PROGRAM MANAGER ROCKY MOUNTAIN ARSENAL

U.S. ARMY
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—COMMITTED TO PROTECTION OF THE ENVIRONMENT—

FINAL DETAILED ANALYSIS OF ALTERNATIVES REPORT

Version 4.1

Soil DAA
Volume III of VII

October 1995

Contract No. DAAA 05-92-D-0002

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Montgomery Watson
International Dismantling & Machinery
Ageiss Environmental
Hazen Research
DataChem
BC Analytical

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TECHNICAL SUPPORT FOR
ROCKY MOUNTAIN ARSENAL

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Prepared by:

FOSTER WHEELER ENVIRONMENTAL CORPORATION
RUST Environment and Infrastructure
Baker Consultants, Inc.

Prepared for:

U.S. Army Program Manager's Office for the
Rocky Mountain Arsenal

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DIRECTORY

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LIST OF ACRONYMS AND ABBREVIATIONS

14DCLB	1,4-Dichlorobenzene
3-D	three-dimensional
ACGIH	American Conference of Governmental Industrial Hygienists
ACM	asbestos–containing material
ALDRN	Aldrin
AMC	Army Materiel Command
AOC	Area of Contamination
AOPs	advanced oxidation processes
AR	Army Regulations
ARARs	applicable or relevant and appropriate requirements
Army	U.S. Army
atm-m^3/mol	atmospheres per cubic meter per mole
ATP	Anaerobic Thermal Processor
ATSDR	Agency for Toxic Substances and Disease Registry
B	Soil Density
BCRL	Below Certified Reporting Limit
BCS	Boundary Containment System
BCY	bank cubic yard
BDA	Bilateral Destruction Agreement
BDAT	best demonstrated available technology
BEST	Basic Extraction Sludge Treatment
BFI	Browning Ferris Industries
BOD	Biological Oxygen Demand
BRRN	North Bedrock Ridge Plume
BRRS	South Bedrock Ridge Plume
BTEX	benzene, toluene, ethylbenzene, and xylenes
BTU	British thermal unit
CAMU	Corrective Action Management Unit
CAR	Contamination Assessment Report
CCA	chromated-copper-arsenate
CCR	Code of Colorado Regulations
CD	Cadmium
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CFS	Confined Flow System
CH2CL2	Methylene Chloride
CHCL3	Chloroform
CL6BZ	Hexachlorobenzene
CLC2A	Chloroacetic Acid
cm/sec	centimeters per second

cm^2	centimeters squared
CMP	Comprehensive Monitoring Program
COC	contaminant of concern
CPE	chlorinated polyethylene
CPMS	p-Chlorophenylmethyl Sulfide
CPRP	Chemical Personnel Reliability Program
CRL	certified reporting limit
CSI	Conservation Services, Inc.
CSPE	chlorosulfonated polyethylene
Cu	copper
CWA	Clean Water Act
CWC	Chemical Weapons Convention
CY	cubic yards
DA	Department of the Army
DAA	Detailed Analysis of Alternatives
DADS	Denver Arapahoe Disposal Service, Inc.
db(A)	decibels
DBCP	dibromochloropropane
DCE	Dichoroethylene
DCPD	dicyclopentadiene
DDE	2,2-bis(p-Chlorophenyl)-1,1-dichloroethene
DDT	2,2-bis(p-Chlorophenyl)-1,1,1-trichloroethane
DHHS	Department of Health and Human Services
DIMP	diisopropylmethyl phosphonate
DMMP	Dimethylmethylphosponate
DNAPL	dense nonaqueous phase liquid
DOD	Department of Defense
DOT	Department of Transportation
DRE	destruction/removal efficiency
DRMO	Defense Reutilization and Marketing Office
DSA	Development and Screening of Alternatives
DTG	Design treatment goal
DWELS	Drinking Water Equivalent Levels
EA	Endangerment Assessment
Ecology	U.S. Ecology, Inc.
EDSVEP	Enhanced Deep Soil Vapor Extraction Process
EIF	enter into force
ENSCO	Environmental Systems Company
Envirosafe	Envirosafe Services of Idaho, Inc.
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ERC	Ecological Risk Characterization
ESSVEP	Enhanced Surface Soil Vapor Extraction Process

ETTS	Ecotechniek Thermal Treatment System
FC2A	fluoroacetic acid
FFA	Federal Facility Agreement
FML	flexible membrane liner
foc	Fraction Organic Carbon in Soil
fpm	feet per minute
FRP	fiber - reinforced plastic
FRG	final remediation goal
FS	feasibility study
ft	feet or foot
ft/day	feet per day
ft^3	cubic feet
GAA	granulated activated alumina
GAC	granular activated carbon
GB	isopropylmethylphosphonofluoridate (nerve agent-sarin)
GIS	Geographical Information System
GMP	Groundwater Monitoring Program
gpm	gallons per minute
H:V	horizontal to vertical
H_2O_2	hydrogen peroxide
HA	Health Advisories
HBCs	Health based criteria
HBr	hydrogen bromide
HCCPD	hexachlorocyclopentadiene
HCL	hydrochloric acid
HCPD	Hexachloropentadiene
HD	mustard
HDPE	high-density polyethylene
HE	high explosive(s)
HEP	habitat evaluation protocol
HEPA	high efficiency particulate air
HF	hydrofluoric acid
HHEA	Human Health Exposure Assessment
HHRC	Human Health Risk Characterization
HI	hazard index
ICP	inductively coupled plasma
ICS	Irondale Containment System
IDLH	Immediately Dangerous to Life and Health
IEA	Integrated Endangerment Assessment
IITRI	IIT Research Institute
IMPA	Isopropyl Methylphosponic Acid
INCS	Internal Containment System
IRA	interim response action

IT	International Technology
IWT	International Waste Technologies
Kg	Kilogram
K_{oc}	partition coefficient
Kp	Partitioning Coefficient for Soil
kW	Kilowatt
kWh	Kilowatt hour
L	Lewisite
lbs	pounds
lbs/acre	pounds per acre
LCY/hr	loose cubic yards per hour
LCY	loose cubic yards
LDR	land disposal restriction
LF	linear foot
LNAPL	light nonaqueous phase liquid
LT^3	Low-Temperature Thermal Treatment
LTTA	Low-Temperature Thermal Aeration
MCL	Maximum Containment Level
MEXCLR	Methoxychlor
mg/l	milligrams per liter
mg/m^3	milligrams per cubic meter
mg/kg	milligrams per kilogram
mg/cm^3	milligrams per cubic centimeter
MGL	milligrams per liter
MKE	Morrison–Knudsen Engineering
ml/g	milliliters per gram
mm	millimeters
MMBTU	million British thermal units
MOU	Memorandum of Understanding
MPA	Methylphosphonic Acid
mph	miles per hour
MTR	minimum technology requirement
n	Total Porosity
NaOH	sodium hydroxide
NAPL	Nonaqueous Phase Liquid
NBCS	North Boundary Containment System
NCP	National Contingency Plan
NDMA	Nitrosodimethylamine
NEPA	National Environmental Policy Act
NNDMEA	N-Nitrosodimethylamine
NWBCS	Northwest Boundary Containment System
O&M	operations and maintenance
OAS	Organizations and State

°C	degrees Centigrade
OCP	organochlorine pesticides
°F	degrees Fahrenheit
OPHGB	organophosphorus compounds, GB-agent related
OPHP	organophosphorus compounds; pesticide related
OSCH	organosulfur compounds; herbicide related
OSCM	organosulfur compounds; mustard agent related
OSHA	Occupational Safety and Health Administration
PAHs	polynuclear aromatic hydrocarbons
PBC	probabalistic biota criteria
PCB	polychlorinated biphenyl
pcf	pounds per cubic foot
PCP	pentachlorophenol
PDA	Pilot Demolition Assessment
PEC	plume evaluation criteria
PKPP	potassium pyrophosphate
ppb	parts per billion
PPDDE	dichlorodiphenyldichloroethylene
PPDDT	dichlorodiphenyltrichloroethane
PPE	personal protective equipment
PPLV	preliminary pollutant limit value
ppm	parts per million
ppt	Parts per Trillion
PQL	practical quantitation limit
PRG	preliminary remediation goal
psi	pounds per square inch
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RAO	remedial action objective
RC	Risk Characterization
RCRA	Resource Conservation and Recovery Act
RF	radio frequency
Ri	Retardation Factor
RI	remedial investigation
RISR	Remedial Investigation Summary Report
RMA	Rocky Mountain Arsenal
ROD	Record of Decision
RPO	representative process option
SACWSD	South Adams County Water and Sanitation District
SAR	Study Area Report
SARA	Superfund Amendments and Reauthorization Act
SCC	Secondary Combustion Chamber
SEC	Site evaluation criteria

SF	square feet
SFS	Supplemental Field Study
Shell	Shell Oil Company
SHO	Semivolatile halogenated organics
SITE	Superfund Innovative Technology Evaluation
SPNP	South Plants North Plume
SPNS	South Plants North Source Plume
SPSE	South Plants Southeast Plume
SQI	submerged quench incinerator
STC	Silicate Technology Corporation
STF	South Plants Tank Farm
SVE	soil vapor extraction
SVOCs	semivolatile organic compounds
SY	square yards
TBCs	to be considered criteria
TCLP	toxicity characteristic leaching procedure
TEA	triethylamine
TEC	Target Effluent Concentration
TIS	transportable incineration system
TMV	toxicity, mobility, and volume
TOC	total organic carbon
tpd	tons per day
TSCA	Toxic Substances Control Act
TSD	Treatment Storage and Disposal
TSGM	two-step geometric mean
UFS	Unconfined Flow System
µg/g	micrograms per gram
µg/l	micrograms per liter
USCS	Unified Soil Classification System
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USPCI	U.S. Pollution Control, Inc.
UST	Underground Storage Program
UV	ultraviolet
UXO	unexploded ordnance
VAO	volatile aromatic organic compounds
VHC	volatile hydrocarbon compounds
VHO	volatile halogenated organics
Vi	Velocity of Component i in Aquifer
VOC	volatile organic compound
VX	ethyl s-dimethyl aminoethyl methyl phosphonothiolate
WES	Waterways Experimental Station

13.0 DETAILED ANALYSIS OF ALTERNATIVES FOR THE SEWER SYSTEMS MEDIUM GROUP

The Sewer Systems Medium Group consists of sites that are located throughout RMA. The sewer lines in these sites conveyed chemical, sanitary, and process water wastes. Release of contaminants at these sites was caused by spillage or leakage from broken pipes or faulty joints and manholes in the sewer lines. The remedial investigation program inferred that some of the soil along the piping runs is contaminated, but the actual areas of contamination have not been well documented due to the difficulties in identifying points of leakage without excavating the entirety of the piping runs. The contaminated soil is typically at depths greater than 6 ft below the ground surface (based on the depth of the sewer piping). These nine sites are subdivided by type and contamination pattern into two subgroups, the Sanitary/Process Water Sewers Subgroup and the Chemical Sewers Subgroup (Figure 13.0-1).

The COCs present in this medium group that exceed the Human Health SEC (EBASCO 1994a) include OCPs, CLC2A, VOCs, and DBCP. Human Health SEC (EBASCO 1994a) are only defined for the Chemical Sewers Subgroup. No human health exceedances have been identified for the Sanitary/Process Water Sewers Subgroup because the concentrations of all the COCs for this subgroup are below CRLs or the Human Health SEC (EBASCO 1994a) in the samples collected. Biota risk was not evaluated for this medium group since the sewer systems are located more than 6 ft below the ground surface while biota impacts were evaluated within 0- to 1-ft interval. The highest concentrations of contaminants—which exceed the principal threat criteria—were detected along the chemical sewer line in site SPSA-10 (South Plants). Sites within this medium group were potential sources of groundwater contamination when in use. Table 13.0-1 contains a summary of the characteristics of this medium group, including the COCs and exceedance volumes, and Appendix A lists the exceedance volumes and areas for the sites within both subgroups.

In the DSA (EBASCO 1992b), alternatives were developed and screened based on the general characteristics of the medium group. In the DAA, however, the characteristics of the two subgroups—including contaminants and contaminant concentrations, site configuration, and depth of contamination—were evaluated to determine the subset of applicable alternatives for each subgroup from the range of alternatives retained in the DSA (EBASCO 1992b) for the medium group. For the Chemical Sewers Subgroup, therefore, the retained alternatives were modified primarily to account for the treatment of principal threat volumes. Based on the IEA/RC report (EBASCO 1994a), it was determined that there are no exceedances in the Sanitary/Process Water Sewers Subgroup. For this reason, the only alternatives evaluated are those that prevent the sewers from acting as a conveyance mechanism for potential migration of contamination to groundwater through the existing manholes and associated sewer lines.

The following sections present the characteristics of the medium group, an evaluation of the retained alternatives against the DAA criteria listed in the NCP (EPA 1990a), and the selection of alternatives, based on a comparative analysis, that was considered in the development of the sitewide alternatives (Section 20).

13.1 SANITARY/PROCESS WATER SEWERS SUBGROUP CHARACTERISTICS

The Sanitary/Process Water Sewers Subgroup consists of sites NCSA-8a (Sanitary Sewer Lines), SPSA-11 (Sanitary Sewer System), SPSA-12 (Process Water Lines), and WSA-7a (Sanitary Sewer Sediment). These sites contain soil that was potentially contaminated by spillage or leakage from broken pipes or faulty joints and manholes in the sewer lines. Contamination entered these sewer lines through inadvertent disposal of liquid wastes or conveyance of contaminated groundwater. However, none of soil samples from the sanitary/process water sewer sites contain contaminants exceeding the Human Health SEC (EBASCO 1994a), so the alternatives for this subgroup are evaluated solely to reduce the potential for migration of contaminated groundwater. The sanitary/process water sewers are covered by 280,000 BCY of overburden (based on a minimum 6 ft of overburden) along their 124,000-ft length. The majority of sewer piping is vitrified clay, but some sections are comprised of steel or cast-iron pipe. Approximately 34 of the sanitary sewer manholes were plugged as part of the Sanitary Sewers IRA to reduce the potential for migration of contaminated groundwater through the sewers. During this IRA, several of the manholes proposed for plugging were not plugged based on access limitations and the potential presence of contaminated soil near the manholes. Table 13.1-1 provides a summary of the frequency of detection of contaminants for this subgroup.

Coordination of alternatives developed for this subgroup with alternatives developed for the water medium is limited to ensuring that any excavation alternatives for the sewer lines do not interfere with groundwater removal systems evaluated for the South Plants and Basin A Plume Groups.

The sites within the Sanitary/Process Water Sewers Subgroup exhibit a range of habitat values from disturbed areas of vegetation to native grasses. In general, the habitat consists of disturbed areas as most of the sewer lines lie within South Plants. However, several segments are located beneath prairie dog colony areas. The areas disturbed during remedial actions are revegetated with native grasses in accordance with a refuge management plan. In most instances, the overall habitat is improved, which should offset the short-term loss of small areas of habitat that will result from the remedial actions.

Since 57,000 ft of the Sanitary/Process Water Sewers Subgroup is located within South Plants, the removal of the sewer lines impacts the alternatives developed for the structures and other soil medium groups that include portions of South Plants. To remove the lines in South Plants, some structures need to be demolished and removed to allow access to the sewer lines. Therefore, coordination with the alternatives evaluated for the Significant Contamination History, Other Contamination History, and Agent History Medium Groups are required. In addition, the removal of the sanitary/process water sewers requires coordination with other soil medium groups such as the South Plants Medium Group.

13.2 SANITARY/PROCESS WATER SEWERS SUBGROUP EVALUATION OF ALTERNATIVES

The alternatives for the Sanitary/Process Water Sewers Subgroup vary in approach from no action to containment. Based on revised Human Health SEC (EBASCO 1994a) values, it was determined that there are no human health exceedances. For this reason, the only alternatives evaluated are those which prevent the sewers from acting as a conveyance mechanism for potential migration of contamination to groundwater through the existing manholes and associated sewer lines.. Treatment alternatives involving thermal desorption were not evaluated since no exceedance volume exists. The following subsections present a description of each alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a).

13.2.1 Alternative 1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA) applies to the entire 124,000-ft length of the sewer lines. Sewers remain in place, and no action is taken to reduce potential migration of contaminated groundwater through the sanitary sewer system. Five-year site reviews are conducted to assess the effectiveness of the alternative. This alternative does not impact existing habitat. Alternative 1 does not affect the development of structures alternatives for South Plants; the latter can range in approach from no action to demolition and removal.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

13.2.1.1 Overall Protection of Human Health and the Environment

This alternative may not achieve RAOs relative to groundwater protection since all of the manholes were not plugged. Potential groundwater impacts are not reduced beyond existing IRA measures. There are no short-term impacts related to this alternative.

13.2.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the subgroup is not located in wetlands or a 100-year flood plain. In addition to ARARs, the alternative complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.2.1.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low since no exposure risks have been identified. No controls are implemented and site reviews are required. The existing habitat is not improved by this alternative, and groundwater impacts are not reduced.

13.2.1.4 Reduction in TMV

There is no reduction in TMV. Treatment residuals are not generated since no materials are treated or contained.

13.2.1.5 Short-Term Effectiveness

The time frame until RAOs are achieved is greater than 30 years because no measures are taken to address the potential continued migration of contaminated groundwater. The alternative does not pose risk to workers and the community during remedial actions because no actions are taken. The existing habitat is not changed.

13.2.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are available to sample soil and inspect the sewer manholes.

13.2.1.7 Cost

The total present worth cost is $82,600 and includes only long-term operations and maintenance costs associated with long-term monitoring and site reviews. Table B4.5-1 details the costing for this alternative. The cost uncertainty associated with site reviews and monitoring is low.

13.2.2 Alternative 2: Access Restrictions

Alternative 2: Access Restrictions (Modifications to FFA) applies to the entire 124,000 ft length of the sewer lines. The estimated 1,130 BCY of void space inside the manholes is plugged with a concrete mixture, which prohibits access to the lines and eliminates them as a potential migration pathway for contaminated groundwater. Five-year site reviews are conducted to review the effectiveness of the alternative. Due to the linear nature of these sewers, physical barriers or habitat modifications cannot be implemented for this alternative; however, the contaminated soil is located more than 6 ft below the ground surface, which eliminates nearly all of the potential exposure pathways. Nonetheless, aboveground warning signs are posted every 1,000 ft along sewer lines to indicate their location underground. Information on the sanitary sewer lines is included as part of the ongoing program to educate the public about areas where contamination is left in place. Alternative 2 does not affect the development of structures alternatives for South Plants; the latter can range in approach from no action to demolition and removal.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

13.2.2.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs since potential groundwater impacts are reduced through the plugging of manholes. The short-term impacts are minimal since no intrusive activities are conducted.

13.2.2.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as site reviews are conducted, endangered species are not impacted, and the subgroup is not located in wetlands or a 100-year flood plain. In addition, the alternative complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.2.2.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low. Sewers remain in place, but manholes are plugged. No other controls are implemented and site reviews are required. The existing habitat is not affected by this alternative, and long-term monitoring is required.

13.2.2.4 Reduction in TMV

By implementing land-use restrictions and plugging manholes, the potential for the sewers to act as a conduit for contaminated groundwater is mitigated. The controls are only reversible should the methods fail. There are no treatment residuals associated with this alternative.

13.2.2.5 Short-Term Effectiveness

The alternative is protective of workers and the community during the remedial action and entails low short term risk. Workers are adequately protected by personal protective equipment while plugging the sewer lines. Migration of contaminants to groundwater is reduced. Plugging of the manholes requires less than 1 year. The existing habitat is not affected by this alternative.

13.2.2.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil and sewer lines left in place, although the overburden adds to the total sewer volume. The alternative is administratively feasible, and materials, specialists, and equipment are readily available for manhole plugging.

13.2.2.7 Cost

The total present worth cost is $423,000 including $3,000, $298,000, and $122,000 for capital, operating, and long-term costs, respectively. Table B4.5-2 details the costing for this alternative. The cost uncertainty associated with plugging manholes and site reviews is low.

13.2.3 Alternative 3: Landfill

Alternative 3: Landfill (On-Post Landfill) involves excavating the unplugged manholes, sewer debris, and cement-plugged manholes (which were filled during the Sanitary Sewers IRA), and transporting and disposing the entire volume (12,000 BCY) in the on-post hazardous waste landfill. Prior to excavation of the manholes and sewer debris in South Plants, the structures along and above the sewer line are demolished and removed to allow access to the sewers, and the 280,000 BCY of overburden soil are excavated and stockpiled nearby.

The sections of sewer piping constructed of vitrified clay, 29,400 linear feet (LF), are crushed during excavation and removed, along with associated soil. Approximately, 94,600 LF of steel and cast-iron pipe are removed from the trench using a backhoe equipped with shears. The pipe is cut into 2-ft lengths and transported to the landfill for disposal. The removal and sizing of steel and cast-iron pipe results in a volume increase of 1 percent for treatment and/or disposal. In addition to the sewer lines, manholes, both plugged and unplugged, are removed and sized. An estimated total of 12,000 BCY of sewer debris is excavated, transported, and placed in the on-post hazardous waste landfill.

The on-post landfill is a multiple-cell facility requiring 1 year for construction of the first cell and associated facilities (Section 4.6.6). The landfill cover is revegetated to limit erosion and control surface-water infiltration, and fencing is installed around the landfill to preserve the integrity of the landfill cover and leachate control system. Long-term maintenance of the landfill cover, leachate collection and treatment, and groundwater monitoring are required.

The excavation is backfilled to the original grade with materials from an on-post borrow area. The uppermost 6 inches of soil are supplemented with conditioners to promote the growth of vegetation. The remedial action is completed by revegetation with native grasses. As a result, the habitat quality is restored or improved at these sites. The borrow area is also regraded and revegetated to restore habitat. Abandoned utilities are removed during the excavation of the South Plants sewer lines, and this debris is combined with the debris from the demolition of structures. The overburden is backfilled upon removal of the piping and debris. Dewatering is not anticipated to be required based on the projected reduction in groundwater elevations after the manmade influence (i.e., leaking sewers) is removed.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.2-1 summarizes the evaluation of all the alternatives developed for this medium group.

13.2.3.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs since the sewers are excavated and placed in the on-post hazardous waste landfill. The removal of the sewers prevents the migration of contaminated groundwater. There are some short-term impacts associated with the excavation of the sewer lines.

13.2.3.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on landfill siting, design, and operation and impacts to endangered species. Sites in the Sanitary/Process Water Sewers Subgroup and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.2.3.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is minimal since 12,000 BCY of soil and sewer line debris that may contribute to groundwater contamination or migration are removed and landfilled. There is high confidence in the engineering controls of the landfill and no difficulties are associated with landfill maintenance. Landfill-cell monitoring is required to ensure the integrity of the controls. Habitat at the sewer site is restored or improved by revegetation; however, habitat at the landfill is eliminated.

13.2.3.4 Reduction in TMV

Although no materials are treated, the potential for the sewers to act as a conduit for contaminated groundwater is eliminated. The reduction in groundwater impacts is irreversible since the sewer lines are removed. There are no treatment residuals associated with this alternative.

13.2.3.5 Short-Term Effectiveness

This alternative entails short-term risks associated with excavation, transportation, and landfilling of the sewer lines. Personal protective equipment adequately protects workers during excavation and transportation. In addition, fugitive dust that may affect the community during excavation is controlled through water sprays. Vapor emissions are not anticipated. There are minimal impacts on the environment due to the linear nature of the site. The potential for migration of the contaminants to the groundwater is eliminated. The time frame until RAOs are achieved is 2 years. Excavation and disposal of the 12,000 BCY of soil and debris is feasible within 1 year, following 1 year for the construction of the landfill.

13.2.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter with periodic landfill-cell monitoring. Additional remedial actions require removal of the landfill cover. The alternative is administratively feasible since the substantive Subtitle C requirements associated with landfill siting, design, and operations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill, and landfill technology has been well demonstrated at full scale.

13.2.3.7 Cost

The total present worth cost is $5,640,000 including $312,000, $5,320,000, and $9,000 for capital, operating, and long-term costs, respectively. Table B4.5-3 details the costing for this alternative. The level of uncertainty associated with the costing of this alternative is low since the location and depth of the sewer lines are known.

13.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

Since the IEA/RC report (EBASCO 1994a) did not identify any exposure risks for human health, the Sanitary/Process Water Sewers Subgroup does not have an associated human health exceedance volume. The Sanitary Sewers IRA has reduced the potential for migration of contaminated groundwater through the sewer lines by plugging sections that acted as potential conduits for contamination. Direct exposure to the sewers for biota is restricted by the overburden covering the lines. Personal protective equipment and site controls are adequate to protect site workers and the community during any intrusive remedial activities.

In general, the habitat at these sites consists of areas of disturbed vegetation, although some segments are located beneath prairie dog colony areas. Alternatives that involve excavation include revegetation and restoration of habitat, so no significant habitat impacts are anticipated.

In summary, the Sanitary/Process Water Sewers Subgroup contains no identified human health or biota exceedances, and the potential for groundwater migration through the lines has been reduced by the plugging of manholes during the Sanitary Sewers IRA. Therefore, a reduction in human and biota exposures was not a factor in the evaluation of alternatives. Habitat impacts and protection of site workers and the community are not significant factors in determining the preferred alternative for this subgroup.

Alternative 1: No Additional Action does not reduce the potential for transport of contaminated groundwater beyond that accomplished by the IRA and so was eliminated from further consideration. The two remaining alternatives achieve RAOs and meet the two DAA threshold criteria, protection of human health and the environment and compliance with action-specific and location-specific ARARs. The alternatives differ only slightly in how they meet the five balancing criteria (Table 13.2-1).

Alternative 3: Landfill requires the excavation of 280,000 BCY of overburden, but removes 12,000 BCY of soil and sewer pipe debris for containment in the on-post hazardous waste landfill. Since a portion of the sewers are located below structures within South Plants, this alternative must be coordinated with alternatives developed for the structures medium. Although the cost for excavating the overburden and landfilling the sewer lines is high ($5,640,000), this alternative eliminates the potential migration of groundwater through the sewer lines by removing the sewer lines. Therefore, this alternative was retained for further evaluation in the development of sitewide alternatives.

Alternative 2: Access Restrictions (Modifications to FFA) has the lowest cost of the protective alternatives ($423,000). This alternative does not remove the sewer lines, but does achieve RAOs by minimizing the potential for migration of contaminated groundwater by plugging the remaining sewer manholes. These access restrictions do not impact alternatives developed for the structures or water media, though coordination between the soil and structures alternatives is required. Because it minimizes the potential migration of groundwater through the sewer lines, this alternative was retained for consideration in developing sitewide alternatives.

Consequently, the alternatives that were retained to represent the Sanitary/Process Water Sewers subgroup in the development of the sitewide alternatives (Section 20) are the following:

- Alternative 2: Access Restrictions (Modifications to FFA)
- Alternative 3: Landfill (On-Post Landfill)

13.4 CHEMICAL SEWERS SUBGROUP CHARACTERISTICS

The Chemical Sewers Subgroup is composed of sites CSA-3 (Chemical Sewer), NCSA-6a (South Plants Chemical Sewer), NCSA-6b (North Plants Chemical Sewer), NPSA-1 (Chemical Sewer System), and SPSA-10 (Chemical Sewer System). Contamination at these sites, which includes exceedances of the principal threat criteria and the potential presence of agent, is a result of broken piping or faulty joints in manholes and sewer lines. The highest concentrations of contamination have been detected along the sewer line in South Plants (site SPSA-10). In addition, these sites exhibit the potential for agent contamination and are potential sources of groundwater contamination. The chemical sewers are covered by 340,000 BCY of overburden (based on an average overburden depth of 7 ft) along their 87,000-ft length.

Table 13.4-1 provides a summary of contaminants, concentrations, and exceedance values for this subgroup. OCPs, CLC2A, DBCP, HCCPD, and VOCs are present at maximum concentrations that exceed the Human Health SEC (EBASCO 1994a). These COCs were found 7 to 11 ft below ground surface. Approximately 47,000 BCY of soil and sewers in site SPSA-10 contain aldrin at concentrations that also exceed the principal threat criteria (10^{-3} excess risk, HI of 1,000). Table 13.4-2 presents the frequency of detection for samples collected along the chemical sewer lines. Figure 13.4-1 shows the distribution of exceedance areas for the Chemical Sewers Subgroup, and Table 13.0-1 presents the exceedance areas and volumes. Figure 13.4-2 shows the overlap of the human health exceedance soil volume with the potential agent presence soil volume. Most of the soil/sewers in this subgroup potentially contains agent; however, two segments of the chemical sewer leading to the former Basin F site are not anticipated to contain agent as the sewer lines and associated contaminated soil were removed.

Coordination of alternatives developed for this medium group with those developed for the water medium is limited to ensuring that any excavation of sewer lines does not interfere with groundwater removal systems evaluated for the South Plants and Basin A Plume Groups. Since the 23,000 LF of principal threat area for the Chemical Sewer Subgroup are located within South Plants, the removal of the sewer lines must be coordinated with the alternatives developed for structures and other soil medium groups in portions of South Plants. The majority of sewer piping is vitrified clay, but some sections are made of steel or cast-iron pipe. To remove the lines in South Plants, some structures, such as sumps, need to be demolished and removed to allow access to the sewer lines. Figure 13.4-1 shows the location of the sewer lines in South Plants relative to structures.

The sites within the Chemical Sewers Subgroup exhibit a range of habitat values from native grasses to areas of disturbed vegetation. In general, the habitat consists of disturbed areas since much of the sewer lines are located within North and South Plants. However, several segments are located beneath prairie dog colony areas. Under most of the alternatives developed for this medium group, the areas disturbed during remedial actions are capped as a result of remediation of other adjacent soil medium groups or revegetated with native grasses in accordance with a refuge management plan. In most instances, the overall habitat is improved, which should offset the short-term loss of habitat resulting from remedial actions.

13.5 CHEMICAL SEWERS SUBGROUP EVALUATION OF ALTERNATIVES

The alternatives for the Chemical Sewers Subgroup vary in approach from no action to treatment. The alternatives retained in the DSA (EBASCO 1992b) for this subgroup were modified during the DAA because it was determined that solidification is not required for treatment of inorganic contaminants. New alternatives were also developed to account for the treatment of principal threat volumes (i.e., Alternative 1a). Solvent washing was screened out in the DSA (EBASCO 1992b) based on concerns regarding effectiveness and implementability concerns. However, treatability studies indicate that solvent washing is effective in removing OCPs and may also be able to treat agent-contaminated soil. Therefore, solvent washing was reintroduced for evaluation in the DAA. An additional alternative (3e) was added to evaluate landfilling of chemical sewers outside of areas that were proposed for capping.

The following subsections present a description of each alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a). The alternatives for this medium group consist of an alternative to address areas of human health exceedances (which is listed first) and an alternative for areas with potential agent presence (the "A" alternative).

13.5.1 <u>Alternative 1/A1: No Additional Action</u>

Alternative 1: No Additional Action (Provisions of FFA), combined with Alternative A1: No Additional Action (Provisions of FFA), applies to the 82,000 BCY of soil and sewers with human health exceedances that also have the potential for presence of agent. These exceedances remain in place, and no action is taken to reduce human exposure to COCs or to reduce potential groundwater migration in the sewers. Exceedance areas are monitored (an average of 16 total samples per year), annual groundwater sampling is conducted, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants. Alternative 1 does not affect the development of structures alternatives for South Plants; the latter can range in approach from no action to demolition and removal.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

13.5.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve RAOs. Contaminated soil remains in place and potential groundwater impacts are not reduced. Natural attenuation is the only means by which long-term reduction in toxicity of contaminants can be achieved. The short-term impacts are minimal since no intrusive activities are conducted.

13.5.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the subgroup is not located in wetlands or a 100-year flood plain In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). This alternative complies with Army regulations regarding the control of agent-contaminated materials because the potential contamination is covered with at least 6 to 7 ft of soil, which prevents potential exposures. (ARARs are listed in Appendix A of the Technology Descriptions Volume).

13.5.1.3 Long-Term Effectiveness and Permanence

There is a moderate residual risk associated with this alternative. High levels of DBCP and OCPs are present, but contaminated soil is more than 7 ft below ground surface. The potential for groundwater impacts is not reduced. No controls are implemented; however, site reviews, soil monitoring, and groundwater compliance monitoring are conducted. The existing habitat is not improved by this alternative.

13.5.1.4 Reduction in TMV

There is no reduction in TMV other than by natural attenuation. Treatment residuals are not generated since no materials are treated or contained. A total of 82,000 BCY of untreated soil and sewers remain in place.

13.5.1.5 Short-Term Effectiveness

The time frame until RAOs are achieved is greater than 30 years because natural attenuation/degradation is the only means by which contaminant reduction can be achieved. The alternative does not pose risk to workers and the community during remedial actions since no actions are taken. No measures are taken to address the potential for continued migration of contaminants to the groundwater. The existing habitat is not affected.

13.5.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are available to sample soil and groundwater.

13.5.1.7 Cost

The total present worth cost is $2,130,000 and includes only long-term operations and maintenance costs associated with long-term monitoring and site reviews. Table B4.6-1 details the costing for this alternative. The cost uncertainty associated with site reviews and monitoring is low.

13.5.2 Alternative 1a/A1: Direct Thermal Desorption of Principal Threat Volumes; No Additional Action

Alternative 1a: Direct Thermal Desorption (Direct Heating) of Principal Threat Volumes; No Additional Action (Provisions of FFA), along with Alternative A1: No Additional Action (Provisions of FFA), involves treatment of 47,000 BCY of soil and sewers with principal threat exceedances in site SPSA-10 and no additional action at other sites. Due to the potential for odor problems, the excavation of the overburden and principal threat soil/sewer volume is conducted such that a minimal area is uncovered and exposed at any one time, and daily soil covers or plastic sheeting are placed over the excavated areas. Screening for the presence of agent is conducted when the principal threat volume is excavated using real-time monitoring equipment. If agent presence is identified and confirmed by RMA laboratory analyses, the soil is excavated and treated by caustic soil washing (Alternative A3, Section 4.4.3).

The 120,000 BCY of overburden are stockpiled near the excavation. Prior to excavation of the sewer lines in South Plants, the structures along and above the sewer line are demolished and removed to allow access to the sewers. While removing the chemical sewer system, abandoned utilities are also removed and combined with the structural debris. The sections of sewer piping constructed of vitrified clay are crushed during excavation of the sewers, but 2,100 LF of steel and cast-iron pipe are removed from the trench using a backhoe equipped with shears. The pipe is cut into 2-ft lengths and transported to the centralized treatment facilities. The sewer pipe is sized, crushed, and screened prior to entering the thermal desorber. Although the soil is expected to be near saturation, dewatering is not anticipated to be required based on the projected reduction in groundwater elevations after the manmade influence (i.e., leaking sewers) is removed.

The principal threat volume of 47,000 BCY is excavated and transported to the centralized thermal desorption facility. (Section 4.6.24 discusses details of this technology.) For the process design purposes, the principal threat soil is assumed to be saturated (i.e., moisture content of 20 percent) due to the high water table in South Plants. Based on this moisture content, the thermal desorber processes the soil/sewer debris at a rate of approximately 1,300 BCY/day at a discharge temperature of 300°C, assuming a total soil residence time of 50 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) The 470 BCY of particulates from the scrubber blowdown equipment, approximately 1 percent of the solids feed, are disposed in the on-post hazardous waste landfill. The treated soil/sewer debris is returned to the site as backfill and covered with the stockpiled overburden. The disturbed area is then revegetated with native grasses.

No additional action is undertaken for the balance of the sites in the Chemical Sewers Subgroup to reduce human exposure to COCs, prevent hazards from soil potentially containing agent, or reduce potential groundwater migration. An exceedance volume of 35,000 BCY remains in place. Exceedance areas are monitored (an average of 16 total samples per year), annual groundwater sampling is conducted, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

13.5.2.1 Overall Protection of Human Health and Environment

This alternative does not achieve RAOs. Despite treatment of the principal threat volume, untreated soil/sewers remain in place; there is no reduction in toxicity other than by natural attenuation. Potential groundwater impacts are reduced through treatment of the principal threat volume, but are not addressed for the remaining soil and sewers. The excavation of contaminated soil associated with the sewer line and the clearance of agent entails significant short-term risks.

13.5.2.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources; landfill siting, design, and operation; and endangered species. Location-specific ARARs are met as the sites, treatment facilities, and landfill are not located in wetlands or a 100-year flood plain. This alternative complies with provisions of the FFA (EPA et al. 1989) and with Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding the control of agent-contaminated materials because the potential contamination is capped with at least 6 to 7 ft of soil. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.5.2.3 Long-Term Effectiveness and Permanence

There is a low residual risk associated with this alternative since the principal threats are removed and treated. Untreated soil and sewers remain, but contaminated materials are encountered at depths greater than 7 ft. Agent is potentially present in sewer lines that are not removed. In addition, approximately 1 percent of soil feed recovered from off-gas treatment equipment is placed in an on-post landfill. Controls for operation and maintenance of the landfill, as well as site reviews and groundwater monitoring, are required. Habitat quality for areas associated with the principal threat volume is restored through revegetation. The habitat for the balance of the site is not affected.

13.5.2.4 Reduction in TMV

Thermal desorption reduces organics in the principal threat volume (47,000 BCY) to detection levels or >99.99 percent DRE. The principal threat volume is screened for agent during excavation, but there is no reduction in potential hazards from agent in the remaining soil. The TMV reduction of organics by thermal desorption is irreversible. Treatment residuals would include approximately 470 BCY of blowdown solids that are landfilled. There is no reduction in TMV other than by natural attenuation for the soil and sewers remaining in place.

13.5.2.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance and the excavation, transportation, and thermal desorption of contaminated soil and sewers. The risks are reduced through engineering controls and use of PPE, but they cannot be completely removed. Engineered dust controls (such as water spraying) and odor/vapor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for odor emissions during excavation despite these controls. In addition, preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and odors. The emissions from the thermal desorber contain low but acceptable levels of some contaminants, although the off-gas control system for the thermal desorber is designed to achieve air quality standards. Environmental impacts of the remedial actions are minimal due to the existing disturbed habitat over most of the sewer lines. The potential for migration of contaminants to groundwater is reduced through treatment of the principal threat volume. The excavation and treatment of the 47,000 BCY is feasible within 1 year, following 2 years for construction and testing of the thermal desorption facility and construction of the landfill. The time frame until RAOs are achieved, however, is greater than 30 years.

13.5.2.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the contaminated soil/sewers. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not yet been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, high moisture content, and materials-handling problems (which are increased by the presence of debris). Administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays, and it may be difficult to implement this alternative due to public perceptions regarding the safety of thermal treatment.

13.5.2.7 Cost

The total present worth cost is $10,900,000 including $1,460,000, $7,580,000, and $1,900,000 for capital, operating, and long-term costs, respectively. Table B4.6-1a details the costing for this alternative. There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination below the sewer line, as well as the potential presence of agent, are difficult to delimit. Second, there is very little operational experience at other sites on which to base cost estimates for the vapor/odor controls and to evaluate their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high moisture content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

13.5.3 Alternative 2/A1: Access Restrictions

Alternative 2: Access Restrictions (Modifications to FFA), along with Alternative A1: No Additional Action (Provisions of FFA), involves the initiation of access restrictions for the contaminated sewer lines in the Chemical Sewers Subgroup. The exceedance volume of 82,000 BCY remains in place, but contaminant migration pathways are interrupted. An estimated 970 CY of void volume within chemical sewer lines and manholes is filled and plugged with a concrete mixture, which prohibits access to these lines and eliminates them as a potential pathway for groundwater migration. Aboveground warning signs are posted every 1,000 ft along the sewer lines to indicate their location underground. Information about the chemical sewers is included in an ongoing program to educate the public about areas where contaminants remain in place. Exceedance areas are monitored (an average of 16 total samples per year), annual groundwater monitoring is conducted, and 5-year site reviews are conducted to review the effectiveness of the alternative and to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

13.5.3.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through the interruption of exposure pathways and through access restrictions. The potential for groundwater impacts is also reduced. The short-term impacts are minimal since no intrusive activities are conducted.

13.5.3.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as site reviews are conducted and the subgroup is not located in wetlands or a 100-year flood plain. In addition, the alternative complies with provisions of the FFA (EPA et al. 1989). The potential for exposure to agent-contaminated materials is controlled, thereby achieving compliance with Army Materiel Command regulations (AMC-R 385-131) (AMC 1987). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.5.3.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is moderate. High concentrations of OCPs and DBCP detected more than 7 ft below the ground surface remain. Monitoring of groundwater and soil, as well as site reviews, are required. The existing habitat is not improved by this alternative.

13.5.3.4 Reduction in TMV

There is no reduction in TMV except by natural attenuation/degradation. The 82,000 BCY of exceedance volume remains untreated. By implementing land-use restrictions and fencing, human exposure pathways are interrupted. There is no reduction in the potential hazards associated with the presence of agent beyond the controls already described. These exposure controls are only reversible should these methods fail. There are no treatment residuals associated with this alternative.

13.5.3.5 Short-Term Effectiveness

The alternative presents minimal short-term risks to workers and the community during the remedial action. Workers are adequately protected by personal protective equipment during fence installation. Dust and vapor emissions are not expected. The potential for migration of contaminants to groundwater is reduced through plugging of the sewer lines, which requires 1 year. The existing habitat is not affected by this alternative.

13.5.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil and sewer lines left in place, although the removal of overburden is required. The alternative is administratively feasible and materials, specialists, and equipment are readily available for sewer-line plugging and fence installation.

13.5.3.7 Cost

The total present worth cost is $2,570,000 including $3,000, $408,000, and $2,160,000 for capital, operating, and long-term costs, respectively. Table B4.6-2 details the costing for this alternative. The cost uncertainty associated with plugging sewer lines and site reviews is low.

13.5.4 Alternative 2a/A1: Direct Thermal Desorption of Principal Threat Volumes; Access Restrictions

Alternative 2a: Direct Thermal Desorption (Direct Heating) of Principal Threat Volumes; Access Restrictions (Modifications to FFA), along with Alternative A1: No Additional Action (Provisions of FFA), involves treatment of 47,000 BCY of soil and sewers with principal threat exceedances in site SPSA-10 of the Chemical Sewers Subgroup by thermal desorption and the initiation of access restrictions for the remaining sewer lines. Due to the potential for odor problems, the excavation of overburden and principal threat soil is conducted such that a minimal area is uncovered and exposed at any one time, and daily soil covers or plastic sheeting are placed over the excavated areas. Screening for the presence of agent is conducted when the principal threat volume is excavated using real-time monitoring equipment. If agent presence is identified and confirmed by RMA laboratory analyses, the soil is excavated and treated by caustic soil washing (Alternative A3 Section 4.4.3).

The 120,000 BCY of overburden are stockpiled near the excavation. Prior to excavation of the sewer lines in South Plants, the structures along and above the sewer line are demolished and removed to allow access to the sewers. While removing the chemical sewer system, abandoned utilities are also removed and combined with the structural debris. The sections of sewer piping constructed of vitrified clay are crushed during excavation of the sewers, but 2,100 LF of steel and cast-iron pipe are removed from the trench using a backhoe equipped with shears. The pipe is cut into 2-ft lengths and transported to the centralized treatment facilities. The sewer pipe is sized, crushed, and screened prior to entering the thermal desorber. Although the soil is expected to be near saturation, dewatering is not anticipated to be required based on the projected reduction in groundwater elevations after the manmade influence (i.e., leaking sewers) is removed.

