removes the perched groundwater and reduces further horizontal migration of contaminants (factors scored a 5). The contaminated perched groundwater is removed, treated, and discharged; thus reducing its volume and mobility (factor scored a 5).

Overall effectiveness of this alternative scored a 21 out of a possible 25.

6.6.2.5.2 Implementability

Constructability factors for this alternative include barrier wall and extraction well system placement; however, working conditions at the FMPC can make construction difficult (factor scored a 3). The containment system will encompass the Production Area as one unit. Reliability and maintainability factors for a barrier wall, extraction well system, and treatment system in place are relatively insignificant (factors scored a 4).

No special approvals other than those agency approvals needed to discharge treated groundwater into the Great Miami River are required (factor scored a 5). Special engineering is required to coordinate the barrier wall and extraction well system design and construction with the underground utilities within the area (factor scored a 3).

Overall implementability of this alternative scored 19 out of a possible 25.

6.6.2.5.3 Cost

The total relative cost for this alternative is high.

6.7 SUBOPERABLE UNIT G: SOILS SURROUNDING TRANSFER LINES

This suboperable unit is defined as any transfer line within or on the perimeter of the Production Area, including slurry lines and effluent lines. Table 6-14 will be updated to show the levels and volumes of contamination when that information is available.

6.7.1 Area Descriptions

6.7.1.1 Effluent Lines

Effluent lines currently under consideration include the line from the Clearwell to Manhole 175 via the general sump, and the main effluent line from Manhole 175 to the Great Miami River. No sampling tests have been conducted on the effluent line from the Clearwell to the general sump. The main effluent line is a 4650-foot long, 16-inch diameter cast iron pipe that runs from Manhole 175 to the Great Miami River. There are seven concrete manholes located along the line for access and maintenance purposes. The FMPC discharge pipeline to the Great Miami River represents a permitted discharge for wastewater for the FMPC. The wastewater conveyed by the main effluent line comes from treated effluent from the general sump, treated effluent from the sanitary wastewater treatment plant, and storm water runoff from the storm water retention basin. Some testing has been conducted on the main effluent line, but the data are not yet available. Therefore, the status of current or past leaks, number of leaks, or what type and level of contamination exists has not been established for this line.

As a result, the screening process for this problem category is very basic and includes no cost estimates or cost ranking. In addition, it is currently assumed that all sections of the effluent lines are either at or below grade level.

TABLE 6-14

OPERABLE UNIT 3 URANIUM CONTAMINATED SOILS - SUBOPERABLE UNIT G

Region	Depth (Feet)					Total Volume (ft^3)
	0.0 - 1.5	1.5 - 3.0	3.0 - 5.5	10 - 15	15 - 20	
Effluent Lines	Information Unavailable					
K-65 Slurry Line	– / 1000'x50'	– / –	– / –	– / –	– / –	75,000

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NOTE:

Measurement= Dimension of Contaminated Material with Uranium Concentrations between 50 and 200ppm	Measurement= Dimension of Contaminated Material with Uranium Concentrations >200ppm

– = Uranium Concentrations Less than 50 ppm

6.7.1.2 K-65 Slurry Line

The K-65 Slurry Line is a sealed pipe placed in a 1000-foot long, 2.5-foot wide covered concrete trench. This trench, or effluent line, extends from the K-65 silos to the general sump.

Sampling data indicates that the actual slurry line and the surrounding soil are contaminated. Soil and sediment samples from the K-65 slurry line show total uranium concentrations to be greater than 150 ppm. These same samples show U-238, Ru-106, and The-232 in concentrations of 50-150 ppm, and radium in concentrations greater than 200 ppm. Also, present in the soils adjacent to the slurry line in concentrations greater than 200 ppm are U-238, The-230, Pb-210, and Tc-99. The total volume of contaminated soils is approximately 75,000 cubic feet.

6.7.2 Alternatives

Alternatives 3 and 4 are eliminated from consideration because no aboveground contaminants are anticipated. Similarly, Alternatives 7 and 8 are not considered because no known facilities are located above the effluent lines. Alternatives 9 through 12 are eliminated because they apply only to perched groundwater contamination. Alternatives 1, 2, 5, and 6 apply. Table 6-15 shows the screening summary for those alternatives that apply. Details of the initial screening are given below.

6.7.2.1 Alternative 1 - No Action

This alternative scored 32 out of a possible 50.

6.7.2.1.1 Effectiveness

In the short term, risks to on-site workers and the public immediately off site are considered low; therefore, the ranking of the short-term public health and environmental protection is high (factors scored a 4) because all material remains in place and undisturbed. Long-term public health and environmental protection are ranked unfavorably because this alternative does not mitigate existing contamination (factors scored a 1). In addition, the potential for environmental contamination exists because this alternative does not remove or contain the soil contamination. This alternative does not reduce the toxicity, mobility, or volume of the soil (factor scored a 1).

TABLE 6-15

OPERABLE UNIT 3 SCREENING SUMMARY - SUBOPERABLE UNIT G
SOILS SURROUNDING TRANSFER LINES

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Effectiveness														
Short-term public health	4	4			3	1								
Short-term environmental protection	4	4			3	2								
Long-term public health	1	3			5	5								
Long-term environmental protection	1	3			5	5								
Reduction in toxcity, mobility, or volume	1	1			5	5								
Subtotal	11	15			21	18								
Implementability														
Constructability	5	4			3	3								
Reliability	5	4			4	4								
Maintainability	5	4			4	4								
Agency approvals	1	1			4	3								
Special engineering	5	4			3	3								
Subtotal	21	17			18	17								
Cost	NOT AVAILABLE				NOT AVAILABLE									
Total	32	32			39	35								

Alternative 1 - No Action
Alternative 2 - Cap
Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap
Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap
Alternative 5 - Mechanical Removal and On-Site Disposal
Alternative 6 - Mechanical Removal and Off-Site Disposal
Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal
Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal
Alternative 9 - Groundwater Extraction, Treatment, and Discharge
Alternative 10 - Groundwater Extraction, Monitoring, Treatment And Discharge
Alternative 11 - Subsurface Barrier
Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge
Alternative 13 - Facility Removal and On-Site Disposal
Alternative 14 - Facility Removal and Off-Site Disposal

Cost:	Ranking (1 to 5):
L=Low	5-Best Satisfies Criteria
M=Medium	
H=High	1-Least Satisfies Criteria

Overall effectiveness of this alternative scored 11 out of a possible 25.