The principal threat volume of 47,000 BCY is excavated and transported to the centralized thermal desorption facility. (Section 4.6.24 discusses details of this technology.) For process design purposes, the principal threat soil is assumed to be saturated (i.e., moisture content of 20 percent) due to the high water table in South Plants. Based on this moisture content, the thermal desorber processes the soil/sewer debris at an approximate rate of 1,300 BCY/day at a discharge temperature of 300°C, assuming a total soil residence time of 50 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) The 470 BCY of particulates from the scrubber blowdown equipment, approximately 1 percent of the solids feed, are disposed in the on-post hazardous waste landfill. The treated soil/sewer debris is returned to the site as backfill and covered with the stockpiled overburden. The disturbed area is then revegetated with native grasses.

The remaining human health and potential agent exceedance areas in the Chemical Sewers Subgroup are addressed by the access-restrictions portion of the alternative. An exceedance volume of 35,000 BCY remains in place, but contaminant migration pathways are interrupted. An estimated 510 CY of void volume within chemical sewer lines and manholes are plugged with a concrete mixture. This prohibits access to these lines and eliminates them as a potential pathway for groundwater migration. Aboveground warning signs are posted every 1,000 ft along the sewer lines to indicate their location underground. Information about the chemical sewers is included in an ongoing program to educate the public about areas where contaminants remain in place. Exceedance areas are monitored (an average of 16 total samples per year), annual groundwater sampling is conducted, and 5-year site reviews are conducted to review the effectiveness of the alternative and to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

13.5.4.1 Overall Protection of Human Health and Environment

This alternative achieves RAOs through the treatment of the principal threat volume and the interruption of human exposure pathways. Potential groundwater impacts are reduced through treatment of the principal threat volume and plugging of the remaining lines. The excavation of contaminated soil associated with the sewer lines and the clearance of agent entails significant short-term risks.

13.5.4.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources; landfill siting, design, and operation; and endangered species. Location-specific ARARs are met as the sites, treatment facilities, and landfill are not located in wetlands or a 100-year flood plain. This alternative complies with provisions of the FFA (EPA et al. 1989) and with Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization for the principal threat area. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.5.4.3 Long-Term Effectiveness and Permanence

There is a low residual risk associated with this alternative. The highest levels of OCPs and DBCP are removed and treated and the residual contamination remains in place. Fencing and land-use restrictions reduce human exposure. Approximately 47,000 BCY of material are thermally desorbed and returned to the site as backfill. There is potential agent presence in sewer lines that are not completely removed. In addition, approximately 1 percent of soil feed recovered from off-gas treatment equipment is placed in an on-post landfill. Monitoring of soil and groundwater, controls for operation and maintenance of the landfill, and site reviews are required.

13.5.4.4 Reduction in TMV

Thermal desorption reduces organics in the principal threat volume (47,000 BCY) to detection levels or >99.99 percent DRE. The principal threat volume is screened for agent during excavation, but there is no reduction in potential hazards from agent in the soil and sewers left in place. The TMV reduction of organics by thermal desorption is irreversible. Treatment residuals include approximately 470 BCY of blowdown solids; these are landfilled. There is no reduction of contaminant volume or toxicity except by natural attenuation for the soil and sewers remaining in place (35,000 BCY), but exposure pathways are interrupted by land-use restrictions and mobility is reduced by plugging the sewer lines.

13.5.4.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance, excavation, transportation, and thermal desorption of contaminated soil and sewers. The risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Engineered dust controls (such as water spraying) and odor/vapor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for odor emissions during excavation despite these controls. In addition, the preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and odors. The emissions from the thermal desorber contain low but acceptable levels of some contaminants, although the off-gas control system for the thermal desorber is designed to achieve air quality standards. Environmental impacts of the remedial actions are minimal due to the existing habitat. The potential for migration of the contaminants to groundwater is reduced through treatment of the principal threat volume. The excavation and treatment of the 47,000 BCY is feasible within 1 year, following 2 years for construction and testing of the thermal desorption facility and construction of the landfill. Sewer plugging and signs can be installed within 1 year. Natural attenuation of untreated soil is ongoing, and soil with potential agent presence remains on site.

13.5.4.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the contaminated soil and sewers. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not yet been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, high moisture content, and material-handling problems (which are increased by the presence of debris). Administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays, and it may be difficult to implement this alterative due to the perceptions regarding the safety of thermal treatment.

13.5.4.7 Cost

The total present worth cost is $11,200,000 including $1,460,000, $7,830,000, and $1,930,000 for capital, operating, and long-term costs, respectively. Table B4.6-2a details the costing for this alternative. There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination below the sewer line, as well as the potential presence of agent, are difficult to delimit. Second, there is very little operational experience at other sites on which to base cost estimates for the vapor/odor controls, and to evaluate their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high moisture content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

13.5.5 Alternative 3/A3: Landfill

Alternative 3: Landfill (On-Post Landfill), along with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), includes the placement of 82,000 BCY of soil and sewers with human health exceedances in the on-post hazardous waste landfill. Due to the potential for odor problems, the excavation of overburden and contaminated soil and sewers is conducted such that minimal area is uncovered and exposed at any one time, and daily soil covers or plastic sheeting are placed over the excavated areas. Prior to excavation of the sewer lines in South Plants, the structures along and above the sewer line are demolished and removed to allow access to the sewers.

During excavation, the soil is screened for agent, which is accomplished by stockpiling the excavated soil and field-screening the samples collected. The presence of agent is verified by analysis at the RMA laboratory. The agent-contaminated soil is then transported to the on-post caustic washing unit as described in Section 4.4.3. Operating parameters of the caustic solution washing unit include a processing rate of 35 BCY/day, and a liquid waste stream of approximately 1,800 gallons/day. The liquid waste stream is evaporated with an evaporator/crystallizer. The evaporator/crystallizer generates approximately 1 pound of salts for every 7.5 gallons of liquid evaporated. Residual salts generated, along with the treated soil, are transported to the on-post hazardous waste landfill.

The 340,000 BCY of overburden are excavated and stockpiled near the excavation. While removing the chemical sewer system, abandoned utilities are removed and consolidated with the structural debris. The sections of sewer piping constructed of vitrified clay are crushed during excavation of the sewers, but 15,100 LF of steel and cast-iron pipe are removed from the trench using a backhoe equipped with shears. The pipe is cut into 2-ft lengths and transported to the landfill for disposal. The removal and sizing of steel and cast-iron pipe results in a volume increase of 1 percent for treatment and/or disposal. This debris is sized and crushed prior to disposal in the landfill.

The human health exceedance volume of 82,000 BCY is excavated, transported, and placed in the on-post hazardous waste landfill. The on-post landfill is a multiple-cell facility requiring 1 year for construction of the first cell and associated facilities (Section 4.6.6). The landfill cover is revegetated to limit erosion and control surface-water infiltration, and fencing is installed around the landfill to preserve the integrity of the landfill cover and leachate control system. Long-term maintenance of the landfill cover, leachate collection and treatment, and groundwater monitoring are required.

The site excavation is backfilled with borrow soil from the on-post borrow area. The overburden is backfilled upon removal of the piping and contaminants. The disturbed area is then revegetated with native grasses. The borrow area is also regraded and revegetated to restore habitat. Dewatering is not anticipated to be required based on the projected reduction in groundwater elevations after the manmade influence (i.e., leaking sewers) is removed.

The following discussion presents a detailed evaluation of this alternative against the DAA listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

13.5.5.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs since agent-contaminated soil is treated and landfilled, and the remaining human health exceedance volume and sewers are excavated and landfilled. The removal of the contaminated soil and sewers interrupts exposure pathways and eliminates the potential for contamination of groundwater. The excavation of contaminated soil associated with the sewer line and the clearance of agent entail significant short-term risks.

13.5.5.2 Compliance with ARARs

This alternative complies with action specific ARARs including state regulations on landfill siting, design, and operation and impacts to endangered species. Sites in the Chemical Sewers Subgroup and the landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.5.5.3 Long-Term Effectiveness and Permanence

The residual risk for the treated agent-contaminated soil and the 82,000 BCY of untreated soil and debris removed and contained in the landfill is minimal. There is high confidence in the engineering controls of the landfill and there are no expected difficulties associated with landfill maintenance. Landfill-cell and groundwater compliance monitoring is required. Habitat at the site is improved by revegetation; however, habitat at the landfill is eliminated.

13.5.5.4 Reduction in TMV

Soil and sewers with agent presence are identified and treated by caustic washing to remove the agent and then landfilled. TMV reduction of agent by caustic washing is irreversible. For the untreated soil and sewers, exposure pathways are interrupted and mobility of contaminants is reduced through containment in the landfill. Mobility reduction is only reversible should the landfill fail. There are no treatment residuals associated with this alternative.

13.5.5.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance, excavation, transportation, and landfilling of contaminated soil and sewers. These risks are reduced through engineering controls and use of PPE, but they cannot be completely removed. Engineered dust controls (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are initiated to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. There are minimal impacts on the environment due to the linear nature of the site and the existing habitat along most of the sewer lines. The potential for migration of the contaminants to the groundwater is reduced. The time frame until RAOs are achieved is 2 years. Excavation of the 82,000 BCY is feasible within 1 year, following 1 year for the construction of the landfill.

13.5.5.6 Implementability

Technically feasible, however vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of soil covers increases the volume to be excavated and requires double handling to access the contaminated soil and sewers. Additional remedial actions require removal of the landfill cover. The alternative is administratively feasible since the substantive requirements associated with the direct treatment unit and Subtitle C landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill. The landfill technology has been well demonstrated at full scale.

13.5.5.7 Cost

The total present worth cost is $8,760,000 including $2,110,000, $6,490,000, and $58,000 for capital, operating, and long-term costs, respectively. Table B4.6-3 details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination below the sewer line, as well as potential presence of agent, are difficult to delimit. Second, there is very little operational experience at other sites in which to base cost estimates for the vapor/odor controls, and to evaluate their impact on excavation and equipment productivity.

13.5.6 Alternative 3a/A3: Direct Thermal Desorption of Principal Threat Volumes; Landfill

Alternative 3a: Direct Thermal Desorption (Direct Heating) of Principal Threat Volume; Landfill (On-Post Landfill), along with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), treats 47,000 BCY of soil and sewers with principal threat exceedances by thermal desorption and contains the entire human health exceedance volume of 82,000 BCY in the on-post hazardous waste landfill, including the treated material. Due to the potential for odor problems, the excavation of overburden and the contaminated soil and sewers is conducted such that minimal area is uncovered and exposed at any one time, and daily soil covers or plastic sheeting are placed over the excavated areas. Prior to excavation of the sewer lines in South Plants, the structures along and above the sewer line are demolished and removed to allow access to the sewers.

During excavation, the soil is screened for agent, which is accomplished by stockpiling the excavated soil and field-screening the samples collected. The presence of agent is verified by analysis at the RMA laboratory. The agent-contaminated soil is then transported to the on-post caustic washing unit as discussed in Section 4.4.3.

The 340,000 BCY of overburden are excavated and stockpiled near the excavation. While removing the chemical sewer system, abandoned utilities are removed and consolidated with the structural debris. The principal threat volume of 47,000 BCY is excavated and transported to the centralized thermal desorption facility. (Section 4.6.24 discusses details of this technology.) The principal threat soil/sewer debris is assumed to be saturated (i.e., moisture content of 20 percent) due to the high water table in South Plants. Based on this moisture content, the thermal desorber processes the soil at a rate of approximately 1,300 BCY/day at a discharge temperature of 300°C, assuming a total soil residence time of 50 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) The 470 BCY of particulates from the scrubber blowdown equipment, approximately 1 percent of the solids feed, are disposed in the on-post hazardous waste landfill. The treated soil/sewer debris is then landfilled.

The remaining human health exceedance volume of 35,000 BCY is excavated, transported, and placed in the on-post hazardous waste landfill. The sections of sewer piping constructed of vitrified clay are crushed during excavation of the sewers, but 15,100 LF of steel and cast-iron pipe are removed from the trench using a backhoe equipped with shears. The pipe is cut into 2-ft lengths and transported to the centralized treatment facilities. The removal and sizing of steel and cast-iron pipe results in a volume increase of 1 percent for treatment and/or disposal. This debris is sized and crushed prior to treatment or disposal in the landfill. The on-post landfill is a multiple-cell facility requiring 1 year for construction of the first cell and associated facilities (Section 4.6.6). The landfill cover is revegetated to limit erosion and control surface-water infiltration, and fencing is installed around the landfill to preserve the integrity of the landfill cover and leachate control system. Long-term maintenance of the landfill cover, leachate collection and treatment, and groundwater monitoring are required. The site excavations are backfilled with borrow soil. The stockpiled overburden is then replaced. The remedial action is completed by revegetation of the disturbed area with native grasses.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.5-1 summarizes the evaluation of all the alternatives evaluated for this subgroup.

13.5.6.1 Overall Protection of Human Health and Environment

This alternative achieves RAOs through the treatment of the principal threat volume, treatment of agent-contaminated soil, and containment for the balance of areas. The principal threat volume is treated through thermal desorption and contained in an on-post landfill. Potential groundwater impacts are reduced through treatment and containment. The excavation of contaminated soil associated with the sewer line and the clearance of agent entails significant short-term risks.

13.5.6.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources; landfill siting, design, and operation; and endangered species. Location-specific ARARs are met as sites in the Chemical Sewers subgroup, treatment facilities, and landfill are not located in wetlands or a 100-year flood plain. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative complies with provisions of the FFA (EPA et al. 1989), and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.5.6.3 Long-Term Effectiveness and Permanence

The residual risk is low since 47,000 BCY of contaminated soil and sewers are thermally desorbed to achieve PRGs and the human health exceedance volume is landfilled. Agent-contaminated soil and sewers are treated by caustic solution washing and landfilled. Landfill-cell monitoring is required. There are no difficulties associated with landfill maintenance, and there is a high confidence in the engineering controls of the landfill. Habitat quality is improved through revegetation of disturbed areas, but eliminates habitat at the landfill.

13.5.6.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants are reduced through containment of 82,000 BCY in an on-post landfill. Agent-contaminated soil is identified, treated, and landfilled. Thermal desorption reduces organics in the principal threat volume to detection levels or >99.99 percent DRE. The TMV reduction of organics by thermal desorption is irreversible. Treatment residuals include approximately 470 BCY of blowdown solids, which are landfilled.

13.5.6.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance, excavation, transportation, and thermal desorption of contaminated soil and sewers. The risks are reduced through engineering controls and use of personal protective equipment, but cannot be completely removed. Engineered dust controls (such as water spraying) and odor/vapor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for odor emissions during excavation despite these controls. In addition, the preparation of the feedstock presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and odors. The emissions from the thermal desorber contain low but acceptable levels of some contaminants, although the off-gas control system for the thermal desorber is designed to achieve air quality standards. Environmental impacts of the remedial actions are minimal due to the existing disturbed habitat. Migration of the contaminants to groundwater is reduced. RAOs can be achieved within 3 years. The excavation and treatment of the 47,000 BCY is feasible within 1 year following 2 years for construction and testing of the thermal desorption facility. The landfill can be constructed within 1 year.

13.5.6.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the contaminated soil and sewers. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, high moisture content, and problems with materials handling. Administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays, and it may be difficult to implement this alterative due to the perceptions regarding the safety of thermal treatment. The requirements of the treatment unit and landfill siting, design, and operating regulations are achieved. Materials and vendors are available for construction of the landfill, and landfills are well demonstrated.

13.5.6.7 Cost

The total present worth cost is \$15,300,000 and includes \$3,490,000, \$11,800,000, and \$54,000 for capital, operating, and long-term costs, respectively. Table B4.6-3a details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination below the sewer line, as well as the potential presence of agent, are difficult to delimit. Second, there is very little operational experience at other sites on which to base cost estimates for the vapor/odor controls, and to evaluate their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high moisture content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

13.5.7 Alternative 3e/A3: Access Restrictions; Landfill

Alternative 3e: Access Restrictions (Modifications to FFA); Landfill (On-Post Landfill), along with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), involves the placement of 62,000 BCY of soil/sewer debris with human health exceedances from outside the South Plants Central Processing Area and Complex Trenches in the on-post hazardous waste landfill and the plugging of sewer lines located with the South Plants Central Processing Area and Complex Trenches prior to capping. Due to the potential for odor problems, the excavation of overburden and contaminated soil is conducted such that minimal area is uncovered and exposed at any one time, and daily soil covers or plastic sheeting are placed over the excavated areas. Prior to excavation of the sewer lines in South Plants, the structures along and above the sewer line are demolished and removed to allow access to the sewers.

During excavation, the soil is screened for agent, which is accomplished by stockpiling the excavated soil and field-screening the samples collected. The presence of agent is verified by analysis at the RMA laboratory. The agent-contaminated soil is then transported to the on-post caustic washing unit as discussed in Section 4.4.3.

The 290,000 BCY of overburden are excavated and stockpiled near the excavation. While removing the chemical sewer system, abandoned utilities are removed and consolidated with the structural debris. For sewers located outside the South Plants Central Processing Area, the sections of sewer piping constructed of vitrified clay are crushed during excavation of the sewers, but 13,000 LF of steel and cast-iron pipe are removed from the trench using a backhoe equipped with shears. The pipe is cut into 2-ft lengths and transported to the landfill for disposal. The removal and sizing of steel and cast-iron pipe results in a volume increase of 1 percent for treatment and/or disposal. This debris is sized and crushed prior to disposal in the landfill.

The human health exceedance volume of 62,000 BCY is excavated, transported, and placed in the on-post hazardous waste landfill. The on-post landfill is a multiple-cell facility requiring 1 year for construction of the first cell and associated facilities (Section 4.6.6). The landfill cover is revegetated to limit erosion and control surface-water infiltration, and fencing is installed around the landfill to preserve the integrity of the landfill cover and leachate control system. Long-term maintenance of the landfill cover, leachate collection and treatment, and groundwater monitoring are required.

For sites outside of the South Plants Central Processing Area, the site excavation is backfilled with borrow soil from the on-post borrow area. The overburden is backfilled upon removal of the piping and contaminants. The disturbed area is then revegetated with native grasses. The borrow area is also regraded and revegetated to restore habitat. Dewatering is not anticipated to be required based on the projected reduction in groundwater elevations after the manmade influence (i.e., leaking sewers) is removed.

For sewers located within the South Plants Central Processing Area, an estimated 150 BCY of void space inside the manholes is plugged with a concrete mixture, which prohibits access to these lines and eliminates them as a potential migration pathway for contaminated groundwater; however, annual groundwater monitoring is conducted to evaluate the potential migration of contaminants. The plugged sewers are covered with a soil cap as a result of the South Plants Central Processing Area remediation.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

13.5.7.1 Overall Protection of Human Health and Environment

This alternative achieves RAOs through containment of the human health exceedance volume outside of the South Plants Central Processing Area and containment and access restrictions for the sewers within the South Plants Central Processing Area. Potential groundwater impacts are reduced through containment. The excavation of contaminated soil associated with the sewer line and the clearance of agent entails significant short-term risks.

13.5.7.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on landfill siting, design, and operation and endangered species. Location-specific ARARs are met as sites in the Chemical Sewers Subgroup and landfill are not located in wetlands or a 100-year flood plain. This alternative complies with provisions of the FFA (EPA et al. 1989). Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). Army Material Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization are achieved for the sewers that are removed, and Army regulations regarding the control of agent-contaminated materials are achieved for the sewers in the South Plants Central Processing Area through plugging and capping. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.5.7.3 Long-Term Effectiveness and Permanence

The residual risk for this alterative is minimal since 62,000 BCY of untreated soil and sewers are contained in an on-post landfill. The soil/sewer volume with agent contamination is treated by caustic solution washing and landfilled. The remaining sewers in the South Plants Central Processing Area and the Complex Trenches are plugged and capped as part of the remedy for these sites. Site reviews, groundwater, compliance monitoring, and landfill-cell monitoring are required. There are no difficulties associated with landfill maintenance, and there is a high confidence in engineering controls for the landfill. Habitat quality is improved through revegetation of disturbed areas, but habitat at the landfill is eliminated.

13.5.7.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants are reduced through containment of 62,000 BCY in an on-post landfill and plugging of sewer lines in South Plants Central Processing Area and the Complex Trenches prior to capping these sites. The soil/sewer volume with agent contamination is identified and treated. Treated material is landfilled and the degradation of agent is irreversible. Pathway reduction is only reversible should the landfill fail.

13.5.7.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance, excavation, transportation, and landfilling of contaminated soil and sewers. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Engineered dust controls (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are initiated to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. Environmental impacts of the remedial actions are minimal. The potential for migration of the contaminants to groundwater is reduced. RAOs can be achieved within 3 years. The excavation and landfilling of the 62,000 BCY is feasible within 1 year following 1 year for construction of the landfill.

13.5.7.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of soil covers increases the volume to be excavated and requires double handling to access the contaminated soil and sewers. The alternative is administratively feasible since Subtitle C landfill siting, design, and operating regulations are achieved. Materials and vendors are available for implementation of the alternative, including plugging the sewer lines in the South Plants Central Processing Area and the Complex Trenches.

13.5.7.7 Cost

The total present worth cost is $7,860,000 including $1,670,000, $4,990,000, and $1,200,000 for capital, operating, and long-term costs, respectively. Table B4.6-3e details the costing for this alternative.

There are two significant uncertainties associated with costing of this alternative. First, the extent and depth of contamination below the sewer line, as well as the potential presence of agent, are difficult to delimit. Second, there is very little operational experience at other sites upon which to base cost estimates for the vapor/odor controls, and to evaluate their impact on excavation and equipment productivity.

13.5.8 Alternative 8a/A5: Direct Soil Washing

Alternative 8a: Direct Soil Washing (Solvent Washing), along with Alternative A5: Direct Soil Washing (Solvent Extraction), treats all 82,000 BCY of contaminated soil and sewers from the Chemical Sewers Subgroup by solvent washing. Due to the potential for odor problems, the excavation of overburden and the contaminated soil/sewer volume is conducted such that minimal area is uncovered and exposed at any one time, and daily soil covers or plastic sheeting are placed over the excavated areas.

Prior to excavation of the sewer lines in South Plants, the structures along and above the sewer line are demolished and removed to allow access to the sewers. The sections of sewer piping constructed of vitrified clay are crushed during excavation of the sewers, but 15,100 LF of steel and cast-iron pipe are removed from the trench using a backhoe equipped with shears. The pipe is cut into 2-ft lengths and transported to the centralized treatment facilities. The removal and sizing of steel and cast-iron pipe results in a volume increase of 1 percent for treatment and/or disposal. This debris is sized and crushed prior to treatment. Dewatering is not anticipated to be required based on the projected reduction in groundwater elevations after the manmade influence (i.e., leaking sewers) is removed.

The 340,000 BCY of overburden are excavated and stockpiled near the excavation. While removing the chemical sewer system, abandoned utilities are removed and consolidated with the structural debris. The 82,000 BCY of excavated soil/sewer volume are treated at the centralized solvent extraction facility. Based on treatability studies at RMA, it is estimated that nine wash cycles are required to achieve Human Health PRGs. The solvent is recycled between wash cycles and treated through distillation (Section 4.6.21). A total of 49,000 gallons of liquid effluent are generated and treated at an off-post commercial facility as part of solvent washing. Multiple solvent extraction units are required to maintain a throughput of approximately 400 BCY/day. Solvent washing also addresses agent-contaminated soil through a caustic solution used to adjust pH. Treated agent-contaminated material is landfilled, and the balance of the washed volume is returned to the site as backfill. The stockpiled overburden is replaced and the disturbed area revegetated with native grasses.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

13.5.8.1 Overall Protection of Human Health and Environment

This alternative achieves RAOs through the treatment of contaminated soil and sewers, which are treated through solvent washing and then backfilled. Potential groundwater impacts are reduced through treatment. The excavation of contaminated soil associated with the sewer lines and the clearance of agent entails significant short-term risks.

13.5.8.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources; landfill siting, design, and operation; and endangered species. Location-specific ARARs are met as sites in the subgroup, treatment facilities, and landfill are not located in wetlands or a 100-year flood plain. This alternative complies with provisions of the FFA (EPA et al. 1989), and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.5.8.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since 82,000 BCY of material are untreated by solvent washing, thereby achieving PRGs. The 49,000 gallons of liquid effluent from the solvent-washing procedure are drummed and transported off-post for treatment. There are no difficulties associated with landfill maintenance, and there is a high confidence in the engineering controls of the landfill. Habitat quality is improved through revegetation of disturbed areas, offsetting loss during excavation.

13.5.8.4 Reduction in TMV

Solvent washing can degrade or reduce organics to below detection levels or >99.5 percent DRE with enough sequential extractions. The soil/sewer volume with agent contamination is treated along with the human health exceedance. The TMV reduction of organics by solvent-washing is irreversible. Treatment residuals include approximately 49,000 gallons of liquid effluent from the solvent washing process. The liquid waste is drummed and transported off-post for treatment.

13.5.8.5 Short-Term Effectiveness

This alternative entails significant short-term risk associated with agent clearance, excavation, transportation, and treatment operations. These risks are reduced through use of engineering controls and personal protective equipment. Fugitive dust and emissions are controlled by water sprays and air emission control equipment associated with the solvent washer. Odor controls, such as daily covers, tarps or foams, are initiated to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. In addition, the preparation of the feedstock presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and vapors/odors. Environmental impacts of the remedial actions are minimal due to the existing disturbed habitat. The potential for migration of the contaminants to groundwater is reduced. RAOs can be achieved within 2 years. The excavation and treatment of the 82,000 BCY is feasible within 2 years, based on a facility of 10 solvent washing units, following 2 years for construction and testing of the facility. The landfill can be constructed within 1 year.

13.5.8.6 Implementability

Technically, this alternative is only marginally feasible due to the large number of treatment units required to achieve PRGs and the lack of performance data to document the reliable operation of solvent washing at the required scale. Although commercial solvent washing units are available, the technology has not been demonstrated at the scale required for RMA. Since solvent washing requires nine extraction steps to achieve PRGs, the number of units required to treat the contaminated soil within the required time frame may lead to operational difficulties. Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of soil covers increases the volume to be excavated and requires double handling to access the contaminated soil. The alternative is administratively feasible since the requirements of the treatment unit and Subtitle C landfill siting, design, and operating regulations are achieved. Materials and vendor sources are readily available for landfill construction; however, vendors for solvent washing are limited in number. The solvent-washing technology has not been well demonstrated at full scale, and solvent washing units have limited throughput.

13.5.8.7 Cost

The total present worth cost is $28,300,000 including $4,650,000, $23,700,000, and $200 for capital, operating, and long-term costs, respectively. Table B4.6-8a details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination below the sewer line, as well as the potential presence of agent, are difficult to delimit. Second, there are no full-scale operating data for the solvent washing technology by which uncertainties relative to maintaining the on-line percentage and extraction efficiency can be well defined. Third, variations in the contaminant concentrations of the feedstock may result in unforeseen delays associated with equipment maintenance or treatment.

13.5.9 Alternative 13a/A3: Direct Thermal Desorption

Alternative 13a: Direct Thermal Desorption (Direct Heating), along with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), treats 82,000 BCY of soil and sewers with human health exceedances by thermal desorption. Due to the potential for odor problems, the excavation of overburden and the principal threat soil/sewer volume is conducted such that a minimal area is uncovered and exposed at any one time, and daily soil covers or plastic sheeting are placed over the excavated areas.

During excavation, the soil is screened for agent, which is accomplished by stockpiling the excavated soil and field-screening the samples collected. The presence of agent is verified by analysis at the RMA laboratory. The agent-contaminated soil is then transported to the on-post caustic washing unit as discussed in Section 4.4.3.

The 340,000 BCY of overburden are stockpiled near the excavation. Prior to excavation of the sewer lines in South Plants, the structures along and above the sewer line are demolished and removed to allow access to the sewers. While removing the chemical sewer system, abandoned utilities are also removed and combined with the structural debris. The sections of sewer piping constructed of vitrified clay are crushed during excavation of the sewers, but 15,100 LF of steel and cast-iron pipe are removed from the trench using a backhoe equipped with shears. The pipe is cut into 2-ft lengths and transported to the centralized treatment facilities. The sewer pipe is sized, crushed, and screened prior to entering the thermal desorber. Although the soil is expected to be near saturation, dewatering is not anticipated to be required based on the projected reduction in groundwater elevations after the manmade influence (i.e., leaking sewers) is removed.

The human health exceedance volume of 82,000 BCY is excavated and transported to the centralized thermal desorption facility. (Section 4.6.24 discusses details of this technology.) For process design purposes, the principal threat soil is considered to be saturated (i.e., moisture content of 20 percent) due to the high water table in South Plants. Based on this moisture content, the thermal desorber processes the soil/sewer debris at a rate of approximately 1,300 BCY/day at a discharge temperature of 300°C, assuming a total soil residence time of 50 minutes.

(Section 4.6.24 discusses emission controls for off gases from thermal desorption.) The 820 BCY of particulates from the scrubber blowdown equipment, approximately 1 percent of the solids feed, are disposed in the on-post hazardous waste landfill due to high inorganic concentrations and salt. The treated soil and sewer debris are returned to the site as backfill and covered with the stockpiled overburden. The disturbed area is then revegetated with native grasses.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 13.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

13.5.9.1 Overall Protection of Human Health and Environment

This alternative achieves RAOs through the treatment of contaminated soil. Potential groundwater impacts are reduced through treatment. The excavation of contaminated soil associated with the sewer line and the clearance of agent entails significant short-term risks.

13.5.9.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources; landfill siting, design, and operation; and endangered species. Location-specific ARARs are met as sites in the subgroup, treatment facilities, and landfill are not located in wetlands or a 100-year flood plain. This alternative complies with provisions of the FFA (EPA et al. 1989), and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

13.5.9.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since 82,000 BCY of material is thermally desorbed to achieve PRGs. Approximately 1 percent of the soil feed recovered from off-gas treatment equipment and soil treated for agent are landfilled. Monitoring of landfill cells is required. There are no difficulties associated with landfill maintenance, and there is a high confidence in the engineering controls of the landfill. Revegetation improves the existing habitat, thereby offsetting losses incurred during excavation.

13.5.9.4 Reduction in TMV

Thermal desorption reduces organics in the exceedance volume to below detection levels or >99.99 percent DRE. The TMV reduction of organics by thermal desorption is irreversible. Treatment residuals include approximately 820 BCY of blowdown solids. Soil and sewers with agent are treated by soil washing and landfilled.

13.5.9.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance, excavation, transportation, and thermal desorption of contaminated soil and sewers. The risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Engineered dust controls (such as water spraying) and odor/vapor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for odor emissions during excavation despite these controls. Environmental impacts of the remedial actions are minimal. In addition, the preparation of the feedstock presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and odors. The emissions from the thermal desorber contain low levels of the contaminants removed from the soil, although the off-gas control system for the thermal desorber is designed to achieve air quality standards. Potential migration of the contaminants to groundwater is reduced. RAOs can be achieved within 3 years. The excavation and treatment of the 82,000 BCY is feasible within 1 year following 2 years for construction and testing of the thermal desorption facility.

13.5.9.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the contaminated soil and sewers. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not yet been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, high moisture content, and problems with materials handling.

Administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays, and it may be difficult to implement this alterative due to public perceptions regarding the safety of thermal treatment.

13.5.9.7 Cost

The total present worth cost is $17,000,000 including $2,490,000, $14,500,000, and $1,000 for capital, operating, and long-term costs, respectively. Table B4.6-13a details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination below the sewer line, as well as the potential presence of agent. are difficult to delimit. Second, there is very little operational experience at other sites upon which to base cost estimates for the vapor/odor controls, and to evaluate their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high moisture content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects. and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

13.6 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Chemical Sewers Subgroup consists of 82,000 BCY of exceedance soil/sewer volume. This contamination has resulted from leakage or spillage from broken pipes and faulty joints in manholes and sewer lines. Table 13.4-2 summarizes the frequency of detections above Human Health SEC (EBASCO 1994a) for OCPs, CLC2A, DBCP, HCCPD, and VOCs. The principal threat criterion is also exceeded for aldrin in approximately 13 percent of the samples collected for the subgroup (Table 13.4-2), resulting in a principal threat exceedance volume of 47,000 BCY.

Most of the chemical sewers have the potential for agent contamination. The presence of high concentrations of OCPs and the potential for agent indicate that protection of site workers and the community is required for alternatives that involve excavation of exceedance soil. The area excavated at any one time is limited and a daily cover or plastic liner is used to reduce odor emissions from the excavations.

In general, the habitat at these sites is disturbed, although some segments are located beneath prairie dog colony areas that are considered desirable habitat. Alternatives that involve disturbance of habitat include revegetation and restoration; therefore, significant impacts on habitat are not anticipated.

In summary, soil in the Chemical Sewers Subgroup exceeds Human Health SEC (EBASCO 1994a) and principal threat criteria and has the potential for agent contamination. Selection of the preferred alternative for this subgroup must consider the short-term risks of worker exposure and community impacts from the potential release of vapors versus the longer-term risk of leaving the contamination in place.

Alternative 1: No Additional Action does not achieve Human Health RAOs as contaminated soil and sewers are left in place without adequate controls. Although the highest levels of contamination are treated, Alternative 1a: Direct Thermal Desorption of Principal Threat Volume; No Additional Action does not achieve RAOs as 35,000 BCY of contaminated soil and sewers, which potentially contain agent, are not controlled or treated. Therefore, both of these alternatives were eliminated from further consideration as the preferred alternative. All seven remaining alternatives use treatment, access restrictions, or containment of the entire exceedance volume to achieve RAOs and meet the two DAA threshold criteria, protection of human health and environment and compliance with action- and location-specific ARARs for the DAA. However, these alternatives exhibit differences in satisfying the five balancing criteria (Table 13.5-1).

Alternative 2: Access Restrictions achieves RAOs by relying on institutional controls and the depth of contamination to prevent exposures to high levels of contamination and agent presence. This alternative has the lowest cost of the protective alternatives. Alternative 2a: Direct Thermal Desorption of Principal Threat Volume; Access Restrictions achieves RAOs by installing institutional controls and treating the principal threat volume. However, the additional cost of treating the principal threat volume, which has limited risk due to the depth of contamination, makes this alternative less cost effective than Alternative 2: Access Restrictions. As a result, Alternative 2a: Direct Thermal Desorption of Principal Threat Volume; Access Restrictions was not retained, but Alternative 2: Access Restrictions was retained for further consideration in the development of sitewide alternatives.

The landfill alternatives (Alternative 3: Landfill, Alternative 3a: Direct Thermal Desorption of Principal Threat Volume; Landfill, and Alternative 3e: Landfill; Access Restrictions) achieve RAOs at the site. The majority of materials are untreated, and the potential exposure and mobility of contaminants are reduced primarily through containment. Landfilling and sewer plugging have been well demonstrated and there is high confidence in the engineering controls and maintenance of these operations although there is less confidence in the operation of thermal desorbers for these materials. These alternatives, however, entail the clearance and treatment of agent and create potentially high risk to workers, which are addressed through personal protective equipment. The costs of these alternatives are below the average cost of the remaining intrusive alternatives; however, significant short-term risks during excavation operations are incurred. Based on the cost effectiveness and permanent containment offered by landfilling, thermal desorption, and plugging, these alternatives were carried forward for development of the sitewide alternatives (Section 20).

Alternative 8a: Direct Soil Washing treats all contamination and thus achieves PRGs; however, this alternative has several disadvantages. The implementation of this alternative requires 10 solvent washing units, a number that presents operational difficulties. Treatment residuals include 49,000 gallons of liquid that require off-post treatment. The alternative also entails significant short-term risks from excavation and agent clearance. The cost is also a negative factor when considering the cost effectiveness of this option. For these reasons, this alternative was not retained for further consideration.

Alternative 13a: Direct Thermal Desorption deals with contamination through treatment that achieves PRGs. This alternative is considered to exhibit significant risks during excavation and agent clearance. The risk reduction for thermal desorption does not warrant the higher cost for thermal desorption compared to containment alternatives. This alternative was not retained since it is not cost effective.

Four alternatives, selected on the basis of overall cost effectiveness and protection, were retained for further consideration in the development of the sitewide alternatives. The four alternatives are the following:

- Alternative 2/A1: Access Restrictions (Plugging, Modifications to FFA)
- Alternative 3/A3: Landfill (On-Post Landfill)
- Alternative 3a/A3: Direct Thermal Desorption (Direct Heating) of Principal Threat Volume; Landfill (On-Post Landfill)
- Alternative 3e/A3: Landfill (On-Post Landfill) Access Restrictions (Plugging, Modifications to FFA)

Several structures must be demolished and the structural debris is removed to allow access to the sewers prior to excavation within South Plants and North Plants. This will limit the range alternatives that may be selected for the structures medium.

Characteristic	Sanitary/Process Water Sewers Subgroup	Chemical Sewers Subgroup
Contaminants of Concern		
Human Health	None	OCPs, DBCP, CLC2A, HCCPD, volatiles, As
Biota	None	None
Exceedance Area (SY)		
Total	0	100,000
Human Health	0	100,000
Principal Threat	0	57,000
Biota	Not applicable	Not applicable
Potential Agent	Not applicable	320,000
Potential UXO	Not applicable	Not applicable
Exceedance Volume (BCY)		
Total	0	82,000
Human Health	0	82,000
Organic	0	82,000
Inorganic	0	47,000
Principal Threat	0	47,000
Biota	Not applicable	Not applicable
Potential Agent	Not applicable	250
Potential UXO	Not applicable	Not applicable
Depth of Contamination (ft)		
Human Health	7–8	5-10
Biota	Not applicable	Not applicable

Table 13.1-1 Frequency of Detections for Sanitary Sewers Subgroup

	Total Samples Analyzed	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
		Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	37	37	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Benzene	29	29	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	29	29	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlordane	37	37	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Chloroacetic Acid	27	27	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlorobenzene	29	29	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chloroform	29	29	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
p,p,DDE	37	37	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
p,p,DDT	37	37	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	64	64	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	29	29	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	64	64	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dieldrin	37	33	89.2%	4	10.8%	0	0.0%	0	0.0%	0	0.0%
Endrin	37	37	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	37	37	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Isodrin	37	37	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Methylene Chloride	27	21	77.8%	6	22.2%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	29	29	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Toluene	29	29	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Trichloroethylene	29	29	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Arsenic	39	31	79.5%	8	20.5%	0	0.0%	0	0.0%	0	0.0%
Cadmium	42	41	97.6%	1	2.4%	0	0.0%	0	0.0%	0	0.0%
Chromium	42	4	9.5%	38	90.5%	--	--	0	0.0%	0	0.0%
Lead	42	40	95.2%	2	4.8%	--	--	0	0.0%	0	0.0%
Mercury	36	35	97.2%	1	2.8%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.

(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.

-- not applicable

Table 13.2-1 Comparative Analysis of Alternatives for the Sanitary/Process Water Sewers Subgroup

Criteria	Alternative 1: No Additional Action	Alternative 2: Access Restrictions	Alternative 3: Landfill
1. Overall protection of human health and the environment	Not Protective: Groundwater impacts not reduced beyond IRA	Protective: Manholes plugged to reduce groundwater impacts	Protective: Sewer lines removed to reduce groundwater impacts
2. Compliance with ARARs	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Low Residual Risk: Groundwater impacts not reduced	Low Residual Risk: Long-term monitoring required	Minimal Residual Risk: Sewer lines removed from site and contained
4. Reduction in TMV	No reduction in TMV	Potential for sewers to carry contaminated groundwater mitigated	Potential for sewers to carry contaminated groundwater eliminated
5. Short-term effectiveness	No risk to workers or community	Low Short-Term Risk: No intrusive activities; RAOs are achieved in less than 1 year	Short-term risks associated with excavation and transportation of sewer lines; adequately mitigated; RAOs are achieved in 2 years
6. Implementability	Feasible	Feasible: No difficulty anticipated	Feasible: No difficulty anticipated
7. Present worth costs	Capital—$0 Operating—$0 Long-term--$82,600 Total-$82,600	Capital—$3,000 Operating—$298,000 Long-term—$122,000 Total—$423,000	Capital—$312,000 Operating—$5,320,000 Long-term—$9,000 Total—$5,640,000
Summary	Not Retained: Impacts to groundwater not reduced	Retained: Impacts to groundwater greatly reduced	Retained: Impacts to groundwater greatly reduced

Table 13.4-1 Summary of Concentrations for the Chemical Sewers Subgroup

Contaminants of Concern	Range of Concentrations	Average Concentrations (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL-20,000	Not Available	71	720	3.8
Dieldrin	BCRL-200	Not Available	41	410	3.7
Isodrin	BCRL-1,000	Not Available	52	52,000	Not applicable
p,p,DDT	BCRL-500	Not Available	410	13,500	14
Chloroacetic Acid	BCRL-230	Not Available	77	77,000	3,900
DBCP	BCRL-32,000	Not Available	8	200	140
HCCPD	BCRL-4,000	Not Available	1,100	Not applicable	13
Carbon Tetrachloride	BCRL-200	Not Available	30	2,000	13,000
Chloroform	BCRL-400	Not Available	370	48,000	2,000
Arsenic	BCRL-740	Not Available	420	42,000	270

Table 13.4-2 Frequency of Detections for Chemical Sewers Subgroup

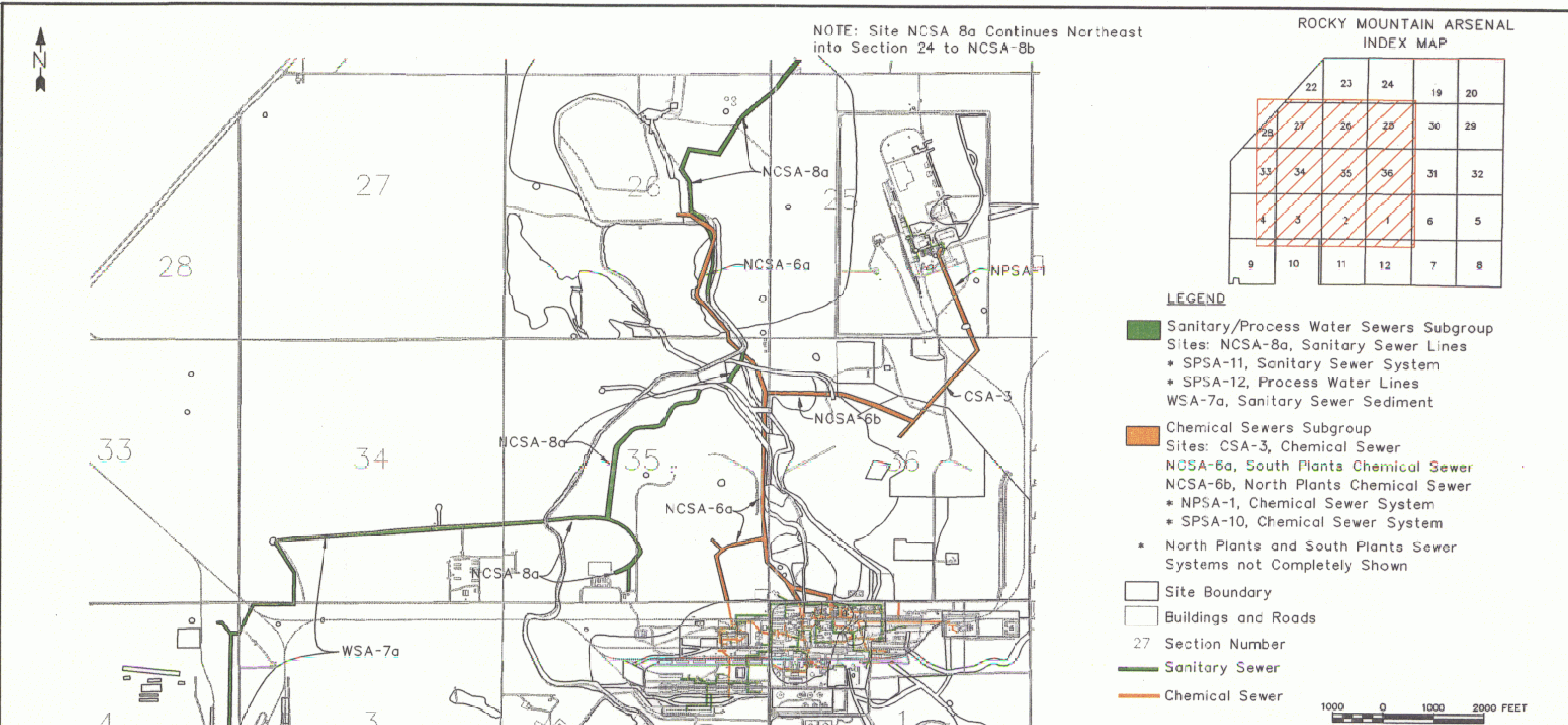
	Total Samples	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
	Analyzed	Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	68	53	77.9%	5	7.4%	0	0.0%	1	1.5%	9	13.2%
Benzene	57	57	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	57	53	93.0%	3	5.3%	--	--	1	1.8%	0	0.0%
Chlordane	23	23	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Chloroacetic Acid	92	91	98.9%	0	0.0%	0	0.0%	1	1.1%	0	0.0%
Chlorobenzene	57	54	94.7%	3	5.3%	--	--	0	0.0%	0	0.0%
Chloroform	57	50	87.7%	7	12.3%	--	--	0	0.0%	0	0.0%
p,p,DDE	55	53	96.4%	2	3.6%	--	--	0	0.0%	0	0.0%
p,p,DDT	55	53	96.4%	2	3.6%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	68	62	91.2%	0	0.0%	--	--	5	7.4%	1	1.5%
1,2-Dichloroethane	57	57	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	63	62	98.4%	1	1.6%	--	--	0	0.0%	0	0.0%
Dieldrin	68	56	82.4%	9	13.2%	0	0.0%	3	4.4%	0	0.0%
Endrin	68	59	86.8%	9	13.2%	0	0.0%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	55	55	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Isodrin	68	56	82.4%	7	10.3%	--	--	5	7.4%	0	0.0%
Methylene Chloride	45	45	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	57	48	84.2%	9	15.8%	--	--	0	0.0%	0	0.0%
Toluene	57	50	87.7%	7	12.3%	--	--	0	0.0%	0	0.0%
Trichloroethylene	57	57	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Arsenic	61	49	80.3%	12	19.7%	0	0.0%	0	0.0%	0	0.0%
Cadmium	21	20	95.2%	1	4.8%	0	0.0%	0	0.0%	0	0.0%
Chromium	21	2	9.5%	19	90.5%	--	--	0	0.0%	0	0.0%
Lead	21	16	76.2%	5	23.8%	--	--	0	0.0%	0	0.0%
Mercury	63	45	71.4%	18	28.6%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.
(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.
-- not applicable

Table 13.5-1 Comparative Analysis of Alternatives for the Chemical Sewers Subgroup

Criteria	Alternative 1: No Additional Action	Alternative 1a: Direct Thermal Desorption of Principal Threat Volume; No Additional Action	Alternative 2: Access Restrictions	Alternative 2a: Direct Thermal Desorption of Principal Threat Volume; Access Restrictions	Alternative 3: Landfill
1. Overall protection of human health and the environment	Not Protective: Does not achieve RAOs; impacts to groundwater not reduced	Not Protective: Does not achieve RAOs; groundwater impacts reduced	Protective: Achieves RAOs; impacts to groundwater reduced	Protective: Achieves RAOs through treatment and plugging sewer lines; impacts to groundwater reduced	Protective: Achieves RAOs through containment; impacts to groundwater reduced
2. Compliance with ARARs	Complies	Complies	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Moderate Residual Risk: High-level contamination remains at depth; impacts on groundwater remain	Low Residual Risk: Principal threat volume removed and treated; balance of site remains	Moderate Residual Risk: High levels of contamination remain, but at depth	Low Residual Risk: Principal threat volume treated, balance of contamination at depth	Minimal Residual Risk: Contaminated soil removed and contained
4. Reduction in TMV	82,000 BCY remain untreated; TMV reduction by natural attenuation only	Thermal desorption destroys organics in principal threat volume; TMV reduction by natural attenuation only for balance of site; 35,000 BCY remain in place	82,000 BCY remain untreated; TMV reduction by natural attenuation only	Thermal desorption destroys OCPs for 47,000 BCY; for balance of site, exposure pathways interrupted by plugging lines and access restrictions	Mobility of contaminants reduced through containment; irreversible TMV reduction by soil washing for agent contamination
5. Short-term effectiveness	Existing poor-quality habitat not changed; impact to groundwater continues; no risk to workers	Significant risk to workers and community during agent screening and excavation, transportation, and treatment of principal threat volume	Minimal short-term risk because intrusive activity is limited; RAOs are achieved in 1 year	Significant risk to workers and community during agent screening and excavation, transportation, and treatment of principal threat volume; RAOs are achieved in 3 years	Significant short-term risks associated with excavation and transport of contaminated soil; vapor/odor controls required; RAOs are achieved in 2 years
6. Implementability	Feasible: No implementation required	Limited feasibility for thermal treatment and vapor controls	Feasible	Limited feasibility for thermal treatment and vapor controls	Feasible; difficulty associated with vapor control
7. Present worth costs	Capital—0 Operating—0 Long-term—$2,130,000 Total—$2,130,000	Capital—$1,460,000 Operating—$7,580,000 Long-term—$1,900,000 Total—$10,900,000	Capital—$3,000 Operating—$408,000 Long-term—$2,160,000 Total—$2,570,000	Capital—$1,460,000 Operating—$7,830,000 Long-term—$1,930,000 Total—$11,200,000	Capital—$2,210,000 Operating—$6,490,000 Long-term—$58,000 Total—$8,760,000
Summary	Not Retained: Not protective of human health and the environment	Not Retained: Not protective of human health and the environment	Retained: Cost effective and protective	Not Retained: High cost for similar level of protection	Retained: Protective due to permanent containment

Criteria	Alternative 3a: Direct Thermal Desorption of Principal Threat Volume; Landfill	Alternative 3e: Access Restrictions; Landfill	Alternative 8a: Direct Soil Washing	Alternative 13a: Direct Thermal Desorption
1. Overall protection of human health and the environment	Protective: Achieves RAOs through treatment and containment; impacts to groundwater reduced	Protective: Achieves RAOs; groundwater impacts reduced through containment	Protective: Achieves RAOs through treatment; groundwater impacts reduced	Protective: Achieves RAOs through treatment; groundwater impacts reduced
2. Compliance with ARARs	Complies	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Low Residual Risk: Principal threat volume treated, balance of contaminated soil contained	Minimal Residual Risk: 82,000 BCY removed and contained, balance of sewers plugged	Minimal Residual Risk: All contamination treated	Minimal Residual Risk: All contamination treated
4. Reduction in TMV	Thermal desorption destroys organics for 47,000 BCY; mobility reduced for balance of contaminants through containment	Mobility reduced by containment and sewer plugging; irreversible TMV reduction for agent-contaminated soil	Solvent washing reduces organics to below PRGs; 49,000 gallons of liquid must be treated off post	Irreversible TMV reduction to below PRGs for entire volume through treatment
5. Short-term effectiveness	Significant risk to workers and community during agent screening and excavation, transportation, and treatment; RAOs are achieved in 3 years	Significant risk to workers and community during agent screening, excavation, transportation, and treatment; RAOs are achieved in 3 years	Significant risk to workers and community during agent screening, excavation, transportation, and treatment; RAOs are achieved in 2 years	Significant risk to workers and community during agent screening, excavation, transportation, and treatment; RAOs are achieved in 3 years
6. Implementability	Technically feasible; administrative difficulty for thermal desorption and limited feasibility for vapor/odor controls	Technically feasible, although limited feasibility for vapor/odor controls	Limited technical feasibility for solvent washing at required scale and vapor/odor controls	Limited administrative feasibility for thermal desorption; limited feasibility for vapor/odor controls
7. Present worth costs	Capital—$3,490,000 Operating—$11,800,000 Long-term—$54,000 Total—$15,300,000	Capital—$1,670,000 Operating—$4,990,000 Long-term—$1,200,000 Total—$7,860,000	Capital—$4,650,000 Operating—$23,700,000 Long-term—$200 Total—$28,300,000	Capital—$2,490,000 Operating—$14,500,000 Long-term—$1,000 Total—$17,000,000
Summary	Retained: High level of protection provided by treatment and containment	Retained: High level of protection provided by containment	Not Retained: High cost and limited feasibility for larger treatment volume without reducing long-term risk compared to containment alternatives	Not Retained: High cost does not warrant minimal risk reduction compared to containment



Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

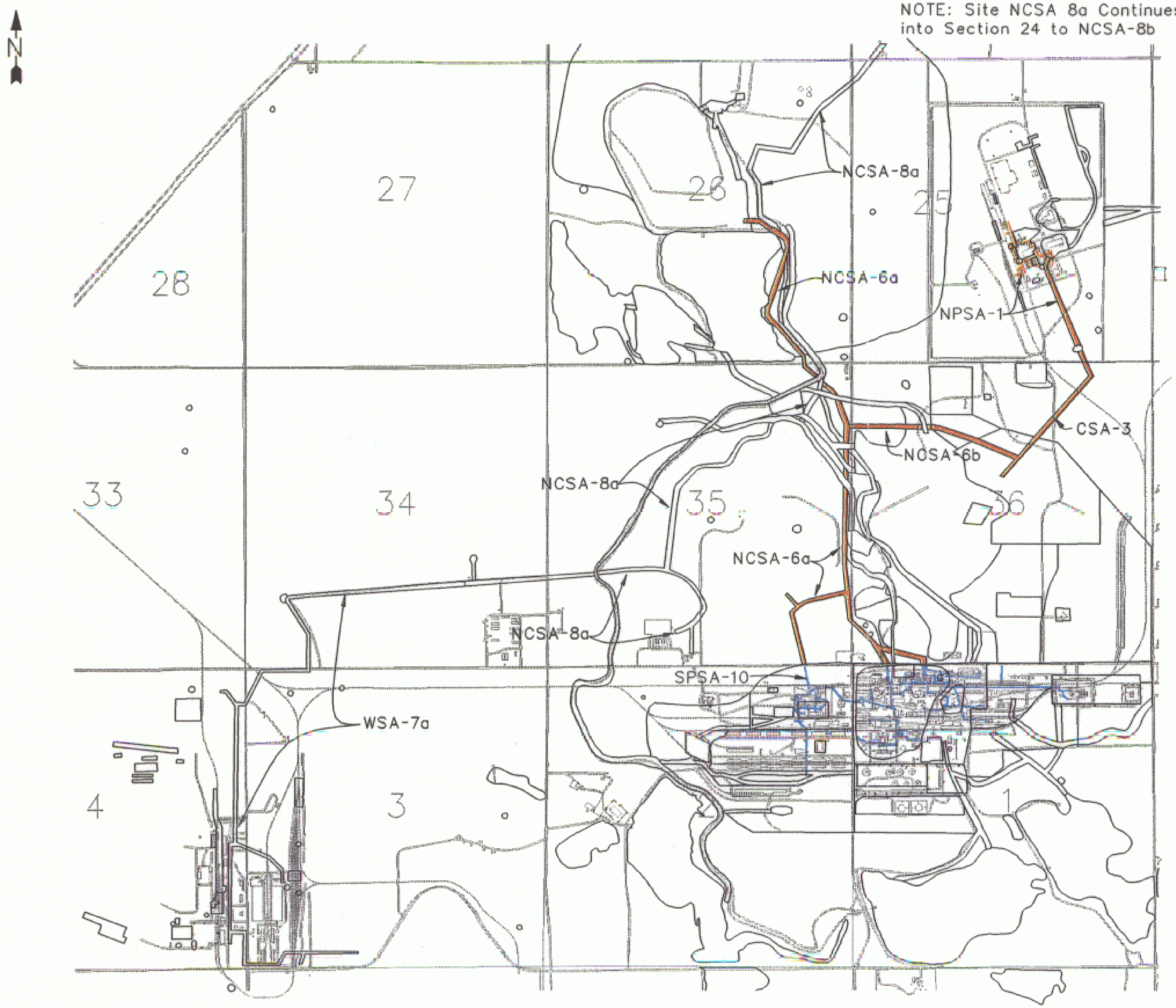
FIGURE 13.0-1

Site Locations
Sewer Systems Medium Group

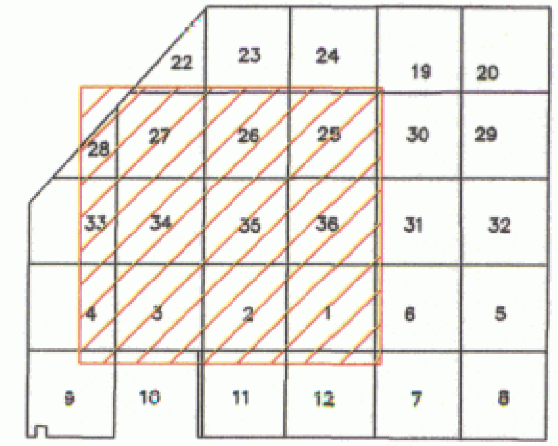
Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

CHECKED BY | APPROVED BY | DRAWN BY EMH | DATE 3/2/93 | FILE NAME 20110\32\F03-032.DWG | REVISION NO. 2

NOTE: Site NCSA 8a Continues Northeast into Section 24 to NCSA-8b



ROCKY MOUNTAIN ARSENAL
INDEX MAP



LEGEND

Human Health Exceedance Area

Principal Threat Exceedance Area

Site Boundary

Buildings and Roads

27 Section Number

NOTE: South Plants and North Plants Sewers Shown as Solid Lines

1000 0 1000 2000 FEET

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

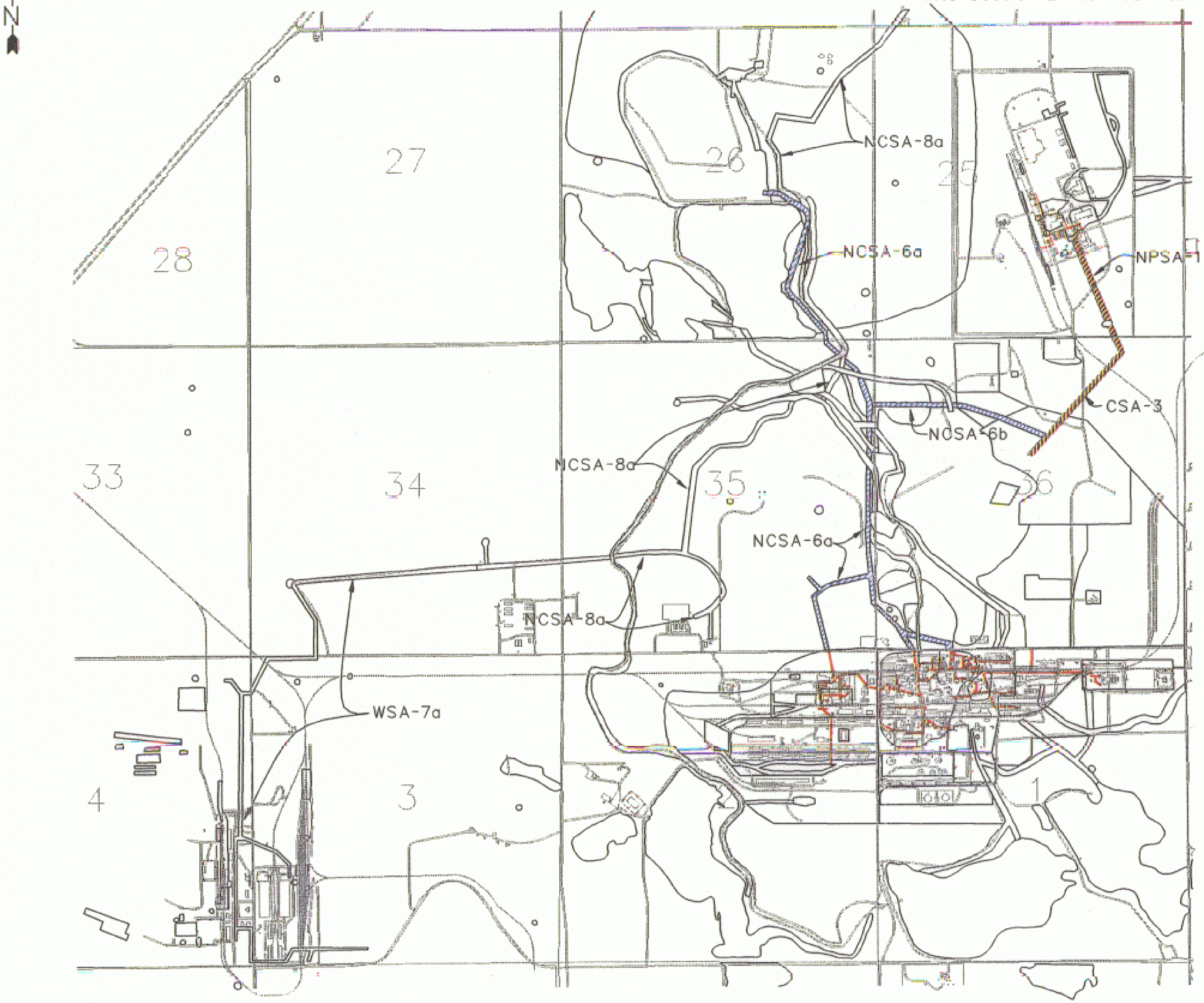
FIGURE 13.4-1

Exceedance Areas
Chemical Sewers Subgroup

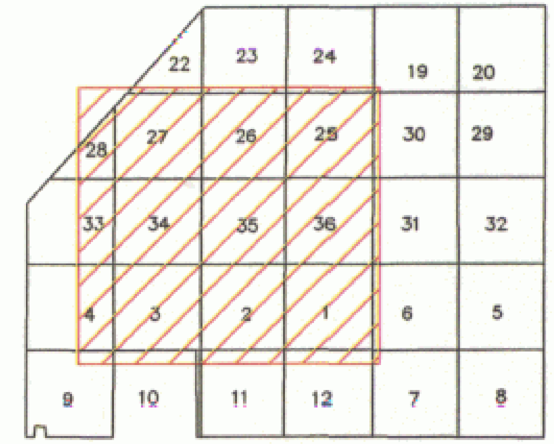
Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

REVISION NO. 2
FILE NAME 20110\32\F04-011.DWG
DATE 3/2/93
DRAWN BY EMH
APPROVED BY
CHECKED BY

NOTE: Site NCSA-8a Continues Northeast into Section 24 to NCSA-8b



ROCKY MOUNTAIN ARSENAL
INDEX MAP



LEGEND

- Human Health Exceedance Area
- Potential Agent Presence Area
- Site Boundary
- Buildings and Roads
- 27 Section Number

NOTE: South Plants and North Plants Sewers Shown as Solid Lines

1000 0 1000 2000 FEET

Prepared for:

U.S. Army Program Manager for Rocky Mountain Arsenal

October 1995

FIGURE 13.4-2

Potential Agent Presence Area Chemical Sewers Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

REVISION NO. 2 | FILE NAME 20110\32\F09-006.DWG | DATE 3/1/93 | DRAWN BY EMH | APPROVED BY | CHECKED BY

14.0 DETAILED ANALYSIS OF ALTERNATIVES FOR THE DISPOSAL TRENCHES MEDIUM GROUP

The Disposal Trenches Medium Group contains three sites (Figure 14.0-1) where disposal practices consisted of excavating open trenches or pits and filling them with trash and manufacturing/military wastes. The wastes are suspected to consist of drums of solid and liquid material, wood, glass, metal, laboratory and manufacturing equipment, and other miscellaneous material. Physical and chemical hazards, including agent and UXO are potentially present at these sites. The depth of contamination is variable, but is generally less than 12 ft, and the contamination patterns are highly heterogeneous. The sites are separated by type and contamination pattern to form three subgroups, Complex Trenches, Shell Trenches, and Hex Pit, each of which contains one site.

The primary Human Health COCs present in this medium group are OCPs, although DBCP, HCCPD, mercury, and inductively coupled plasma (ICP) metals are also present at concentrations well above the Human Health SEC (EBASCO 1994a). The entire volume of the disposal trenches in these sites is considered a principal threat because results from trench soil samples show high concentrations of OCPs and ICP metals, because containerized wastes are present, and because there are known sources of groundwater contamination. Table 14.0-1 presents the characteristics of this medium group, including exceedance volumes and COCs, and Appendix A details the calculation of exceedance volumes and areas for these subgroups.

In the DSA (EBASCO 1992b), alternatives were developed and screened based on the general characteristics of the medium group. In the DAA, however, the characteristics of the three subgroups—including contaminants and contaminant concentrations, site configuration, and depth of contamination—were evaluated to determine the subset of applicable alternatives for each subgroup from the range of alternatives retained in the DSA (EBASCO 1992b) for the medium group.

The following sections present the characteristics of each subgroup and an evaluation of the alternatives against the DAA criteria listed in the NCP (EPA 1990a).

14.1 COMPLEX TRENCHES SUBGROUP CHARACTERISTICS

The Complex Trenches Subgroup consists of site CSA-1c (Complex Disposal Area North) (Figure 14.0-1). This site consists of soil and debris disposed in a series of trenches. The trenches were investigated during the RI and were found to contain trash and manufacturing/military waste including scrap metal, bricks, concrete and asphalt rubble, empty and full glass bottles, white phosphorous, containerized wastes, burned incendiary device casings, and UXO. The trench areas, outlined by geophysical investigations, include 120,000 SY of contaminated soil and debris and are considered a principal threat area for this subgroup (Figure 14.1-1). Table 14.1-1 contains a summary of the estimated area and depth of trench material for each trench area as well as a catalog of the materials identified during the RI investigation of these trenches. The estimated 440,000 BCY of trench materials defined by the geophysical anomalies are considered a principal threat volume based on the anticipated high levels of contamination and presence of containerized waste (Table 14.0-1). Table 14.1-2 presents the range of concentrations within the disposal trenches and in the areas surrounding the trenches that potentially pose risk to biota, and Table 14.1-3 lists the frequency of detections. The contaminants listed for the disposal trenches in the Complex Trenches Subgroup are based on the contaminants identified in the RI, but the concentrations are based on the maximum levels identified for any disposal trench due to the heterogeneous nature of contamination in the trenches.

In addition to the principal threat volume, approximately 4,000 BCY of contaminated soil outside of the anomalous areas contain chlordane exceeding the Human Health SEC (EBASCO 1994a). These areas generally occur within the 0- to 1-ft depth interval. Approximately 87,000 BCY of soil outside the trench areas contain COCs that may pose potential risk to biota. Table 14.1-2 summarizes contaminants, concentrations, and exceedance values for this subgroup. The maximum concentration found in any trench area was assumed to apply to all of the areas. In addition, this site is considered to be a potential agent and UXO presence area (Figure 14.1-2).

Site CSA-1c has been identified as a source of two discrete groundwater contamination plumes. These plumes, the Section 36 Bedrock Ridge Plumes, occur in the unconfined bedrock aquifer in the northeast portion of the section, and appear to emanate from the burial sites and extend to the northeast. These plumes are currently being monitored through the Complex Trenches IRA. Groundwater alternatives for the Basin A Plume Group involve interception or mass reduction systems for individual plumes or continued operation of the existing Basin A Neck IRA system. Coordination of excavation or containment alternatives for soil in this subgroup is required with those developed for groundwater in the Basin A Plume Group. In addition, if dewatering is required for excavation or long-term hydraulic control, coordination is necessary with alternatives developed for the Basin A Plume Group in order to determine whether additional soil dewatering systems are necessary, and which treatment system should be used for the groundwater removed during dewatering.

The Complex Trenches Subgroup is considered to exhibit areas of disturbed vegetation types. The areas disturbed during remediation are revegetated with native grasses in accordance with a refuge management plan. In general, the overall habitat quality is improved by the remedial actions, although, under the capping alternatives, the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat.

14.2 COMPLEX TRENCHES SUBGROUP EVALUATION OF ALTERNATIVES

The alternatives for the Complex Trenches Subgroup include no action or containment and treatment approaches. The alternatives retained from the DSA (EBASCO 1992b) for this subgroup were not modified during the DAA. The following subsections present a description of each alternative and an evaluation of the alternative against the EPA criteria for the DAA. The alternatives for this subgroup consist of a component to address human health exceedances (which is listed first), a component to address areas located outside the disposal trenches that potentially pose risk to biota (the "B" alternatives), and components to address areas of potential agent (the "A" alternatives) or UXO (the "U" alternatives) presence.

14.2.1 Alternative 1/B1/A1/U1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA), along with Alternative B1: No Additional Action (Provisions of FFA), Alternative A1: No Additional Action (Provisions of FFA), and Alternative U1: No Additional Action (Provisions of FFA), applies to the entire 390,000-SY area (530,000 BCY) in the Complex Trenches Subgroup. No action is taken to reduce human or biota exposure to COCs or UXO or to reduce the potential for continued groundwater contamination from this site. The human health exceedance area and area that potentially poses a risk to biota outside of the disposal trenches are monitored (an average of 42 samples per year), groundwater compliance monitoring will be conducted, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 14.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.2.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve Human Health or Biota RAOs. Groundwater impacts are not reduced and the only long-term reduction in toxicity of contaminants is through natural attenuation or degradation.

14.2.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the subgroup is not located in wetlands or a 100-year flood plain. In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.) This alternative does not comply with Army regulations regarding agent-contaminated materials and UXO since no controls are initiated.

14.2.1.3 Long-Term Effectiveness and Permanence

There is a high residual risk associated with this alternative. High concentrations of OCPs, DBCP, ICP metals, arsenic, and mercury exceeding Human Health SEC (EBASCO 1994a) remain in the soil and may impact human health and biota. In addition, potential agent or UXO presence remains in place. No controls are implemented; however, site reviews, soil monitoring, and groundwater monitoring are required. The existing habitat is not changed by this alternative.

14.2.1.4 Reduction in TMV

There is no reduction in TMV except by natural attenuation, and there are no treatment residuals since no materials are treated or contained. A total of 540,000 BCY of untreated soil remains in place; no reduction in hazards associated with agent and UXO presence is achieved.

14.2.1.5 Short-Term Effectiveness

The time frame until RAOs are achieved is greater than 30 years because natural attenuation is the only process by which contaminants in soil surrounding the disposal trenches can be reduced. There is no short-term risk to workers and the community during remedial action since no actions are taken, but the environmental impacts include continued migration of contaminants to the groundwater. The existing habitat is not changed.

14.2.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are available to sample soil and groundwater.

14.2.1.7 Cost

The total present worth cost is $3,420,000 and includes only long-term O&M costs associated with long-term monitoring and site reviews. Table B4.7-1 details the costing for this alternative. The cost uncertainties for monitoring and site reviews are low.

14.2.2 Alternative 5/B5/A2/U2: Caps/Covers; Vertical Barriers

Alternative 5: Caps/Covers (Multilayer Cap); Vertical Barriers (Slurry Walls), in conjunction with Alternative B5: Caps/Covers (Multilayer Cap), Alternative A2: Caps/Covers (Soil Cover), and Alternative U2: Caps/Covers (Multilayer Cap), addresses the containment of 390,000 SY of contaminated soil with a low-permeability soil cap and installation of slurry walls around the following areas: Anomaly A; Anomalies B, C, and F; Anomaly H; and Anomaly G (Figure 14.1-1). It is assumed that the cap is RCRA-equivalent, which will meet performance criteria to be developed by the Parties prior to the remedial design.

Prior to installing the cap, a surface UXO sweep is conducted to identify potential UXO. If located, UXO are removed and detonated off-post in conjunction with Alternative U4: Detonation (Off-Post Army Facility); Incineration/Pyrolysis (Off-Post Incineration). Prior to installing the slurry wall, a geophysical survey is conducted along the alignment of the slurry wall to ensure that UXO are not encountered during the installation of the slurry wall. If necessary, the alignment of the slurry wall is modified; otherwise, the UXO is removed in accordance with Alternative U4.

Following UXO clearance, a soil/bentonite slurry wall, as described in Section 6.3 of the Technology Descriptions Volume, is installed into competent bedrock (as deep as 28 ft below grade) around the perimeter of each trench area (8,700 LF total) to create four individual isolation cells. During the installation of the slurry wall, agent sampling will be conducted. Fill materials for the slurry wall mix are excavated from an on-post borrow area. The soil excavated for the slurry wall trench, which is potentially contaminated, is graded over the surface of the isolation cell to be included under the cap. For the purposes of conceptual design and costing in the FS, it is assumed that a dewatering system, which creates a reduced hydraulic head within the cell (minimizing the potential for further contamination via groundwater), is required. This assumption will be evaluated during the remedial design. Groundwater is removed from the cell at 0.2 gpm and pumped to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA or a new groundwater treatment system.

Following slurry-wall installation and UXO clearance, the disposal trench area is contained with a 390,000-SY low-permeability soil cap. (Section 4.6.14 discusses low-permeability multilayer caps in detail.) The surface is crowned and graded to allow for surface-water drainage. The area is then covered with a 2-ft-layer of low-permeability soil, a 6-inch barrier of concrete, and a 4-ft soil/vegetation layer. Approximately 900,000 BCY of gradefill are excavated from an on-post borrow area to achieve the design grades for capping. The uppermost 6 inches of soil over the capped area are supplemented with conditioners and then revegetated with native grasses. The borrow area is also recontoured and revegetated to restore habitat. Long-term maintenance activities ensure the continued integrity of the cap and operation of the dewatering system. Five-year site reviews and annual groundwater monitoring are conducted to assess potential migration of contaminants to groundwater and the integrity of the containment system.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 14.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.2.2.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs. Human and biota exposure pathways are interrupted by installation of a low-permeability soil cap and slurry walls. Groundwater impacts are reduced by the dewatering system, and there are low short-term risks associated with installing the cap.

14.2.2.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding the construction of covers and the monitoring of contained material. Location-specific ARARs are met as the site is not located in wetlands or a 100-year flood plain. In addition, the alternative complies with provisions of the FFA (EPA et al. 1989), and does not impact endangered species. Soil potentially containing agent or UXO is contained and is not subject to Army regulations governing agent or UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.2.2.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is minimal. The 530,000 BCY of untreated soil are contained within the 390,000-SY low-permeability soil cap and slurry walls. Long-term groundwater monitoring and site reviews are required for the untreated soil. In addition, the vegetative cover, slurry walls, and the dewatering system require maintenance. There is high confidence in the engineering controls for the cap and slurry wall. Habitat quality is improved by revegetation of disturbed areas, although types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area for habitat, thus helping to preserve the integrity of the cap and prevent exposure.

14.2.2.4 Reduction in TMV

The installation of the low-permeability soil cap, slurry wall, and dewatering system interrupts exposure pathways and reduces the mobility of contaminants for all 530,000 BCY. The cap reduces the physical hazards of agent or UXO exposure. Reduction of the mobility of contaminants is only reversible should the cap or slurry wall degrade. Residuals from this alternative include groundwater, which is pumped at 0.2 gpm to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system.

14.2.2.5 Short-Term Effectiveness

The alternative entails low short-term risk to workers and the community during installation of the cap. Workers are adequately protected from physical and chemical risks by personal protective equipment during agent/UXO clearance, installation of the cap/cover and slurry wall, and dewatering. Fugitive dust from installing the cap/cover is controlled by water sprays, and odor and vapor emissions are not anticipated. Impacts to the environment are minimal; however, the types of vegetation placed at the site and the maintenance activities conducted there are designed to discourage burrowing animals from using the area for habitat. RAOs can be achieved within 2 years through implementation of this alternative.

14.2.2.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible and materials, specialists, and equipment are readily available. Low-permeability soil caps and slurry walls have been well demonstrated at full scale. Personnel and equipment are available for groundwater compliance monitoring.

14.2.2.7 Cost

The total present worth cost is $36,900,000 including $320,000, $33,200,000, and $3,340,000 for capital, operating, and long-term costs, respectively. Table B4.7-5 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the cap are available on post and the area to be capped is well defined (i.e., the uncertainty commonly associated with excavation does not exist).

14.2.3 Alternative 14/B3/A4/U4: Incineration/Pyrolysis; Landfill

Alternative 14: Incineration/Pyrolysis (Rotary Kiln Incineration); Landfill (On-Post Landfill), along with Alternative B3: Landfill (On-Post Landfill), treats 440,000 BCY of trench materials and contaminated soil exceeding Human Health SEC (EBASCO 1994a) by rotary kiln incineration. In addition, 87,000 BCY of soil that may pose a potential risk to biota and 4,000 BCY of human health exceedances outside the trench areas are contained in an on-post hazardous waste landfill. During excavation operations, areas with potential agent presence are addressed by Alternative A4: Incineration/Pyrolysis (Rotary Kiln Incineration) and areas with potential UXO by Alternative U4: Detonation (Off-Post Facility); Incineration/Pyrolysis (Off-Post Incineration).

Prior to excavation, the areas are cleared for UXO using geophysical surveys or other field-screening methods. An estimated 1,300 BCY of identified UXO are packaged and shipped to an off-post Army facility for demilitarization. Approximately 130,000 BCY of metallic debris mixed with soil excavated for landfilling or incineration are placed in the on-post hazardous waste landfill along with the human health and biota exceedance volumes. During excavation, contaminated soil is screened for the presence of agent with real-time field analytical methods. An estimated 1,300 BCY of soil (confirmed to contain agent through RMA laboratory analysis) are treated by rotary kiln incineration along with the 440,000 BCY of trench materials. Incineration destroys any agent that is present.

Volatile emissions and noxious odors are controlled during excavation by enclosing the disposal trench excavations with a vapor enclosure that includes a vapor treatment system. The containment structures are fabricated from aluminum structural members covered with a synthetic fabric coated to achieve very low air permeability. The structures can be erected on a level surface with no foundation, although large precast concrete blocks must be used for ballast. Multiple structures are utilized to maintain a constant excavation rate while structures are relocated. Each structure is constructed to permit the lifting and relocation of the structure as a single unit to a new excavation area or to allow in-place detonation of any UXO determined to be unsafe for transport without damaging the structure. Two structures of 490 feet by 90 feet will be utilized for vapor control with excavation occurring in one structure while the second is relocated. One structure will be placed to excavate alternating spaced rows leaving a mound at each row skipped. A second structure will be moved to continue excavation at the mound locations remaining. Excavations will be partially backfilled, and an interim sprayed cover will act as vapor control at slopes during relocation of the structure. A total of 55 structure moves are required.

An air pollution control system draws air from the structure for treatment with a wet scrubber, reducing the level of personal protective equipment required for safe working conditions within the structure. Because the air pollution control system creates a slight negative pressure within the structure, entry and exit doors can be opened for short periods of time without releasing contaminants or odors, thus eliminating the need for airlocks. The alkaline aqueous solution from the wet scrubber system is neutralized and subsequently treated at the CERCLA Wastewater Treatment Plant. In this manner, volatile emissions and odors are controlled and do not impact the community. However, extensive worker health and safety measures are required during excavation based on the high levels of contamination and the physical and acute chemical hazards present. Dewatering is also required 2 years prior to and during excavation of soil near the water table, primarily near Anomaly H. The groundwater is removed at 0.2 gpm and pumped to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA System, or a new groundwater treatment system.

After excavation, 440,000 BCY of soil and debris are treated by incineration. (Section 4.6.28 discusses the details of incineration.) A portion of the debris contained in this soil is very large (based on materials found during the RI). All oversize debris is removed and landfilled prior to rotary kiln incineration. The disposal of the large debris requires sizing operations such as grinding and crushing, which increases the risk to site workers. The incinerator has a soil processing rate of 470 BCY/day, requires approximately 1 year to build, and requires an additional year for testing. The incinerator operates with a soil discharge temperature of 760°C and has a soil residence time of 66 minutes. (Section 4.6.29 describes emission controls for off gases from incineration). The treated soil and debris are transported from the incineration facility to the multiple-cell hazardous waste landfill. (Section 4.6.6 presents details of the landfill).

The excavations are backfilled with 530,000 BCY of borrow material that are transported from the on-post borrow area. The uppermost 6 inches of soil over the approximately 390,000 SY of disturbed area are supplemented with conditioners and revegetated with native grasses. In addition, the borrow area is recontoured and revegetated to restore habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 14.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.2.3.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs through treatment and containment of contaminated soil. The soil from the disposal trenches is treated through incineration and then placed in an on-post landfill. Soil that potentially poses risk to biota is landfilled as well. The potential for migration of contaminants to groundwater is reduced through treatment and containment; however, this alternative entails significant short-term risks relative to the excavation of the disposal trenches. These risks cannot be completely eliminated.

14.2.3.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emission sources; landfill siting, design, and operation; and endangered species. Location-specific ARARs are met as the site, incineration facilities, and landfill are not located in wetlands or a 100-year flood plain. This alternative also complies with provisions of the FFA (EPA et al. 1989) and Army regulations regarding agent/UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.2.3.3 Long-Term Effectiveness and Permanence

The residual risk associated with the 440,000 BCY of treated soil is minimal. The 440,000 BCY of soil are incinerated and placed in an on-post landfill. The 87,000 BCY of soil potentially posing risk to biota and the remaining 4,000 BCY of human health exceedances are removed and contained, also leaving minimal residual risk at the site. There is high confidence in the engineering controls of the landfill and there are no expected difficulties associated with landfill maintenance. Revegetation of disturbed areas improves the existing habitat at the site, but habitat is eliminated at the landfill.

14.2.3.4 Reduction in TMV

Incineration of 440,000 BCY destroys organic compounds. Prior to incineration, oversize debris is separated and landfilled along with the treated material. The 87,000 BCY of soil that may pose potential risk to biota and 4,000 BCY of additional human health exceedances are landfilled. In addition, soil with agent contamination or UXO is identified and treated. Organics are reduced to detection levels or >99.99 percent DRE through incineration, and the TMV of organics is irreversibly eliminated. Scrubber blowdown solids from off-gas and salts are disposed in an on-post landfill. The blowdown solids account for a volume of approximately 4,400 BCY. Residuals also include groundwater, pumped at a rate of 0.2 gpm to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system.

14.2.3.5 Short-Term Effectiveness

This alternative entails very high short-term risks associated with excavation, materials handling, transportation, incineration, and landfilling of highly contaminated soil, some of which has the potential for generating contaminated vapors or odors. These risks are reduced through the installation of a vapor enclosure and use of personal protective equipment, but they cannot be completely eliminated. A vapor enclosure is installed to collect and treat vapors and odors that emanate during excavation; however, field demonstrations of vapor enclosures have not indicated that adequate controls can consistently be achieved. The short-term risks to workers inside the vapor enclosure are increased due to the confined working area and are dependent on the performance of the air treatment system. The presence of UXO and agent materials in the disposal trenches further raises safety concerns regarding excavation of the disposal trenches. Since historical operations at these trenches involved burning munitions inside the trenches, the potential exists to encounter UXO that are unstable and must be detonated in place. Therefore, the possibility exists for vapor/odor emissions during excavation in spite of these controls. In addition, the materials handling of the soil and debris prior to incineration presents short-term risks, especially since partially filled and corroded drums need to be separated, although the materials handling-activities are conducted within an enclosure in an attempt to control dust and vapors/odors. The emissions from the incinerator contain low but acceptable levels of some contaminants. Although the off-gas control system for the incinerator is designed to achieve air quality standards, the treatment of soil with extremely high levels of contamination may result in emissions exceeding the standards. Due to the existing disturbed habitat, habitat impacts are minimal. Excavation and treatment of all materials is feasible within 6 years; 2 years are required for construction of the incinerator, vapor enclosures, and landfill, prior to excavation.

14.2.3.6 Implementability

Vapor enclosures have not been demonstrated at full scale for hazardous waste operations similar to RMA, although construction of vapor enclosures is well documented. In addition, vapor enclosures are not available from many vendors. Excavation within vapor enclosures requires double handling of soil when the enclosure must be moved around the site during operations. Incinerators are widely available; however, the operation of the incinerator may be difficult based on the characteristics of the feed materials, including the presence of large debris and corroded drums. Administrative difficulties associated with demonstrating compliance with permits, and performing O&M and operating difficulties associated with the solids feed may lead to delays. It may be difficult to implement this alternative due to public perception regarding the safety of incineration and the adequacy of the vapor enclosure to control odors/vapors during excavation of the disposal trenches. Safety of workers within the enclosure will also be a major implementation concern. Materials and vendors are readily available for implementation of the landfill portion of this alternative.

14.2.3.7 Cost

The total present worth cost is $263,000,000, including $78,200,000, $184,000,000, and $290,000 for capital, operating, and long-term costs, respectively. Table B4.7-14 details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, there is no experience at other sites by which costs for the performance of the vapor enclosures and the air treatment system, and their impact on excavation and worker productivity, can be well defined. Second, the elevated concentrations of the contaminants and the need for more intensive materials handling (due to the drums and debris) increase uncertainties relative to excavation rates and maintaining the assumed on-line percentage of the incinerator. These operating conditions may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs. Third, the potential presence of UXO and agent within the disposal trenches further decrease the excavation productivity.

14.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Complex Trenches Subgroup contains 530,000 BCY of human health exceedance soil and soil that potentially poses risk to biota. The exceedance volumes are a result of the disposal of contaminated soil and debris into a series of trenches. The 440,000 BCY of disposal trench materials are considered a principal threat. Areas of this subgroup outside of the trenches proper include human health exceedances of chlordane (4,000 BCY) and contaminated soil that potentially poses risk to biota (87,000 BCY). The trench materials are considered principal threat exceedances based on the anticipated high concentrations of contamination, the heterogeneous nature of the materials, and the presence of containerized waste. Based on the site history and remedial investigations, this subgroup also potentially contains UXO and agent and has been identified as the source of two groundwater contamination plumes.

This subgroup entails areas of disturbed vegetation. Alternatives that disrupt habitat include revegetation and restoration activities. No significant habitat impacts are anticipated, although burrowing animals are excluded under the alternatives involving caps/covers.

There are extremely high short-term worker and community risks associated with the excavation of this subgroup due to the high levels of contamination, the potential presence of UXO and agent, and the risks associated with excavation within vapor enclosures. Site workers require extensive health and safety measures to protect against the potential physical and acute chemical hazards present. The adequacy of a vapor enclosure to control emissions and reduce community risk is not certain, especially due to the potential for explosion from white phosphorous and unstable UXO. These controls reduce the productivity of workers and substantially increase the cost and difficulty of the excavation operation.

In summary, the Complex Trenches Subgroup contains high levels of heterogeneous contamination, including potential UXO and agent presence. Alternatives retained for this subgroup must balance the potential long-term risks of contaminant migration if the trench materials are left in place with the high short-term risks to workers and the community from excavation operations.

Alternative 1: No Additional Action does not achieve RAOs and is eliminated from further consideration due to the residual risks associated with leaving the trenches in place without controls. The two remaining alternatives include a treatment and a containment process option. Both alternatives achieve RAOs and meet the two DAA threshold criteria: protection of human health and the environment and compliance with action- and location-specific ARARs for the DAA.