6.7.2.1.2 Implementability

The No Action Alternative requires no implementation; therefore, constructability, reliability, maintainability, and special engineering are ranked high (factors scored a 5). However, agency approvals may be required for this alternative (factor scored a 1).

Overall implementability of this alternative scored 21 out of a possible 25.

6.7.2.1.3 Cost

There is no cost determined for this alternative at this time.

6.7.2.2 Alternative 2 - Cap

This alternative scored 32 out of a possible 50.

6.7.2.2.1 Effectiveness

This nonremoval alternative represents a minimum action scenario intended to isolate waste and minimize vertical infiltration of rainfall or runoff into and through soil. A cap will affect the saturation of contaminated materials and will reduce leaching of contaminants to the groundwater. Capping poses low short-term public health and environmental protection risk to the on-site workers because of limited construction and associated exposure time (factors scored a 4). There is little or no expected risk to the public immediately off site. But with respect to the long-term public health and environmental protection, the cap will prevent direct contact exposure to individuals from contaminants and will reduce the risks of wind dispersion of the materials. However, this alternative does not remove or treat the contaminated soil (factors scored a 3). This alternative does not reduce the toxicity or volume of the contamination, but does diminish the mobility by reducing vertical infiltration of precipitation. Even though the cap minimizes initial rainfall from penetrating the contaminated soils, excess water at the edges of the cap will penetrate vertically and, ultimately, horizontally, into the contaminated soils (factor scored a 1).

Overall effectiveness of this alternative scored 15 out of a possible 25.

6.7.2.2.2 Implementability

The constructability factors for a cap are relatively simple. The technology, equipment, manpower, and materials exist and are readily available; however, working conditions at the FMPC can make construction difficult (factor scored a 4). Capping is also reliable (factor scored a 4) and test methods exist to verify adequate construction.

Maintainability factors for a cap include periodic maintenance (factor scored a 4). If left unattended, natural biological succession will occur and the cap will deteriorate. Eventually, insects and small burrowing animals will penetrate the cap and reach the soil. This opens pathways for precipitation to infiltrate first the cap liner and subsequently the soil itself. Periodic maintenance involves regrading the cap and revegetating the surface.

No agency approvals are required to implement this alternative (contaminated soils remain in place); however, state and federal agencies are unlikely to accept a cap alone as a long-term remedial action (factor scored a 1). One special engineering requirement is the coordination of the cap design and construction with the aboveground structures within the region (factor scored a 4).

Overall implementability of this alternative scored 17 out of a possible 25.

6.7.2.2.3 Cost

There is no cost determined for Alternative 2 at this time.

6.7.2.3 Alternative 5 - Mechanical Removal and On-Site Disposal

This alternative scored 39 out of a possible 50.

6.7.2.3.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated soil (factors scored a 3). There is little or no expected risk to the public immediately off site. Long-term public health and environmental protection are ranked high because the waste is removed from the immediate area and disposed of on site (factors

scored a 5). The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative scored 21 out of a possible 25.

6.7.2.3.2 Implementability

Constructability factors for this alternative include the capability to use construction equipment to mechanically remove the soil; however, working conditions at the FMPC can make construction difficult (factor scored a 3). An on-site disposal facility to house the waste can be constructed; manpower, technology, equipment, and materials are available. The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the on-site disposal facility will include periodic long-term maintenance (factor scored a 4).

There are no local agency approvals needed for this alternative, and state and federal agencies are likely to accept this alternative as a long-term remedial action (factor scored a 4). Special engineering is required to design the on-site disposal facility and construction of an alternate or bypass outfall line (factor scored a 3).

Overall implementability of this alternative scored 18 out of a possible 25.

6.7.2.3.3 Cost

There is no cost determined for Alternative 5 at this time.

6.7.2.4 Alternative 6 - Mechanical Removal and Off-Site Disposal

This alternative scored 35 out of a possible 50.

6.7.2.4.1 Effectiveness

Short-term public health and environmental protection are impacted by the mechanical removal of the contaminated waste. There is little or no expected risk to the public immediately off site. The waste will be removed from the FMPC area and disposed of off site. The local community will be affected by the traffic flow of the contaminated waste to the off-site disposal facility. Public road transport of contaminated waste is more likely to affect public health than

the environment; therefore, the short-term public health risk (factor scored a 1) is higher than the short-term environmental risk (factor scored a 2). Long-term public health and environmental protection are ranked high (factors scored a 5) due to the permanent storage of the waste off site. The treatment of the soil will reduce the volume and mobility of the contaminants (factor scored a 5).

Overall effectiveness of this alternative scored 18 out of a possible 25.

6.7.2.4.2 Implementability

Constructability factors for this alternative include the capability to use construction equipment to mechanically remove the soil and a temporary on-site storage structure to house the waste is easily constructed. Manpower, technology, equipment, and materials are available; however, working conditions at the FMPC can make construction more difficult (factor scored a 3). The process technologies and equipment are considered technically feasible and operationally reliable (factor scored a 4). Maintainability factors for the off-site disposal facility will include long-term maintenance (factor scored a 4).

Transportation of contaminated wastes off site will be in compliance with NRC40CFR and 49CFR. State hazard permits will be required from all transportation route states that have this requirement. These permits will be obtained by the company transporting the waste (factor scored a 3). Special engineering is required to construct an alternate or bypass outfall line and design of the off-site disposal facility (factor scored a 3).

Overall implementability of this alternative scored 17 out of a possible 25.

6.7.2.4.3 Cost

There is no cost determined for Alternative 6 at this time.

7.0 GENERAL SUMMARY

After the initial screening of alternatives, the next step in the RI/FS process is the detailed analysis of alternatives. This chapter provides a summary of the Operable Unit 3 remedial action alternative development, the media and contaminants of concern, the alternative evaluation assumptions, and a summary of the alternatives recommended for detailed analysis.