Alternative 14: Incineration/Pyrolysis; Landfill achieves RAOs through excavation and treatment of the disposal trenches and surrounding contaminated soil. A vapor enclosure is required during excavation to control vapor emissions and protect the community and workers elsewhere at RMA; however, the adequacy of the vapor enclosure is not certain as these trenches contain explosive materials, including unstable UXO and white phosphorous. The presence of these explosive materials, in combination with risks associated with excavation within a vapor enclosure and high levels of contamination and Army agent, result in very high short-term risks to site workers even though protective equipment is used. In addition, this alternative requires the disposal of highly contaminated oversize debris with potential agent presence, some of which is very large (e.g., forklifts and mixing vats) prior to rotary kiln incineration. It may also be difficult to administratively implement this alternative due to public perceptions regarding the safety of incineration and the adequacy of vapor enclosures to control odors/vapors during excavation. Alternative 14: Incineration/Pyrolysis; Landfill has a significantly higher cost ($263,000,000) than Alternative 5 ($36,900,000). As a result, the incineration alternative is not retained for further evaluation.

Alternative 5: Caps/Covers; Vertical Barriers achieves RAOs through containment by interrupting exposure pathways and reducing the migration of contaminants to groundwater. This alternative requires the long-term operation of the dewatering system to maintain hydraulic controls and the 390,000-SY low-permeability soil cap with a concrete barrier. EPA guidance on principal threats (OERR-EPA 1991) indicates that treatment alternatives for principal threats may not be appropriate for instances in which the implementation of the treatment-based alternative would result in a greater overall risk to human health and the environment as compared to engineering controls due to the risks posed to site workers and the community during the remedial action. The construction of the low-permeability soil cap and the vertical barrier results in significantly lower short-term risks to workers and the community. Because this alternative exhibits much lower short-term impacts (since the soil and debris in the disposal trench are not excavated), and the alternative is protective of human health and the environment, it was retained for consideration in development of the sitewide alternatives.

Consequently, the alternative that was retained to represent the Complex Trenches Subgroup in the development of the sitewide alternatives (Section 20) is the following:

- Alternative 5: Caps/Covers (Multilayer Cap); Vertical Barriers (Slurry Walls)

This alternative requires long-term dewatering to ensure the inward migration of groundwater. This dewatering affects the selected alternative for the Basin A Plume Group, Alternative AC-9, which involves the collection and treatment of contaminated groundwater associated with the Section 36 Bedrock Ridge Plumes and the continued operation of the Basin A Neck IRA. Thus, the design of the long-term hydraulic controls associated with the slurry walls must be coordinated with the well locations for the groundwater alternative.

14.4 SHELL TRENCHES SUBGROUP CHARACTERISTICS

The Shell Trenches Subgroup is composed of site CSA-1a (Pesticide Pits) (Figure 14.0-1). This site contains approximately 18 trenches that were filled with a variety of solid and liquid wastes from Shell production facilities. Wastes were buried both in bulk form and in drums from 1952 through 1966. Due to the presence of high levels of contamination, containerized wastes, and historical evidence as a source of groundwater contamination, the entire site (100,000 BCY) is considered a principal threat. The contamination has been contained as part of the Shell Trenches IRA. A vertical barrier was installed around the site to reduce the migration of contaminated groundwater away from the site and a soil cap was placed over the site to reduce infiltration of rainwater through the contaminated area. The soil cover is approximately 3 ft thick and has been revegetated; however, the types of vegetation placed at the site and the maintenance activities conducted there are designed to discourage burrowing animals from using the area for habitat.

The disposal trenches themselves contain elevated levels of OCPs, HCCPD, and DBCP, which are encountered to a depth of 10 ft. In addition to the COCs identified in the trenches, numerous nontarget compounds, which are intermediates and byproducts from the manufacturing of pesticides, are identified at concentrations as high as 40,000 ppm. Army-agent-related compounds were also detected in soil samples and from monitoring wells nearby. Table 14.4-1 summarizes contaminants, concentrations, and exceedance values for this subgroup and Table 14.4-2 provides the frequency of detections.

Site CSA-1a is identified as a source of groundwater contamination. The Basin A Plume emanates from the trench area and the Basin A liquid waste disposal area and extends northwest in the unconfined aquifer, where it is intercepted and treated by the Basin A Neck IRA. The Shell Trenches IRA reduces the migration of contaminated groundwater away from the site and reduces the migration of contaminants from the trenches to groundwater. Groundwater alternatives that address improved performance for the Basin A Neck IRA treatment system or the addition of individual plume group remediation systems are being evaluated as part of the Basin A Plume Group. Coordination is required with the Basin A Plume Group for excavation or containment alternatives developed for the Shell Trenches Subgroup. The installation of hydraulic controls or use of dewatering is also to be coordinated with alternatives evaluated for the Basin A Plume Group.

The vegetation introduced during the IRA generally consists of native grasses, however, the ability of biota to access the contaminated volume by burrowing through it lowers the overall habitat quality of the subgroup. In general, the overall habitat quality is improved by the remedial actions, although, under the capping alternatives, the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat.

14.5 SHELL TRENCHES SUBGROUP EVALUATION OF ALTERNATIVES

The alternatives for the Shell Trenches Subgroup include no action, containment, and treatment approaches. The alternatives retained in the DSA (EBASCO 1992b) for this subgroup were modified to include Alternative 3: Landfill (On-Post Landfill), which was initially screened out in the DSA (EBASCO 1992b) based on the characteristics of the Complex Trenches Subgroup. Prior to landfilling the soil and debris from this subgroup, any sludges are stabilized through mixing with stabilizing agents and contaminated soil from the excavation. The following subsections present a description of each alternative and an evaluation of the alternative against the EPA criteria for the DAA.

14.5.1 Alternative 1: No Additional Action

Alternative 1: No Additional Action applies to all 32,000 SY of exceedance area in the Shell Trenches Subgroup. The 100,000 BCY of principal threat volume remain in place. No additional actions beyond the existing vertical barrier and soil cap are taken to reduce human or biota exposure to COCs or to reduce the potential for further groundwater contamination from this site. Five-year site reviews and groundwater compliance monitoring are conducted to assess natural attenuation or degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 14.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.5.1.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health RAOs because the existing soil cover is left in place, but it does not achieve Biota RAOs because burrowing animals have access to contaminated soil through the soil cover. Groundwater impacts are reduced as a result of the protection provided by the existing IRA soil cover. This alternative does not entail short-term risks.

14.5.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the site is not located in wetlands or a 100-year flood plain. The alternative also complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.5.1.3 Long-Term Effectiveness and Permanence

There is a low residual risk associated with this alternative. High levels of OCPs, HCCPD, DBCP exceeding Human Health SEC (EBASCO 1994a) remain in the soil, but the existing containment system reduces human health exposure. No controls are implemented, but site reviews and groundwater monitoring are required. The existing habitat is not impacted by this alternative.

14.5.1.4 Reduction in TMV

There is mobility reduction by the existing system, but no reduction in toxicity or volume. A total of 100,000 BCY of untreated soil remains in place.

14.5.1.5 Short-Term Effectiveness

This alternative does not achieve Biota RAOs and may not achieve complete groundwater protection. The alternative does not entail short-term risks and is protective of workers and the community since no actions are taken, but the environmental impacts include potential continued migration of contaminants to the groundwater, albeit at lower levels than prior to the IRA. The existing habitat is not affected.

14.5.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are available to sample groundwater.

14.5.1.7 Cost

The total present worth cost is $479,000 and includes only the long-term O&M costs associated with long-term monitoring and site reviews. Table B4.8-1 details the costing for this alternative. This alternative entails low levels of uncertainty relative to site reviews and monitoring.

14.5.2 Alternative 3: Landfill

Alternative 3: Landfill (On-Post Landfill) involves the disposal of 100,000 BCY of trench materials in an on-post hazardous waste landfill. Volatile emissions and noxious odors are controlled during excavation by enclosing the trenches with a vapor enclosure as described in Section 14.2.3. Two structures of 890 ft by 90 ft will be utilized for vapor control with excavation occurring in one structure while the second is relocated. One structure will be placed to excavate alternating spaced rows leaving a mound at each row skipped. A second structure will be moved to continue excavation at the mound locations remaining. Excavations will be partially backfilled and an interim sprayed cover will act as vapor control at slopes during relocation of the structures. The work should be completed in less than 1 year based on relocating the structures a total of five times.

The alkaline aqueous solution from the wet scrubber system is neutralized and subsequently treated at the CERCLA Wastewater Treatment Plant. Dewatering is required for 1 year prior to and during the excavation of the soil. The groundwater is removed at 3 gpm and also pumped to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system.

The IRA soil cover (32,000 SY) is excavated and stockpiled nearby as overburden prior to excavation of the trenches. The 100,000 BCY of principal threat volume are then excavated, transported, and placed in the on-post hazardous waste landfill. Any sludges or soil with free liquids are mixed with stabilizing agents and contaminated soil prior to landfilling in order to achieve landfill operating regulations. The on-post landfill is a multiple-cell facility requiring 1 year for construction of the first cell and associated facilities (Section 4.6.6). The landfill cover is revegetated to limit erosion and control surface-water infiltration, and fencing is installed around the landfill to preserve the integrity of the landfill cover and leachate control system. Long-term maintenance of the landfill cover, leachate collection and treatment, and groundwater monitoring are required.

The 100,000 BCY of borrow material are transported from the on-post borrow area to backfill the site excavations. The stockpiled overburden is used to cover the backfill, and the site is revegetated with native grasses to improve the habitat quality. The borrow area is also regraded and revegetated to restore habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 14.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.5.2.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs since the contaminated soil and trench materials are excavated and transferred to a containment cell. The removal of the contaminated soil interrupts exposure pathways and eliminates any further contamination of groundwater. However, the excavation of the disposal trenches entails significant short-term impacts that cannot be eliminated.

14.5.2.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on landfill siting, design, and operation and impacts to endangered species. The site and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs because the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.5.2.3 Long-Term Effectiveness and Permanence

The 100,000 BCY of principal threat volume are removed from the site and contained in the landfill. Therefore, residual risk at the site is minimal. There is high confidence in the engineering controls of the landfill and there are no expected difficulties associated with landfill maintenance. Landfill-cell monitoring is required. Habitat at the site is improved by revegetation; however, habitat at the landfill is eliminated.

14.5.2.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants is reduced through containment in the landfill, although no materials are treated. Mobility reduction is only reversible should the landfill fail. Treatment residuals associated with this alternative include the 3 gpm of groundwater removed during dewatering (1 year prior to and during excavation), which is pumped to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system installed.

14.5.2.5 Short-Term Effectiveness

This alternative entails extremely high short-term risks associated with excavation, materials handling, stabilization, transportation, and landfilling of highly contaminated soil and debris, some of which has the potential for generating contaminated vapors or odors. These risks are reduced through the installation of a vapor enclosure and use of personal protective equipment, but they cannot be completely eliminated. The vapor enclosure is installed to collect and treat vapors and odors emitted during excavation; however, field demonstrations of vapor enclosures have not indicated that adequate controls can consistently be achieved. Therefore, the possibility exists for vapor/odor emissions during excavation despite these controls. The short-term risks to workers inside the vapor enclosure are increased due to the confined working area and are dependent on the performance of the air treatment system. There are minimal impacts to the environment due to the linear nature of the site and the existing habitat. Migration of the contaminants to the groundwater is eliminated. The time frame until RAOs are achieved is 2 years. Excavation of the 100,000 BCY is feasible within 1 year after 1 year for the construction of the landfill.

14.5.2.6 Implementability

Technically, this alternative is only moderately feasible, given the difficulties of operating within a vapor enclosure and the elevated concentrations of contaminants. However, it can be implemented within the required time frame and the landfill can be reliably operated and maintained thereafter with periodic monitoring. Additional remedial actions require removal of the landfill cover. The alternative is administratively feasible since the substantive Subtitle C requirements associated with landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill, and this technology has been well demonstrated at full scale. Vapor enclosures have not been demonstrated at full scale for hazardous waste operations similar to RMA, although construction of vapor enclosures is well documented. In addition, vapor enclosures are not available from many vendors.

14.5.2.7 Cost

The total present worth cost is $47,100,000 including $3,050,000, $44,000,000, and $70,000 for capital, operating, and long-term costs, respectively. Table B4.8-3 details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, there is no experience at other sites by which costs for the performance of the vapor enclosures, and their impact on excavation, can be well defined. Second, the high maintenance requirements of the air treatment system and a potential for reduced worker productivity inside the vapor enclosures increase uncertainties relative to maintaining the assumed schedule. These operating conditions may result in changes in maintenance requirements or delays in implementation, both of which may impact costs.

14.5.3 Alternative 5a: Caps/Covers; Vertical Barriers with Modifications to Existing System

Alternative 5a: Caps/Covers (Multilayer Cap); Vertical Barriers (Slurry Walls) with Modifications to Existing System addresses the containment of the 100,000 BCY of principal threat volume with a 32,000-SY low-permeability soil cap. It is assumed that this cap is RCRA-equivalent, which will meet performance criteria to be developed by the Parties prior to the remedial design. The existing 6-inch-thick slurry wall is modified to a thickness of 3 ft with a soil/bentonite slurry wall. The soil/bentonite slurry wall is installed into competent bedrock (to approximately 26 ft below grade) around the perimeter of the site (2,300 LF) to form an isolation cell. (Section 4.6.14 presents details of low-permeability soil caps and slurry walls.) The soil excavated for the modified slurry wall trench is graded over the surface of the isolation cell and included under the cap as it is potentially contaminated. For the purposes of conceptual design and costing in the FS, it is assumed that a dewatering system, which creates a reduced hydraulic gradient within the cell (minimizing the potential for further contaminant migration via groundwater), is required. This assumption will be evaluated during the remedial design. Groundwater removed from the cell is pumped at 3 gpm to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system.

Following slurry wall installation, a low-permeability soil cap is constructed over the existing soil cover. The subgrade is regraded and compacted before any cover materials are installed to minimize topographic irregularities in the subgrade. The area is covered by a 2-ft-thick layer of low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and a 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil. The uppermost 2 ft of the existing soil cover are removed, stockpiled, and incorporated into the soil/vegetation layer. Most of the fill materials for the cap and slurry wall are excavated from an on-post borrow area.

The uppermost 6 inches of soil over the 32,000 SY of principal threat area are supplemented with conditioners and revegetated with native grasses. The types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area for habitat. The borrow area is also recontoured and revegetated to restore habitat. The slurry wall and capping operations take 1 year to complete, and the maintenance activities ensure the upkeep of the soil cover and the dewatering system. Five-year site reviews and groundwater compliance monitoring are conducted to assess the potential migration of contaminants and the integrity of the containment system.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in NCP (EPA 1990a). For purposes of comparison, Table 14.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.5.3.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs. Human and biota exposure pathways are interrupted by installation of a low-permeability soil cap and slurry walls. Groundwater impacts are reduced by the dewatering system, and short-term impacts are minimal since intrusive activities are not conducted.

14.5.3.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of the contained material. Location-specific ARARs are met as the site is not located in wetlands or a 100-year flood plain. In addition, the alternative complies with provisions of the FFA (EPA et al. 1989), and does not impact endangered species. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.5.3.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low. The 100,000 BCY of untreated soil are contained within the 32,000-SY low-permeability soil cap and slurry walls. Long-term monitoring and site reviews are required for the untreated soil. In addition, the vegetative cover, slurry walls, and the dewatering system require maintenance. There is high confidence in the engineering controls of the cap and slurry wall. Habitat quality is improved through revegetation of disturbed areas, although the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area for habitat.

14.5.3.4 Reduction in TMV

The enhancement of the low-permeability soil cap, slurry wall, and dewatering system interrupts exposure pathways and minimizes the mobility of contaminants for 100,000 BCY. Reduction of the mobility of contaminants is only reversible should the cap or slurry wall degrade. Residuals from this alternative include groundwater, which is pumped at 3 gpm to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system.

14.5.3.5 Short-Term Effectiveness

This alternative entails low short-term risk and is protective of workers and the community during the remedial action. Workers are adequately protected by personal protective equipment during installation of the cap/cover and slurry wall and during dewatering. Uncontaminated fugitive dust associated with cap construction is controlled by water sprays; odor and vapor emissions are not anticipated. Impacts to biota are minimal; however, the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area for habitat. RAOs can be achieved within 1 year through implementation of this alternative.

14.5.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible and materials, specialists, and equipment are readily available. Low-permeability soil caps and slurry walls have been well demonstrated at full scale.

14.5.3.7 Cost

The total present worth cost is \$3,390,000 including \$212,000, \$1,940,000, and \$1,230,000 for capital, operating, and long-term costs, respectively. Table B4.8-5a details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the cap are available on post and the area to be capped is well defined (i.e., the uncertainty commonly associated with excavation does not exist).

14.5.4 <u>Alternative 14: Incineration/Pyrolysis; Landfill</u>

Alternative 14: Incineration/Pyrolysis (Rotary Kiln Incineration); Landfill (On-Post Landfill) treats 100,000 BCY of trench materials through rotary kiln incineration and landfilling. (Sections 4.6.6 and 4.6.29 discuss details of these technologies.) Volatile emissions and noxious odors are controlled during excavation by enclosing the trenches with a vapor enclosure as described in Section 14.2.3. The alkaline aqueous solution from the wet scrubber system is neutralized and subsequently treated at the CERCLA Wastewater Treatment Plant. Dewatering is required for 2 years prior to and during the excavation of the soil. The groundwater is removed at 3 gpm and also pumped to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system.

The IRA soil cover (32,000 SY) is excavated and stockpiled nearby as overburden prior to excavation of the trenches. The 100,000 BCY of exceedance volume are then excavated and transported to the on-post incinerator (Section 4.6.29 presents details of incineration). The incinerator has a soil processing rate of 470 BCY/day, and requires approximately 1 year for construction and 1 year for testing. The incinerator operates with a soil discharge temperature of 760°C and has a soil residence time of 66 minutes for dry soil. (Section 4.6.29 discusses emission controls for off gases from incineration.) Approximately 1 percent of the total soil feed (1.000 BCY) is recovered as particulates from scrubber blowdown and is placed in the on-post landfill. The treated soil is transported from the incineration facility to the hazardous waste landfill (Section 4.6.6 presents details of the landfill). The landfill is a multiple-cell facility that requires 1 year for construction of the first cell and associated facilities. The construction of the cell starts during year 2 to have the same completion date as the incinerator.

The site excavations are backfilled with 100,000 BCY of borrow material that are transported from the on-post borrow area. The stockpiled overburden is used to cover the backfill, and the site is revegetated with native grasses to improve habitat quality. The borrow area is also regraded and revegetated to restore habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 14.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.5.4.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs through treatment of contaminated soil. The soil is treated to organic detection levels or >99.99 percent DRE and then placed in an on-post landfill. The potential for migration of contaminants to groundwater is greatly reduced through removal and treatment. However, the excavation of the disposal trenches involves significant short-term impacts that cannot be eliminated.

14.5.4.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emission sources; landfill siting, design, and operation; and endangered species. Location-specific ARARs are met as the site, incineration facility, and landfill are not located in wetlands or a 100-year flood plain. This alternative also complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.5.4.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since the entire 100,000 BCY of exceedance volume are treated, thus achieving PRGs at the site. The soil is incinerated and placed in an on-post landfill; approximately 1 percent of the soil feed, which is recovered from the off-gas treatment, is also placed in the landfill. There is high confidence in the engineering controls the landfill, and there are no expected difficulties associated with landfill maintenance. Revegetation of disturbed areas improves the existing habitat; however, habitat is eliminated at the landfill.

14.5.4.4 Reduction in TMV

Incineration of the 100,000 BCY degrades OCPs, DBCP, and HCCPD. Organics are reduced to >99.99 percent DRE or detection levels. The TMV of organics is irreversibly eliminated. Scrubber blowdown solids from off-gas treatment are contained in an on-post landfill. The blowdown solids account for a volume of approximately 1,000 BCY. Residuals also include groundwater, pumped at a rate of 3 gpm to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system.

14.5.4.5 Short-Term Effectiveness

This alternative entails very high short-term risks associated with excavation; transportation, incineration, and landfilling of highly contaminated soil and debris and potential vapor- and odor-causing contaminants. These risks are reduced through the installation of a vapor enclosure and use of personal protective equipment, but they cannot be completely eliminated. A vapor enclosure is installed to collect and treat vapors and odors emitted during excavation; however, the adequacy of the air treatment system has not been fully demonstrated and field demonstrations of vapor enclosures have not indicated that adequate controls can consistently be achieved. The short-term risks to workers inside the vapor enclosure are increased due to the confined working area and are dependent on the performance of the air treatment system. In addition, the materials handling of the soil and debris prior to incineration presents short-term risks, especially since partially filled and corroded drums need to be separated. The materials-handling activities are conducted within an enclosure in an attempt to control dust and vapors/odors, but the possibility exists for vapor/odor emissions during excavation despite these controls. The off-gas control system is designed to achieve air quality standards. However, the treatment of soil with variable and extremely high concentrations of contamination may results in emissions from the control system that contain low but acceptable levels of some contaminants. Assuming that there are no significant delays due to processing problems, excavation and treatment of all materials should be feasible within 1 year after 2 years for construction of the incineration facility and landfill.

14.5.4.6 Implementability

Except for the landfill component, this alternative is technically difficult to implement because highly contaminated soil must be excavated within a vapor enclosure and because the incineration component must be carefully controlled. Vapor enclosures have not been demonstrated at full scale at hazardous waste sites, and incineration, while well demonstrated, will be difficult to implement based on the highly contaminated soil, the moisture content of the soil, and materials-handling problems associated with the large debris and corroded drums. Additional operational difficulties associated with incineration include demonstrating and maintaining compliance with permits and performing O&M. It may also be difficult administratively to implement this alternative due to public perceptions regarding the safety of incineration and the adequacy of the vapor enclosure to control odors/vapors during excavation. Safety of workers within the enclosure will also be a major implementation concern.

The landfill component of this alternative is administratively and technically feasible: all landfill siting, design and operating requirements are achieved; the technology is well demonstrated at full scale; and materials and vendors for the technology are readily available.

14.5.4.7 Cost

The total present worth cost is $75,000,000, including $18,900,000, $56,000,000, and $66,000 for capital, operating, and long-term costs, respectively. Table B4.8-14 details the costing for this alternative.

There are two significant uncertainties associated with the costing of this alternative. First, there is no experience at other sites by which costs for the performance of the vapor enclosures and the air treatment system, and their impact on excavation and worker productivity, can be well defined. Second, the elevated concentrations of the contaminants and the need for more intensive materials handling (due to the drums and debris) increase uncertainties relative to excavation rates and maintaining the assumed on-line percentage of the incinerator. These operating conditions may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

14.6 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Shell Trenches Subgroup contains 100,000 BCY of soil that are considered a principal threat exceedance due to the high levels of contamination, the presence of containerized waste, and the groundwater contamination associated with the site. The contamination in the trenches is highly heterogeneous as the disposal trenches were filled with a variety of solid and liquid wastes from Shell production facilities. Investigations show elevated concentrations of OCPs, HCCPD, and DBCP are present (Table 14.4-1). In addition, Army-agent-related compounds were identified in soil and groundwater.

The Shell Trenches IRA involved containing the contaminated groundwater with a vertical barrier and installing a soil cover over the entire site. This action reduces the migration of contaminants from the trenches to groundwater and the migration of contaminated groundwater away from the site. The cap also reduces human and biota exposure pathways to contaminated soil.

The IRA also revegetated the site, but IRA maintenance activities prevent the use of the site as habitat. Alternatives that disrupt habitat include revegetation and restoration of habitat after remediation. No significant habitat impacts are anticipated, although the types of vegetation and maintenance activities for alternatives that involve containment with a cap/coverage are designed to discourage burrowing animals from using the area as habitat.

Excavation of the trenches in this subgroup requires extensive health and safety measures to protect workers. Excavation is conducted under a vapor enclosure to reduce any potential for community exposure. These measures decrease worker productivity and increase the cost and difficulty of the excavation operations.

In summary, the Shell Trenches Subgroup contains heterogeneous debris and soil that is highly contaminated. The soil cover and vertical barrier installed during the IRA reduces the migration of contaminants to groundwater. In retaining alternatives for this subgroup, the short-term risks to workers and the community during excavation must be balanced against the longer-term risks of potential contaminant migration if the trench materials are left in place and the IRA provides insufficient containment.

Alternative 1: No Additional Action is protective of human health due to the presence of the cap, but it does not achieve Biota RAOs or protect groundwater over the long term. Therefore, this alternative was eliminated from further consideration. The three remaining alternatives include one treatment and two containment process options. Each of these alternatives achieves RAOs and meets the two DAA threshold criteria: protection of human health and the environment and compliance with action- and location-specific ARARs for the DAA.

Alternative 14: Incineration/Pyrolysis; Landfill achieves RAOs through treatment of the trench materials. Although this alternative requires extensive worker health and safety measures and excavation under a vapor enclosure to reduce the potential short-term impacts of excavating the disposal trenches, these risks cannot be completely eliminated. This alternative exhibits a substantially higher cost ($75,000,000) than Alternative 5a: Caps/Covers; Vertical Barriers with Modifications to Existing System ($3,390,000). Although incineration of the disposal trenches entails significant short-term impacts, the long-term risks are minimal, and the short-term impacts can be controlled to reduce the risks. Therefore, this alternative is retained for further consideration in the development of sitewide alternatives.

Alternative 3: Landfill achieves RAOs through containment but it entails the same, short-term impacts associated with excavation of the trench materials, although with lower impacts than incineration. This alternative was retained for further evaluation in the development of sitewide alternatives based on the minimal long-term risks associated with landfilling and the lower cost ($47,100,000) than incineration.

Alternative 5a: Caps/Covers; Vertical Barriers with Modifications to Existing System achieves RAOs by interrupting exposure pathways and reducing groundwater contamination. This alternative also entails long-term operation of the dewatering system and maintenance of the enhanced low-permeability soil cap. EPA guidance on principal threats (OERR-EPA 1991) indicates that treatment alternatives for principal threats may not be appropriate for instances in which the implementation of the treatment-based alternative would result in a greater overall risk to human health and the environment as compared to engineering controls due to the risks posed to site workers and the community during the remedial action. The modification of the low-permeability soil cap and the vertical barrier results in significantly lower short-term risks to workers and the community, so this alternative was consequently retained for further evaluation in the development of sitewide alternatives.

Consequently, the alternatives that were retained to represent the Shell Trenches Subgroup in the development of the sitewide alternatives (Section 20) are the following:

- Alternative 3: Landfill (On-Post Landfill)

- Alternative 5a: Caps/Covers (Multilayer Cap); Vertical Barriers (Slurry Walls) with Modifications to Existing System
- Alternative 14: Incineration/Pyrolysis (Rotary Kiln Incineration); Landfill (On-Post Landfill)

As part of the excavation of the disposal trenches, dewatering is required to allow the excavation of soil and debris from near the water table. Thus, coordination with alternatives for the Basin A Plume Group is required as the groundwater alternative, and depending on the schedule for groundwater remediation, may reduce the need for a soil dewatering system.

14.7 HEX PIT SUBGROUP CHARACTERISTICS

The Hex Pit Subgroup is composed of site SPSA-1f (Buried Hex Pit) (Figure 14.0-1). The Hex Pit was historically used for disposal of residual materials (resinous materials called hex bottoms) resulting from the production of HCCPD. This material was buried in thin-gauge barrels and in bulk. The site is currently overlain by Building 571B. Assuming a contamination depth of 10 ft, the site is estimated to contain approximately 3,300 BCY of trench materials. (Appendix A summarizes volume and area calculations.) The entire exceedance volume is considered a principal threat based on the presence of containerized waste and high levels of contamination (Table 14.0-1). Table 14.7-1 provides a summary of contaminants, concentrations, and exceedance criteria for the Hex Pit Subgroup and Table 14.7-2 summarizes the frequency of detections. The levels of HCCPD are expected to be similar to those encountered in the Shell Trenches Subgroup. The site has not been classified as an identifiable source of groundwater contamination within the South Plants Central Processing Area, although potential migration pathways for the contamination of groundwater exist.

Since the site is currently overlain by structures within South Plants, the soil alternatives for the Hex Pit Subgroup must be coordinated with the selection of structures alternatives. The containment of the site requires the demolition of structures, but the resulting debris could be contained along with the disposal pit/trench. The consideration of a direct treatment alternative for this subgroup entails the demolition and removal of Building 571B and any associated structures.

The Hex Pit Subgroup consists of areas of disturbed vegetation. The areas disturbed during remediation are revegetated with native grasses. In general, the overall habitat quality is improved by the remedial actions, although, under the capping alternatives, the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat.

14.8 HEX PIT SUBGROUP EVALUATION OF ALTERNATIVES

The five alternatives developed for the Hex Pit Subgroup include no action, containment, and treatment approaches. The alternatives retained in the DSA (EBASCO 1992b) for this subgroup were modified to include Alternative 3: Landfill (On-Post Landfill), which had been screened out in the DSA (EBASCO 1992b) based on the characteristics of the Complex Trenches Subgroup. The following subsections present a description of each alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a).

14.8.1 Alternative 1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA) applies to the 3,300 BCY of principal threat volume in the Hex Pit Subgroup. This material remains in place, and no actions are taken to reduce human or biota exposure to COCs or to reduce any potential for groundwater contamination from this site. Five-year site reviews and groundwater compliance monitoring are conducted to assess potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in NCP (EPA 1990a). For purposes of comparison, Table 14.8-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.8.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve RAOs since untreated soil remains and no controls are implemented. Groundwater impacts are not reduced, but monitoring activities do not entail short-term risks.

14.8.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the site is not located in wetlands or a 100-year flood plain. In addition to ARARs, the alternative complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.8.1.3 Long-Term Effectiveness and Permanence

There is a high residual risk associated with this alternative. Levels of OCPs and HCCPD that pose a principal threat remain in the soil at depth. No controls are implemented; however, site reviews, soil monitoring, and groundwater monitoring are required. The existing habitat is not impacted by this alternative.

14.8.1.4 Reduction in TMV

There is no reduction in TMV, except by natural attenuation, and there are no treatment residuals since no materials are treated or contained. A total of 3,300 BCY of untreated soil remain in place, with no reduction in hazards.

14.8.1.5 Short-Term Effectiveness

RAOs are not achieved. The alternative does not entail risk to workers and the community during remedial actions since no actions are taken, but the environmental impacts include the continued potential for migration of contaminants to groundwater. The existing habitat is not changed.

14.8.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are available to sample soil and groundwater.

14.8.1.7 Cost

The total present worth cost is $272,000 and includes only long-term O&M costs associated with long-term monitoring and site reviews. Table B4.9-1 details the costing for this alternative. This alternative entails low levels of uncertainty relative to site reviews and monitoring.

14.8.2 Alternative 3: Landfill

Alternative 3: Landfill (On-Post Landfill) involves the disposal of the entire 3,300 BCY of principal threat pit materials in an on-post hazardous waste landfill. Prior to excavation, the overlying structure is demolished and removed from the area. Volatile emissions and noxious odors are controlled during excavation by enclosing the area with a vapor enclosure as described in Section 14.2.3. Two structures of 430 ft by 90 ft will be utilized for vapor control with excavation occurring in one structure while the second is relocated. One structure will be placed to excavate alternating spaced rows leaving a mound at each row skipped. A second structure will be moved to continue excavation at the mound locations remaining. Excavations will be partially backfilled and an interim sprayed cover will act as vapor control on slopes during relocation of the structures. The work should be completed in less than 1 year based on relocating the structures a total of two times. The alkaline aqueous solution from the wet scrubber system is neutralized and subsequently treated at the CERCLA Wastewater Treatment Plant.

The 3,300 BCY of principal threat volume are excavated, transported, and placed in the on-post hazardous waste landfill. To achieve landfill operating regulations, any sludges or soil with free liquids are stabilized by mixing them with stabilizing agents and contaminated soil prior to landfilling. The on-post landfill is a multiple-cell facility requiring 1 year for construction of the first cell and associated facilities (Section 4.6.6). The landfill cover is revegetated to limit erosion and control surface-water infiltration, and fencing is installed around the landfill to preserve the integrity of the landfill cover and leachate control system. Long-term maintenance of the landfill cover, leachate control system, and groundwater monitoring are required.

The 3,300 BCY of borrow material are transported from the on-post borrow area to backfill the site excavations. The uppermost 6 inches over the 900 SY of backfilled area are supplemented with conditioners and revegetated with native grasses to improve the habitat quality. The borrow area is also regraded and revegetated to restore habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 14.8-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.8.2.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs since the contaminated soil is excavated and removed from the site for containment. The removal of the contaminated soil interrupts exposure pathways and greatly reduces the contamination of groundwater. However, the excavation of the pit entails significant short-term risks that cannot be completely eliminated.

14.8.2.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on landfill siting, design, and operation and impacts to endangered species. The site and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs because the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.8.2.3 Long-Term Effectiveness and Permanence

This alternative entails minimal residual risks since the entire 3,300 BCY of untreated soil are removed and contained in the landfill. There is high confidence in the engineering controls of the landfill and there are no expected difficulties associated with landfill maintenance. Landfill-cell monitoring is required. Habitat at the site is improved by revegetation; however, habitat at the landfill is eliminated.

14.8.2.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants is reduced through containment in the landfill for 3,300 BCY, although no materials are treated. Mobility reduction is only reversible should the landfill fail.

14.8.2.5 Short-Term Effectiveness

This alternative entails high short-term risks associated with excavation; materials handling, stabilization, transportation, and landfilling of highly contaminated soil and debris; and potential vapor- or odor-causing contaminants. These risks are reduced through the installation of a vapor enclosure and use of personal protective equipment, but they cannot be completely eliminated. The vapor enclosure is installed to collect and treat vapors and odors from the excavation; however, field demonstrations of vapor enclosures have not indicated that adequate controls can consistently be achieved. The possibility exists for vapor/odor emissions during excavation despite these controls. The short-term risks to workers inside the vapor enclosure are increased due to the confined working area and are dependent on the performance of the air treatment system. There are minimal impacts to the environment due to the small size of the site. Migration of the contaminants to groundwater is reduced. The time frame until RAOs are achieved is 2 years. Excavation of the 3,300 BCY is feasible in less than 1 year, after 1 year for construction of the landfill.

14.8.2.6 Implementability

Technically, the alternative is moderately feasible given the difficulties of operating within an enclosure and the very high contamination levels. However, it can be implemented within the required time frame and the landfill can be reliably operated and maintained thereafter with periodic monitoring. The alternative is administratively feasible since the substantive requirements associated with Subtitle C landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill, and landfill technology has been well demonstrated at full scale. Vapor enclosures have not been demonstrated at full scale for hazardous waste operations similar to RMA, although construction of vapor enclosures is well documented. In addition, vapor enclosures are not available from many vendors.

14.8.2.7 Cost

The total present worth cost is $1,540,000 including $1,500,000, $33,000, and $2,000 for capital, operating, and long-term costs, respectively. Table B4.9-3 details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, there is no experience at other sites by which costs for the performance of the vapor enclosures, and their impact on excavation, can be well defined. Second, the high maintenance requirements of the air treatment system and a potential for reduced worker productivity inside the vapor enclosures increase uncertainties relative to maintaining the assumed schedule. These operating conditions may result in changes in maintenance requirements or delays in implementation, both of which may impact costs.

14.8.3 Alternative 5: Caps/Covers; Vertical Barriers

Alternative 5: Caps/Covers (Multilayer Cap); Vertical Barriers (Slurry Walls) includes the demolition of Building 571B and any associated structures and the containment of 3,300 BCY of principal threat area with a 900-SY low-permeability soil cap. (Section 4.6.14 discusses low-permeability soil caps and slurry walls in detail.) A soil/bentonite slurry wall is installed into competent bedrock (to approximately 33 ft below grade) around the perimeter of the site (380 LF) to form an isolation cell. The soil excavated for the slurry wall trench is potentially contaminated and is graded over the surface of the isolation cell and included under the cap.

Though not required based on present groundwater elevations, a dewatering system is installed as a contingency. Any groundwater recovered from the cell is pumped to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system. Depending on the pumping rate and the contaminant concentrations, pre-treatment may be required or the water may be sent off post for treatment.

Following slurry wall installation, the low-permeability soil cap is constructed. This cap may be part of a larger cover installed over the South Plants Central Processing Area (see Section 17.2) because the Hex Pit site is located within the Central Processing Area. The subgrade is regraded and compacted before any cover materials are installed to minimize topographic irregularities in the subgrade. The surface is crowned with slurry wall excavation soil or borrow materials from the on-post borrow area to provide adequate surface-water runoff. The area is then covered by a 2-ft-thick layer of low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and a 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil. Most of the fill materials for cap and slurry wall are excavated from the on-post borrow area.

The uppermost 6 inches of soil are supplemented with conditioners and revegetated to restore habitat. Although the cap is revegetated, the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area for habitat. The borrow area is also recontoured and revegetated to restore habitat. The slurry wall and capping operations take less than 1 year to complete. Long-term maintenance activities ensure the continued integrity of the soil cover and operation of the dewatering system. Five-year site reviews and groundwater compliance monitoring are conducted to assess potential migration of contaminants and the integrity of the containment system.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 14.8-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.8.3.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs. Human and biota exposure pathways are interrupted by installation of a low-permeability soil cap and a slurry wall. Groundwater impacts are reduced by the dewatering system, and short-term impacts are minimal since intrusive activities are not conducted.

14.8.3.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of the contained material. Location-specific ARARs are met as the site is not located in wetlands or a 100-year flood plain. In addition, the alternative complies with provisions of the FFA (EPA et al. 1989), and does not impact endangered species. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.8.3.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low since all 3,300 BCY of untreated soil are contained within the 900-SY low-permeability soil cap and slurry wall. Long-term monitoring and site reviews are required for the untreated soil. In addition, the vegetative cover, slurry wall, and the dewatering system require maintenance. There is high confidence in the engineering controls for the cap and slurry wall. Habitat quality is improved through revegetation of disturbed areas, although the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat.

14.8.3.4 Reduction in TMV

The low-permeability soil cap, slurry wall, and dewatering system interrupt exposure pathways and reduce the mobility of contaminants. Reduction of the mobility of contaminants is only reversible should the cap or slurry wall degrade. Residuals from this alternative include any groundwater recovered during dewatering, which is pumped to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system.

14.8.3.5 Short-Term Effectiveness

The alternative entails low short-term risk to workers and the community during the remedial action, even through contaminant levels are high, because the intrusive actions are limited. Workers are adequately protected by personnel protective equipment during structure demolition, installation of the cap/cover and slurry wall, and dewatering. Uncontaminated fugitive dust associated with cap construction is controlled by water sprays, and odor and vapor emissions are not anticipated. Due to the existing disturbed habitat, impacts to biota are minimal; however, the types of vegetation placed at the site following capping and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat. RAOs can be achieved within 1 year through implementation of this alternative.

14.8.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible and materials, specialists, and equipment are readily available. Low-permeability soil caps and slurry walls have been well documented at full scale.

14.8.3.7 Cost

The total present worth cost is $622,000 including $167,000, $181,000, and $274,000 for capital, operating, and long-term costs, respectively. Table B4.9-5 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the cap are available on post and the area to be capped is a well defined (i.e., the uncertainty commonly associated with excavation does not exist).

14.8.4 <u>Alternative 14: Incineration/Pyrolysis; Landfill</u>

This alternative is evaluated as a representative thermal treatment technology for the hex pits. Other innovative treatment technologies will be evaluated prior to selecting the remedy for this site. Alternative 14: Incineration/Pyrolysis (Rotary Kiln Incineration); Landfill (On-Post Landfill) treats 3,300 BCY of principle threat exceedance soil of trench materials by rotary kiln incineration and landfilling. (Sections 4.6.6 and 4.6.29 discuss the details of these technologies.)

Volatile emissions and noxious odors are controlled during excavation by enclosing the Hex Pit within a vapor enclosure as described in Section 14.8.2. Dewatering for excavation is not required based on the anticipated decrease in groundwater levels once manmade recharge sources (i.e., leaking water lines) are removed.

The 3,300 BCY of principal threat volume are excavated and transported to the on-post incinerator. The incinerator has a soil processing rate of 470 BCY/day, and takes approximately 1 year to build and an additional year for testing. The incinerator operates with a soil discharge temperature of 760°C and has a soil residence time of 66 minutes for dry soil. (Section 4.6.29 discusses emission controls for off gases from incineration.) Approximately 1 percent of the total soil feed (33 BCY) is recovered as particulates from scrubber blowdown and is placed in the on-post landfill. The treated soil is transported from the incineration facility to the hazardous waste landfill. The multiple-cell landfill and the associated facilities take 1 year to build. The 3,300 BCY of borrow material are transported from the on-post borrow area to backfill the site excavations. The uppermost 6 inches over the 900 SY of backfilled area are supplemented with conditioners and revegetated with native grasses to improve the habitat. This area may be covered as part of a cap for the South Plants Central Processing Area (see Section 17.2).

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 14.8-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.8.4.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs through treatment of contaminated soil and sludge. The material is treated through incineration and then placed in an on-post landfill. The potential for migration of contaminants to groundwater is eliminated through treatment and landfilling. However, the excavation of the Hex Pit entails high short-term impacts that cannot be eliminated.

14.8.4.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources; landfill siting, design, and operation; and endangered species. Location-specific ARARs are met as the site, incinerator facility, and landfill are not located in wetlands or a 100-year flood plain. This alternative complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.8.4.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since the entire principal threat volume of 3,300 BCY is treated, thus achieving PRGs. The soil is incinerated and placed in an on-post landfill, and approximately 1 percent of soil feed that is recovered from off gas treatment is also placed in the landfill. There is high confidence in the engineering controls of the landfill and there are no expected difficulties associated with landfill maintenance. Revegetation of disturbed areas improves the existing habitat, but habitat is eliminated at the landfill. The area may be capped as part of the remediation of the South Plants Central Processing Area because the two areas are proximate to each other.

14.8.4.4 Reduction in TMV

The 3,300 BCY of principal threat volume are incinerated to degrade HCCPD. Organic compounds are reduced to detection levels or >99.99 percent DRE. The TMV of organics is irreversibly eliminated. Scrubber blowdown solids from off-gas treatment (33 BCY) are contained in an on-post landfill along with the treated soil.

14.8.4.5 Short-Term Effectiveness

This alternative entails very high short-term risks associated with excavation, transportation, incineration, and landfilling of highly contaminated soil and sludge; and potential vapor- or odor-causing contaminants. These risks are reduced through the installation of a vapor enclosure and use of personal protective equipment, but they cannot be completely eliminated. The vapor enclosure is installed to collect and treat vapors and odors from excavation; however, field demonstrations of vapor enclosures have not indicated that adequate controls can consistently be achieved. The possibility exists for vapor/odor emissions during excavation despite these controls. The short-term risks to workers inside the vapor enclosure are increased due to the confined working area and are dependent on the performance of the air treatment system. In addition, although the materials-handling activities are conducted within an enclosure to control dust and vapor/odors, the materials handling of the soil and debris prior to incineration presents short-term risks since partially filled and corroded drums need to be separated. The emissions from the incinerator will contain low but acceptable levels of the contaminants removed from the soil. Incineration of variable and high levels of contamination may result in emissions exceeding the air quality standards, although the off-gas control system for the incinerator is designed to achieve air quality standards. Due to the small size of the site, environmental impacts are minimal. Excavation and treatment of all materials is feasible within 1 year, assuming there are no operational problems related to excavation within an enclosure or incineration, after 2 years for construction of incineration facility and landfill.