7.1 DEVELOPMENT OF ALTERNATIVES

The remedial action objectives for Operable Unit 3 were designed for source control, rather than management of migration alternatives. These objectives were formulated to achieve the overall goal of protecting human health and the environment by isolating, removing, or treating the source of contamination. The specific remedial action objectives are as shown in Table 7-1.

The total uranium criteria established for cleanup and source control is 20 pCi/l (30 μg/l) for drinking water and 35 pCi/gm (approximately 50 ppm) for surface soils. (See Section 2.1 in Chapter 2.0 for further discussion and references for these criteria.) However, the presence of other contaminants has not been fully characterized; data collection and analysis is currently an ongoing effort.

These objectives and criteria were the driving force for the selection of the general response actions. The response actions consist of No Action, Containment/Treatment, Excavation/ Treatment/Disposal, Collection/Treatment/Disposal, and Near-Term Containment, Far-Term Excavation/Treatment/Disposal. These five response actions were used to develop the list of alternatives presented in Chapter 4.0. In some instances, alternatives were tailored to address specific problems. Initially, the Production Area and suspect areas were separated into two categories: solid waste and perched groundwater. The alternatives, therefore, were separated into these two categories. Within the solid waste category, Alternatives 3 and 4 were designed specifically for removal of aboveground contamination sources, Alternatives 7 and 8 for

TABLE 7-1

OPERABLE UNIT 3 REMEDIAL ACTION OBJECTIVES

Media	Remedial Action Objective
Solid Waste • Soils • Metals • Facilities	Prevent current and future radiation emissions from causing detectable chronic effects.
	Prevent current and future above-background airborne radiation doses from exceeding 2.5 mrem, and radon concentrations from exceeding risk levels of $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk.
	Prevent current and future airborne chemical concentrations from exceeding $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk and/or a hazard index of 0.25.
	Prevent direct contact with soils or other solid wastes containing uranium at levels greater than 35 pCi/gm (approximately 50 ppm).
	Prevent erosion of soil that would contribute to inorganic and organic chemical surface water concentrations exceeding risk levels of $2.5x10^{-5}$ to $2.5x10^{-7}$ cancer risk and/or a hazard index of 0.25.
	Prevent erosion of soils that would contribute to surface water concentrations of chemicals in Operable Unit 3 from reaching concentrations in excess of 25 percent of those reported in Tables 2-3 and 2-4.
	Prevent circumstances that may cause leaching of contaminants to groundwater.
	Prevent current and future radiation doses migrating from soils or wastes from exceeding 25 mrem/year.
Perched Groundwater	Prevent releases of radionuclides to the groundwater exceeding total uranium levels of 20 pCi/l (approximately 30 μg/l).
	Prevent releases of inorganic and organic chemicals in excess of concentrations shown in Tables 2-3 and 2-4.

removal of soils under facilities after the facility is removed, and Alternatives 13 and 14 for facility removal. Table 7-2 shows the 14 alternatives, and process options associated with each alternative, that were screened in Chapter 6.0.

7.2 CONTAMINATION SUMMARY

Operable Unit 3 contamination is generally related to high uranium activity levels in soils and perched groundwater underlying site facilities. In addition, metal scrap piles and miscellaneous discarded equipment/materials contain low levels of uranium contamination. Although preliminary data indicates that other Hazardous Substance List contaminants are present within Operable Unit 3, uranium is likely to be the dominant contaminant. All contaminants, however, will be addressed through the RI/FS process, as migration of contamination into the underlying Great Miami Aquifer is the primary area of concern.

7.2.1 Soils

The majority of soils containing uranium exceeding acceptable residual concentration levels (50 ppm, see Section 2.1 of Chapter 2.0) are located in the top 1.5 feet of surficial material. With respect to surface area, approximately 50 percent of the Production Area soils contain uranium contamination exceeding these levels.

Significantly high uranium concentration levels are found throughout the Production Area. The majority of these high concentrations are between 200 and 500 ppm. Two exceptionally high concentrations are the south-central and north areas of Plant 6 in the southeast quadrant. Within these areas, uranium concentrations approach 70,000 ppm in north Plant 6 and 17,000 ppm in south central Plant 6. Table 7-3 details locations, depths, and quantities of uranium concentrations in the Production Area.

Additional contaminants that are likely to be found in soils were discovered through RI/FS perched groundwater sampling at concentrations above background levels. These contaminants are magnesium, thorium, radium-226, technetium-99, and manganese. However, nonradiological sampling data is not yet available.

TABLE 7-2

OPERABLE UNIT 3 REMEDIAL ACTION ALTERNATIVES AND TECHNOLOGY TYPES

Technology Types	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Monitoring	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Maintenance	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Subsurface Barrier											●	●		
Cap		●	●	●			●	●						
Storm Water Management		●	●	●			●	●	●	●		●		
Groundwater Extraction									●	●		●		
Mechanical Removal			●	●	●	●	●	●					●	●
Facility Removal													●	●
Groundwater Treatment									●	●		●		
Soil Treatment					●	●	●	●					●	●
Thermal Treatment			●	●	●	●	●	●					●	●
Metals Decontamination			●	●	●	●							●	●
Stabilization		●	●	●	●	●	●	●					●	●
Waste Segregation and Volume Reduction			●	●	●	●	●	●					●	●
Transportation and Packaging			●	●	●	●	●	●					●	●
On-Site Waste Disposal			●		●		●						●	
Off-Site Waste Disposal				●		●		●						●
Discharge									●	●		●		

Alternative 1 - No Action

Alternative 2 - Cap

Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap

Alternative 4 - Mechanical Removal of Aboveground Contaminants, Off-Site Disposal, and Cap