14.8.4.6 Implementability

The alternative is difficult to implement due to the problems related to excavation and incineration of high levels of contamination. The landfill portion of the alternative is administratively feasible since the requirements of landfill siting, design, and operating regulations are achieved. Materials and vendors are readily available for implementation of the landfill, and landfills are well demonstrated at full scale. Vapor enclosures have not been demonstrated at full scale for hazardous waste operations similar to RMA, although construction of vapor enclosures is well documented. In addition, vapor enclosures are not available from many vendors. Incinerators are widely available; however, the operation of the incinerator may be difficult based on the characteristics of the feed materials, including high contaminant concentrations and the presence of corroded drums. Operational difficulties may lead to problems in demonstrating compliance with permits and performing O&M, which may lead to delays. It may also be difficult to implement this alternative due to public perceptions regarding the safety of incineration and the adequacy of the vapor enclosure to control odors/vapors during excavation of the disposal trenches.

14.8.4.7 Cost

The total present worth cost is $3,680,000 including $1,960,000, $1,72,000, and $2,000 for capital, operating, and long-term costs, respectively. Table B4.9-14 details the costing for this alternative.

There are two significant uncertainties associated with the costing of this alternative. First, there is no experience at other sites by which costs for the performance of the vapor enclosures and the air treatment system, and their impact on excavation and worker productivity, can be well defined. Second, the elevated concentrations of the contaminants and the need for more intensive materials handling (due to the drums and debris) increase uncertainties relative to maintaining the assumed on-line percentage of the incinerator. These operating conditions may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

The cost estimate for incineration is based on treating several hundred thousand bank cubic yards of contaminated soil on a continuous basis. The treatment of the small volume of agent-contaminated soil requires operating the equipment on a batch basis, which would substantially increase the unit costs were incineration not selected for other medium groups.

14.8.5 Alternative 22/A3: In Situ Solidification/Stabilization

Alternative 22/A3: In Situ Solidification/Stabilization (Cement-Based Solidification or Silica/Proprietary Agent-Based Solidification), treats 3,300 BCY of contaminated soil by solidification. The predominant COCs in this subgroup are organic compounds that are amenable to solidification using a proprietary agent. However, there is some concern that the in situ process may be difficult to implement for these materials. Therefore, following additional evaluation, ex-situ (direct) solidification/stabilization may be substituted.

The principal threat volume of 3,300 BCY is solidified using a transportable track-mounted boring/mixing unit and a batch plant capable of processing 600 BCY/day. Silica or another proprietary solidification agent is mixed with soil at a ratio of 0.2 tons of solidification agent per 1 ton of soil. The solidification agent is used in lieu of portland cement to address the organic contaminants and minimize odors and volatile emissions. Upon solidification, the soil swells approximately 10 to 25 percent due to incorporation of the mixing agent. Borrow soil from the on-post borrow area is recontoured over the solidified soil (900 SY). The uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses to improve the habitat quality of the site. The soil cover ensures integrity of the solidified soil and prevents freeze/thaw degradation of the materials. The soil may also be capped as part of the remediation of the South Plants Central Processing Area (Section 17.2). Groundwater compliance monitoring is performed to evaluate the potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 14.8-1 summarizes the evaluation of all the alternatives developed for this subgroup.

14.8.5.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through immobilization of contaminants. Solidification eliminates exposure pathways and reduces migration of contaminants to groundwater by rainwater infiltration. Fewer short-term risks due to odors and vapor emissions are associated with in situ treatment.

14.8.5.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources, monitoring of solidified soil, and endangered species. Location-specific ARARs are met as the pits are not located in wetlands or a 100-year flood plain. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

14.8.5.3 Long-Term Effectiveness and Permanence

The residual risks associated with this alternative are minimal. A total of 3,300 BCY of soil is solidified in place. There is high confidence in the immobilization of contaminants by solidification; however, monitoring of the soil is required. Revegetation of disturbed areas improves the existing habitat.

14.8.5.4 Reduction in TMV

Solidification interrupts exposure pathways and reduces the mobility of 3,300 BCY of contaminated soil. This mobility reduction is irreversible so long as the integrity of the solidified materials is maintained. There are no residuals associated with the solidification process, but the solidified soil requires monitoring.

14.8.5.5 Short-Term Effectiveness

This alternative entails moderate short-term risks associated with in situ treatment. Personal protective equipment adequately protects workers, and fugitive dust associated with excavation is controlled by water sprays. Any vapors/odors generated during treatment are collected in a hood and treated in the off-gas control system. The off-gas control system is designed to achieve air quality standards, although the emissions from the in situ solidification unit may contain low but acceptable levels of some contaminants. Solidification is feasible within 1 year, after 1 year for construction of the landfill.

14.8.5.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame. The alternative is administratively feasible since the regulations for in-place treatment are achieved. Volatile emissions and noxious odors are minimized by the use of specialized solidification agents and are controlled during treatment with a hood associated with the solidification unit. Personnel and equipment are available for groundwater compliance monitoring.

14.5.7.7 Cost

The total present worth cost is $888,000, including $622,000 and $266,000 for operating and long-term costs, respectively. Table B4.9-22 details the costing for this alternative. There are significant uncertainties associated with the costing of this alternative. Full-scale demonstrations of the in situ solidification technology at other hazardous waste sites are not available by which actual operating costs can be documented especially for proprietary solidification agents.

14.9 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Hex Pit Subgroup contains 3,300 BCY of trench materials from the disposal of residual hex bottoms from HCCPD production. The entire volume is considered a principal threat exceedance based on the presence of containerized waste and high levels of contamination (Table 14.7-1). Contaminants consist primarily of HCCPD. Potential migration pathways exist for contamination of groundwater. UXO and agent are not expected to occur at this site.

The Hex Pit site is currently overlain by structures, and areas of disturbed vegetation. Disturbed areas are revegetated following remediation, so no significant environmental impacts are anticipated. For alternatives involving containment with a cap/cover, the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat.

The risk associated with direct exposure to soil is moderate as the relatively high concentrations are not at the surface but are covered by structures; however, but there is potential for migration of contamination to groundwater. Excavation of the pits in this subgroup requires extensive health and safety measures due to the high concentrations and the heterogeneous nature of materials in the pits. Excavation is conducted under a vapor enclosure to control potential exposure of other on-site workers and the community to volatile emissions and noxious odors. These measures decrease worker productivity and increase the cost and difficulty of the excavation operations.

In summary, the Hex Pit Subgroup contains high levels of contamination. The decision to retain alternatives for this subgroup for consideration in the development of sitewide alternatives must weigh the short-term risks to workers and the community of excavation against the longer-term risks of contaminant migration if materials are left in place.

Alternative 1: No Additional Action does not achieve Human Health or Biota RAOs as untreated soil and debris remain on site if controls are not implemented. As a result, this alternative was eliminated from further consideration. The four remaining alternatives achieve RAOs and meet the two DAA threshold criteria: protection of human health and the environment and compliance with action- and location-specific ARARs for the DAA.

Alternative 14: Incineration/Pyrolysis; Landfill achieves RAOs through treatment of the contaminated materials. This alternative requires extensive worker health and safety measures and a vapor enclosure to manage the short-term impacts of excavating the disposal trenches, which can be reduced but not completely eliminated. Although incineration of the Hex Pit entails very high short-term impacts, which can be controlled, the long-term risks are minimal. Therefore, this alternative was retained for further consideration in the development of sitewide alternatives.

Alternative 3: Landfill achieves RAOs through containment and involves the same, but somewhat lower, short-term impacts as compared to incineration. This alternative was retained for further evaluation in the development of sitewide alternatives based on the minimal long-term risks associated with landfilling and the lower cost ($1,540,000) versus incineration ($3,680,000).

Alternative 5: Caps/Covers; Vertical Barriers achieves RAOs by interrupting exposure pathways and reducing groundwater contamination. EPA guidance on principal threats (OERR-EPA 1991) indicates that treatment alternatives for principal threats may not be appropriate for instances in which the implementation of the treatment-based alternative would result in a greater overall risk to human health and the environment due to the risks posed to site workers and the community during the remedial action. The installation of the low-permeability soil cap and slurry wall results in lower short-term risks to worker and the community, so this alternative was retained for further evaluation in the development of sitewide alternatives.

Alternative 22/A3: In Situ Solidification/Stabilization achieves RAOs through solidification resulting in a reduction in mobility and volume of contaminants. In situ solidification entails some short-term risks associated with the control of vapors and odors. However, specialized solidification agents are used instead of cement to minimize these risks.

Consequently, the alternatives that were retained to represent the Hex Pit Subgroup in the development of the sitewide alternatives (Section 20) are the following:

- Alternative 3: Landfill (On-Post Landfill)
- Alternative 5: Caps/Covers (Multilayer Cap); Vertical Barriers (Slurry Walls)
- Alternative 14: Incineration/Pyrolysis (Rotary Kiln); Landfill (On-Post Landfill) (or other innovative treatment process)

- Alternative 22/A3: In Situ Solidification/Stabilization (Cement-Based Solidification or Silica/Proprietary Agent-Based Solidification) (or ex situ solidification)

The selection of Alternative 14, Alternative 3, or Alternative 22/A3 necessitates the demolition of Building 571B and associated structures and the removal of the debris. As discussed in the Structures DAA, structural debris can be landfilled or used as gradefill prior to containment of these areas.

Table 14.0-1 Characteristics of the Disposal Trenches Medium Group

Characteristic	Complex Trenches Subgroup	Shell Trenches Subgroup	Hex Pit Subgroup
Contaminants of Concern			
Human Health	OCPs, DBCP, ICP metals, As, Hg	OCPs, DBCP, HCCPD	OCPs, HCCPD[2]
Biota	OCPs, DBCP, ICP metals, As, Hg	OCPs[1]	OCPs[1]
Exceedance Areas (SY)			
Total	390,000	32,000	900
Human Health	130,000	32,000	900
Biota	260,000	0	0
Potential Agent	390,000	0	0
Potential UXO	390,000	0	0
Exceedance Volume (BCY)			
Total	530,000	100,000	3,300
Human Health	450,000	100,000	3,300
Organic	450,000	100,000	3,300
Inorganic	440,000	0	3,300
Principal Threat	440,000	100,000	3,300
Biota	87,000	0	0
Potential Agent	1,300	0	0
Potential UXO	1,300	0	0
Depth of Contamination (ft)			
Human Health	0–14	0–10	0–10
Biota	0–1	0–1	0–1

1 Biota COCs are only present as overlap within human health exceedance areas.
2 Assumed contaminant of concern based on historical information.

Table 14.1-1 Summary of the Disposal Trench Materials for the Complex Trenches Subgroup

Trench Anomaly	Trench Anomaly Areas (SY)	Trench Depth Encountered (ft)	Trench Materials Encountered During RI Programs
A	28,000	10	Scrap metal including wire, steel straps, burned incendiary-device casings, incendiary bomb parts and devices, HN sampling tubes, steel rebar, 30- and 55-gallon drums, ceramic containers, and 1/4-inch-diameter metal cable at 0.5 ft.
B	15,000	14	35- and 55-gallon steel drums, fence posts, heavy piping, bomb casings, metal vats, baby bottles, metal debris, and small lab bottles.
C	25,000	10	Exploded bomb parts, 55-gallon steel drums, plastic igniter cups, piping with crusted white phosphorous residue, white phosphorous grenades, 55-gallon barrels, incendiaries, fuses, scrap iron, asbestos, scrap metal debris, rusted 55-gallon steel drums with dark-gray putty-like material that tested positive for Lewisite, reinforced concrete, metal bins, assembly-line rollers, barrels of 105-millimeter rounds, metal vats loaded with 500-pound bomb bursters, assembly-line roller tables, 55-gallon steel drums filled with bomb parts, 6,000-pound battery-powered forklift, metal vats with bomb bursters and scrap metal, and a 1-inch-diameter pipe. Excavation was backfilled when a large white phosphorous fire was started.
F	9,000	4	1/8-inch wire, burn residue, nose piece for mortar shell, and metal debris.
G	17,000	14	Trench materials assumed to be similar to other trench areas.
H	28,000	11	Metal rebar, bricks, concrete rubble, fibrous pipe insulation (asbestos), scrap metal, asphalt rubble, plastic caps, wire rebar, 55-gallon barrel lids, crystalline sulfur on surface of site, burned wood, charcoal, metal pipe, wire, cable, rubber hoses, black and gray sludge, wood, burned fuse casings, pipes, metal straps, bars, metal debris, amber and clear empty bottles, glass, clear glass vials, rock fragments, 4-inch-diameter metal pipes, scrap metal, full amber and clear glass bottles, light gray powdery material, full clear-glass vials, metal pipe, scrap metal, white phosphorous encountered at 9 ft, large broken concrete vats, burned incendiary device casings, firebricks, plastic, lumber, black tar-like substance, metal casing, pipe fragments, metal canister for flame throwers filled with black oily liquid, glass vials filled with clear liquid, lab bottles, burn material, positive test for mustard. Excavation was backfilled to extinguish white phosphorous fire.

Table 14.1-2 Summary of Concentrations for the Complex Trenches Subgroup

Contaminants of Concern	Range of Concentrations (ppm)	Average Concentration (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL–40	Not Available	71	720	3.8
Isodrin	BCRL–27	Not Available	41	410	3.7
Chlordane	BCRL–150	Not Available	55	3,700	12
DBCP	BCRL–6.7	Not Available	8	200	140
Chromium	BCRL–5,200	Not Available	750	7,500	2,400
Lead	BCRL–10,000	Not Available	2,200	Not Available	Not Available
Mercury	BCRL–860	Not Available	570	570	82
Arsenic	BCRL–4,500	Not Available	420	4,200	270
Biota Risk Volume					
Aldrin	BCRL–0.19	Not Available			
Dieldrin	BCRL–3	Not Available			
Endrin	BCRL–4.7	Not Available			
p,p,DDE	BCRL–2.9	Not Available			
p,p,DDT	BCRL–0.18	Not Available			
Arsenic	BCRL–98	Not Available			
Mercury	BCRL–70	Not Available			

Table 14.1-3 Frequency of Detections for Complex Trenches Subgroup

	Total Samples Analyzed	BCRL Number	BCRL %	CRL-SEC(1) Number	CRL-SEC(1) %	Acute-HH SEC(2) Number	Acute-HH SEC(2) %	HH SEC-Pr. Threat(2) Number	HH SEC-Pr. Threat(2) %	>Pr. Threat(2) Number	>Pr. Threat(2) %
Aldrin	352	336	95.5%	16	4.5%	0	0.0%	0	0.0%	0	0.0%
Benzene	80	80	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	80	80	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlordane	318	276	86.8%	33	10.4%	7	2.2%	2	0.6%	0	0.0%
Chloroacetic Acid	81	81	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlorobenzene	80	80	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chloroform	80	80	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
p,p,DDE	357	349	97.8%	8	2.2%	--	--	0	0.0%	0	0.0%
p,p,DDT	340	332	97.6%	8	2.4%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	379	371	97.9%	8	2.1%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	80	80	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	4	4	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	340	340	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dieldrin	338	289	85.5%	48	14.2%	1	0.3%	0	0.0%	0	0.0%
Endrin	353	328	92.9%	25	7.1%	0	0.0%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	318	315	99.1%	3	0.9%	--	--	0	0.0%	0	0.0%
Isodrin	349	345	98.9%	4	1.1%	--	--	0	0.0%	0	0.0%
Methylene Chloride	72	64	88.9%	8	11.1%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	2	2	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	80	79	98.8%	1	1.3%	--	--	0	0.0%	0	0.0%
Toluene	80	80	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Trichloroethylene	80	77	96.3%	3	3.8%	--	--	0	0.0%	0	0.0%
Arsenic	381	217	57.0%	156	40.9%	0	0.0%	4	1.0%	4	1.0%
Cadmium	308	269	87.3%	39	12.7%	0	0.0%	0	0.0%	0	0.0%
Chromium	308	54	17.5%	249	80.8%	--	--	5	1.6%	0	0.0%
Lead	308	209	67.9%	94	30.5%	--	--	5	1.6%	0	0.0%
Mercury	384	267	69.5%	113	29.4%	0	0.0%	4	1.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.

(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.

-- not applicable

Criteria	Alternative 1: No Additional Action	Alternative 5: Caps/Covers; Verical Barriers	Alternative 14: Incineration/ Pyrolysis; Landfill
1. Overall protection of human health and the environment	Not Protective: RAOs not achieved; impacts to groundwater not reduced	Protective: RAOs achieved and impacts to groundwater reduced through in-place containment and dewatering system	Protective: RAOs achieved and groundwater impacts reduced
2. Compliance with ARARs	Does not comply with Army regulations on agent and UXO	Complies with action-specific ARARs if not in wetlands or 100-year flood plain	Complies
3. Long-term effectiveness and permanence	High Residual Risk: High concentrations and potential agent/UXO remain	Minimal Residual Risk: Contaminated soil and debris contained in place	Minimal Residual Risk: Contaminated soil and debris excavated and incinerated or landfilled.
4. Reduction in TMV	Natural attenuation only for 540,000 BCY	Exposure pathways and mobility reduced for all 540,000 BCY through containment; residuals include groundwater from dewatering pumped to a treatment plant	TMV eliminated for 440,000 BCY incinerated; exposure pathways and mobility eliminated for 100,000 BCY landfilled; residuals include 4,400 BCY solids, which are landfilled, and groundwater from dewatering pumped to a treatment plant
5. Short-term effectiveness	No short-term risk to workers and community; no implementation required	Low short-term risk; intrusive action limited. RAOs achieved within 2 years.	Very high short-term risk during excavation, transport, and treatment of contaminated materials, UXO and agent, amplified by required vapor enclosure. RAOs Achieved in 6 years, 2 years for landfill vapor enclosures and incinerator construction.
6. Implementability	Feasible; No implementation required	Feasible	Difficult technical and administrative feasibility associated with incineration and vapor enclosure
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$3,420,000 Total—$3,420,000	Capital—$320,000 Operating—$33,200,000 Long-term—$3,340,000 Total—$36,900,000	Capital—$78,200,000 Operating—$184,000,000 Long-term—$290,000 Total—$263,000,000
Summary	Not Retained: Not protective of human health and the environment	Retained: Containment in place provides protection	Not Retained: Excessive short-term risk, low implementability and high cost for treatment without reducing residual risk compared to containment

Table 14.4- 1 Summary of Concentrations for the Shell Trenches Subgroup

Contaminants of Concern	Range of Concentrations (ppm)	Average Concentration (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL–1,000	Not Available	71	720	3.8
Dieldrin	BCRL–500	Not Available	41	410	3.7
Endrin	BCRL–400	Not Available	230	230	56
Isodrin	BCRL–1,000	Not Available	52	52,000	Not applicable
Chlordane	BCRL–70	Not Available	55	3,700	12
DBCP	BCRL–700	Not Available	8	200	140
HCCPD	BCRL–40,000	Not Available	1,100	Not available	13,000

Table 14.4-2 Frequency of Detections for Shell Trenches Subgroup

	Total Samples	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
	Analyzed	Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	95	57	60.0%	26	27.4%	1	1.1%	10	10.5%	1	1.1%
Benzene	55	43	78.2%	12	21.8%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	55	50	90.9%	5	9.1%	--	--	0	0.0%	0	0.0%
Chlordane	95	95	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Chloroacetic Acid	10	10	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlorobenzene	55	54	98.2%	1	1.8%	--	--	0	0.0%	0	0.0%
Chloroform	55	33	60.0%	22	40.0%	--	--	0	0.0%	0	0.0%
p,p,DDE	95	90	94.7%	5	5.3%	--	--	0	0.0%	0	0.0%
p,p,DDT	95	90	94.7%	5	5.3%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	107	81	75.7%	20	18.7%	--	--	6	5.6%	0	0.0%
1,2-Dichloroethane	55	54	98.2%	1	1.8%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	41	40	97.6%	1	2.4%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	107	94	87.9%	13	12.1%	--	--	0	0.0%	0	0.0%
Dieldrin	95	35	36.8%	45	47.4%	7	7.4%	8	8.4%	0	0.0%
Endrin	95	43	45.3%	47	49.5%	0	0.0%	5	5.3%	0	0.0%
Hexachlorocyclopentadiene	95	72	75.8%	16	16.8%	--	--	7	7.4%	0	0.0%
Isodrin	95	61	64.2%	26	27.4%	--	--	8	8.4%	0	0.0%
Methylene Chloride	55	39	70.9%	16	29.1%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	55	36	65.5%	19	34.5%	--	--	0	0.0%	0	0.0%
Toluene	55	31	56.4%	24	43.6%	--	--	0	0.0%	0	0.0%
Trichloroethylene	55	48	87.3%	7	12.7%	--	--	0	0.0%	0	0.0%
Arsenic	19	11	57.9%	8	42.1%	0	0.0%	0	0.0%	0	0.0%
Cadmium	16	9	56.3%	7	43.8%	0	0.0%	0	0.0%	0	0.0%
Chromium	16	3	18.8%	13	81.3%	--	--	0	0.0%	0	0.0%
Lead	16	8	50.0%	8	50.0%	--	--	0	0.0%	0	0.0%
Mercury	76	55	72.4%	21	27.6%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.

(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.

-- not applicable

Table 14.5-1 Comparative Analysis of Alternatives for the Shell Trenches Subgroup

Criteria	Alternative 1: No Additional Action	Alternative 3: Landfill	Alternative 5a: Caps/Covers; Vertical Barriers with Modifications to Existing System	Alternative 14: Incineration/ Pyrolysis; Landfill
1. Overall protection of human health and the environment	Not Protective: Human Health RAOs achieved through existing cover; Biota RAOs not achieved; impacts to groundwater not reduced beyond existing IRA	Protective: Achieves RAOs and greatly reduces impacts to groundwater through containment	Protective: RAOs achieved and impacts to groundwater reduced through containment in place	Protective: RAOs achieved and groundwater impacts reduced
2. Compliance with ARARs	Complies	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Low Residual Risk: High concentrations remain, but are contained by existing cover	Minimal Residual Risk: 100,000 BCY removed and contained	Low Residual Risk: Contaminated soil and debris contained in place	Minimal Residual Risk: Contaminated materials excavated, incinerated, and landfilled.
4. Reduction in TMV	Mobility reduction through existing cover for 100,000 BCY	Exposure pathways eliminated and mobility reduced for all 100,000 BCY through containment; residuals include groundwater from dewatering pumped to a treatment plant	Exposure pathways and mobility reduced for all 100,000 BCY through in-place containment; residuals include groundwater from dewatering pumped to a treatment plant	TMV eliminated for 100,000 BCY incinerated; residuals include 1,000 BCY solids, which are landfilled, and groundwater from dewatering pumped to a treatment plant
5. Short-term effectiveness	No short-term risk; No implementation required	High short-term risks during excavation, materials handling, stabilization, transportation, and landfilling; amplified by required vapor enclosure. RAOs achieved in 2 years.	Low short-term risk; intrusive action limited. RAOs achieved in 1 year.	Very high short-term risk during excavation, transport, and treatment, amplified by required vapor enclosure. RAOs achieved within 3 years.
6. Implementability	Feasible; No implementation required	Moderate technical feasibility due to high concentrations and need for vapor enclosure	Feasible	Technical and administrative difficulty associated with incineration and vapor enclosure
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$479,000 Total—$479,000	Capital—$3,050,000 Operating—$44,000,000 Long-term—$70,000 Total—$47,100,000	Capital—$212,000 Operating—$1,940,000 Long-term—$1,230,000 Total—$3,390,000	Capital—$18,900,000 Operating—$56,000,000 Long-term—$66,000 Total—$75,000,000
Summary	Not Retained: Not protective of the environment	Retained: Containment provides protection although high short-term risks	Retained: Containment in place provides protection with lower short-term risks	Retained: Treatment provides protection although high short-term risks

Table 14.7-1 Summary of Concentrations for the Hex Pit Subgroup

Contaminants of Concern	Range of Concentrations (ppm)	Average Concentration (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL–1,000	Not Available	71	720	3.8
Dieldrin	BCRL–500	Not Available	41	410	3.7
Endrin	BCRL–400	Not Available	230	230	56
Isodrin	BCRL–1,000	Not Available	52	52,000	Not applicable
Chlordane	BCRL–70	Not Available	55	3,700	12
HCCPD	BCRL–40,000	Not Available	1,100	Not available	13,000

Table 14.7-2 Frequency of Detections for Hex Pit Subgroup

	Total Samples Analyzed	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
		Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	1	0	0.0%	1	100.0%	0	0.0%	0	0.0%	0	0.0%
Chlordane	1	1	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
p,p,DDE	1	1	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
p,p,DDT	1	1	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	2	2	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	1	1	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dieldrin	1	0	0.0%	0	0.0%	1	100.0%	0	0.0%	0	0.0%
Endrin	1	0	0.0%	1	100.0%	0	0.0%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	1	0	0.0%	1	100.0%	--	--	0	0.0%	0	0.0%
Isodrin	1	0	0.0%	1	100.0%	--	--	0	0.0%	0	0.0%
Arsenic	1	1	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Cadmium	1	1	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Chromium	1	1	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Lead	1	0	0.0%	1	100.0%	--	--	0	0.0%	0	0.0%
Mercury	1	0	0.0%	1	100.0%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.

(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.

-- not applicable

Criteria	Alternative 1: No Additional Action	Alternative 3: Landfill	Alternative 5: Caps/Covers; Vertical Barriers	Alternative 14: Incineration/ Pyrolysis; Landfill	Alternative 22/A3: In Situ Solidification/Stabilization
1. Overall protection of human health and the environment	Not protective: RAOs not achieved; impacts to groundwater not reduced	Protective: Achieves RAOs and greatly reduces impacts to groundwater through containment	Protective: RAOs achieved and impacts to groundwater reduced through in-place containment and dewatering system	Protective: RAOs achieved and groundwater impacts reduced	Protective: RAOs achieved through treatment and containment; impacts to groundwater reduced
2. Compliance with ARARs	Complies	Complies	Complies	Complies	Complies
3. Long-term effectiveness and permanence	High Residual Risk: High concentrations that exceed principal threat criteria remain	Minimal Residual Risk: 3,300 BCY removed and contained	Low Residual Risk: Contaminated soil contained in place	Minimal Residual Risk: PRGs achieved at the site through treatment	Low Residual Risk: PRGs achieved through solidification
4. Reduction in TMV	Natural attenuation only for 3,300 BCY	Exposure pathways eliminated and mobility reduced for all 3,300 BCY through containment	Exposure pathways and mobility reduced for all 3,300 BCY through in-place containment	TMV eliminated for 3,300 BCY incinerated; residuals include 33 BCY of solids, which are landfilled	Mobility reduced for solidified soil (3,300 BCY)
5. Short-term effectiveness	No implementation required	High short-term risks during excavation, materials handling, stabilization, transportation, and landfilling, amplified by required vapor enclosure; RAOs achieved within 2 years	Low short-term risk; intrusive action limited; RAOs achieved within 1 year	Very high short-term risk during excavation, transport, and treatment, amplified by required vapor enclosure; RAOs achieved within 3 years	Moderate short-term risks during in situ treatment; RAOs achieved within 2 years
6. Implementability	No implementation required; Feasible	Moderate technical feasibility due to high concentrations and need for vapor enclosure; Admistratively feasible	Feasible	Technical and administrative difficulty associated with incineration and vapor enclosure	Feasible
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$272,000 Total—$272,000	Capital—$1,500,000 Operating—$33,000 Long-term—$2,000 Total—$1,540,000	Capital—$167,000 Operating—$181,000 Long-term—$274,000 Total—$622,000	Capital—$1,960,000 Operating—$1,720,000 Long-term—$2,000 Total—$3,680,000	Capital—$0 Operating—$622,000 Long-Term—$266,000 Total—$888,000
Summary	Not Retained: Not protective of human health and the environment	Retained: Containment provides protection	Retained: Containment in place provides protection	Retained: Treatment provides protection	Retained: Treatment provides protection

ROCKY MOUNTAIN ARSENAL
INDEX MAP

LEGEND

Complex Disposal Trenches Subgroup
SITE: CSA-1c, Complex Disposal Area North

Shell Trenches Subgroup
SITE: CSA-1a, Pesticide Pits

Hex Pit Subgroup
SITE: SPSA-1f, Buried Hex Pit

Site Boundary

Buildings and Roads

36 Section Number

300 0 300 600 FEET

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 14.0-1

Site Locations
Disposal Trenches Medium Group

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

CHECKED BY | APPROVED BY | DRAWN BY EMH | DATE 3/2/93 | FILE NAME 20110\32\F03-023.DWG | REVISION NO. 2

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 14.1-1

Exceedance Areas
Complex Trenches Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

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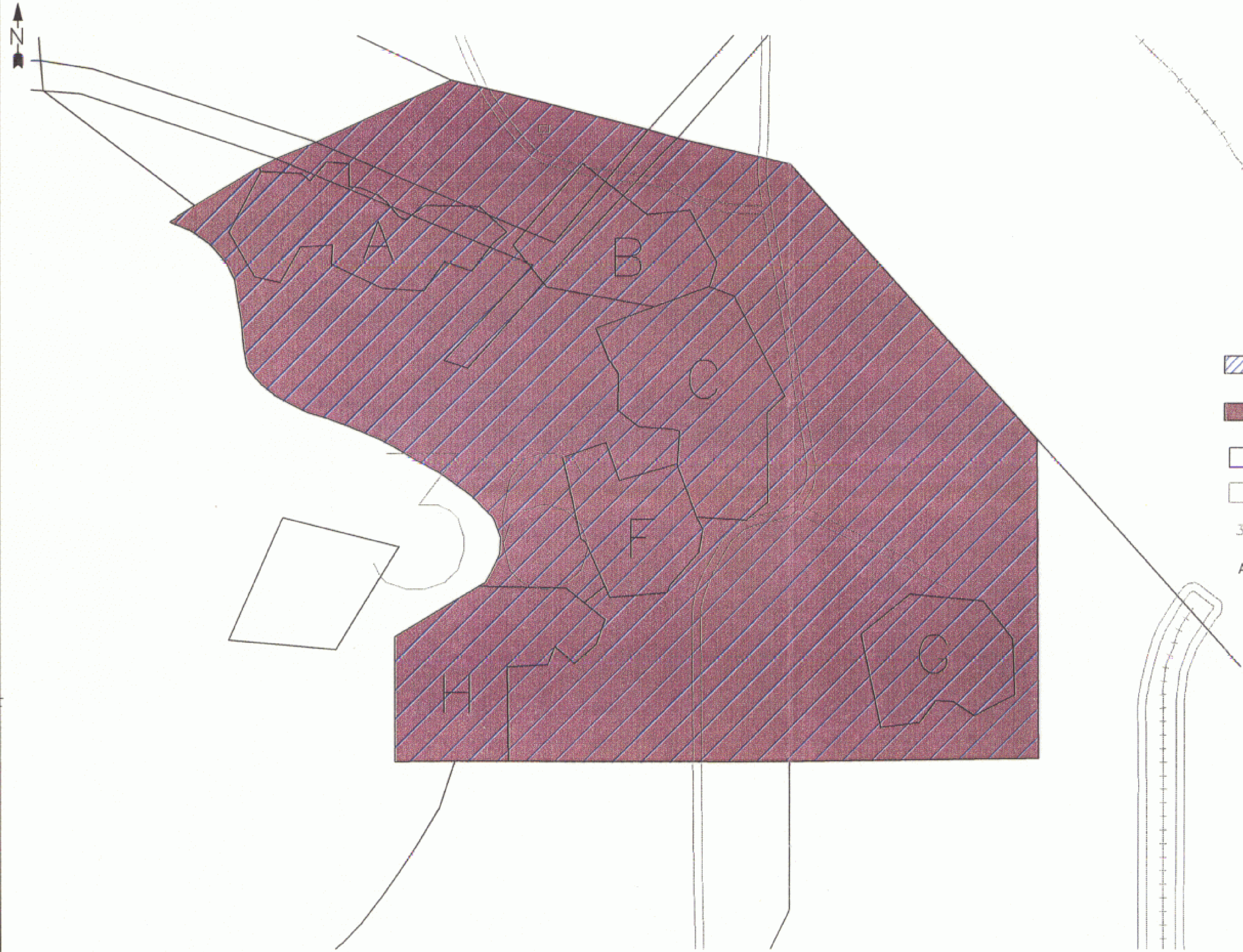


ROCKY MOUNTAIN ARSENAL
INDEX MAP

LEGEND

- Human Health Exceedance Area and Potential Biota Risk Area
- Potential Agent and UXO Presence Area
- Site Boundary
- Buildings and Roads
- 36 Section Number
- A Anomaly Area

150 0 150 300 FEET

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 14.1-2

Potential Agent/UXO Presence Areas
Complex Trenches Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

15.0 DETAILED ANALYSIS OF ALTERNATIVES FOR THE SANITARY LANDFILLS MEDIUM GROUP

The Sanitary Landfills Medium Group consists of eight sites that include sanitary landfills and landfill trenches located in various areas at RMA (Figure 15.0-1). These sites primarily contain trash and rubbish, and differ from sites within the Disposal Trenches Medium Group by the absence of containerized wastes (drums), agent, and UXO.

The primary Human Health COCs and contaminants potentially posing risk to biota in this medium group include OCPs and ICP metals; no principal threat areas were identified in this medium group. Portions of the medium group contain mercury at levels that may pose potential risk to biota, but that are not above the Human Health SEC (EBASCO 1994a). Sites within this medium group are also potential sources of groundwater contamination as identified in the RISR (EBASCO 1992a). Table 15.0-1 presents the characteristics of the Sanitary Landfills Medium Group, including exceedance volumes and COCs, and Appendix A presents a summary of the calculation of exceedance volumes and areas for this medium group.

In the DSA (EBASCO 1992b), alternatives were developed and screened based on the general characteristics of the medium group. In the DAA, individual subgroups were not developed for these eight sites, so the retained alternatives apply to the Sanitary Landfills Medium Group as a whole. The characteristics of the medium group—including contaminant types and contaminant concentrations, site configuration, and depth of contamination—were reviewed to determine whether any modifications to the alternatives retained from the DSA (EBASCO 1992b) for the medium group would be appropriate. The alternatives for this medium group were only changed in that a new alternative was developed to consolidate a portion of the materials in Basin A prior to capping the basin and landfilling the remaining materials.

The following sections present the characteristics of the medium group, an evaluation of the retained alternatives against the DAA criteria listed in the NCP (EPA 1990a), and the selection of alternatives, based on a comparative analysis, that was considered when the sitewide alternatives were developed (Section 20).

15.1 MEDIUM GROUP CHARACTERISTICS

The Sanitary Landfills Medium Group consists of sites CSA-1d (Sanitary Landfill and Incinerator 834), ESA-2b (Sanitary Landfill), SSA-4 (Trash Dump), WSA-2 (West Landfill), WSA-3c (Surface Disposal Area), WSA-5a (Inferred Trench), WSA-5c (Inferred Trench), and WSA-5d (Trenches) (Figure 15.0-1). These sites include the contaminated soil surrounding the landfills. The soil and debris contained within the landfills consists of rubbish, construction debris, wood, paper, asbestos, and metal piping. The contamination patterns within the landfill materials are heterogeneous as various materials were disposed in the same landfill trench. Most of the landfills are not surrounded by areas posing potential risk to biota (Figure 15.1-1). The soil posing potential risk to biota comprises a small portion (5.5%) of the total exceedance volume (Table 15.0-1).

Table 15.1-1 provides a summary of contaminants, exceedance volume concentrations, and the corresponding exceedance values for this medium group. Table 15.1-2 summarizes the frequency of detections for samples taken at sites in this medium group. The maximum concentrations of OCPs and ICP metals exceed the Human Health SEC (EBASCO 1994a), and the average concentrations of isodrin, cadmium, and chromium also exceed the Human Health SEC (EBASCO 1994a). Less than 5 percent of the analytical results exceeded Human Health SEC (EBASCO 1994a) for any given analyte (Table 15.1-2). The Human Health COCs were detected at depths ranging from the ground surface to approximately 8 ft below ground surface with a total volume of 14,000 BCY. Soil posing potential risk to biota was found in 23,000 BCY of shallow soil (0- to 1-ft depth interval) surrounding the landfills. Refuse consisting of debris and soil occurs to an average of 8 ft below ground surface with a total volume of 383,000 BCY (Table 15.0-1).

Sites within the Sanitary Landfills Medium Group contain a variety of habitat ranging from weedy forbs to native grasses. Under most of the alternatives developed for this medium group, the areas disturbed during remedial actions are revegetated with native grasses in accordance with a refuge management plan, which generally improves the overall habitat, thereby offsetting the short-term loss of habitat resulting from remedial actions. The institutional controls alternative includes provisions for modifying the habitat by seeding lower-quality grasses to reduce the desirability of the area as habitat for biota. In this instance, the habitat quality is lowered and the available habitat at RMA is reduced by 190,000 SY. A small area in site CSA-1d has a unique habitat of native grasses, but this is located outside of the landfill trench area. In addition, several of the sites are located within the Bald Eagle Management Area. Therefore, the evaluation of alternatives for this medium group must consider the impacts of alternatives on the habitat within these sites.

The sites in the Sanitary Landfills Medium Group have been identified as historical sources of groundwater contamination. In addition, site WSA-2 has been identified as a potential source for a groundwater plume in the unconfined aquifer in the western tier of RMA. As discussed in the Water DSA (EBASCO 1992b), the concentrations of VOCs in the groundwater are slightly higher downgradient from the site. However, the generally low levels of contamination within the plume and the likelihood that they originate elsewhere do not warrant the evaluation of groundwater alternatives related to this specific site. The plume is intercepted and treated by the Irondale Containment System.

15.2 EVALUATION OF ALTERNATIVES

The alternatives for the Sanitary Landfills Medium Group include no action, containment, and treatment approaches. One of the alternatives retained from the DSA (EBASCO 1992b) for this medium group was renamed to indicate clearly that treated soil and debris are placed in a landfill following thermal desorption (Alternative 13b versus Alternative 13). Containment in place was modified to remove the installation of vertical barriers based on the low levels of contamination in the groundwater plume that may be associated with site WSA-2. A new alternative (Alternative 3f) was developed to consist of landfilling human health exceedances and consolidating refuse and soil posing risk to biota into Basin A prior to capping the basin. The following subsections present a description of each alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a). The alternatives for this medium group consist of a component to address the human health exceedances, which is listed first, and a component to address areas potentially posing risk to biota outside the landfill trenches (the "B" alternative).

15.2.1 Alternative 1/B1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA), along with Alternative B1: No Additional Action (Provisions of FFA), applies to all 190,000 SY (420,000 BCY) of area with human health exceedances and refuse and soil that potentially poses risk to biota in the Sanitary Landfills Medium Group. All soil and refuse remains in place, and no actions are taken to reduce potential human or biota exposure to COCs or to reduce the limited potential for groundwater contamination from this group. The area is monitored (23 samples per year), annual groundwater samples are collected around each site, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 15.2-1 summarizes the evaluation of all the alternatives developed for this medium group.

15.2.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve human health or biota RAOs. Potential groundwater impacts are not reduced and the only long-term reduction in toxicity of contaminants is through natural attenuation/degradation.

15.2.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the subgroup is not located in wetlands or a 100-year flood plain. In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

15.2.1.3 Long-Term Effectiveness and Permanence

There is a low residual risk associated with this alternative since low levels of OCPs and ICP metals exceeding Human Health SEC (EBASCO 1994a) remain in the soil and soil potentially posing risk to biota remains in place. No controls are implemented, although site reviews and long-term soil and groundwater monitoring are performed. The existing habitat is not impacted by this alternative.

15.2.1.4 Reduction in TMV

There is no reduction in TMV except by natural attenuation since no materials are treated or contained. A total of 420,000 BCY of untreated soil and refuse remain in place. There are no treatment residuals associated with this alternative.

15.2.1.5 Short-Term Effectiveness

RAOs are not achieved for more than 30 years because natural attenuation/degradation is the only process by which contamination can be reduced. The alternative does not pose risk to workers or the community since no actions are taken. No measures are taken to address continued migration of contaminants to the groundwater. The existing habitat is not affected since no action is taken.

15.2.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are available to sample soil and groundwater.

15.2.1.7 Cost

The total present worth cost is $1,920,000 and includes only long-term O&M costs associated with long-term monitoring and site reviews. Table B4.10-1 details the costing for this alternative. The cost uncertainty associated with monitoring and site reviews is low.

15.2.2 Alternative 2/B2: Access Restrictions

Alternative 2: Access Restrictions (Modifications to FFA), along with Alternative B2: Biota Management (Exclusion, Habitat Modification), applies to the total exceedance area of 190,000 SY in the Sanitary Landfills Medium Group. The human health exceedance volume, refuse, and soil that may pose potential risk to biota (420,000 BCY) remain in place, but exposure pathways are interrupted. Human and biota access to the sites is restricted by the installation of a 17,000-ft-long chain-link fence around the perimeter. Signs prohibiting access to the sites are posted along the fence, and the importance of maintaining and respecting access restrictions to prevent exposure is presented in an ongoing public education program. In addition, biota exclusion is promoted by revegetating potential biota risk areas with grasses that are unappealing to biota. Revegetation of the 190,000-SY area is accomplished over a 3-year period. Long-term activities include maintaining fences, mowing and maintaining revegetated areas, and monitoring for damage caused by erosion. No actions are taken to reduce the potential for groundwater contamination from sites in this group. Exceedance areas are monitored (23 samples per year), annual groundwater samples are collected, and 5-year site reviews are conducted to review the effectiveness of the alternative and to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 15.2-1 summarizes the evaluation of all the alternatives developed for this medium group.

15.2.2.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs since human and biota exposure pathways are interrupted through access restrictions and biota controls. Potential groundwater impacts are not reduced, and short-term risks are low.

15.2.2.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs since site reviews are conducted and the sites are not located in wetlands or a 100-year flood plain. In addition, the alternative complies with provisions of the FFA (EPA et al. 1989), and does not impact endangered species. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

15.2.2.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low. Low levels of ICP metals and OCPs exceeding Human Health SEC (EBASCO 1994a) remain in the soil, thereby potentially posing risk to biota. Human exposure is reduced through installation of fencing and land-use restrictions, while biota exposure is reduced by fencing and modifications to the habitat. Impacts to groundwater are not reduced. Long-term maintenance, site reviews, wildlife-exclusion monitoring, and groundwater monitoring are required. The existing habitat is eliminated by cultivation and fencing.

15.2.2.4 Reduction in TMV

There is no reduction in TMV except by natural attenuation/degradation. By implementing land-use restrictions, biota controls, and fencing, human and biota exposure pathways are interrupted over 190,000 SY. These exposure controls are reversible should these methods fail. There are no treatment residuals associated with this alternative.

15.2.2.5 Short-Term Effectiveness

The alternative is protective of workers and the community during the remedial action. Workers are adequately protected by personal protective equipment during fence installation and cultivation, and dust and vapor emissions that could affect the surrounding community are not anticipated. There are minimal short-term risks to workers and minimal environmental impacts; however, migration of contaminants to groundwater is not reduced. RAOs can be achieved within 3 years given the ongoing natural attenuation/degradation of the contaminants in soil.

15.2.2.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil left in place. The alternative is administratively feasible and materials, specialists, and equipment are readily available for fence installation habitat modification, and groundwater compliance monitoring.