Alternative 5 - Mechanical Removal and On-Site Disposal

Alternative 6 - Mechanical Removal and Off-Site Disposal

Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal

Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal

Alternative 9 - Groundwater Extraction, Treatment, and Discharge

Alternative 10- Groundwater Extraction, Monitoring, Treatment, and Discharge

Alternative 11 - Subsurface Barrier

Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge

Alternative 13 - Facility Removal and On-Site Disposal

Alternative 14 - Facility Removal and Off-Site Disposal

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TABLE 7-3

OPERABLE UNIT 3 URANIUM CONTAMINATION IN SOIL WITHIN THE PRODUCTION AREA

Quadrant	Depths of Contamination (ft)				
	0 - 1.5	1.5 - 3	3 - 5.5	10 - 15	15 - 20
Open Areas					
Northeast Quadrant Graphite Furnace and Oil Burner Area	■	—	—	—	—
Northeast Quadrant - Area South and North of NE Scrap Metal Pile	▲	—	—	—	—
Northeast Quadrant Buffer Zone and Area East of Plant 9	■	—	—	—	—
Northwest Quadrant Plant 1 Drum Storage Pad	■	—	—	—	—
Northwest Quadrant Thorium Storage Area	■	—	—	▲	▲
Southwest Quadrant Area Between Plant 2/3 and 4	▲	—	—	—	—
Southwest Quadrant Plant 8 Area	■	—	▲	▲	▲
Southwest Quadrant Laboratory Area	■	—	—	—	—
Southeast Quadrant Area East and West of Plant 5	■	—	▲	—	▲
Southeast Quadrant Area South of Garage and In-Vivo Building	■	▲	—	—	—
Southeast and Southwest Quadrant Area Along First Street	■	▲	▲	▲	▲
Southeast and Northeast Quadrant Area South of Maintenance Bldg & Plant 9	▲	▲	■	—	■
Under Facilities					
Northeast Quadrant Plant 9	■	■	■	■	—
Southwest Quadrant Plant 2/3	■	■	■	■	■
Southwest Quadrant Building 39A, Incinerator	■	■	▲	▲	■
Southwest Quadrant Pilot Plant and Pilot Plant Tank Farm	■	▲	▲	■	—
Southeast Quadrant Plant 4	■	—	—	—	—
Southeast Quadrant Plant 6	■	■	■	■	■

LEGEND:

■ = Contamination Greater than 200 ppm

▲ = Contamination Between 50 and 200 ppm

— = Contamination Less Than 50 ppm

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Contamination data currently available for suspect areas are as follows: the fire training area contains surficial total uranium contamination above 200 ppm over a large area and 1,1,1-trichloromethane, 1,1-dichlorethane, 1,1-dichlorethene, ethyl benzene, tetrachloroethane, toluene and total xylenes at levels above background. The sewage treatment plant/incinerator area contains a large quantity of surficial soils with total uranium levels above 200 ppm to the northeast of the incinerator. Total volumes of uranium contaminated wastes are detailed by suboperable unit in Table 7-4.

TABLE 7-4

OPERABLE UNIT 3 URANIUM CONTAMINATED WASTE VOLUMES

Suboperable Unit	Volume (cubic feet)
A	2,570,100
B	2,517,100
C	1,197,100
D	2,101,450
E	1,027,500 (soil) 4,400,000 (material)
F	not applicable
G	75,000
Total	9,488,250 (soil) 4,400,000 (material)

7.2.2 Perched Groundwater

Approximately 80 percent of the Production Area perched groundwater samples contain measurable levels of uranium contamination, some greater than 100,000 μg/l. The extent of this contamination likely underlies the majority of facilities in the southeast and southwest quadrants, parts of Plant 1, Plant 9, the boiler plant, and the pilot plant. Table 7-5 details locations and ranges of uranium in the perched groundwater.

Other chemicals that have been detected in perched groundwater, in addition to uranium, include 1,1-dichloroethene and trichloroethene detected near Plant 2/3 and Plant 9. Other volatile and semivolatile organic compounds, as well as PCBs and lead, were also encountered north of the maintenance area.

Additional contaminants were discovered through RI/FS perched groundwater sampling at concentrations above background levels. These contaminants are magnesium, thorium, and manganese contained in the northeast quadrant; and magnesium and thorium contained the northwest quadrant. The southeast and southwest quadrants contain thorium, with the southwest quadrant also containing radium-226, and the southeast quadrant containing technetium-99 at levels above background. However, nonradiological sampling data is not yet available in these areas.

7.2.3 Scrap Metal and Miscellaneous Scrap

Miscellaneous scrap metals are contained in the northeast and northwest quadrants. Reported uranium contamination levels are relatively low. Additional testing is targeted for these piles.

Miscellaneous discarded scrap material and equipment are located within the northeast quadrant, primarily in the former drum baling area. A detailed inventory of these materials has not been performed, but preliminary inspections have identified scrap vehicles and construction equipment contaminated with low levels of uranium, as well as asbestos transit and possibly PCB-contaminated scrap transformer carcasses and capacitors.

TABLE 7-5

OPERABLE UNIT 3
PERCHED GROUNDWATER URANIUM CONTAMINATION WITHIN THE PRODUCTION AREA

Area	Contamination
Southeast Quadrant East of Plant 6	■
Southwest Quadrant Southeast of Plant 2 / 3	●
Southwest Quadrant Surrounding Plant 2 / 3	●
Southwest Quadrant Surrounding Plant 8	●
Southwest Quadrant Incinerator, Building 39A	▲
Southwest Quadrant West of Plant 8	▲
Southwest Quadrant Northeast of Plant 2 / 3	▲
Southwest Quadrant West of Pilot Plant	●
Northeast Quadrant South of Plant 9	■

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LEGEND:

■ = Contamination Greater than 50,000 µg/l

▲ = Contamination Between 10,000 µg/l and 50,000 µg/l

● = Contamination Less than 10,000 µg/l

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7.3 RANKING ASSUMPTIONS FOR THE SCREENING PROCESS

When considering short-term public health and environmental protection, the effectiveness of each alternative in protecting human health and the environment from the initiation of remedial action activities up to the time when the remedial response objectives are achieved is evaluated. The greater the nature, magnitude, and duration of the remedial activity, the greater the environmental risk associated with the implementation of the action. In cases where contamination has migrated off the FMPC property, any actions that do not remove the contamination have been downgraded in ranking.

The short-term public health and environmental protection has been ranked the lowest for off-site transportation and disposal due to traffic flow through the local community. It is assumed that this action would likely represent the greatest potential short-term impact to the community. In addition, disturbing the contamination will affect both workers and the public immediately off site. Engineered dust controls are assumed in use, but they typically cannot be one hundred percent effective.

Long-term public health and environmental protection risk of each alternative has been evaluated on the basis of the magnitude of remaining risk, adequacy of control, and reliability of controls. In addition, this assessment will focus on the effectiveness of each alternative in protecting human health and the environment from residuals or untreated materials. These factors assume that the long-term effects of on-site disposal are equivalent to off-site disposal.

For reduction of toxicity, mobility, or volume through treatment, all remedial actions that do not include treatment have been downgraded in ranking. Although the cap prevents further vertical penetration of rainfall and runoff, continual horizontal infiltration can occur. Once horizontal infiltration has penetrated the contaminated waste, further migration can occur. All excavation actions assume treatment of the soils prior to disposal. Containment (e.g., subsurface barriers) is considered to be physical treatment, and thus, reduces the mobility, but not the toxicity or volume of the contaminants.

Constructability evaluation considers not only the developmental status of any physical process units, but also any site-specific constraints such as subsurface conditions, space limitations,

and/or site obstructions. The difficulty of the construction (e.g., facility removal or excavation under a facility) impacts the ranking of this factor. The more difficult the construction, the lower the ranking. Due to the working conditions within the Production Area, a loss of efficiency has been considered in the ranking.

Reliability of alternatives has been evaluated based on the ability of a given process option to meet specified efficiencies or performance goals, and how well it will maintain its performance requirements over time. In many situations, the reliability of the operation has been designed into the system through engineering requirements. If complex technologies are required for the alternative, the ranking has been lowered.

The maintainability of alternatives has been evaluated based on the ability to monitor and maintain the effectiveness of the remedial action. Most maintenance requirements will be routine, but if complex technologies are required of the alternative, the ranking has been lowered.

Agency approvals have been evaluated on the basis of agency and permit requirements. For areas outside the FMPC property, alternatives that do not remove the contamination are ranked low. In addition, if a delay is involved with the remedial action, the ranking has been lowered.

Special engineering has been evaluated based on any special design or implementation factors, including the need for specially trained or experienced personnel to set up or operate equipment or to implement a specific component of an alternative. The design of the permanent storage facility requires significantly more special engineering than a temporary storage facility; therefore, alternatives requiring special equipment or design factors or complex technologies have been ranked lower than the more simple alternatives.

7.4 ALTERNATIVES RECOMMENDED FOR DETAILED ANALYSIS

In Chapter 4.0, the alternatives were assembled for the screening process discussed in Chapter 6.0. They were screened with respect to their impact in mitigating a particular problem category. A subjective ranking for each factor of the effectiveness and

implementability criteria were assigned. Cost was assigned a relative value of low, medium, or high and was not considered as a stand-alone screening criterion for purposes of this analysis. Table 7-6 provides a summary of the ranking scores of each alternative with respect to the applicable problem area(s). The "X" overprint on Table 7-6 indicates those alternatives that have been deleted from further consideration in the detailed analysis of alternatives.

Primarily, the basis for retaining or deleting an alternative from consideration during initial screening is that alternative's relative score versus Alternative 1, the No Action Alternative. If the overall score of the alternative under evaluation is less than or equal to the No Action Alternative, then deletion of that alternative is evaluated as to its impact on maintaining adequate alternatives for detailed analysis. Essentially, this resulted in preserving an alternative that offers an off-site or on-site disposal option if only one of these similar (sister) alternatives would normally have been saved (e.g., Alternative 6 is preserved only because its sister, Alternative 5, rates above the score of the No Action Alternative). At this time in the screening process, it is not possible to accurately quantify all factors involved in evaluating on-site versus off-site disposal options.

As shown in Table 7-6, the alternative screening process results in the complete elimination of Alternatives 2, 3, 4, and 11. They will not be considered further in the detailed analysis phase.

7.5 TREATABILITY STUDIES

Chapter 3.0 discusses various technology types and process options that might be applicable for Operable Unit 3 remediation. In many cases, these technology types and process options have not been sufficiently demonstrated, with supporting data, to satisfy remediation criteria. This is especially true for soil volume or toxicity reduction processes. As input from the treatability studies report is not expected to be available until after the Detailed Analysis of Alternatives, this information will not likely be considered until the preparation of the Draft Feasibility Study Report.

TABLE 7-6

OPERABLE UNIT 3 ALTERNATIVE EVALUATION SUMMARY

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12	Alternative 13	Alternative 14
Suboperable Unit A														
Effectiveness	13	15			21	18								
Implementability	21	18			18	17								
Total	34	33			39	35								
Cost	L	L			H	H								
Suboperable Unit B														
Effectiveness	11	15			21	18								
Implementability	21	17			18	17								
Total	32	32			39	35								
Cost	L	L			H	H								
Suboperable Unit C														
Effectiveness	13				21	18	19	17						
Implementability	21				16	15	16	15						
Total	34				37	33	35	32						
Cost	L				H	H	H	H						
Suboperable Unit D														
Effectiveness	13				21	18	19	17					19	18
Implementability	21				16	15	16	15					17	16
Total	34				37	33	35	32					36	34
Cost	L				H	H	H	H					H	H
Suboperable Unit E														
Effectiveness	13	13	17	14	21	18								
Implementability	21	14	16	16	18	17								
Total	34	27	33	30	39	35								
Cost	L	L	H	H	H	H								
Suboperable Unit F														
Effectiveness	11								23	23	13	21		
Implementability	21								20	18	16	19		
Total	32								43	41	29	40		
Cost	L								M	M	L	H		
Suboperable Unit G														
Effectiveness	11	15			21	18								
Implementability	21	17			18	17								
Total	32	32			39	35								
Cost	N/A	N/A			N/A	N/A								

NOTE:

14
16
32
N/A

Alternative not carried forward to Task 14.