15.2.2.7 Cost

The total present worth cost is $2,820,000 including $578,000, $85,000, and $2,160,000 for capital, operating, and long-term costs, respectively. Table B4.10-2 details the costing for this alternative. The cost uncertainty associated with this alternative is low because the areal extent of the landfills requiring access restrictions is well defined.

15.2.3 Alternative 3/B3: Landfill (On-Post Landfill)

Alternative 3: Landfill (On-Post Landfill), combined with Alternative B3: Landfill (On-Post Landfill), involves containing 14,000 BCY of human health exceedance volume, 383,000 BCY of refuse, and 23,000 BCY of soil that may pose potential risk to biota. The contaminated soil and debris are excavated and placed in a centralized on-post hazardous waste landfill as described in Section 4.6.6. The landfill is a multiple-cell facility requiring 1 year for construction of the first cell and associated facilities. A final cover, placed over the landfill upon closure, is vegetated to limit erosion and facilitate surface-water runoff. A leachate collection and treatment system is constructed to ensure there is no migration of leachate into the groundwater, and a fence is installed at the landfill to exclude biota. Since 420,000 BCY of untreated soil and debris are contained in the landfill, the landfill cell requires long-term monitoring and maintenance, which includes cover maintenance and leachate collection.

The site excavations are backfilled with borrow soil from the on-post borrow area. The uppermost 6 inches of soil are supplemented with conditioners, and the area is revegetated with native grasses to improve the habitat at the site. The borrow area is also recontoured and revegetated to restore habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 15.2-1 summarizes the evaluation of all the alternatives developed for this medium group.

15.2.3.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through containment in an on-post landfill. Potential human and biota exposures and groundwater impacts are greatly reduced at the sites, although the excavation of contaminated soil and debris creates some short-term impacts.

15.2.3.2 Compliance with ARARs

This alternative complies with action specific ARARs including state regulations on landfill siting, design, and operation and impacts to endangered species. The Sanitary Landfill Medium Group and the landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

15.2.3.3 Long-Term Effectiveness and Permanence

The residual risk for the sites in this medium group is minimal since 420,000 BCY of untreated soil and refuse are excavated and contained in the on-post landfill. There is high confidence in the engineering controls for the landfill and there are no expected difficulties associated with maintenance. Landfill-cell monitoring is required. Habitat at the sites is improved by revegetation; however, habitat at the landfill is eliminated.

15.2.3.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants is reduced through containment in the landfill, although no materials are treated. Reduction of mobility is only reversible should the landfill should fail. There are no treatment residuals associated with this alternative.

15.2.3.5 Short-Term Effectiveness

This alternative entails short-term risks associated with excavation, transportation, and landfilling of contaminated soil. These risks are addressed through personal protective equipment and dust controls such as water sprays. Vapor emissions are not anticipated. The existing habitat at the sites is improved by revegetation. Potential migration of the contaminants to the groundwater is greatly reduced. The time frame until RAOs are achieved is 3 years. Excavation of the 420,000 BCY is feasible within 2 years after 1 year for construction of the landfill.

15.2.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter with periodic landfill-cell monitoring. Additional remedial actions require removal of the landfill cover. The alternative is administratively feasible since the substantive requirements associated with landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill, and landfill technology has been well demonstrated at full scale.

15.2.3.7 Cost

The total present worth cost is $27,400,000 including $10,800,000, $16,200,000, and $293,000 for capital, operating, and long-term costs, respectively. Table B4.10-3 details the costing for this alternative. The excavation of contaminated soil and refuse entails a cost uncertainty relative to identifying the extent and depth of contamination; however, the magnitude of this uncertainty is small based on the adequate definition of the areal extent of the landfills.

15.2.4 Alternative 3f: Landfill (On-Post Landfill); Caps/Covers with Consolidation

Alternative 3f: Landfill (On-Post Landfill); Caps/Covers with Consolidation consists of excavating 420,000 BCY of soil with human health exceedance volume, refuse, and soil that may pose a potential risk to biota for landfilling or consolidation. This alternative includes the excavation and disposal of the 14,000 BCY human health exceedance soil in a centralized on-post hazardous waste landfill as described in Section 15.2.3. The 23,000 BCY of soil posing risk to biota and the 383,000 BCY of refuse including both soil and debris will be consolidated at Basin A prior to capping the basin.

A final cover, placed over the landfill upon closure, is vegetated to limit erosion and facilitate surface-water runoff. A leachate collection and treatment system is constructed to ensure there is no migration of leachate into the groundwater, and a fence is installed at the landfill to exclude biota. The landfill, the landfill cell requires long-term monitoring and maintenance, which includes cover maintenance and leachate collection.

The site excavations are backfilled with borrow soil from the on-post borrow area. The uppermost 6 inches of soil are supplemented with conditioners, and the area is revegetated with native grasses to improve the habitat at the site. The borrow area is also recontoured and revegetated to restore habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 15.2-1 summarizes the evaluation of all the alternatives developed for this medium group.

15.2.4.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through containment or consolidation in an on-post landfill and Basin A. Human and biota exposures and groundwater impacts are greatly reduced at the sites, although the excavation of contaminated soil and debris creates some short-term impacts.

15.2.4.2 Compliance with ARARs

This alternative complies with action specific ARARs including state regulations on landfill siting, design, and operation and impacts to endangered species. The Sanitary Landfill Medium Group, Basin A, and the landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Consolidation to Basin A does not trigger LDRs since the sites in this medium group are either located within the on-post AOC (as defined in Section 1.4), or they do not contain hazardous waste (based on historical records and TCLP results). Materials within the consolidation volume may be landfilled based on visual observations such as soil stains, barrels, or newly-discovered evidence of contamination; this landfill volume will be part of the 150,000 CY contingent volume. This alternative complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

15.2.4.3 Long-Term Effectiveness and Permanence

The residual risk for the sites in this medium group is minimal since 14,000 BCY of untreated human health exceedance soil and refuse are excavated and contained in the on-post hazardous waste landfill, and the 23,000 BCY of soil posing risk to biota and 383,000 BCY of refuse are excavated and placed in Basin A which is then capped. There is high confidence in the engineering controls for the landfills and cap/cover for Basin A there are no expected difficulties associated with maintenance. Landfill-cell monitoring is required. Habitat at the sites is improved by revegetation; however, habitat is eliminated at the landfill.

15.2.4.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants is reduced through containment or consolidation in the landfill and Basin A, although no materials are treated. Reduction of mobility is only reversible should the landfill or Basin A cap fail. There are no treatment residuals associated with this alternative.

15.2.4.5 Short-Term Effectiveness

This alternative entails short-term risks associated with excavation, transportation, and landfilling or consolidation of contaminated soil and refuse. These risks are addressed through personal protective equipment and dust controls such as water sprays. Vapor emissions are not anticipated. The existing habitat at the sites is improved by revegetation. Migration of the contaminants to the groundwater is greatly reduced. The time frame until RAOs are achieved is 3 years. Excavation of the 420,000 BCY total volume is feasible within 2 years after 1 year for construction of the landfill.

15.2.4.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter with periodic landfill-cell and Basin A monitoring. Additional remedial actions require removal of the landfill or Basin A cover. The alternative is administratively feasible since the substantive requirements associated with landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill and cap over Basin A, and landfill and capping technology has been well demonstrated at full scale.

15.2.4.7 Cost

The total present worth cost is $12,300,000 including $362,000, $12,000,000, and $9,000 for capital, operating, and long-term costs, respectively. Table B4.10-3f details the costing for this alternative. The excavation of contaminated soil and refuse entails a cost uncertainty relative to identifying the extent and depth of contamination; however, the magnitude of this uncertainty is small based on the adequate definition of the areal extent of the landfills.

15.2.5 Alternative 6/B5: Caps/Covers (Multilayer Cap)

Alternative 6: Caps/Covers (Multilayer Cap), along with Alternative B5: Caps/Covers (Multilayer Cap), includes containment of the 420,000 BCY of debris and soil with human health exceedances and potential risk to biota with a total of 190,000 SY of multilayer caps. The subgrade is compacted before any cover materials are installed, and the surface is graded to enhance surface-water drainage. Approximately 390,000 BCY of borrow material are needed to bring the sites to design grade. The sanitary landfills are then covered by a 2-ft-thick layer of low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and 4-ft-thick layer of common fill. The uppermost 6 inches of soil are supplemented with soil conditioners and revegetated. Most of the fill material for the caps is excavated from the on-post borrow area.

The borrow area is recontoured and revegetated. Habitat at the sites is improved through revegetation, although the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the site as habitat. Long-term maintenance activities are conducted to ensure the continued integrity of the soil cover and repair any damage to the caps from erosion. Five-year site reviews are conducted to review the effectiveness of the alternative. Annual groundwater monitoring will be performed to evaluate the potential for contaminant migration.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 15.2-1 summarizes the evaluation of all the alternatives developed for this medium group.

15.2.5.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs. Human and biota exposure pathways are interrupted by the installation of multilayer caps. Groundwater impacts are also reduced, and low short-term risks are associated with capping.

15.2.5.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of the contained material. Location-specific ARARs are met as the sites are not located in wetlands or a 100-year flood plain. In addition, the alternative complies with provisions of the FFA (EPA et al. 1989) and does not impact endangered species. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

15.2.5.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is minimal since all 420,000 BCY of untreated soil and refuse are contained within the multilayer caps. Impact to groundwater is reduced. Long-term groundwater monitoring and site reviews are required for the untreated soil, erosion controls must be monitored, and the vegetated covers require maintenance. There is high confidence in the engineering controls for the caps. Habitat quality is improved through revegetation of disturbed areas, although the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the sites as habitat.

15.2.5.4 Reduction in TMV

The installation of the multilayer caps interrupts exposure pathways and reduces the mobility of contaminants. Reduction of the mobility of contaminants is reversible should the caps leak or fail. There are no treatment residuals associated with this alternative.

15.2.5.5 Short-Term Effectiveness

This alternative entails low short-term risks as no intrusive activities are conducted. Dust controls are adequate for addressing uncontaminated fugitive dusts from cap construction and vapor/odor emissions are not anticipated. In addition, workers are protected from potential physical and chemical hazards by personal protective equipment. Environmental impacts are minimal; however, the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the sites as habitat, and the disturbance of borrow areas is required for gradefill and capping materials. RAOs can be achieved through installation of the caps, and installation is feasible within 2 years. Natural attenuation/degradation is ongoing.

15.2.5.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil left in place, although the caps add to the overall site volume. The alternative is administratively feasible and achieves the substantive requirements of Subtitle C for cap/cover design and construction. Materials, specialists, and equipment are readily available for construction, and multilayer caps have been well demonstrated at full scale.

15.2.5.7 Cost

The total present worth cost is $13,100,000, including $11,600,000 and $1,450,000 for operating and long-term costs, respectively. Table B4.10-6 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the caps are available on post and the areas to be capped are well defined (i.e., the uncertainty commonly associated with excavation does not exist).

15.2.6 Alternative 13b/B3: Direct Thermal Desorption; Landfill

Alternative 13b: Direct Thermal Desorption (Direct Heating); Landfill (On-Post Landfill), paired with Alternative B3: Landfill (On-Post Landfill), involves treating 14,000 BCY of soil with human health organic exceedances by thermal desorption. The treated human health organic exceedances are then landfilled along with the 23,000 BCY of soil outside the trenches that may pose potential risk to biota and the 383,000 BCY of refuse. The human health exceedance portions of the landfills are excavated and the debris is separated. The oversize debris is landfilled without treatment, and the remaining debris and soil with organics exceeding Human Health SEC (EBASCO 1994a) are thermally desorbed. The thermal desorber requires 1 year for construction and an additional year for testing. For dry soil, the thermal desorber has a processing rate of approximately 2,000 BCY/day and operates with a soil discharge temperature of 300°C and a soil residence time of 30 minutes. Section 4.6.24 discusses emission controls for off gases from thermal desorption. One percent (140 BCY) of the soil feed from the scrubber blowdown is placed in a centralized on-post landfill along with the soil and debris.

The 14,000 BCY of thermally desorbed human health exceedance sanitary landfill materials are landfilled following treatment because there are elevated levels of metals in the treated materials and because the materials are too large to be solidified. The remaining soil that may pose potential risk to biota (23,000 BCY) and 383,000 BCY of refuse are also contained in the landfill. The landfill is a multiple-cell facility requiring 1 year for construction of the first cell and associated facilities. Section 4.6.6 presents a discussion of the construction of the on-post landfill. A fence is constructed around the perimeter of the landfill facility to exclude biota, and a biota barrier is placed in the cover for protection against burrowing animals. A leachate collection system is placed in the liner of the facility to collect leachate generated for treatment. Long-term maintenance of the cover and monitoring of the leachate is required.

The 420,000 BCY of borrow material are excavated from the on-post borrow area and placed in the excavated areas at each site. The uppermost 6 inches of soil are conditioned and the site revegetated with native grasses to improve the habitat quality. The borrow area is also recontoured and revegetated to restore the habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 15.2-1 summarizes the evaluation of all the alternatives developed for this medium group.

15.2.6.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment and containment of contaminated soil and debris. The human health exceedance soil is treated through thermal desorption and placed in an on-post landfill along with the refuse and soil potentially posing risk to biota. The potential for migration of contaminants to groundwater is greatly reduced through treatment and containment, but the excavation and treatment of the contaminated soil and debris entails short-term risks.

15.2.6.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources, landfill siting, design, and operation. Endangered species are not impacted. Location-specific ARARs are met since the Sanitary Landfills Medium Group, treatment facilities, and the landfill are not located in wetlands or a 100-year flood plain. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

15.2.6.3 Long-Term Effectiveness and Permanence

The 14,000 BCY of soil are treated, thereby achieving PRGs. The treated soil, 383,000 BCY of untreated soil potentially posing risk to biota, and approximately 1 percent of the soil feed that is recovered from off gas treatment are placed in the on-post landfill, leaving minimal residual risk at the sites. There is high confidence in the engineering controls for the landfill, and there are no expected difficulties associated with landfill maintenance. Landfill-cell monitoring is required. Revegetation of disturbed areas improves the habitat at the site, but habitat at the landfill is eliminated.

15.2.6.4 Reduction in TMV

Thermal desorption degrades or destroys organics to detection levels or >99.99 percent DRE. The mobility of the soil potentially posing risk to biota is reduced by containment in the on-post landfill. The TMV reduction of organics in 14,000 BCY by thermal desorption is irreversible.

The blowdown solids are the only treatment residuals and will account for a volume of approximately 140 BCY to be landfilled.

15.2.6.5 Short-Term Effectiveness

This alternative entails short-term risks associated with excavation, transportation, and thermal desorption of contaminated soil. These risks are addressed through personal protective equipment and dust controls such as water sprays. In addition, the materials handling of the contaminated soil prior to thermal desorption presents short-term risks, and is problematic due to the large amount of debris; however, the materials handling is conducted in an enclosed building to control dust. The off-gas control system for the thermal desorber is designed to achieve air quality standards, although low but acceptable levels of some contaminants are present in the emissions. The time frame for completion of the alternative is 3 years, including 2 years for construction and testing of the thermal desorption facility and 1 year for the construction of the landfill. Excavation and treatment of the 14,000 BCY of material is feasible within 1 year.

15.2.6.6 Implementability

Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The materials handling prior to thermal desorption is problematic due to the large amount of debris. The thermal desorption facility, which can be constructed within the required time frame, is difficult to operate based on the materials-handling problems. Administrative difficulties associated with demonstrating compliance with permits and O&M may lead to delays, and it may be difficult to implement this alternative due to public perceptions regarding the safety of thermal treatment.

15.2.6.7 Cost

The total present worth cost is $27,600,000 including $10,600,000, $16,700,000, and $260,000 for capital, operating, and long-term costs, respectively. Table B4.10-13b details the costing for this alternative. The excavation of contaminated soil entails a cost uncertainty relative to identifying the extent and depth of contamination. The thermal desorption of contaminated soil and refuse entails high cost uncertainties relative to maintaining the assumed on-line percentage, possible delays in implementation, and difficulties with materials handling.

15.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Sanitary Landfills Medium Group has 420,000 BCY of exceedance soil and refuse containing OCPs and ICP metals. The contamination pattern is heterogeneous because various types of trash and rubbish were disposed in the same landfill trenches. Sites do not contain containerized waste, agent, or UXO. Some sites are potential sources of groundwater contamination. In general, the average contaminant concentrations in the human health exceedance volume are below the Human Health SEC (EBASCO 1994a) (Table 15.1-1), so the sites represent a relatively low risk to human health. There are no exceedances of the principal threat criteria.

Most of the sites within this medium group contain weedy forbs or native grasses and remedial alternatives do not cause significant impacts to habitat. Site CSA-1d has a small area of unique native grasses located outside of the landfill trenches, and several sites are located within the Bald Eagle Management Area. However, the selection of alternatives for further consideration is not constrained by habitat-quality issues.

Alternatives that involve excavation of human health exceedances require protection of site workers during remedial activities, but the short-term risk to site workers is mitigated by the proper use of personal protective equipment. The level and type of contamination in sites in this subgroup do not necessitate special measures of vapor/odor controls to protect the community.

In summary, the Sanitary Landfills Medium Group has heterogeneous contamination in trenches that exceeds Human Health SEC (EBASCO 1994a). In evaluating alternatives for this medium group, the impact on habitat is not a major factor. Worker and community protection are readily provided and are not significant factors in the selection process.

Alternative 1: No Additional Action does not achieve RAOs as the contaminated landfill materials are not controlled or treated. Therefore, this alternative was eliminated from further consideration. The four remaining alternatives achieve RAOs and meet the threshold criteria—i.e., they are protective of human health and the environment and comply with action-specific and location-specific ARARs. They differ, however, in how they meet the five balancing criteria (Table 15.2-1).

Alternative 2: Access Restrictions has the lowest cost of the remaining alternatives ($2,820,000), but does not remove or treat contaminated material and eliminates 190,000 SY of habitat outside of the central corridor of RMA. This alternative also does not reduce the potential impacts to groundwater that are associated with this medium group. This alternative was not retained for consideration in developing sitewide alternatives based on the higher residual risks.

The treatment alternative, Alternative 13b: Direct Thermal Desorption; Landfill has a higher cost ($27,600,000) than the containment alternatives. This alternative requires the disposal of the 14,000 BCY of treated material, 383,000 BCY of refuse, and 23,000 BCY of soil with a potential risk to biota. Since this alternative relies on containment after treatment to achieve RAOs, thermal desorption does not provide any more reductions in risk than does containment. Therefore, Alternative 13b was not retained for further evaluation in developing sitewide alternatives because its higher cost is not offset by substantially reduced risks.

The three containment alternatives, Alternative 3: Landfill (On-Post Landfill), Alternative 3f: Landfill (On-Post Landfill); Caps/Covers with Consolidation, and Alternative 6: Caps/Covers (Multilayer Cap) achieve similar reductions in mobility and exposure pathways and cost $27,400,000; $12,300,000; and $13,100,000, respectively. Each alternative improves the habitat at the sites. The landfill, consolidation, and capping alternatives apply engineering controls to reduce contaminant mobility and interrupt exposure pathways, which makes these alternatives cost effective compared to the treatment alternative (Alternative 13b: Direct Thermal Desorption; Landfill). The landfill, consolidation and capping alternatives are consistent with NCP guidance (EPA 1990a) on the use of engineering controls to address low levels of contamination like those found in this medium group.

Consequently, the alternatives that were retained to represent the Sanitary Landfills Medium Group in the development of the sitewide alternatives (Section 20) are the following:

- Alternative 3: Landfill (On-Post Landfill)
- Alternative 3f: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap) With Consolidation
- Alternative 6: Caps/Covers (Multilayer Cap)

Table 15.0-1 Characteristics of the Sanitary Landfills Medium Group

Characteristic	Sanitary Landfills Medium Group
Contaminants of Concern	
Human Health and Refuse	OCPs, ICP metals
Biota	OCPs, Hg
Exceedance Area (SY)	
Total	190,000
Human Health and Refuse	130,000
Principal Threat	0
Biota	69,000
Potential Agent	not applicable
Potential UXO	not applicable
Refuse (soil and debris)	125,000
Exceedance Volume (BCY)	
Total	420,000
Human Health and Refuse	14,000
Organic	14,000
Inorganic	14,000
Principal Threat	0
Biota	23,000
Potential Agent	not applicable
Potential UXO	not applicable
Refuse (soil and debris)	383,000
Depth of Contamination (ft)	
Human Health and Refuse	0–8
Biota	0–1
Refuse	Avg 8'

Contaminants of Concern	Range of Concentrations[1] (ppm)	Average Concentration[1] (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL-420	2.5	71	720	3.8
Dieldrin	BCRL-300	3.0	41	410	3.7
Endrin	BCRL-38	0.31	230	230	56
Isodrin	BCRL-27	0.16	52	52,000	Not applicable
Chlordane	BCRL-3.1	0.02	55	3,700	12
p,p,DDT	BCRL-61	0.44	410	13,500	14
Chromium	BCRL-1,800	18	39	7,500	2,400
Lead	BCRL-8,600	65	2,200	1,000,000	Not applicable
Cadmium	BCRL–1,100	5.8	530	24,000	140
p,p,DDE[2]	BCRL-5.6	0.63	1,250	12,500	Not applicable
Mercury[2]	BCRL-4.0	0.11	570	570,000	82
Biota Volume					
Aldrin	BCRL–3.2	0.09			
Dieldrin	BCRL-2.6	0.17			
Mercury	BCRL–3.5	0.11			
p,p,DDE	BCRL–5.6	0.19			
p,p,DDT	BCRL–61	1.3			
Endrin	BCRL–20	0.39			
Arsenic	BCRL–120	5.5			

[1] Based on concentrations of COCs exceeding SEC within the human health exceedance volume, and on concentrations within the potential biota risk area for the biota volume.

[2] Presents biota risk but was detected in the human health exceedance volume.

Table 15.1-2 Frequency of Detections for Sanitary Landfills Medium Group

	Total Samples Analyzed	BCRL Number	BCRL %	CRL-SEC(1) Number	CRL-SEC(1) %	Acute-HH SEC(2) Number	Acute-HH SEC(2) %	HH SEC-Pr. Threat(2) Number	HH SEC-Pr. Threat(2) %	>Pr. Threat(2) Number	>Pr. Threat(2) %
Aldrin	287	260	90.6%	24	8.4%	1	0.3%	2	0.7%	0	0.0%
Benzene	171	167	97.7%	4	2.3%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	206	206	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlordane	283	276	97.5%	7	2.5%	0	0.0%	0	0.0%	0	0.0%
Chloroacetic Acid	53	53	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlorobenzene	206	206	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chloroform	206	205	99.5%	1	0.5%	--	--	0	0.0%	0	0.0%
p,p,DDE	287	276	96.2%	11	3.8%	--	--	0	0.0%	0	0.0%
p,p,DDT	286	266	93.0%	17	5.9%	3	1.0%	0	0.0%	0	0.0%
Dibromochloropropane	386	386	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	206	206	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	68	68	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	357	355	99.4%	2	0.6%	--	--	0	0.0%	0	0.0%
Dieldrin	287	234	81.5%	37	12.9%	13	4.5%	3	1.0%	0	0.0%
Endrin	294	277	94.2%	17	5.8%	0	0.0%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	289	278	96.2%	11	3.8%	--	--	0	0.0%	0	0.0%
Isodrin	287	276	96.2%	11	3.8%	--	--	0	0.0%	0	0.0%
Methylene Chloride	195	184	94.4%	11	5.6%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	16	16	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	206	200	97.1%	6	2.9%	--	--	0	0.0%	0	0.0%
Toluene	160	160	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Trichloroethylene	206	203	98.5%	3	1.5%	--	--	0	0.0%	0	0.0%
Arsenic	294	221	75.2%	73	24.8%	0	0.0%	0	0.0%	0	0.0%
Cadmium	310	285	91.9%	23	7.4%	1	0.3%	1	0.3%	0	0.0%
Chromium	310	74	23.9%	233	75.2%	--	--	3	1.0%	0	0.0%
Lead	310	174	56.1%	135	43.5%	--	--	1	0.3%	0	0.0%
Mercury	292	253	86.6%	39	13.4%	0	0.0%	0	0.0%	0	0.0%

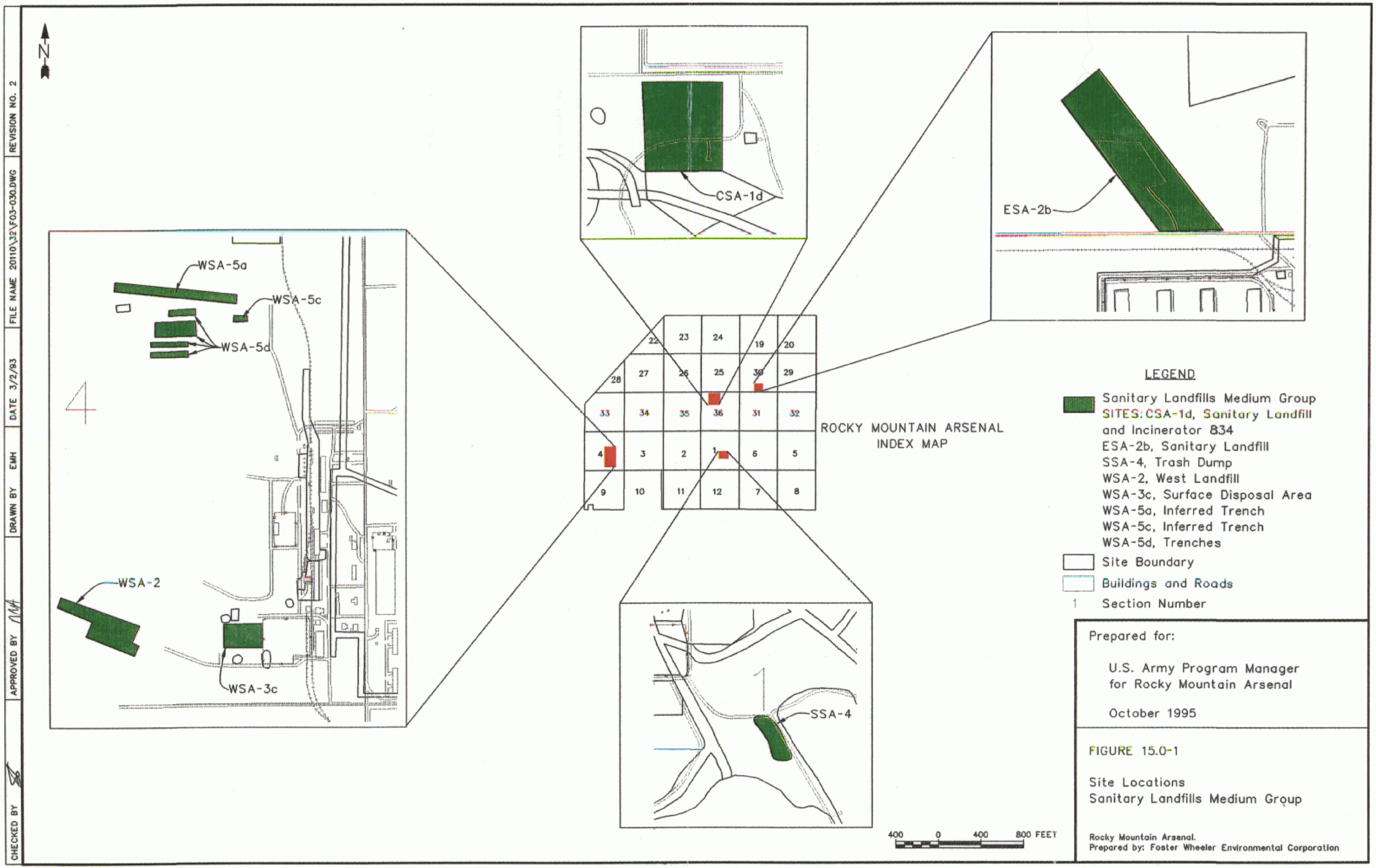
(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.

(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.

-- not applicable

Table 1?.?-1 Comparative Analysis of Alternatives for the Sanitary La..dfills Medium Group

Criteria	Alternative 1: No Additional Action	Alternative 2: Access Restrictions	Alternative 3: Landfill	Alternative 3f: Landfill; Caps/Covers with Consolidation	Alternative 6: Caps/Covers	Alternative 13b: Direct Thermal Desorption; Landfill
1. Overall protection of human health and the environment	Does not achieve Human Health or Biota RAOs; impacts to groundwater not reduced	Protective: achieves Human Health and Biota RAOs since exposure pathways are interrupted by access restrictions and cultivation of lower-quality habitat	Protective: achieves human health and biota RAOs through containment of entire volume; impacts to groundwater greatly reduced	Protective: achieves RAOs through containment of entire volume; impacts to groundwater greatly reduced	Protective: achieves Human Health and Biota RAOs through containment; Groundwater impacts reduced	Protective: achieves Human Health and Biota RAOs through treatment and containment
2. Compliance with ARARs	Complies	Complies	Complies	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Low Residual Risk: Contaminated soil remains in place	Low Residual Risk: Exposure pathways interrupted; contaminated soil remains, and impacts to groundwater not reduced	Minimal Residual Risk: Contaminated soil and debris removed and contained	Minimal Residual Risk: Contaminated soil removed from site	Minimal Residual Risk: Contaminated soil/debris contained and impacts to groundwater reduced	Minimal Residual Risk: PRGs achieved by treatment and exposure pathways eliminated by containment
4. Reduction in TMV	No reduction in TMV except by natural attenuation	No reduction in TMV except by natural attenuation	Exposure pathways and mobility reduced for 420,000 BCY through containment	Exposure pathways and mobility reduced for 420,000 BCY through containment	Exposure pathways and mobility reduced for 420,000 BCY through containment	TMV reduced for 14,000 BCY thermally desorbed; mobility reduced for remaining volume through containment; 140 BCY particulate residual landfilled
5. Short-term effectiveness	No risk to workers or community	Minimal short-term risk to workers during fence installation and cultivation of lower-quality habitat; adequately mitigated; RAOs achieved in 3 years	Short-term risk and environmental impacts during excavation and transport of contaminated soil/debris; adequately mitigated; RAOs achieved in 3 years	Short-term risk to workers and the community associated with excavation and transportation adequately mitigated; RAOs achieved in 3 years	Low short term risk to workers and the community; no intrusive actions performed; RAOs achieved within 2 years	Short-term risks and environmental impacts during excavation, transport, and thermal desorption; RAOs achieved within 3 years
6. Implementability	No implementation required	Technically and administratively feasible	Feasible: No difficulties anticipated	Technically and administratively feasible	Feasible: No difficulties anticipated	Technically feasible: Difficult administrative feasibility due to permitting requirements and public acceptance of on-post treatment facility
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$1,920,000 Total—$1,920,000	Capital—$578,000 Operating—$85,000 Long-term—$2,160,000 Total—$2,820,000	Capital—$10,800,000 Operating—$16,200,000 Long-term—$293,000 Total—$27,400,000	Capital—$362,000 Operating—$12,000,000 Long-term—$9,000 Total—$12,300,000	Capital—$0 Operating—$11,600,000 Long-term—$1,450,000 Total—$13,100,000	Capital—$10,600,000 Operating—$16,700,000 Long-term—$260,000 Total—$27,600,000
Summary	Not Retained: Not protective of human health and the environment	Not Retained: Residual risk to human health and biota not eliminated; impacts to groundwater not reduced	Retained: Protective of human health and the environment and impacts to groundwater greatly reduced	Retained: Contaminated soil contained	Retained: RAOs achieved and low short-term risk; impacts to groundwater reduced	Not Retained: High cost for treatment without risk reduction as compared to containment alternatives



Prepared for:

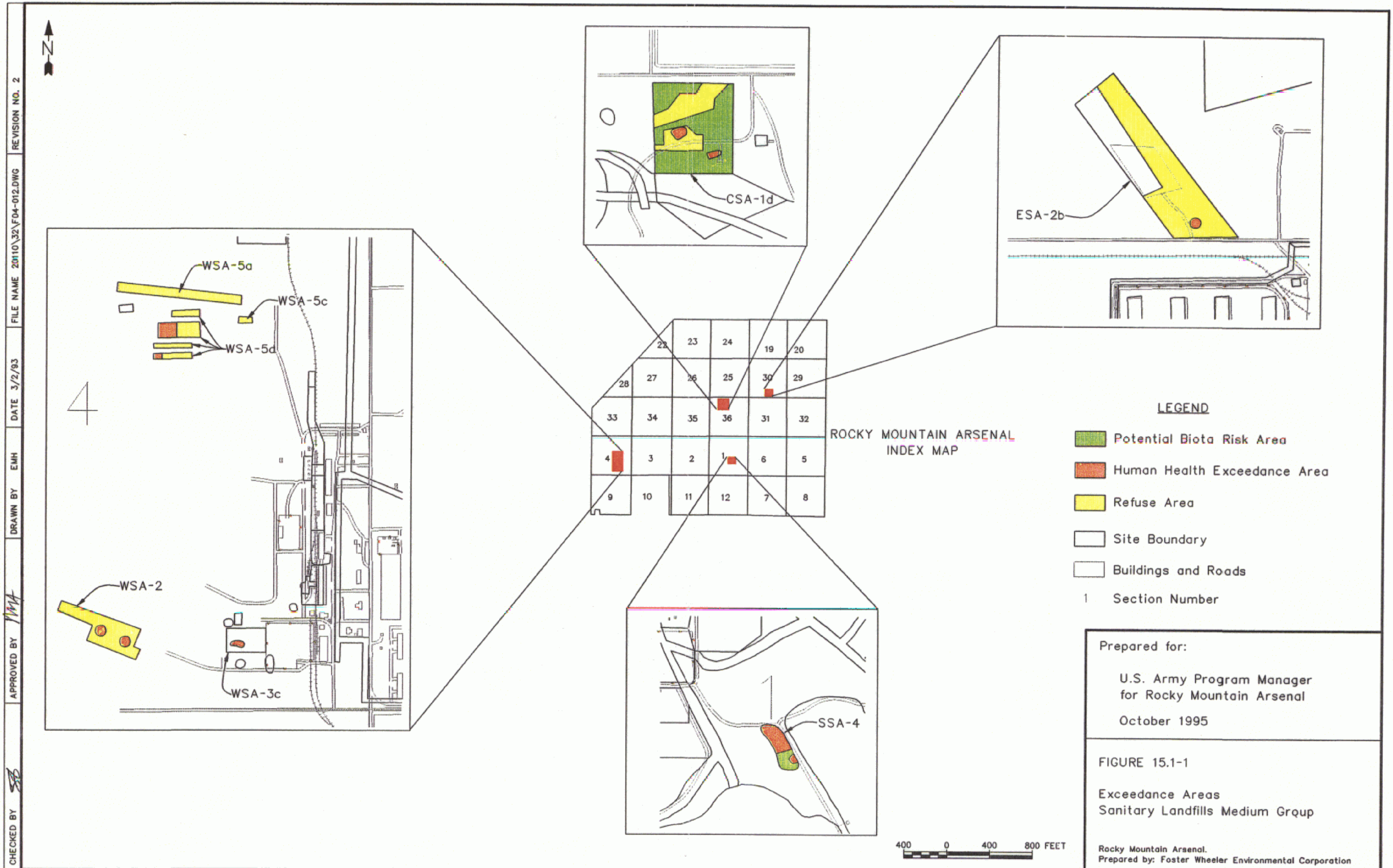
U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 15.0-1

Site Locations
Sanitary Landfills Medium Group

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation



Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 15.1-1

Exceedance Areas
Sanitary Landfills Medium Group

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

16.0 DETAILED ANALYSIS OF ALTERNATIVES FOR THE LIME BASINS MEDIUM GROUP

The Lime Basins Medium Group consists of two adjacent sites that have similar histories and contaminant types. These sites were used for the neutralization of process wastes related to agent production and are characterized by soil/sludge mixtures with high pH levels and the potential presence of agent. In addition, sites within this medium group are potential sources of groundwater contamination. This medium group is separated into two subgroups—Section 36 Lime Basins and Buried M-1 Pits—each containing one site. Figure 16.0-1 depicts the locations of the subgroups and the respective sites.

The primary Human Health COCs in this medium groups are OCPs. DCPD, arsenic, mercury, and cadmium are also present at levels exceeding Human Health SEC (EBASCO 1994a). Both subgroups contain contaminated areas that are considered principal threats and are potential sources of groundwater contamination. For these sites, the soil with potential risk to biota is either overlapped by the human health exceedance area or the area has been capped. Therefore, specific biota alternatives were not developed since the human health alternatives will address the contamination. Table 16.0-1 lists the characteristics of the subgroups, including exceedance volumes and areas and COCs.

In the DSA (EBASCO 1992b), alternatives were developed and screened based on the general characteristics of the medium group. In the DAA, however, the characteristics of the two subgroups—including contaminants and contaminant concentrations, site configuration, and depth of contamination—were used to determine the subset of applicable alternatives for each subgroup from the range of alternatives retained in the DSA for this medium group.

For each subgroup, the following subsections present the characteristics of the subgroup, an evaluation of the retained alternatives against the DAA criteria listed in the NCP (EPA 1990a), and the selection of alternatives, based on a comparative analysis, that was considered in the development of the sitewide alternatives (Section 20).

16.1 SECTION 36 LIME BASINS SUBGROUP CHARACTERISTICS

The Section 36 Lime Basins Subgroup consists of site NCSA-1b (Lime Settling Basins Area) (Figure 16.0-1). The three individual basins within the site were used to remove arsenic from South Plants wastewater by precipitation. Wastewater, generated both by manufacturing processes and later by the demilitarization of lewisite, was treated with lime at the site to precipitate metals and reduce arsenic concentrations. As a result, 34,000 SY of this subgroup potentially contain agent-contaminated soil. The recently completed Soil Volume Refinement Program (EBASCO 1994b) identified agent-contaminated soil at the southern end of Basin A, near the Section 36 Lime Basins. Therefore, it is probable that agent-contaminated soil will be encountered. The basins were also constructed to receive wastewater from industrial activities conducted at South Plants until the chemical sewer was constructed. A 1.5-ft-thick compacted soil cap and a 6-inch-thick layer of topsoil was placed over the site as part of the Lime Basins IRA to reduce groundwater contamination. Construction of a slurry wall was planned, but munitions casings were encountered during installation and the excavation halted. Contaminated soil and sludges from outside the basin were excavated and consolidated within the center of the site as gradefill prior to the installation of the multilayer cap.

Table 16.1-1 provides a summary of contaminants, human health exceedance volume concentrations, and corresponding exceedance criteria for this subgroup. Table 16.1-2 summarizes frequency of detections for samples taken in this subgroup. Two OCPs (aldrin and dieldrin) exceed the Human Health SEC (EBASCO 1994a) in approximately 10 percent of the samples, and the average concentrations of these OCPs in the human health exceedance volume exceed the Human Health SEC (EBASCO 1994a). Maximum concentrations of aldrin and dieldrin (1,700 ppm and 700 ppm) exceed the principal threat criteria (10^{-3} excess cancer risk, HI of 1,000) in 5,400 BCY; however, an additional 3,600 BCY of overburden would have to be removed to address the principal threat exceedance volume. Because of the difficulties associated with identifying and removing this isolated exceedance, specific alternatives to address principal threat treatment or containment were not developed. Figure 16.1-1 presents the human health and principal exceedance area. Figure 16.1-2 shows the overlap between the potential agent presence areas and the human health exceedance area. The Human Health COCs were detected at depths ranging from 0 to 8 ft below ground surface; however, the majority of the contaminants are found in the uppermost 5 ft of soil.

Vegetation in the Section 36 Lime Basins Subgroup consists of weedy forbs. The areas disturbed during remedial actions are revegetated with native grasses, so the overall habitat value is improved through remedial actions. However, burrowing animals are excluded from areas of the site that are addressed through modifications to the existing cap/cover.

This subgroup has been identified as the source of a groundwater contamination plume that occurs in the unconfined aquifer in conjunction with the Basin A Plume. The Basin A Plume follows the Basin A Neck paleochannel to the northwest where it is intercepted and treated by the Basin A Neck IRA treatment system. The cap installed as part of the Lime Basins IRA reduces groundwater contamination, thereby decreasing the migration of contaminants from the basins' soil and sludges to groundwater. Groundwater alternatives that address improved performance for the Basin A Neck IRA treatment system or the addition of individual plume group remediation systems are being evaluated. Coordination of alternatives developed for the soil medium with those developed for the Basin A Plume Group is limited to capping or excavation. Due to the contaminant mass loading already in the aquifer, it is unlikely that the remediation of the Section 36 Lime Basins could result in the discontinuation of the Basin A Neck IRA treatment system.

16.2 SECTION 36 LIME BASINS SUBGROUP EVALUATION OF ALTERNATIVES

The alternatives evaluated for the Section 36 Lime Basins Subgroup include no action, containment, and treatment approaches. The retained alternatives for the Section 36 Lime Basins Subgroup were modified to address residual contamination (below the water table or 10 ft) with a containment option. In addition, Alternative 5 was changed to Alternative 6 to eliminate the use of slurry walls. Slurry walls were removed from the alternatives for this subgroup because groundwater contamination is currently being reduced by the Basin A Neck treatment system and is more appropriately addressed by alternatives developed for the Basin A Plume Group (see Water DAA). Due to the low concentrations of inorganics, Alternatives 10 and 21, which address high concentrations of inorganics, were removed from the range of alternatives. Alternative 13d, which involves thermal desorption, however, was added to the range of alternatives to address the organics contamination, which is the predominant contamination in this subgroup.

The following subsections present a description of each alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a). The alternatives for this subgroup consist of a component to address areas of human exceedances (which is listed first) and a component to address areas with the potential presence of agent (the "A" alternative).

16.2.1 Alternative 1/A1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA), along with Alternative A1: No Additional Action (Provisions of FFA), applies to all 34,000 SY of exceedance area in the Section 36 Lime Basins Subgroup. The 54,000 BCY of total exceedance volume, including human health, principle threat, and potential agent exceedances, remain in place. No additional action beyond maintenance of the existing IRA soil cap is taken to reduce human or biota exposure or migration of contaminants to groundwater. Exceedance areas are monitored (an average of 25 samples per year), groundwater compliance monitoring is performed, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.2.1.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health RAOs since the untreated soil that remains in place is contained by an existing IRA soil cover; however, Biota RAOs are not achieved since the cover does not include biota barriers. Groundwater impacts are not reduced beyond existing IRA measures and the only long-term reduction in toxicity of contaminants is through natural attenuation/degradation.

16.2.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted. The basins are not located in wetlands or a 100-year flood plain. In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). This alternative complies with Army regulations regarding agent-contaminated soil through the IRA soil cover. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.2.1.3 Long-Term Effectiveness and Permanence

There is a moderate residual risk associated with this alternative. High levels of OCPs exceeding Human Health SEC (EBASCO 1994a) remain in soil, but exposure pathways are significantly reduced by the IRA cap. In addition, the potential for the presence of agent remains. No controls beyond the existing IRA are implemented, although site reviews and groundwater monitoring are required. The existing habitat is neither improved nor impacted by this alternative.

16.2.1.4 Reduction in TMV

There is no reduction in TMV beyond the limited mobility reduction provided by the existing cover, except by natural attenuation, and no treatment residuals are generated. A total of 54,000 BCY of untreated soil with the potential presence of agent remains below the existing cover.

16.2.1.5 Short-Term Effectiveness

The time frame until RAOs are achieved is more than 30 years because natural attenuation/degradation is the only process by which contaminants are reduced. RAOs are partially achieved by existing IRA soil cover. The alternative is protective of workers and the community during maintenance operations, and no fugitive dust or vapor emissions are generated. Environmental impacts include continued migration of contaminants to the groundwater (although the existing IRA does reduce migration) and soil with potential agent presence remains in place. The existing habitat is not affected.

16.2.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are available to sample groundwater.

16.2.1.7 Costs

The total present worth cost is $743,000 and includes only long-term O&M costs associated with long-term monitoring and site reviews. Table B4.11-1 details the costing for this alternative. The cost uncertainty associated with site reviews and monitoring is low.

16.2.2 Alternative 3b/A3: Landfill; Caps/Covers

Alternative 3b: Landfill (On-Post Landfill); Caps/Covers (Soil Cover or Multilayer Cap), along with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), includes treating soil with potential agent presence by caustic solution washing and containing the treated soil, along with 54,000 BCY of human health exceedances, in the on-post hazardous waste landfill. Prior to excavation of the human health exceedance soil, 23,000 BCY of the existing soil cover are removed and set aside. The excavation is backfilled with on-post borrow material and the cover is repaired over the entire site (34,000 SY) to contain any residual contamination more than 10 ft below ground surface or the water table. For the purpose of costing the FS, it is assumed that dewatering is required prior to excavation (this assumption will be reevaluated during the remedial design). Installation of a dewatering system 2 years prior to excavation lowers the groundwater table prior to and during excavation activities. During dewatering, groundwater is removed at 0.2 gpm and then pumped to the CERCLA Wastewater Treatment Plant, Basin A Neck IRA or a new groundwater treatment system for treatment. To reduce odor emissions, a minimal area is excavated and exposed to the atmosphere at any one time, and soil covers or plastic liners are placed over the excavated areas daily during periods of inactivity to further control odors and reduce volatile emissions.

The area with potential agent presence is screened for agent, which is accomplished by field screening the samples collected during excavation operations. The presence of agent is verified by analysis at the RMA laboratory. Any agent-contaminated soil is excavated and transported to the on-post caustic washing unit as described in Section 4.4.3. Based on the identification of munition casings during the IRA, a geophysical or other field-screening survey will be conducted prior to excavation. Operating parameters of the caustic washing unit include a processing rate of 35 BCY/day and a liquid waste stream of approximately 1,800 gallons/day; the latter is evaporated with a crystallizer. The crystallizer generates approximately 1 pound of salts for every 7.5 gallons of liquid evaporated. These salts are placed in the on-post hazardous waste landfill along with the treated soil.

The human health exceedance volume of 54,000 BCY is excavated, transported, and placed in the on-post hazardous waste landfill. The on-post landfill is a multiple-cell facility requiring 1 year for construction of the first cell and associated facilities. Because of the high alkalinity and potential incompatibility of Lime Basins materials with other landfilled soil, this material will be placed in a separate, triple-lined cell. The landfill cover is revegetated to limit erosion and control surface-water infiltration, and fencing is installed around the landfill to preserve the integrity of the landfill cover and leachate control system. Long-term maintenance of the landfill cover, leachate collection and treatment, and groundwater monitoring are required.

The existing soil cover material that had been stockpiled is then installed over the entire site to contain residual contamination more than 10 ft below ground surface. The design of the soil cover is discussed in Section 16.1, and includes a 1.5-foot-thick compacted soil cover and a 6-inch-thick layer of topsoil. The soil cover is revegetated with native grasses, and the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat. Maintenance activities, such as mowing and replacement of eroded cover materials, ensure the continued integrity of the soil cover. Five-year site reviews are conducted to review the effectiveness of the alternative and to assess potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.2.2.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs since the human health exceedance volume is excavated and placed in the on-post hazardous waste landfill and any agent-contaminated soil is addressed. The soil cover is replaced over the entire site to contain the residual contamination at depths below 10 ft or the water table. The removal of the contaminated soil and replacement of the soil cover interrupts exposure pathways and reduces the migration of contaminants to groundwater; however, excavation activities entail significant short-term risks.

16.2.2.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on landfill siting, design, and operation, and impacts to endangered species. The basins, treatment facility, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.2.2.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is minimal since the entire human health exceedance volume is removed from the site and any agent-contaminated soil is treated. There is high confidence in the engineering controls of the landfill and soil cover, and there are no expected difficulties associated with maintenance. Landfill and cover monitoring are required to ensure the integrity of the controls. Habitat at the site is improved by revegetation; however, habitat at the landfill is eliminated.

16.2.2.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants reduced through containment in the landfill or by the soil cover for residual contamination. Mobility reduction is only reversible should the landfill fail or the cover degrade. Residual salts are generated from the treatment of agent-contaminated soil and are landfilled. TMV reduction for identified agent by caustic washing is irreversible. Toxicity and volume are not reduced for the human health exceedance volume.

16.2.2.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance, excavation, transportation, and landfilling of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Dust controls (such as water sprays), and vapor/odor controls (such as daily covers, tarps, or foams), are initiated to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. There are minimal impacts to the environment. Migration of the contaminants to the groundwater is reduced. The time frame until RAOs are achieved is 2 years. Excavation of the human health exceedance volume, 54,000 BCY, is feasible within 1 year after 1 year for the construction of the landfill.

16.2.2.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter with periodic landfill-cell monitoring. Additional remedial actions require removal of landfill cover and the soil cover, which adds to the overall excavation volume. The alternative is administratively feasible since the substantive requirements associated with the treatment unit and Subtitle C landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill and installation of the soil cover. Both containment technologies have been well demonstrated at full scale. Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of soil covers increases the volume to be excavated and requires double handling to access the contaminated soil.

16.2.2.7 Cost

The total present worth cost is $4,900,000 including $2,090,000, $2,550,000, and $268,000 for capital, operating, and long-term costs, respectively. Table B4.11-3b details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate which increase uncertainties relative to excavation costs. Second, there is very little operational experience at other sites upon which to base cost estimates for the vapor/odor controls, and to evaluate their impact on excavation and equipment productivity.

16.2.3 Alternative 6/A1: Caps/Covers

Alternative 6: Caps/Covers (Multilayer Cap), along with Alternative A1: No Additional Action (Provisions of the FFA), involves the installation of a 34,000-SY low-permeability multilayer cap to contain the human health exceedance and potential agent presence areas. The design of the multilayer cap is discussed in Section 4.6.14. The subgrade is compacted before any cover materials are installed. The cap consists of a 2-ft-thick layer of compacted low-permeability soil, a 1-ft-thick biota barrier of cobbles, and a 4-ft-thick layer of soil/vegetation layer that includes 6 inches of soil supplemented with conditioners to promote the growth of vegetation. The stockpiled material (from the existing cover over the excavated human health volume) is used as part of the gradefill, as are an additional 46,000 BCY of gradefill. An on-post borrow area supplies the remaining material for the cap required to achieve the 3 to 5 percent grade for the cap design. The cap is revegetated with native grasses and the types of vegetation placed at the site and the maintenance activities conducted there are designed to discourage burrowing animals from using the area as habitat. The borrow area is also recontoured and revegetated. Maintenance activities, such as mowing and replacement of eroded cap materials, ensures the continued integrity of the soil cover. Five-year site reviews and annual groundwater sampling are conducted to review the effectiveness of the alternative and to assess potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.2.3.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through containment since the multilayer cap interrupts exposure pathways and reduces migration of contaminants and impacts to groundwater. Short-term risks are minimal since intrusive activities are not conducted.

16.2.3.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of caps/covers and monitoring of contained material. Location-specific ARARs are met as the basins are not located in wetlands or a 100-year flood plain. In addition, the alternative complies with provisions of the FFA (EPA et al. 1989), and does not impact endangered species. Soil potentially containing agent is contained in place so it is not subject to Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) governing agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.2.3.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low since the entire site is contained. Long-term groundwater monitoring and site reviews are required for the untreated soil, and the multilayer cap requires maintenance. There is high confidence in the engineering controls of the cap. Habitat quality is improved through revegetation of disturbed areas, although burrowing animals are discouraged from using the area as habitat through the types of vegetation placed at the site and the maintenance activities performed there.

16.2.3.4 Reduction in TMV

The multilayer cap interrupts exposure pathways and reduces the mobility of contaminants. The mobility reduction of contaminants is only reversible should the cap degrade. Soil with potential agent presence remains, but is contained by the multilayer cap. Toxicity and volume are not reduced.

16.2.3.5 Short-Term Effectiveness

The alternative entails minimal risk to workers and the community during the remedial action since no intrusive activities are conducted. Workers are adequately protected by personal protective equipment during installation of the cap/cover, and uncontaminated fugitive dust associated with cap construction is controlled by water sprays. Impacts to biota are minimal during installation; however, the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat. Installation of the 34,000-SY multilayer cap is feasible within 1 year.

16.2.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible and materials, specialists, and equipment are readily available for installation of the multilayer cap and groundwater compliance monitoring. Caps are well demonstrated at full scale.

16.2.3.7 Cost

The total present worth cost is $3,210,000 including $2,800,000 and $405,000 for O&M and long-term costs, respectively. Table B4.11-6 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the cap are available on post and the area to be capped is well defined (i.e. the uncertainty commonly associated with excavation does not exist).

16.2.4 <u>Alternative 13d/A3: Direct Thermal Desorption; Direct Solidification/Stabilization; Caps/Covers</u>

Alternative 13d: Direct Thermal Desorption (Direct Heating); Direct Solidification/Stabilization (Cement-Based Solidification); Caps/Covers (Multilayer Cap), along with Alternative A3: Direct

Soil Washing (Solution Washing); Landfill (On-Post Landfill), involves treating (through caustic washing) and landfilling soil with potential agent presence and treating 54,000 BCY of human health exceedance soil by thermal desorption and/or solidification. The thermally desorbed soil is backfilled, and the entire site, 34,000 SY, is capped to contain any residual contamination below 10 ft or the water table. Prior to excavation of the contaminated soil, 23,000 BCY of the existing soil cover are removed and stockpiled for use as gradefill during cap installation, and an additional 46,000 BCY of gradefill materials are required. Installation of a dewatering system 2 years prior to excavation lowers the groundwater table prior to and during excavation activities. During dewatering, groundwater is removed at 0.2 gpm and then pumped to the CERCLA Wastewater Treatment Plant, Basin A Neck IRA, or a new groundwater treatment system for treatment. To reduce odor emissions, a minimal area is excavated and exposed to the atmosphere at any one time, and soil covers or plastic liners are placed over the excavated areas daily during periods of inactivity to further control odors and reduce volatile emissions.

The potential agent area is screened by field screening samples collected during excavation operations. The presence of agent is verified by analysis at the RMA laboratory. Any agent-contaminated soil detected is excavated and transported to the on-post caustic washing unit as described in Section 4.4.3. Based upon the identification of munition casings during the IRA, a survey will be conducted prior to excavation by using geophysical or other field-screening methods.

Of the remaining human health exceedance soil that does not contain agent (54,000 BCY) or organics (52,000 BCY) are treated at the centralized treatment facilities by thermal desorption and inorganics (2,100 BCY) by solidification. The thermal desorber has a soil processing rate of approximately 1,300 BCY/day based on the saturated conditions of the soil (i.e., moisture content of 20 percent) and operates with a soil discharge temperature of 300°C and a soil residence time of 50 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) Approximately 1 percent of the soil feed is entrained in the off-gas stream and recovered from the scrubber blowdown. Approximately 520 BCY of blowdown particulates are placed in the on-post hazardous waste landfill. The treated soil is returned to the site excavations as backfill prior to capping.

The 2,100 BCY of human health inorganics exceedance soil is excavated and solidified using a portable pug mill capable of treating 1,500 BCY/day. The contaminated soil is solidified by adding cement as a binder at a 20-percent ratio to immobilize arsenic, mercury, and ICP metals in the soil. As a result of excavation and solidification, the volume of contaminated soil increases by approximately 38 percent, which results in a total solidified volume of 2,900 BCY. The solidified volume is placed in the site excavations and covered with at least 4 ft of thermally desorbed soil. Due to the volume expansion from solidification, the cover is crowned, which aids in the control of surface water. The soil cover ensures the integrity of the solidified materials and prevents freeze/thaw degradation of the materials.

A multilayer cap is then installed over the entire site to contain residual contamination at depths more than 10 ft below ground surface. The subgrade is compacted before any cover materials are installed. The cap design is described in Section 4.6.14. The stockpiled material from the existing cover is used as part of the 46,000 BCY of gradefill required. An on-post borrow area supplies the remaining materials for the cap. The cap is revegetated with native grasses. The types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat. The borrow area is also recontoured and revegetated. Maintenance activities, such as mowing and replacement of eroded cap materials, ensure the continued integrity of the multilayer cap. Five-year site reviews are conducted to review the effectiveness of the alternative and to assess potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.2.4.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment of contaminated soil and containment of residual contamination. Organics are treated through thermal desorption and inorganics are solidified to minimize their mobility. The site is then covered by a multilayer cap to reduce the potential migration of residual contamination to groundwater through leaching. Short-term impacts are associated with agent-screening and excavation activities.

16.2.4.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources, monitoring of solidified soil, and landfill siting, design, and operation. Endangered species are not impacted. Location-specific ARARs are met as the basins, treatment facilities, and landfill are not located in wetlands or a 100-year flood plain. In addition to ARARs, this alternative also complies with provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.2.4.3 Long-Term Effectiveness and Permanence

This alternative entails minimal long-term risk since PRGs are achieved in the treated soil, the residuals from the treatment processes are contained, and residual contamination at the site is capped. There is high confidence in the engineering controls of the landfill and caps, and there are no expected difficulties associated with maintenance. Monitoring of the landfill, solidified soil, and cap are required to ensure the integrity of the controls. Revegetation of disturbed areas improves the existing habitat, offsetting the habitat loss incurred during excavation.

16.2.4.4 Reduction in TMV

Thermal desorption degrades or destroys organics to detection levels or >99.99 percent DRE. The TMV reduction by thermal desorption and caustic washing for agent is irreversible. Solidification eliminates the mobility of the contaminants and interrupts the exposure pathways to humans and biota. The mobility reduction by solidification is irreversible so long as the integrity of the solidified mass is maintained. For residual contamination, pathways of exposure are interrupted and mobility of contaminants reduced through installation of the multilayer cap. The mobility reduction is only reversible should the cap degrade. Scrubber blowdown solids from off-gas treatment systems (520 BCY) and residual salts generated by caustic washing are landfilled.

16.2.4.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance, excavation, transportation, and landfilling of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Dust controls (such as water spraying), and vapor/odor controls (such as daily covers, tarps, or foams), are initiated to reduce short term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. In addition, the preparation of the feedstock prior to thermal desorption or solidification presents short-term risks, but the materials handling is conducted in an enclosed building to control dust. During thermal desorption, low but acceptable levels of some contaminants are released, although the off-gas control system for the thermal desorber is designed to achieve air quality standards. The time frame for completion of the alternative is 3 years, including 2 years for construction and testing of the thermal desorption and solidification facility and landfill. Excavation and treatment of the 54,000 BCY of soil is feasible within 1 year.

16.2.4.6 Implementability

Thermal desorption and solidification are widely available and have been used to treat similar contaminants; however, the thermal desorption technology has not been demonstrated at the scale required for RMA or at the concentrations present at the site. The treatment facilities can be constructed within the required time frame, but operation of thermal desorption is not well demonstrated. The moisture content of the soil and the materials-handling problems associated with the soil feed may result in delays in implementation. Administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of soil covers increases the volume to be excavated and would require double handling to access the contaminated soil.

16.2.4.7 Cost

The total present worth cost is $12,200,000 including $1,690,000, $10,400,000, and $202,000 for capital, operating, and long-term costs, respectively. Table B4.11-13d details the costing for this alternative. There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate, which increase uncertainties relative to excavation costs. Second, there is very little operational experience at other sites upon which to base cost estimates for the vapor/odor controls, and to evaluate their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high moisture content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorptions projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

16.2.5 Alternative 19b/A3: In Situ Thermal Treatment; In Situ Solidification/Stabilization; Caps/Covers

Alternative 19b: In Situ Thermal Treatment (RF/Microwave Heating); In Situ Solidification/ Stabilization (Cement-Based Solidification); Caps/Covers (Multilayer Cap), along with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), involves treating 54,000 BCY of human health exceedance soil by in situ heating and solidification and of agent-contaminated soil by caustic solution washing.

Any soil that indicates the potential presence of agent using real-time field analytical methods during remedial construction will be tested at the RMA laboratory and transported to the on-post caustic washing unit as described in Section 4.4.3. Operating parameters of the caustic washing unit are described in Section 16.2.2.

The human health organic exceedance soil, 52,000 BCY, is treated by RF heating. RF heating mobilizes the organic contaminants by raising the temperature of the soil to more than 250°C. The mobilized contaminants are collected and treated in the off-gas treatment system as discussed in Section 4.6.31. One RF unit is used for the Section 36 Lime Basins Subgroup. The unit treats a block of soil with a moisture content of 20 percent at a rate of approximately 130 BCY/day. The treated block of soil has approximate dimensions of 100 ft long by 48 ft wide and 10 ft deep. The liquid sidestream (predominantly salts) generated by RF heating is transported to the thermal desorption facility for treatment in the evaporator with the scrubber effluent sidestream.

The human health inorganic exceedance volume of 2,100 BCY is solidified by a transportable track-mounted boring/mixing unit and a cement batch plant capable of processing 600 BCY/day. Portland cement is mixed with soil at a ratio of 0.2 tons of cement per 1 ton of soil. Upon solidification, the soil swells approximately 10–25 percent due to the incorporation of the cement.

Following treatment, the entire site, 34,000 SY, is contained with a multilayer cap. The subgrade is compacted before any cover materials are installed. The cap design is described in Section 4.6.14. The on-post borrow area supplies the 46,000 BCY of gradefill that is required. The cap is revegetated with native grasses and burrowing animals are excluded to prevent damage to the containment system. The borrow area is also recontoured and revegetated. Maintenance activities, such as mowing and replacement of eroded cap materials, ensures the continued integrity of the soil cover. Five-year site reviews and annual groundwater monitoring are conducted to review the effectiveness of the alternative and to assess potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.2.5.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment of contaminated soil and containment of residual contamination (below 10 ft or the water table) with a multilayer cap. Concentrations of contaminants can theoretically be reduced to achieve PRGs through RF heating. Solidification of inorganics eliminates the mobility of the contaminants and interrupts the exposure pathways to humans and biota. The potential for migration of contaminants to groundwater is reduced through treatment of the soil, as well as through containment of residual contamination. Short-term impacts are associated with in situ heating.

16.2.5.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources, monitoring of solidified material, and landfill siting, design, and operation. Endangered species are not impacted. Location-specific ARARs are met as the basins, treatment facility, and landfill are not located in wetlands or a 100-year flood plain. In addition to the ARARs, this alternative also complies with provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.2.5.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low since the entire site is contained and human health exceedances are treated to concentrations approximating Human Health PRGs. The treated agent-contaminated soil is placed in the on-post hazardous waste landfill. There is high confidence in the engineering controls of the landfill and cap, and there are no expected difficulties associated with maintenance. Landfill and cap monitoring are required to ensure the integrity of the controls. Revegetation of disturbed areas improves the existing habitat.

16.2.5.4 Reduction in TMV

RF heating can theoretically achieve Human Health and Biota RAOs with low residual risk as OCPs and volatile metals can be driven from the soil by this form of in situ thermal treatment. However, the pilot-scale test of the RF technology at RMA, as described in the Technology

Descriptions Volume (Section 8.2.1), failed to confirm the temperature distribution and OCP removal efficiencies required for confident treatment of soil to achieve PRGs. The 2,100 BCY of soil with inorganic exceedances are solidified in place, which reduces the mobility of contaminants and interrupts the exposure pathways. For residual contamination and treated soil, pathways of exposure are interrupted and mobility of contaminants is reduced through installation of a multilayer cap. The mobility reduction is only reversible should the cap degrade.

16.2.5.5 Short-Term Effectiveness

The in situ treatment of soil entails short-term impacts. There are significant risks to workers and the community during agent screening and in situ treatment. Although the off-gas control system for in situ heating is designed to achieve air quality standards, the emissions from the in situ heating unit contain low levels of the contaminants removed from the soil. RF treatment and solidification of the 54,000 BCY can be completed within 2 years.

16.2.5.6 Implementability

In situ thermal heating is currently not implementable because no full-scale in situ heating units have been constructed or demonstrated. The technology was demonstrated at a pilot-scale at RMA; however, several problems were identified in the pilot-scale test regarding the durability of the equipment. The resolution of these problems may lead to delays in the construction of full-scale units and in the estimated 2-year operation of the in situ heating units. In addition, administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays. It may also be difficult to implement this alternative due to public perceptions regarding the safety of in situ thermal treatment and the thermal treatment portion of the off-gas control system. Additional remedial actions are easily undertaken for soil that does not achieve PRGs, but the cap adds to overall site volume. The containment portion of the alternative is administratively feasible since the requirements for capping and landfill siting, design, and operating regulations are achieved. Materials and vendors are readily available for installation of the cap. Personnel and equipment are available for groundwater compliance monitoring.

16.2.5.7 Cost

The total present worth cost is $35,800,000 including $13,200,000, $22,200,000, and $395,000 for capital, operating, and long-term costs, respectively. Table B4.11-19b details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First there are no full-scale demonstrations of the in situ heating technology at other hazardous waste sites by which actual construction and operation costs can be documented. This uncertainty is especially noteworthy because the pilot-scale demonstration of the technology at RMA indicated there were potential problems regarding the durability of the equipment. Second, the lack of full-scale implementation data increases uncertainties relative to maintaining the assumed on-line percentage of the heating unit. The level and depth of contamination at RMA may result in changes in treatment times or delays in implementation, both of which may impact treatment costs.

16.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Section 36 Lime Basins Subgroup contains 54,000 BCY of human health exceedance volume contaminated with OCPs, arsenic, and mercury. These basins were used to treat wastewater from manufacturing operations and from the demilitarization of lewisite. Approximately ten percent of the individual OCP samples exceed the Human Health SEC (EBASCO 1994a) (Table 16.1-2). The human health risk is moderate since the average OCP concentrations in the human health exceedance volume exceed the Human Health SEC (EBASCO 1994a), but the site is capped, so exposure pathways are interrupted and the mobility of the contaminants reduced.

Detections of aldrin and dieldrin exceeded the principal threat criteria in less than 2 percent of the samples (Table 16.1-2), resulting in a principal threat volume of 5,400 BCY for the subgroup. Due to the overburden, the soil volume associated with principal threat (9,000 BCY) was not individually addressed. In addition, 34,000 SY are also potentially contaminated with agent since lewisite was demilitarized on site.

Alternatives that address residual contamination through installation of a multilayer cap include revegetation and restoration activities following remediation. No significant habitat impacts are anticipated, although the types of vegetation and the maintenance activities developed for the capped area are designed to discourage burrowing animals from using the area as habitat.

As part of the Lime Basins IRA, contaminated soil and sludges from outside the basin were consolidated within the center of the site, and a layer of compacted soil and topsoil was placed over the area to reduce surface-water infiltration and groundwater contamination identified as originating from the site. Construction of a slurry wall was abandoned when munitions casings were found during excavation operations. The soil cap reduces the potential for exposure to humans, but does not protect biota and groundwater over the long term. To reduce odor emissions during excavation, a minimal area is exposed to the atmosphere at any one time, and a daily cover or plastic liner is used to further reduce odor emissions.

In summary, this subgroup contains soil that exceeds Human Health SEC (EBASCO 1994a) and has limited areas where OCP concentrations exceed principal threat criteria. The existing soil cap limits exposure pathways, but contaminants may still leach to groundwater. When comparing alternatives, the short-term risks of worker exposure and community impacts from the potential release of vapors must be weighed against the long-term risks of leaving the contamination in place.

Alternative 1: No Additional Action is protective of human health through the existing soil cap, but long-term groundwater protection and biota protection is not achieved. Therefore, this alternative is eliminated from further consideration. The remaining four alternatives involve containment or treatment, achieve RAOs, are protective of human health and the environment, and comply with action- and location-specific ARARs. In addition, all alternatives address residual contamination at depths more than 10 ft below ground surface with a multilayer cap.

Alternative 3b: Landfill, Caps/Covers achieves RAOs through containment. The short-term risks associated with agent clearance and excavation are controlled, but they cannot be completely removed. However, this alternative is considered cost effective and is retained for further consideration.

In Alternative 6: Caps/Covers the contaminated soil remains in place, but is contained by a cap. The long-term performance of the existing cap is improved with the additional clay layer, so the capping alternative enhances the effectiveness of groundwater remedial alternatives for the Basin A Plume Group by reducing groundwater recharge. This alternative was retained for further consideration.

Alternative 13d: Direct Thermal Desorption; Direct Solidification/Stabilization; Caps/Covers addresses with contamination through treatment that achieves PRGs and containment of the remaining contamination. This alternative is considered to pose significant risks during excavation and agent clearance. Since the alternative ultimately relies on containment, the risk reduction for thermal desorption does not warrant the higher cost for thermal desorption ($12,200,000) compared to containment alternatives. This alternative was not retained as it is not cost-effective.

Alternative 19b: In Situ Thermal Treatment; In Situ Solidification/Stabilization; Caps/Covers is capable of achieving RAOs. However, the in situ thermal treatment process is not yet available for full-scale operation. Alternative 19b is also the most expensive alternative ($35,800,000). This alternative was not retained based on the lack of equipment for full-scale operation, the high cost, and ultimate reliance on containment.

Consequently, the alternatives that were retained to represent the Section 36 Lime Basins Subgroup in the development of the sitewide alternatives (Section 20) are the following:

- Alternative 3b: Landfill (On-Post Landfill); Caps/Covers (Soil Cover or Multilayer Cap)
- Alternative 6: Caps/Covers (Multilayer Cap)

16.4 BURIED M-1 PITS SUBGROUP CHARACTERISTICS

The Buried M-1 Pits Subgroup consists of one site, SPSA-1e (Buried M-1 Pits) (Figure 16.0-1). The pits were used to treat waste fluids from the lewisite facility. However, waste materials from alleged spills within the acetylene-generation building, the thionylchloride plant, and the arsenic trichloride plant were allegedly routed through floor drains and the connecting piping to the pits. The pits were primarily used to precipitate arsenic out of solution. In addition, a considerable amount of mercuric chloride catalyst from a possible spill entered the pits. The pits were backfilled in 1947 and are now covered with several feet of soil; they were covered by several structures that have since been removed. The entire 8,700 SY of this site exceeds the principal threat criteria, and based on the history of the site, exhibits the potential for the presence of agent.

Table 16.4-1 provides a summary of contaminants, exceedance volume concentrations, and corresponding exceedance values for this subgroup, and Table 16.4-2 summarizes detections for samples taken in this subgroup. Maximum concentrations of OCPs, HCCPD, DCPD, arsenic, cadmium, and mercury exceed the Human Health SEC (EBASCO 1994a) in 26,000 BCY throughout the 10-ft depth interval. Due to the high concentration of DCPD, it is assumed that vapor enclosures will be used for any excavation alternatives. Less than 2 percent of the samples for any individual organic COC exceed the Human Health SEC (EBASCO 1994a); arsenic and mercury have the highest proportion of samples exceeding Human Health SEC (EBASCO 1994a) (42 and 21.6 percent, respectively). The only compounds within the human health exceedance volume that when averaged exceed the Human Health SEC (EBASCO 1994a) are arsenic and mercury. Figure 16.4-1 shows the distribution of exceedance areas for the subgroup, and Table 16.0-1 presents the exceedance volumes. Figure 16.4-2 presents the overlap between potential agent presence areas and the human health exceedance areas. Since the entire site is defined as a human health exceedance, areas of potential risk to biota are completely overlapped by human health exceedance areas. Therefore, separate biota alternatives were not developed for this subgroup.

The Buried M-1 Pits Subgroup consists of areas of disturbed vegetation. The areas disturbed during remedial actions are revegetated with native grasses or are covered with a cap related to the remediation of other South Plants sites, thus improving the overall habitat value. However, the types of vegetation and the maintenance activities for the capped area are designed to discourage burrowing animals from using the area as habitat.

This subgroup is identified as the source of a groundwater contamination plume occurring in the unconfined aquifer in conjunction with the South Plants North Plume and the Basin A Plume Group. The Basin A Plume follows the Basin A Neck paleochannel to the northwest where it is intercepted and treated by the Basin A Neck IRA treatment system. Groundwater alternatives that address improved performance for the Basin A Neck IRA treatment system or mass reduction of individual plumes are being evaluated. Coordination of alternatives developed for the soil medium with those developed for the water medium is necessary for alternatives involving hydraulic controls or dewatering. Due to the contaminant mass loading already in the aquifer, it is unlikely that the remediation of the M-1 pits would result in the shutdown of the Basin A Neck IRA treatment system. Groundwater compliance monitoring would be performed to assess the potential migration of contaminants for any human health exceedances left in place.

16.5 EVALUATION OF ALTERNATIVES

The alternatives for the Buried M-1 Pits Subgroup include no action, containment, and treatment approaches. The range of alternatives retained in the DSA (EBASCO 1992b) was modified by the addition of two alternatives. A containment alternative (Alternative 5) was added since the proposed IRA for the pits has not yet been initiated, and a treatment alternative (Alternative 22) was added to address in situ solidification of inorganic contamination. The following subsections present a description of each alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a). The alternatives for this subgroup consist of a component to address human health exceedances (which is listed first) and a component to address areas with the potential presence of agent (the "A" alternative).

16.5.1 Alternative 1/A1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA), along with Alternative A1: No Additional Action (Provisions of FFA), applies to all 8,700 SY of exceedance area in the Buried M-1 Pits Subgroup. The 26,000 BCY of soil with human health and potential agent exceedances remain in place. No action is taken to reduce human or biota exposure to COCs, to prevent acute chemical hazards from agent, or to reduce migration of contaminants to groundwater.

Exceedance areas are monitored (an average of 7 samples per year), annual groundwater sampling is conducted, and 5-year site reviews are conducted to assess potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.5.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve RAOs. Groundwater impacts are not reduced, and the only long-term reduction in toxicity of contaminants is through natural attenuation/degradation.

16.5.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the pits are not located in wetlands or a 100-year flood plain. In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). This alternative does not achieve Army Materiel Command regulations regarding the control of materials with potential agent presence (AMC-R 385-131) (AMC 1987). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.5.1.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is high. Elevated concentrations of ICP metals, OCPs. DCPD, arsenic, and mercury exceeding Human Health SEC (EBASCO 1994a) remain in the soil. In addition, the potential presence of agent remains. No controls are implemented; however, site reviews, soil monitoring, and groundwater monitoring are required. The existing habitat is not impacted by this alternative.

16.5.1.4 Reduction in TMV

There is no reduction in TMV other than that provided by natural attenuation. Treatment residuals are not generated since no materials are treated or contained. A total of 26,000 BCY of untreated principal threat soil with the potential presence of agent remains.

16.5.1.5 Short-Term Effectiveness

RAOs are not achieved and migration of contaminants to the groundwater is not reduced. This alternative poses no short-term risk to workers and the community since no actions are taken. There are no fugitive emissions or dust. The existing habitat is not changed.

16.5.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are available to sample soil and groundwater.

16.5.1.7 Cost

The total present worth cost is $670,000 and includes only long-term O&M costs associated with long-term monitoring and site reviews. Table B4.12-1 details the costing for this alternative. The cost uncertainty related to monitoring and site reviews is low.

16.5.2 Alternative 3/A3: Landfill (On-Post Landfill)

Alternative 3: Landfill (On-Post Landfill), along with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), involves treating soil with potential agent presence (29 BCY) by caustic solution washing and containing the treated soil and 26,000 BCY of human health exceedances in an on-post hazardous waste landfill. Based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed, dewatering for worker safety during excavation is not required.

Volatile emissions and noxious odors (primarily DCPD) are controlled during excavation by enclosing the trenches in a vapor enclosure. A vapor control system is included in this enclosure to prevent impacts on the community. The containment structures utilized during the excavation are fabricated from aluminum structural members covered with a coated synthetic fabric. The structures can be erected on an even, level surface with no foundation. Two vapor enclosures with the dimensions of 430 feet in length and 90 feet in width will be used. There will be four structure setups with two moves using this configuration. Excavations will be partially backfilled prior to dome movement and an interim soil cover will minimize odors on open side slopes when the structures are moved. Vapor enclosures are discussed in detail in Section 4.1 of the Technology Descriptions Volume.

An air pollution control system draws air from the structure for treatment with a wet scrubber, controlling the concentrations of airborne contaminants as required for safe working conditions within the structure. Because the air pollution control system creates a slight negative pressure within the structure, entry and exit doors can be opened for short periods of time without releasing contaminants or odors and thus eliminating the need for airlocks. The structure is fabricated from a synthetic fabric coated to achieve very low air permeability, and is designed to withstand wind velocities of 80 mph and a snow load of 4 ft. The alkaline aqueous solution from the wet scrubber system is neutralized and subsequently treated at the CERCLA Wastewater Treatment Plant.

All excavated soil is tested for agent using portable testing equipment. The excavated material is placed in a covered staging area while the presence of agent is verified by analysis at the RMA laboratory. The agent-contaminated soil is then transported to the on-post caustic washing unit as described in Section 4.4.3.

The human health exceedance volume of 26,000 BCY is excavated, transported, and placed in the on-post hazardous waste landfill. The on-post landfill is a multiple-cell facility requiring 1 year for construction of the first cell and associated facilities (Section 4.6.6). The landfill cover is revegetated to limit erosion and control surface-water infiltration, and fencing is installed around the landfill to preserve the integrity of the landfill cover and leachate control system. Long-term maintenance of the landfill cover, leachate collection and treatment, and groundwater monitoring are required.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.5.2.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs since the human health exceedance volume is excavated and placed in the on-post hazardous waste landfill, and agent-contaminated soil is treated. The removal of the contaminated soil interrupts exposure pathways and greatly reduces the contamination of groundwater. However, the excavation of the pits entails significant short-term impacts.

16.5.2.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on landfill siting, design, and operation. Endangered species are not impacted. The pits, treatment facility, and the landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.5.2.3 Long-Term Effectiveness and Permanence

Because the entire exceedance volume is removed and either treated or contained, the residual risk for this alternative is minimal. There is high confidence in the engineering controls of the landfill, and there are no expected difficulties associated with maintenance. Landfill monitoring is required to ensure the integrity of the controls. Habitat at the site is improved by revegetation; however, habitat at the landfill is eliminated.

16.5.2.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants are reduced through containment in the landfill. Mobility reduction is only reversible should the landfill fail. TMV reduction of agent contamination by caustic washing is irreversible. Residual salts are generated from the treatment of agent-contaminated soil and are landfilled.

16.5.2.5 Short-Term Effectiveness

This alternative entails high short-term risks associated with agent screening and excavation, and transportation and landfilling of highly contaminated soil, some of which has the potential for generating contaminated vapors or odors. These risks are reduced through the installation of a vapor enclosure and use of personal protective equipment, but they cannot be completely eliminated. The vapor enclosure is installed to collect and treat vapors and odors from the excavation; however, field demonstrations of vapor enclosures have not indicated that adequate controls can consistently be achieved. The short-term risks to workers inside the vapor enclosure are increased due to the confined working area, and risk management is dependent on the performance of the air treatment system. Therefore, the possibility exists for vapor/odor emissions during excavation in spite of these controls. Migration of the contaminants to the groundwater is reduced. The time frame until RAOs are achieved is 2 years. Excavation of the 26,000 BCY is feasible within 1 year after 1 year for the construction of the landfill.

16.5.2.6 Implementability

The landfill portion of this alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter with periodic landfill-cell monitoring. Additional remedial actions require removal of the landfill cover. The alternative is administratively feasible as the substantive requirements associated with Subtitle C landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill, and the landfill technology has been well demonstrated at full scale. The performance of vapor enclosures has not been demonstrated at full scale for hazardous waste operations similar to RMA, although construction of vapor enclosures is well documented. In addition, vapor enclosures are not available from many vendors. Excavation within vapor enclosures leads to a lower excavation rate, and the enclosure must be moved twice during operations.

16.5.2.7 Cost

The total present worth cost is $3,910,000 including $2,380,000, $1,510,000, and $18,000 for capital, operating, and long-term costs, respectively. Table B4.12-3 details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate which increase, uncertainties relative to excavation costs. Second, there is very little operational experience at other sites upon which to base cost estimates for the vapor/odor controls and the air treatment system for the enclosure, and to evaluate their impact on excavation and equipment productivity, can be well defined. The estimated cost to construct and operate the vapor enclosure is $962,000.

16.5.3 Alternative 5/A1: Caps/Covers; Vertical Barriers

Alternatives 5: Caps/Covers (Multilayer Caps); Vertical Barriers (Slurry Walls), along with Alternative A1: No Additional Action (Provisions of FFA), contains 26,000 BCY of human health exceedance volume by installing an 8,700-SY multilayer cap and a 2,500-SY slurry wall. The areas that potentially contain agent are contained by this cap, interrupting exposure pathways, so no separate action is taken to address this soil. A soil/bentonite slurry wall, as described in Section 4.6.14, is installed around the perimeter of the site (1,200 LF) into competent bedrock (approximately 19 ft below grade). The soil excavated from the slurry wall trench is potentially contaminated and is therefore graded over the surface of the isolation cell to be included under the cap. Though not required based on present groundwater elevations, a dewatering system is installed as a contingency to ensure a reduced hydraulic head within the cell, minimizing the potential for further groundwater contamination. Groundwater removed by this system is pumped to the Basin A Neck IRA or a new groundwater treatment system. Depending on the pumping rate and contaminant concentrations, additional pre-treatment steps may be required.

Following slurry-wall installation, the multilayer cap is constructed. The design of the multilayer cap is discussed in Section 4.6.14. The subgrade is compacted before any cover materials are installed and the surface is crowned to facilitate surface-water runoff. The area is then covered by a 2-ft-thick layer of compacted low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and a 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil. This cap may be part of a larger cap covering the South Plants Central Processing Area (see Section 17.2). Approximately 5,000 BCY of gradefill material are required to achieve the design grades for capping. Revegetation of the reconditioned soil with native grasses completes the remedial action. The cap provides a physical barrier protecting human and biota receptors from directly contacting the contaminated soil. The fill materials used for the cap and slurry wall construction are excavated from the on-post borrow area. After completion of the remedial action, the borrow area is recontoured and the habitat is restored through revegetation. The types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.5.3.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs. Human and biota exposure pathways are interrupted by installation of a multilayer cap, slurry wall, and dewatering system. Groundwater impacts are also reduced, and short-term impacts are minimal since intrusive activities are limited.

16.5.3.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of CERCLA covers and monitoring of the contained material. Location-specific ARARs are met as the pits are not located in wetlands or a 100-year flood plain. In addition, the alternative complies with provisions of the FFA (EPA et al. 1989), and does not impact endangered species. Soil potentially containing agent is contained in place and is not subjected to Army regulations governing agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.5.3.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low. The 26,000 BCY of untreated soil are contained within the 8,700-SY multilayer cap and slurry wall. Long-term groundwater monitoring and site reviews are required. In addition, the containment and dewatering system require maintenance. There is high confidence in the engineering controls for the cap and slurry wall. Habitat quality is improved through revegetation of disturbed areas, although the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the area as habitat.

16.5.3.4 Reduction in TMV

The installation of the containment system interrupts exposure pathways and reduces the mobility of the contaminants. The mobility reduction of contaminants is only reversible should the cap or slurry wall degrade. Residuals from this alternative include groundwater from the dewatering system, which is pumped to the Basin A Neck IRA or a new groundwater treatment system.

16.5.3.5 Short-Term Effectiveness

The alternative entails low short-term risks since no intrusive activities are conducted. Dust controls are adequate for addressing uncontaminated fugitive dust from cap construction, and vapor/odor emissions are not anticipated. Construction of the cap entails only minimal environmental impacts, although the disturbance of borrow areas is required for gradefill and capping materials. RAOs are achieved through installation of the containment system. Installation is feasible within 1 year.

16.5.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible and achieves the substantive requirements of cap/cover and slurry wall design and construction regulations. Materials, specialists, and equipment are readily available for construction, and multilayer caps and slurry walls have been well documented at full scale.

16.5.3.7 Cost

The total present worth cost is $1,020,000 including $171,000, $553,000, and $291,000 for capital, operating, and long-term costs, respectively. Table B4.12-5 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the cap are available on post and the area to be capped is well defined (i.e., the uncertainty commonly associated with excavation does not exist).

16.5.4 Alternative 10/A3: Direct Solidification/Stabilization

Alternative 10: Direct Solidification/Stabilization (Cement-Based Solidification), along with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), involves treating 26,000 BCY of human health exceedance soil by solidification and agent-contaminated soil by caustic washing followed with containment. The predominant COCs in this subgroup are inorganics that are amenable to solidification. Based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed, dewatering for worker safety during excavation is not required.

Volatile emissions and noxious odors (primarily DCPD) are controlled during excavation by enclosing the pits with a vapor enclosure and by using a vapor control system as described in Section 16.5.2. During excavation, all soil is tested for agent using field-screening methods. The presence of agent is verified by analysis at the RMA laboratory. The agent-contaminated soil is transported to the on-post caustic washing unit as described in Section 4.4.3.

As described in Section 4.6.23, the 26,000 BCY of exceedance soil are excavated and solidified using a portable pug mill capable of treating 1,500 BCY/day. The contaminated soil is solidified by adding cement as a binder at a ratio of 20 percent to immobilize arsenic, mercury, and ICP metals in the soil. As a result of excavation and solidification, the volume of contaminated soil increases by approximately 38 percent, which results in a total solidified volume of 36,000 BCY. The solidified volume is placed in the on-post hazardous waste landfill.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.5.4.1 Overall Protection of Human Health and Environment

This alternative achieves RAOs through treatment and containment of material. Human and biota exposures are prevented and groundwater impacts are reduced.

16.5.4.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding monitoring of solidified soil. Endangered species are not effected. Location-specific ARARs are met as the pits, treatment facilities, and landfill are not located in wetlands or a 100-year flood plain. In addition to the ARARs, this alternative also complies with provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.5.4.3 Long-Term Effectiveness and Permanence

The long-term risk is minimal since the entire volume of contaminated soil is treated. PRGs are achieved for the 26,000 BCY of human health exceedance soil solidified and landfilled. Controls for monitoring the solidified soil and for operation and maintenance of the landfill are adequate. The overall habitat quality for the site is improved through revegetation of the soil cover.

16.5.4.4 Reduction in TMV

Solidification eliminates the mobility of the contaminants and interrupts the exposure pathways to humans and biota. The mobility reduction of inorganics by solidification is irreversible so long as the integrity of the solidified mass is ensured. TMV reduction by caustic washing for agent is irreversible. The volume of solidified soil increases by approximately 38 percent after bulking and expansion, resulting in 36,000 BCY of material to be landfilled. Residual salts are generated from the treatment of agent; these are landfilled.

16.5.4.5 Short-Term Effectiveness

This alternative entails high short-term risks associated with agent screening, and excavation, transportation and solidification of highly contaminated soil, some of which has the potential for generating contaminated vapors or odors. These risks are managed through the installation of a vapor enclosure and use of personal protective equipment, but they cannot be completely eliminated. The vapor enclosure is installed to collect and treat vapors and odors from the excavation; however, field demonstrations of vapor enclosures have not indicated that adequate controls can consistently be achieved. The short-term risks to workers inside of the vapor enclosure are increased due to the confined working area and are dependent on the performance of the air treatment system. Therefore, the possibility exists for vapor/odor emissions during excavation in spite of these controls. Environmental impacts of the remedial actions are minimal due to the existing poor-quality habitat. The time frame for completion of the alternative is 2 years, including 1 year for construction of the landfill.