Alternative 1 - No Action
Alternative 2 - Cap
Alternative 3 - Mechanical Removal of Aboveground Contaminants, On-Site Disposal, and Cap
Alternative 4 - Mechanical Removal of Aboveground Contaminants Off-Site Disposal
Alternative 5 - Mechanical Removal and On-Site Disposal
Alternative 6 - Mechanical Removal and Off-Site Disposal
Alternative 7 - Near Term: Temporary Cap
Far Term: Mechanical Removal and On-Site Disposal
Alternative 8 - Near Term: Temporary Cap
Far Term: Mechanical Removal and Off-Site Disposal
Alternative 9 - Groundwater Extraction, Treatment, and Discharge
Alternative 10 - Groundwater Extraction, Monitoring, Treatment, and Discharge
Alternative 11 - Subsurface Barrier
Alternative 12 - Subsurface Barrier and Groundwater Extraction, Treatment, and Discharge
Alternative 13 - Facility Removal and On-Site Disposal
Alternative 14 - Facility Removal and Off-Site Disposal

Suboperable Unit A: Open Field Areas with Limited Access to Contaminated Soils
Suboperable Unit B: Open Field Areas With Good Access to Contaminated Soils
Suboperable Unit C: Soil Contamination Under Facilities
Suboperable Unit D: Soil Contamination Under Facilities Designated for Possible Demolition
Suboperable Unit E: Aboveground Contaminants
Suboperable Unit F: Perched Groundwater Contamination
Suboperable Unit G: Soils Surrounding Transfer Lines

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APPENDIX A
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

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 3 within the Comprehensive Environmental Response, Compensation, and Liability Act/Superfund Amendments and Reauthorization Act of 1986/National Oil and Hazardous Substance 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. This information was presented to DOE on June 13, 1989 in the Initial Screening of Alternatives presentation and is based on project and regulatory information available at the time.

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 circumstances 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, such that their use is 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.1 POTENTIAL ARARs FOR OPERABLE UNIT 3

In accordance with current 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 that, 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 ambient 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 brief discussion of each of the primary federal and state of Ohio ARARs, along with pertinent agency-issued criteria, advisories, and guidance, is given below. A summary listing of potential ARARs is found in Table A-1.

A.1.1 Federal ARARs

Federal ARARs and other criteria, advisories, or guidelines include:

- Safe Drinking Water Act (42USC300f, et seq., and 40CFR141 to 149) - Establishes maximum contaminant levels that are enforceable standards for chemicals in public drinking water supplies. They not only consider health factors, but also the economic and technical feasibility of removing a contaminant from a water supply system. The EPA has recently proposed maximum contaminant level goals for several organic and inorganic compounds in drinking water. Maximum contaminant level goals are nonenforceable guidelines that do not consider the technical feasibility of contaminant removal. The SDWA also authorizes the following programs:

  - The Underground Injection Control Program
  - The Sole-Source Aquifer Program
  - The Wellhead Protection Program

- Toxic Substances Control Act (15USC2601, et seq., and 40CFR702 to 799) - Regulates the use and disposal of polychlorinated biphenyls (PCBs) and asbestos.

- Resource Conservation and Recovery Act (42USC6901, et seq., as amended, and 40CFR260 to 279) - Establishes the criteria and standards for identification, management, and disposal of hazardous waste.

- Federal Water Pollution Control Act, as amended by the Clean Water Act (33USC-1251, et seq., and 40CFR104 to 140) - Governs point-source discharges through the National Pollutant Discharge Elimination System (NPDES), dredge and fill activities that may degrade or disturb wetlands or other aquatic habitats, and oil or hazardous substance spills to waters of the United States.

- Ambient Water Quality Criteria (AWQC) - Criteria for 64 chemicals were established in 1980, pursuant to Section 304(a)(1) of the CWA. AWQC are available for the protection of human health from exposure to chemicals in drinking water, from ingestion of aquatic biota, and for the protection of fresh-water and salt-water aquatic life.

- Regulation of Activities Affecting Waters of the U.S. (33CFR320 to 329) - U.S. Army Corps of Engineers (COE) regulations that are applicable to wetlands and navigable waters.

- Occupational Safety and Health Act (29USC651, et seq., and 29CFR1904, 29CFR1910, and 29CFR1926) - Provides occupational safety and health requirements applicable to workers engaged in on-site field and remediation activities.

- Endangered Species Act of 1978 (16USC1531, et seq.) - Provides for consideration of the impacts of remedial actions on endangered and threatened species.

- Fish and Wildlife Coordination Act (16USC661, et seq.) - Provides for consideration of the impacts on wetlands and protected habitats.

- Fish and Wildlife Improvement Act of 1978 (16USC742a) - Provides for consideration of the impacts on wetlands and protected habitats.

- Clean Air Act (42USC4701, et seq.) - Through the National Ambient Air Quality Standards (NAAQS), it identifies primary and secondary standards for six "criteria pollutants," and through the National Emission Standards for Radionuclides Emissions from DOE facilities (40CFR61), it provides annual exposure limits from air emissions from DOE facilities.

- EPA Regulations for Environmental Radiation Protection Standards for Nuclear Power Operations (40CFR190) - Applies to radiation doses received by members of the public in the general environment and to radioactive materials introduced into the general environment as a result of operations that are part of the nuclear fuel cycle.

- EPA Regulations for Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40CFR192) - Applies to the control of residual radioactive material at designated processing or repository sites under Section 108 of the Uranium Mill Tailings Radiation Control Act of 1978 and to restoration of such sites following any use of subsurface minerals under Section 104 (h) of the above-referenced act.

- NRC Regulations for Standards for Protection against Radiation (10CFR20) - Establishes standards for protection against radiation hazards arising out of activities under licenses issued by the U.S. Nuclear Regulatory Commission (NRC) and issued pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974.

- The Atomic Energy Act of 1954 (42USC2011, as amended) - Authorizes the conduct of atomic energy activities.

- Licensing Requirements for Land Disposal of Radioactive Waste (10CFR61) - Establishes procedures and criteria for the land disposal of radioactive wastes.

A.1.2 State of Ohio ARARs

State of Ohio ARARs and other criteria, advisories, or guidance include the authority of the Ohio Environmental Protection Agency (OEPA) to manage federal environmental programs. OEPA shares several responsibilities with other Ohio agencies, including the Ohio Department of Health (ODH), the Ohio Department of Natural Resources (ODNR), and the Public Utilities Commission. State of Ohio ARARs include:

- Ohio Water Pollution Control Act (ORC Chapter 6111) - OEPA has the authority to administer all of the federally mandated water discharge programs, including the NPDES programs for all source categories (OAC3745-33-01 through 3745-33-05), and an effective pretreatment program (OAC3745-3).

- Solid and Hazardous Waste Disposal Law (OAC Chapter 3734) - OEPA has been developing extensive solid and hazardous waste regulations (OAC3745 Chapters 27-70). These programs are administered by the Solid and Hazardous Waste Division of OEPA.

- Water Quality Standards (OAC3745-1) - Ohio has developed water quality standards applicable to state surface water (OAC3745-1-04), an antidegradation policy (OAC3745-1-05), and has designated water use criteria for all major surface water bodies (OAC3745-1-07 to 32). Specific criteria for chemical concentrations have so far only been established for Lake Erie and the Ohio River.

- Drinking Water Rules - The rules for public drinking water are set forth by OAC3745-81-01 to 55, and include maximum contaminant levels. OAC3745-82 sets secondary contaminant standards.

- Water Well Installation - For new wells intended for human consumption, well installation is regulated under OAC3745-9 by OEPA and ODNR.

- The Underground Injection Well Control Program - Approvals for injection wells are required from the ODNR and OEPA. The requirements for permits to inject fluids via wells are set forth in OAC3745-34.

- Water System - Authority to establish and enforce rules regarding private water systems is granted to the Department of Health under OAC3701. The Department of Health governs plan approvals, procedures, construction, and abandonment for private water systems (OAC3701-38). Community and public water supply systems are governed and approved by the OEPA under OAC3745-83 to 95.

- Radiation Standards - Standards for protection and handling of equipment and materials associated with ionizing radiation are governed by rules set by the Department of Health under OAC3701-38.

A.2 GUIDANCE TO BE CONSIDERED (TBC)

Because ARARs may not exist or may not be sufficient to protect human health and the environment at a CERCLA site, it is necessary to evaluate nonlegally binding or promulgated criteria, advisories, guidance, or policies for protective cleanup levels when determining cleanup requirements or designing a remedy. EPA and support agencies may, as appropriate, identify

other advisories, criteria, or guidance to be considered for a particular remediation activity. This TBC category consists of advisories, criteria, or guidance that are not ARARs that were developed by EPA, other federal agencies, or states.

The application of the ARARs to Operable Unit 3 at the FMPC is complicated by the fact that the DOE and radionuclides (particularly uranium) have been exempted from most environmental regulations. From a radiological standpoint, the DOE has been primarily self-regulating for environmental activities, and has established its own policies for environmental monitoring, waste disposal, and limits of exposure to employees and the public. EPA regulations regarding the handling and disposal of wastes containing radionuclides are under programs set up by the Uranium Mill Tailings Act and the NRC. It should also be noted that DOE orders are not promulgated requirements but fall under the category of TBCs.

A brief discussion of each of the primary federal TBCs presently being considered is given below.

- Health Effects Assessments - Presents toxicity data for specific chemicals for use in public health assessments. Also considered applicable are cancer potency factors and referenced doses provided in the Human Health Evaluation Manual (EPA 1989a).

- Groundwater Protection Strategy - Documents EPA policy to protect groundwater for its highest present or potential beneficial use. The strategy designates three categories of groundwater:

  - Class 1 - Special Groundwaters: Waters that are highly vulnerable to contamination and are either irreplaceable or ecologically vital sources of drinking water

  - Class 2 - Current and Potential Sources of Drinking Water and Waters Having Other Beneficial Uses: Waters that are currently used or that are potentially available for use

  - Class 3 - Groundwater not a Potential Source of Drinking Water and of Limited Beneficial Use: Class 3 groundwater units are further subdivided into the following two subclasses:

    a. Subclass 3A includes groundwater units that are highly to intermediately interconnected to adjacent groundwater units of a higher class and/or surface waters. They may, as a result, be contributing to the degradation of the adjacent waters. They may

be managed at a similar level as Class 2 groundwaters, depending upon the potential for producing adverse effects on the quality of adjacent waters.

b. Subclass 3B is restricted to groundwater units characterized by a low degree of interconnection to adjacent surface waters or other groundwater units of a higher class within the Classification Review Area. These groundwaters are naturally isolated from sources of drinking water in such a way that there is little potential for producing adverse effects on quality. They have low resource value outside of mining or waste disposal.

- DOE Order for CERCLA Program (5400.4) (Draft) - Provides direction for DOE to implement a CERCLA program.

- DOE Order for Radiation Protection of the Public and the Environment (5400.5) (February 8, 1990) - Establishes standards and requirements with respect to protection of the public and the environment against radiation.

- DOE Order for Hazardous and Radioactive Mixed Waste Management (5480.2) (December 13, 1982) - Establishes hazardous waste management procedures for facilities operated under authority of the Atomic Energy Act of 1954, as amended.

- DOE Order for Environmental Protection, Safety, and Health Protection Information Reporting Requirements (5484.1) (February 24, 1981) - Establishes the requirements and procedures for reporting and investigating matters of environmental protection, safety, and health protection significant to DOE operations.

- DOE Order for Quality Assurance (5700.6B) (September 23, 1986) - Establishes DOE's quality assurance program.

- DOE Order for Radioactive Waste Management (5820.2A) (September 26, 1988) - Establishes policies and guidelines for the management of radioactive waste and contaminated facilities.

- DOE Order for Radiation Protection for Occupational Workers (5480.11) (December 21, 1988) - Establishes standards and requirements with respect to protection of the occupational worker against radiation.

A summary listing of to be considered (TBC) items is found in Table A-1.

TABLE A-1
APPLICABLE, OR RELEVANT AND APPROPRIATE REQUIREMENTS AND GUIDANCE TO BE CONSIDERED

Chemical-Specific ARARs

Requirement	Description
Resource Conservation and Recovery Act (RCRA), Subtitle C (42USC6901, et seq.)	Sets standards applicable to hazardous waste treatment, storage, and disposal
Safe Drinking Water Act (42USC300, et seq.)	
a. Maximum contaminant levels b. Maximum contaminant level goals	Remedial actions may provide cleanup to the maximum contaminant levels considered pursuant to SARA Section 121(d)(2)(A)(ii)
Clean Water Act Ambient Water Quality Criteria (33USC1313, et seq.)	Remedial actions may involve discharge to surface waters
EPA Regulations for Environmental Radiation Protection Standards for Nuclear Power Operations (40CFR190)	40CFR190 establishes radiation dose limits to the public of annual dose equivalents not to exceed 25 mrem to the whole body
EPA Regulations for Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40CFR192)	Establishes cleanup limits for uranium and thorium mill tailings in soil and groundwater
Clean Air Act (42USC7401, et seq.)	
a. National Ambient Air Quality Standards (NAAQS) for six criteria pollutants (40CFR50)	Identifies primary and secondary standards for six "criteria pollutants" (e.g., lead, particulates)
b. National Emission Standards for Radionuclides Emissions from DOE Facilities (40CFR61 Subpart H)	Provides annual limits of 10 mrem/yr (whole body) for air emissions from DOE facilities
NRC Licensing Requirements for Land Disposal of Radioactive Waste (10CFR61)	Provides for protection of the general population from releases of radioactivity (<25 mrem/yr)
NRC Regulations for Standards for Protection Against Radiation (10CFR20)	Establishes dose limits in unrestricted areas (10CFR20.105-106) and for waste disposal (10CFR20.301-302)

TABLE A-1
(Continued)

Chemical-Specific ARARs		
	Requirement	Description
Ohio Regulations		
a.	Air Pollution OAC3745-17-07 OAC3745-17-05 OAC3745-17-07 OAC3745-17-08 OAC3745-21-07	Escape, releases, emissions to open air Nondegradation policy Particulate emissions to air Fugitive dust emissions Emissions of organics to air Air quality
b.	Water Pollution OAC3745-81	Drinking water rules, sets maximum contaminant levels for gross alpha, beta, and radium-226 and radium-228
	OAC3745-1	Water quality standards, 3745-01-4(D) sets the criterion applicable to all waters, 3745-01-05 sets forth the antidegradation policy for state waters, 3745-01-21 describes use designations for the Great Miami River, 3745-1-32 (c) (9) specifically excludes uranium from the Ohio River
c.	Other Regulations OAC3701-38	Ohio Radiation Protection Standards provide concentration limits for discharge of radioactive materials into air or water in unrestricted areas

TABLE A-1
(Continued)

Location-Specific ARARs	
Requirement	Description
Rivers and Harbors Act of 1899 (33CFR320 to 327)	Remedial alternatives may affect the Great Miami River
Ohio Location Standards (OAC3745-45018)	Governs the location of hazardous waste treatment, storage, or disposal with respect to seismic conditions and floodplains
Fish and Wildlife Improvement Act of 1978 (16USC742, et seq.)	The effects of no action and the construction, demolition, and discharge activities must be considered if endangered species are located in an area impacted by Operable Unit 3
Regulations of activities affecting waters of the U.S. (33CFR320 to 329)	DOE regulations apply to both wetlands and navigable waters (33CFR320-329), and for Ohio (OAC3745-32)
Endangered Species Act of 1978 (16USC1531, et seq.)	The effects of no action and the construction, demolition, and discharge activities must be considered if endangered species are located in area impacted by Operable Unit 3
Fish and Wildlife Coordination Act (16USC1531, et seq.)	Provides for coordination of the impacts on wetlands and protected habitats

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TABLE A-1
(Continued)

Action-Specific ARARs	
Requirement	Description
OSHA Requirements (29CFR1904, 29CFR1910, and 29CFR1926)	Required for workers engaged in on-site remedial activities
Clean Water Act Ambient Water Quality Criteria (33USC1313, et seq.)	Alternatives include discharge to surface waters
NRC Regulations for Standards for Protection Against Radiation (10CFR20)	Provides standards for discharge of radionuclides to unrestricted areas (air and water), a variety of waste disposal requirements (licensed materials), and sets guidelines for surveys, personnel monitoring, and other radiation safety requirements
EPA Regulations for Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40CFR192)	Provides standards for control of residual radioactive materials from inactive uranium processing sites
EPA Regulations for National Emission Standards for Radionuclide Emissions from DOE Facilities (40CFR61)	Applies principally to air emissions from DOE facilities
Safe Drinking Water Act (40CFR141 to 149)	Establishes maximum contaminant levels for potential drinking water sources
Ohio General Radiation Protection Standards (OAC3701 to 70)	Applies to all facilities that receive, possess, use, store, transfer, etc., any source of radiation
Ohio Radiation Protection Standards (OAC3701 to 38)	Applies to all facilities that receive, possess, use, store, transfer, etc., any source of radiation
Hazardous Waste Transport (OAC3745-53-11)	Remedial alternative may include off-site transport

TABLE A-1
(Concluded)

Action-Specific ARARs	
Requirement	Description
Executive Order 11990 Protection of the Wetlands	This order may affect the administrative ability of alternatives that cause disturbance or destruction of wetlands
Threshold Limit Values, American Conference of Governmental Industrial Hygienists	Sets requirements for air concentrations during remedial activities
Radioactive Waste Management (DOE Order 5820.2A)	Sets requirements for management of radioactive wastes at DOE facilities
Radiation Protection of the Public and the Environment (DOE Order 5400.5)	Sets requirements for protection of the public and the environment from radioactive materials at DOE facilities
Radiation Protection for Occupational Workers (DOE Order 5480.11)	Sets requirements for protection of workers from radiation and radioactive materials at DOE facilities
CERCLA Program (5400.4) (Draft)	Provides direction for DOE to implement a CERCLA program
Hazardous and Radioactive Mixed Waste Management (5480.2) (December 13, 1982)	Establishes hazardous waste management procedures for facilities operated under authority of the Atomic Energy Act of 1954, as amended
Environmental Protection, Safety, and Health Protection Information Reporting Requirements (5484.1) (February 24, 1981)	Establishes the requirements and procedures for reporting and investigating matters of environmental protection, safety, and health protection significant to DOE operations
Quality Assurance (5700.6B) (September 23, 1986)	Establishes DOE's quality assurance program

A.3 SUMMARY

The establishment of final federal and state ARARs and TBCs for uranium and other constituents found in the operable unit for the evaluation of remedial action alternatives for Operable Unit 3 at the FMPC will be a progressive, multistep process involving interactive discussions among DOE, EPA, and OEPA. The critical application of the final ARARs will be performed during the detailed analysis of alternatives. The ARARs, in conjunction with the Baseline Risk Assessment, will assist in the determination of the cleanup levels required to adequately protect public health and the environment at the FMPC.

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