16.5.4.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter. The alternative is administratively feasible and achieves the substantive requirements of the treatment system design and operation. Materials and vendors are readily available for implementation of the alternative, and solidification is well demonstrated at full scale. The performance of vapor enclosures has not been demonstrated at full scale for hazardous waste operations similar to RMA, although construction of vapor enclosures is well documented. In addition, vapor enclosures are not available from many vendors. Excavation within vapor enclosures requires double handling of some soil.

16.5.4.7 Cost

The total present worth cost is $6,030,000 including $2,470,000, $3,400,000, and $160,000 for capital, operating, and long-term costs, respectively. Table B4.12-10 details the costing for this alternative. There are two significant uncertainties associated with the costing of this alterative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate, which increases uncertainties relative to excavation costs. Second, there is very little operational experience at other sites upon which to base cost estimates for the vapor/odor controls and the air treatment system for the enclosure, and to evaluate their impact on excavation and equipment productivity, can be well defined. The estimated costs to construct and operate the vapor enclosure are $1,070,000.

16.5.5 Alternative 19/A3: In Situ Thermal Treatment; In Situ Solidification/Stabilization

Alternative 19: In Situ Thermal Treatment (RF/Microwave Heating); In Situ Solidification/Stabilization (Cement-Based Solidification), combined with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), addresses 26,000 BCY of human health exceedance soil. Since the entire Buried M-1 Pits Subgroup potentially contains agent, any soil that indicates the presence of agent using real-time field analytical methods will be tested at the RMA laboratory. Confirmed agent-contaminated soil is transported to the on-post caustic washing unit as described in Section 4.4.3.

Approximately 1,700 BCY of soil are then treated for OCPs by in situ thermal treatment. RF heating raises the temperature of the soil to more than 250°C, which mobilizes the organic contaminants. The mobilized contaminants are then collected and treated in the off-gas treatment system as described in Section 4.6.31. One RF unit is used to treat 1,700 BCY of soil containing organic exceedances at a processing rate of up to 130 BCY/day given a moisture content of 20 percent. The unit can treat a contaminated block of soil that is 100 ft long, 48 ft wide, and 10 ft deep. The liquid sidestream, which contains predominantly salts, is transported to the thermal desorption facility for treatment along with the scrubber effluent sidestream or to the evaporator/crystallizer for treatment. RF heating only treats the organic contaminants, so soil containing inorganic exceedances is addressed by in situ cement-based solidification.

The human health inorganic volume of 26,000 BCY is solidified using a transportable track-mounted boring/mixing unit and a cement batch plant capable of processing 600 BCY/day. Portland cement is mixed with excavated soil at a ratio of 0.2 ton of cement per 1 ton of soil. Upon solidification, the soil swells approximately 10 to 25 percent due to the incorporation of the cement. Borrow soil from the on-post borrow area is recontoured over the solidified soil (8,700 SY). The uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses to improve the habitat quality of the site. The soil cover ensures the integrity of the solidified soil and prevents freeze/thaw degradation of the materials. The soil may also be capped as part of the remediation of the South Plants Central Processing Area (see

Section 17.2). Groundwater compliance monitoring is performed to evaluate potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.5.5.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment of contaminated soil. Concentrations of organic contaminants are reduced to concentrations near the Human Health PRGs and exposure pathways are further interrupted by solidification of contaminated soil. The potential for migration of contaminants to groundwater is reduced by treatment and solidification. The clearance of agent-contaminated soil and the in situ treatment of the pits entails moderate short-term impacts.

16.5.5.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources, monitoring of solidified soil, and endangered species. Location-specific ARARs are met as the pits are not located in wetlands or a 100-year flood plain. In addition to the ARARs, this alternative also complies with provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.5.5.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low. The 1,700 BCY of organic exceedance soil is thermally treated for OCPs. Human Health PRGs are generally achieved, and residual levels of OCPs are within acceptable levels for human health (10^{-4} to 10^{-6} excess cancer risk). The entire 26,000 BCY of human health exceedance soil is then solidified in place to immobilize inorganic contaminants. Controls are not required, but the solidified soil and groundwater require monitoring. The existing habitat is improved.

16.5.5.4 Reduction in TMV

RF heating can theoretically achieve Human Health and Biota RAOs with low residual risk as OCPs and volatile metals can be driven from the soil by this form of in situ thermal treatment. However, the pilot-scale test of the RF technology at RMA, as described in the Technology Descriptions Volume (Section 8.2.1) failed to confirm the temperature distribution and OCP removal efficiencies required for confident treatment of soil to achieve PRGs. The mercury and arsenic are condensed in the blowdown liquid and treated at the thermal desorption facility.

Solidification interrupts exposure pathways and reduces the mobility of inorganic contaminants. This mobility reduction is irreversible so long as the integrity of the solidified materials is maintained. TMV reduction by caustic washing for agent is irreversible. Liquids associated with the blowdown sidestream contain mercury, arsenic, and salts. This waste is treated at a thermal desorption facility along with scrubber effluent. Residual salts generated from treatment of agent-contaminated soil are landfilled.

16.5.5.5 Short-Term Effectiveness

The in situ thermal treatment of soil entails high short-term impacts. Although the off-gas control system for in situ heating is designed to achieve air quality standards, the emissions from the in situ heating unit contain low but acceptable levels of some contaminants. The in situ solidification of soil also entails short-term impacts. Any vapor/odors generated during treatment are collected in a hood and treated in the off-gas control system. RF treatment and in situ solidification is feasible within 1 year, after 1 year for construction of the on-post landfill used to dispose the treated soil. RAOS are achieved in 2 years.

16.5.5.6 Implementability

In situ thermal heating is currently not implementable because no full-scale in situ heating units have been constructed or demonstrated. The technology was demonstrated at a pilot-scale at RMA; however, several problems were identified in the pilot-scale test regarding the durability of the equipment. In addition, administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays, and it may be difficult to implement this alternative due to public perceptions regarding the safety of in situ thermal treatment and the thermal treatment portion of the off-gas control system. In situ solidification equipment is available at full scale from several vendors. The required materials are widely available, and in situ solidification has been demonstrated at full-scale. Personnel and equipment for groundwater compliance monitoring are available.

16.5.5.7 Cost

The total present worth cost is $16,700,000, including $13,300,000, $3,120,000, and $323,000 for capital, operating, and long-term costs, respectively. Table B4.12-19 details the costing for this alternative.

There are two significant uncertainties associated with the costing of this alternative. First, there are no full-scale demonstrations of the in situ heating technology at other hazardous waste sites by which actual construction costs can be documented. This uncertainty is especially noteworthy because the pilot-scale demonstration of the technology at RMA indicated there were potential problems regarding the durability of the equipment. Third, the lack of full-scale implementation data increases uncertainties relative to maintaining the assumed on-line percentage of the heating unit. The concentration and depth of contamination at RMA may result in changes in treatment times or delays in implementation, both of which may impact treatment costs. Fourth, there are no full-scale demonstrations of the in situ solidification technology at other hazardous waste sites by which actual operating costs can be documented.

16.5.6 Alternative 21/A1: In Situ Thermal Treatment

Alternatives 21: In Situ Thermal Treatment (In Situ Vitrification), along with Alternative A1: No Additional Action (Provisions of FFA), addresses 26,000 BCY of human health exceedance soil. In situ vitrification uses electricity passed between electrodes in the soil to melt the contaminated soil into a vitreous mass. Section 8.3.1 of the Technology Descriptions discusses in situ vitrification. The majority of organic contaminants are destroyed by pyrolysis at a temperature of 3,000°C, with a small fraction being bound up in the melt mass and another fraction being driven off and captured in the off-gas treatment system (Section 4.6.33).

Three sidestreams are generated including wastewater, treated off gas, and spent carbon from the off-gas treatment system. The wastewater is treated at the CERCLA Wastewater Treatment Plant. The spent carbon is regenerated off post and the off gas is treated as described in Section 4.6.33. The vitrified mass is left in place. Residual contaminants in the vitrified mass are immobilized, greatly reducing the potential for leaching of contamination. Since in situ vitrification results in a reduction of the soil volume by approximately 45 percent, 12,000 BCY of borrow material from the on-post borrow area are used to bring the site to grade. The uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses to improve the habitat of the site. After completion of the alternative, the borrow site is recontoured and revegetated to restore the habitat. The soil may also be capped as part of the remediation of the South Plants Central Processing Area (see Section 17.2). Groundwater compliance monitoring is performed to evaluate the potential for migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.5-1 summarizes the evaluation of all the alternatives developed for this medium group.

16.5.6.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment and immobilization of contaminants. Contaminated soil is vitrified, thereby preventing exposure and reducing groundwater impacts. Some short-term impacts are associated with in situ vitrification.

16.5.6.2 Compliance with ARARs

Action-specific ARARs regarding monitoring of vitrified material are met. In addition, the pits are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. The alternative complies with provisions of the FFA (EPA et al. 1989), but may not comply with Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization as vitrification is not an approved method of incineration. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.5.6.3 Long-Term Effectiveness and Permanence

This alternative entails minimal residual risk since the 26,000 BCY of soil are vitrified in place, reducing human health hazards and biota exposure, thus achieving PRGs at the site. The existing habitat is improved through revegetation of disturbed areas. Monitoring of the vitrified soils is required.

16.5.6.4 Reduction in TMV

The vitrification of 26,000 BCY of contaminated soil interrupts exposure pathways and reduces the toxicity, mobility and volume of contaminants. Soil with potential agent presence is included in the volume to be vitrified. TMV reduction by this method is irreversible; however, the site requires periodic monitoring and site reviews.

16.5.6.5 Short-Term Effectiveness

The in situ vitrification of soil entails some significant short-term impacts that are reduced through engineering controls and use of personal protective equipment. Although the off-gas control system for in situ vitrification is designed to achieve air quality standards, the emissions from the in situ vitrification unit contain low levels of the contaminants removed from the soil. RAOs are achieved in 2 years.

16.5.6.6 Implementability

In situ vitrification may not be feasible as very few full-scale in situ heating units are currently available. The technology has been demonstrated at full scale, but several problems were identified regarding the durability of the equipment. The resolution of these problems may lead to delays in the construction of full-scale units and in their operation. In addition, administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of in situ thermal treatment and the thermal treatment portion of the off-gas control system. Treatment and achievement of RAOs are feasible within 2 years, recognizing that soil with potential agent presence is treated with an unapproved technology. Personnel and equipment are available for groundwater compliance monitoring.

16.5.6.7 Cost

The total present worth cost is $24,400,000, including $1,120,000, $22,600,000 and $638,000 for capital, operating, and long-term costs, respectively. Table B4.12-21 details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, there are few full-scale demonstrations of the in situ vitrification technology at other hazardous waste sites by which actual construction and operational costs can be documented. This uncertainty is especially noteworthy because some of the full-scale demonstrations of the technology have indicated there are potential problems regarding the durability of the equipment. Second, the limited amount of full-scale implementation data increases uncertainties relative to maintaining the assumed on-line percentage of the heating unit. The moisture content of the soil in the pits may result in changes in treatment times, which may impact treatment costs.

16.5.7 Alternative 22/A3: In Situ Solidification/Stabilization

Alternative 22: In Situ Solidification/Stabilization (Silica-Based or Cement-Based Solidification), along with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), treats 26,000 BCY of contaminated soil by solidification. The predominant COCs in this subgroup are inorganics that are amenable to solidification. Based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed, dewatering is not required.

Any soil identified as containing agent using real-time analytical methods during remedial construction will be tested at the RMA laboratory. Confirmed agent-contaminated soil will be treated by caustic solution washing as described in Section 4.4.3.

The human health inorganic and organic exceedance volume of 26,000 BCY is solidified using a transportable track-mounted boring/mixing unit and a cement batch plant capable of processing 600 BCY/day. Portland cement is mixed with soil at a ratio of 0.2 tons of cement per 1 ton of soil. Upon solidification, the soil swells approximately 10–25 percent due to incorporation of the cement. Borrow soil from the on-post borrow area is recontoured over the solidified soil (8,700 SY). The uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses to improve the habitat quality of the site. The soil cover ensures integrity of the solidified soils and prevents freeze/thaw degradation of the materials. The soil may also be capped as part of the remediation of the South Plants Central Processing Area (Section 17.2). Groundwater compliance monitoring is performed to evaluate the potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 16.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

16.5.7.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment and immobilization of contaminants. Solidification eliminates exposure pathways and reduces migration of contaminants to groundwater by rainwater infiltration. Significant short-term risks are associated with agent clearance and in situ treatment.

16.5.7.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources, monitoring of solidified soil, and endangered species. Location-specific ARARs are met as the pits are not located in wetlands or a 100-year flood plain. In addition to the ARARs, this alternative also complies with provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

16.5.7.3 Long-Term Effectiveness and Permanence

The residual risks associated with this alternative are low. A total of 26,000 BCY of soil is solidified in place. There is high confidence in the immobilization of contaminants by solidification; however, monitoring of the soil is required. Revegetation of disturbed areas improves the existing habitat.

16.5.7.4 Reduction in TMV

Solidification interrupts exposure pathways and reduces the mobility of contaminants. This mobility reduction is irreversible so long as the integrity of the solidified materials is maintained. There are no residuals associated with the solidification process, but the solidified soil requires monitoring. Caustic-washing residuals from agent treatment are placed in the on-post hazardous waste landfill. TMV for the agent-contaminated soil is eliminated by caustic washing.

16.5.7.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with in situ treatment. Personal protective equipment adequately protects workers, and fugitive dust associated with excavation is controlled by water sprays. Any vapors/odors generated during treatment are collected in a hood and treated in the off-gas control system. Although the off-gas control system is designed to achieve air quality standards, the emissions from the in situ solidification unit contain low but acceptable levels of some contaminants. Solidification is feasible within 1 year, after 1 year for construction of the landfill. RAOs are achieved in 2 years.

16.5.7.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame. The alternative is administratively feasible since the regulations for in-place treatment are achieved. Volatile emissions and noxious odors are controlled during treatment with a hood associated with the solidification unit. Personnel and equipment are available for groundwater compliance monitoring.

16.5.7.7 Cost

The total present worth cost is $2,840,000, including $8,000, $2,510,000, and $323,000 for capital, operating, and long-term costs, respectively. Table B4.12-22 details the costing for this alternative. There is a low level of uncertainty associated with costing of in situ treatment.

16.6 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Buried M-1 Pits Subgroup contains 26,000 BCY of exceedance soil. The pits were used to treat waste fluids from the lewisite facility and were possibly used to treat spills from surrounding buildings. The pits were backfilled and are now covered with several feet of soil. Maximum concentrations of OCPs, HCCPD, DPCD, arsenic, cadmium, and mercury exceed Human Health SEC (EBASCO 1994a). Less than 1 percent of the samples for any individual OCP exceed Human Health SEC (EBASCO 1994a), but 42 percent of the arsenic samples and 21.6 percent of the mercury samples exceeded the Human Health SEC (EBASCO 1994a) (Table 16.4-2). Average concentrations of COCs in the human health exceedance volume are below the Human Health SEC (EBASCO 1994a), except for arsenic and mercury, which substantially exceed the Human Health SEC (EBASCO 1994a) (Table 16.4-1). Soil posing potential risk to biota is overlapped by the human health exceedance volume, so specific alternatives addressing biota were not developed.

Twenty three percent of the arsenic samples exceed the principal threat criteria, producing an exceedance area that encompasses the entire site. The entire site also has the potential for agent contamination based on the historical usage and has been identified as the source of groundwater contamination. To reduce odor and vapor emissions, and a vapor enclosure is used for excavation.

This subgroup predominantly consists of disturbed areas of vegetation. Alternatives that disrupt habitat include revegetation and restoration following remediation. No significant habitat impacts are expected, although alternatives that involve caps/covers require the exclusion of burrowing animals.

In summary, this subgroup contains soil that exceed Human Health SEC (EBASCO 1994a), and has an area of principal threat exceedances with high arsenic and mercury concentrations that encompasses the entire site. When comparing alternatives, the short-term risks of worker exposure and community impacts from the potential release of vapors and the use of vapor enclosures must be weighed against the longer-term risks of contaminant migration if soil is left in place.

Alternative 1: No Additional Action is not protective and does not achieve RAOs as soil with high levels of contamination and the potential presence of agent are left in place without treatment or controls. This alternative was eliminated from further consideration. The remaining six alternatives achieve RAOs, are protective of human health and the environment, and comply with action- and location-specific ARARs.

Alternative 3: Landfill achieves RAOs through containment; however, the excavation of the pits entails high potential short-term impacts due to the potential presence of agent, high levels of contamination, and the potential for vapor/odor emissions. These potential impacts can be reduced, but not eliminated, using engineering controls. In spite of the potential short-term impacts, this alternative is considered cost effective and was retained for further consideration.

Alternative 5: Caps/Covers; Slurry Walls achieves RAOs through in-place containment. Although short-term risks are minimal for in-place containment, the long-term risks involve leaving high concentrations of contamination in place using engineering controls to reduce risks. This alternative has the lowest cost among the protective alternatives ($1,020,000). Therefore, this alternative was retained for consideration in developing sitewide alternatives.

Alternative 10: Direct Solidification/Stabilization achieves RAOs through treatment and containment, and entails similar potential short-term impacts and engineering controls as landfilling (Alternative 3). This alternative is considered cost effective and was retained for further consideration.

Alternative 19: In Situ Thermal Treatment; In Situ Solidification/Stabilization achieves RAOs through in situ solidification. In situ RF heating reduces the organic contaminant concentrations to concentrations near PRGs; however, in situ solidification is the treatment technology that actually achieves PRGs. Thus, this alternative is not significantly more effective than

Alternative 22: In Situ Solidification/Stabilization. Furthermore, RF heating equipment is unavailable and unproven at full scale and has a high cost compared to other solidification alternatives. This alternative was therefore eliminated from further consideration.

Alternative 21: In Situ Thermal Treatment (in situ vitrification) has the highest cost ($24,400,000) of the alternatives for this subgroup. In addition, the technology for this alternative is not well demonstrated at full scale and has limited commercial availability. Based on the high cost and limited implementability, in situ vitrification was not retained for consideration in the development of the sitewide alternatives.

Alternative 22: In Situ Solidification/Stabilization achieves RAOs through solidification, in a manner similar to Alternative 10: Direct Solidification/Stabilization. Both in situ and direct solidification entail short-term risks associated with the control of vapors and odors. However, direct solidification/stabilization is more reliable than in situ solidification and allows for screening the entire site for the presence of agent; therefore, this alternative was eliminated from consideration in developing sitewide alternatives.

Consequently, the alternatives that were retained to represent the Buried M-1 Pits Subgroup in the development of the sitewide alternatives (Section 20) are as follows:

- Alternative 3: Landfill (On-Post Landfill)
- Alternative 5: Caps/Covers (Multilayer Cap); Vertical Barriers (Slurry Walls)
- Alternative 10: Direct Solidification/Stabilization (Cement-Based Solidification)

Table 16.0-1 Characteristics of the Lime Basins Medium Group

Characteristic	Section 36 Lime Basins Subgroup	Buried M-1 Pits Subgroup
Contaminants of Concern		
Human Health	OCPs, As	OCPs, HCCPD, DCPD, As, Hg
Biota	OCPs, As, Hg	not applicable
Exceedance Area (SY)		
Total	34,000	8,700
Human Health	34,000	8,700
Principal Threat	6,700	8,700
Biota	0	0
Potential Agent	34,000	8,700
Potential UXO	not applicable	not applicable
Exceedance Volume (BCY)		
Total	54,000	26,000
Human Health	54,000	26,000
Organic	52,000	1,700
Inorganic	2,100	26,000
Principal Threat		
Organic	9,000	22,000
Inorganic	5,400	16,000
Biota	0	0
Potential Agent	91	29
Potential UXO	not applicable	not applicable
Depth of Contamination (ft)		
Human Health	0-8	0-10
Biota	0-1	--

Table 16.1-1 Summary of Concentrations for the Section 36 Lime Basins Subgroup

Contaminants of Concern	Range of Concentrations[2] (ppm)	Average Concentration[2] (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL–1,700	190	71	720	3.8
Dieldrin	BCRL–780	90	41	410	3.7
Endrin	BCRL–400	41	230	230	56
Isodrin	BCRL–400	48	52	52,000	Not applicable
Chlordane	BCRL–240	25	55	3,700	12
p,p,DDE[1]	BCRL–13	1.9	1,250	12,500	Not applicable
p,p,DDT[1]	BCRL–2.6	0.06	410	13,500	14
Arsenic[1]	BCRL–900	100	420	4,200	270
Mercury[1]	BCRL–56	5.4	570	570,000	82

1 Presents biota risk but was detected in the human health exceedance volume.
2 Based on modeled concentrations within the human health exceedance volume or potential biota risk area.

Table 16.1-2 Frequency of Detections for Section 36 Lime Basins Subgroup

	Total Samples Analyzed	BCRL Number	BCRL %	CRL-SEC(1) Number	CRL-SEC(1) %	Acute-HH SEC(2) Number	Acute-HH SEC(2) %	HH SEC-Pr. Threat(2) Number	HH SEC-Pr. Threat(2) %	>Pr. Threat(2) Number	>Pr. Threat(2) %
Aldrin	156	89	57.1%	38	24.4%	14	9.0%	13	8.3%	2	1.3%
Benzene	51	45	88.2%	6	11.8%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	52	52	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlordane	145	123	84.8%	19	13.1%	2	1.4%	1	0.7%	0	0.0%
Chloroacetic Acid	49	49	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlorobenzene	53	48	90.6%	5	9.4%	--	--	0	0.0%	0	0.0%
Chloroform	52	37	71.2%	15	28.8%	--	--	0	0.0%	0	0.0%
p,p,DDE	157	126	80.3%	31	19.7%	--	--	0	0.0%	0	0.0%
p,p,DDT	156	133	85.3%	23	14.7%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	147	140	95.2%	7	4.8%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	52	52	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	25	25	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	146	139	95.2%	7	4.8%	--	--	0	0.0%	0	0.0%
Dieldrin	155	64	41.3%	67	43.2%	16	10.3%	6	3.9%	2	1.3%
Endrin	156	95	60.9%	60	38.5%	0	0.0%	1	0.6%	0	0.0%
Hexachlorocyclopentadiene	145	135	93.1%	10	6.9%	--	--	0	0.0%	0	0.0%
Isodrin	156	101	64.7%	50	32.1%	--	--	5	3.2%	0	0.0%
Methylene Chloride	46	43	93.5%	3	6.5%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	11	11	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	52	46	88.5%	6	11.5%	--	--	0	0.0%	0	0.0%
Toluene	51	50	98.0%	1	2.0%	--	--	0	0.0%	0	0.0%
Trichloroethylene	52	51	98.1%	1	1.9%	--	--	0	0.0%	0	0.0%
Arsenic	159	59	37.1%	96	60.4%	0	0.0%	4	2.5%	0	0.0%
Cadmium	117	97	82.9%	20	17.1%	0	0.0%	0	0.0%	0	0.0%
Chromium	117	49	41.9%	68	58.1%	--	--	0	0.0%	0	0.0%
Lead	116	77	66.4%	39	33.6%	--	--	0	0.0%	0	0.0%
Mercury	160	79	49.4%	81	50.6%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.
(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.
-- not applicable

Table 16.2-1 Comparative Analysis of Alternatives for the Section 36 Lime Basins Subgroup

Criteria	Alternative 1: No Additional Action	Alternative 3b: Landfill; Caps/Covers	Alternative 6: Caps/Covers	Alternative 13d: Direct Thermal Desorption; Direct Solidification/Stabilization; Caps/Covers	Alternative 19b: In Situ Thermal Treatment; In Situ Solidification/Stabilization; Caps/Covers
1. Overall protection of human health and the environment	Human Health RAOs achieved by existing IRA soil cover; groundwater impacts and biota exposure not reduced	Protective: Achieves Human Health and Biota RAOs through containment; impacts to groundwater greatly reduced	Protective: Achieves Human Health and Biota RAOs through containment; impacts to groundwater reduced	Protective: Achieves Human Health and Biota RAOs through treatment and containment; impacts to groundwater reduced	Protective: Achieves Human Health and Biota RAOs through treatment and containment; impacts to groundwater reduced
2. Compliance with ARARs	Complies	Complies	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Moderate Residual Risk: High contamination levels and potential agent remain under existing IRA soil cover	Minimal Residual Risk: Contaminated soil removed and/or contained	Low Residual Risk: Contaminated soil contained in place	Minimal Residual Risk: Human health exceedances treated, balance of contaminated soil contained	Low Residual Risk: Human health exceedances treated, balance of contaminated soil contained
4. Reduction in TMV	Limited mobility reduction by existing soil cover; TMV reduction otherwise by natural attenuation only	Mobility of contaminants reduced by containment; toxicity and volume not reduced	Mobility of contaminants reduced through containment; toxicity and volume not reduced	Thermal desorption reduces organics to below PRGs; mobility reduced for balance of site by treatment and containment	TMV reduced by treatment; mobility reduced for treated soil and balance of contaminants through containment
5. Short-term effectiveness	No risk to workers; contaminant migration to groundwater continues although reduced; RAOs achieved in more than 30 years	Significant risk to workers and community during agent screening and excavation, and transportation and disposal of human health exceedance soil; RAOs achieved in 2 years	Minimal risk to workers and the community; no intrusive action; RAOs achieved in 1 year	Significant risk to workers and community during agent screening, excavation, transportation, and treatment of human health exceedances; RAOs achieved in 3 years	Significant risks to workers and community during agent screening and in situ treatment; RAOs achieved in 2 years
6. Implementability	Feasible	Feasible	Feasible	Technically feasible; administrative difficulty for thermal desorption	Not currently implementable since full-scale in situ heating units are not available
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$732,000 Total—$732,000	Capital—$2,090,000 Operating—$2,550,000 Long-term—$268,000 Total—$4,900,000	Capital—$0 Operating—$2,800,000 Long-term—$405,000 Total—$3,210,000	Capital—$1,690,000 Operating—$10,400,000 Long-term—$202,000 Total—$12,200,000	Capital—$13,200,000 Operating—$22,200,000 Long-term—$395,000 Total—$35,800,000
Summary	Not Retained: Biota and long-term groundwater protection not achieved by existing IRA soil cover	Retained: Contaminated soil contained; cost effective	Retained: Contaminated soil contained in place	Not Retained: High cost for larger treatment volume without reducing long-term risk compared to containment	Not Retained: Not commercially available, high cost, long-term risks not reduced compared to containment alternatives.

Table 16.4–1 Summary of Concentrations for the Buried M-1 Pits Subgroup

Contaminants of Concern	Range of Concentrations[1] (ppm)	Average Concentration[1] (ppm)	Human Health SEC (ppm)	Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL–27	0.55	71	720	3.8
Dieldrin	BCRL–36	0.82	41	410	3.7
Isodrin	BCRL–7.1	0.099	52	52,000	Not applicable
HCCPD	BCRL–1,300	44	1,100	NA	13,000
DCPD	BCRL–7,800	195	3,700	NA	54,000
Cadmium	BCRL–2,400	320	530	24,000	140
Arsenic	27–100,000	17,000	420	4,200	270
Mercury	1.3–83,000	4,300	570	570,000	82

1 Based on modeled concentrations within the human health exceedance volume or potential biota risk area.

	Total Samples	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
	Analyzed	Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	130	119	91.5%	8	6.2%	2	1.5%	1	0.8%	0	0.0%
Benzene	67	66	98.5%	1	1.5%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	67	67	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlordane	124	113	91.1%	11	8.9%	0	0.0%	0	0.0%	0	0.0%
Chloroacetic Acid	53	48	90.6%	5	9.4%	--	--	0	0.0%	0	0.0%
Chlorobenzene	67	67	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chloroform	67	67	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
p,p,DDE	131	127	96.9%	4	3.1%	--	--	0	0.0%	0	0.0%
p,p,DDT	131	128	97.7%	3	2.3%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	122	122	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	67	67	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	25	25	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	123	94	76.4%	27	22.0%	--	--	2	1.6%	0	0.0%
Dieldrin	129	106	82.2%	16	12.4%	6	4.7%	1	0.8%	0	0.0%
Endrin	135	129	95.6%	6	4.4%	0	0.0%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	133	124	93.2%	8	6.0%	--	--	1	0.8%	0	0.0%
Isodrin	116	109	94.0%	7	6.0%	--	--	0	0.0%	0	0.0%
Methylene Chloride	63	57	90.5%	6	9.5%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	35	35	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	67	67	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Toluene	63	60	95.2%	3	4.8%	--	--	0	0.0%	0	0.0%
Trichloroethylene	67	67	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Arsenic	126	12	9.5%	60	47.6%	1	0.8%	24	19.0%	29	23.0%
Cadmium	64	31	48.4%	26	40.6%	0	0.0%	7	10.9%	0	0.0%
Chromium	64	22	34.4%	41	64.1%	--	--	1	1.6%	0	0.0%
Lead	64	22	34.4%	42	65.6%	--	--	0	0.0%	0	0.0%
Mercury	125	18	14.4%	75	60.0%	5	4.0%	27	21.6%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.

(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.

-- not applicable

Criteria	Alternative 1: No Additional Action	Alternative 3: Landfill	Alternative 5: Caps/Covers; Vertical Barriers	Alternative 10: Direct Solidification/Stabilization
1. Overall protection of human health and the environment	Not Protective: Soil remains with high levels of contamination; groundwater impacts not reduced	Protective: RAOs achieved through containment; impacts to groundwater greatly reduced	Protective: RAOs achieved through containment; impacts to groundwater greatly reduced	Protective: RAOs achieved through treatment and containment; impacts to groundwater greatly reduced
2. Compliance with ARARs	Does not comply with Army regulations on agent contamination	Complies	Complies	Complies
3. Long-term effectiveness and permanence	High Residual Risk: 26,000 BCY principal threat soil remains in place	Minimal Residual Risk: Entire volume removed and contained	Low Residual Risk: Protection provided by containment, dewatering	Minimal Residual Risk: PRGs achieved through solidification
4. Reduction in TMV	Natural attenuation not effective for 26,000 BCY of inorganic contamination	Mobility reduced for 26,000 BCY of landfilled soil	Mobility reduced for 26,000 BCY through containment	Mobility eliminated for solidified soil (26,000 BCY)
5. Short-term effectiveness	No implementation required; RAOs not achieved	High short-term risks during agent screening and excavation of contaminated soil (reduced by vapor enclosure but not eliminated); RAOs achieved in 2 years	Low short-term risks; no intrusive activities conducted; RAOs achieved in 1 year	High short-term risks during excavation of contaminated soil (reduced by vapor enclosure but not eliminated); RAOs achieved in 2 years
6. Implementability	Feasible	Feasible: No difficulties anticipated except for vapor enclosure	Feasible	Feasible: No difficulties anticipated except for vapor enclosure
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$670,000 Total—$670,000	Capital—$2,380,000 Operating—$1,510,000 Long-term—$18,000 Total—$3,910,000	Capital—$171,000 Operating—$553,000 Long-term—$291,000 Total—$1,020,000	Capital—$2,470,000 Operating—$3,400,000 Long-term—$160,000 Total—$6,030,000
Summary	Not Retained: Not protective of human health and the environment; RAOs not achieved	Retained: Containment provides protection although high risks and difficulties associated with excavation; cost effective	Retained: Containment in-place provides protection; lowest cost	Retained: Treatment provides protection although high risks and difficulties associated with excavation; cost effective

Table 16.5-1 Comparative Analysis of Alternatives for the Buried M-1 Pits Subgroup

Criteria	Alternative 19: In Situ Thermal Treatment; In Situ Solidification/Stabilization	Alternative 21: In Situ Thermal Treatment	Alternative 22: In Situ Solidification/Stabilization
1. Overall protection of human health and the environment	Protective: RF heating lowers organic concentrations, but RAOs achieved through solidification; impacts to groundwater greatly reduced	Protective: Achieves RAOs through treatment; impacts to groundwater greatly reduced	Protective: RAOs achieved through treatment and containment
2. Compliance with ARARs	Complies	May not comply with Army regulations on agent contamination regarding approved method of treatment	Complies
3. Long-term effectiveness and permanence	Low Residual Risk: Soil solidified to achieve PRGs	Minimal Residual Risk: PRGs achieved through vitrification	Low Residual Risk: PRGs achieved through solidification
4. Reduction in TMV	Mobility reduced for solidified soil (26,000 BCY)	TMV reduced for vitrified soil	Mobility reduced for solidified soil (26,000 BCY)
5. Short-term effectiveness	High short-term risks during in situ treatment; RAOs achieved in 2 years	Significant short-term risks during in situ treatment; RAOs achieved in 2 years	Significant short-term risks during in situ treatment; RAOs achieved in 2 years
6. Implementability	Not currently implementable since full-scale in situ heating units are not available	Very limited number of full-scale treatment units available; technology not demonstrated	Feasible
7. Present worth costs	Capital—$13,300,000 Operating—$3,120,000 Long-term—$323,000 Total—$16,700,000	Capital—$1,120,000 Operating—$22,600,000 Long-Term—$638,000 Total—$24,400,000	Capital—$8,000 Operating—$2,510,000 Long-Term—$323,000 Total—$2,840,000
Summary	Not Retained: Not commercially available and high cost compared to other solidification alternatives	Not Retained: High cost for vitrification and limited implementability	Not Retained: Less protective than direct solidification

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 16.0-1

Site Locations
Lime Basins Medium Group

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 16.1-1

Exceedance Areas
Section 36 Lime Basins Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

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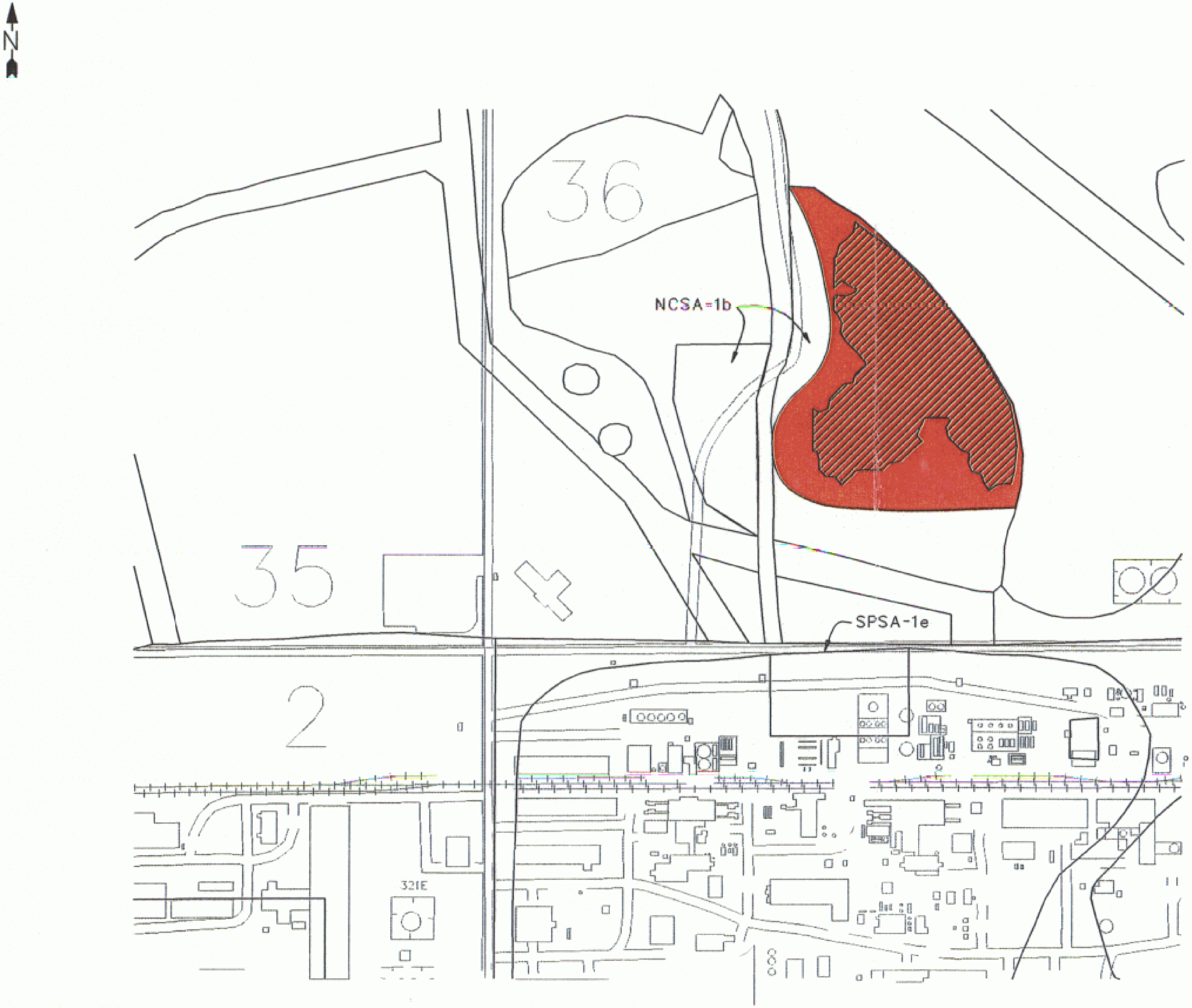

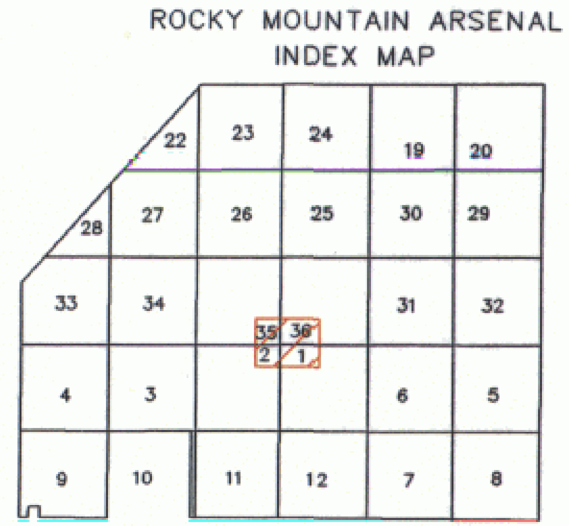

LEGEND

Human Health Exceedance Area

Potential Agent Presence Area

Site Boundary

Buildings and Roads

36 Section Number

150 0 150 300 FEET

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

FIGURE 16.1-2

Potential Agent Presence Area
Section 36 Lime Basins Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

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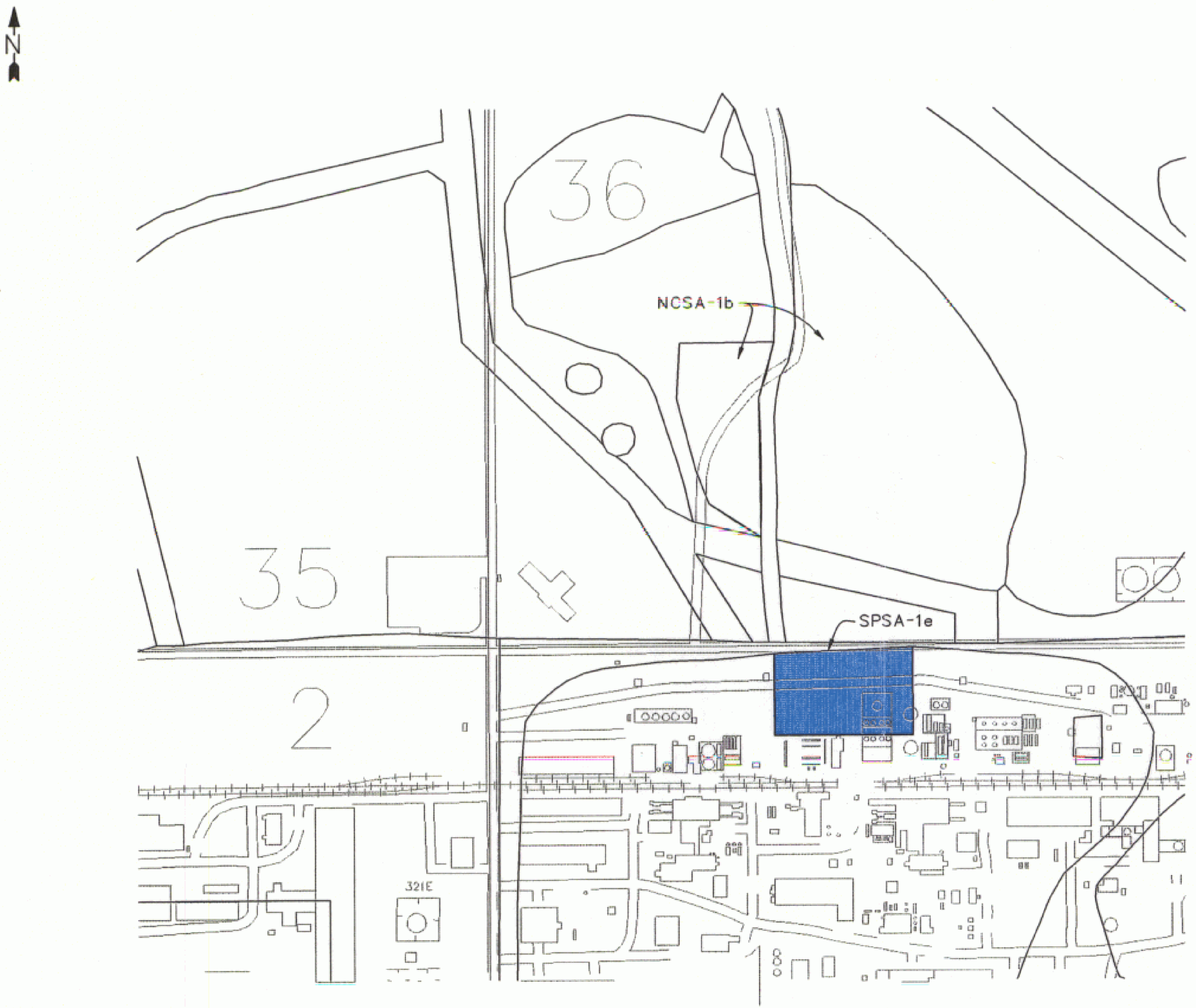

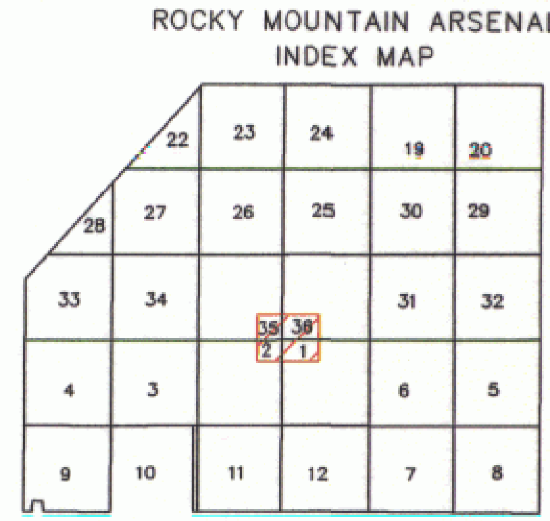

LEGEND

Principal Threat Exceedance Area (Human Health Exceedance Area)

Site Boundary

Buildings and Roads

36 Section Number

150 0 150 300 FEET

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 16.4-1

Exceedance Areas
Buried M-1 Pits Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

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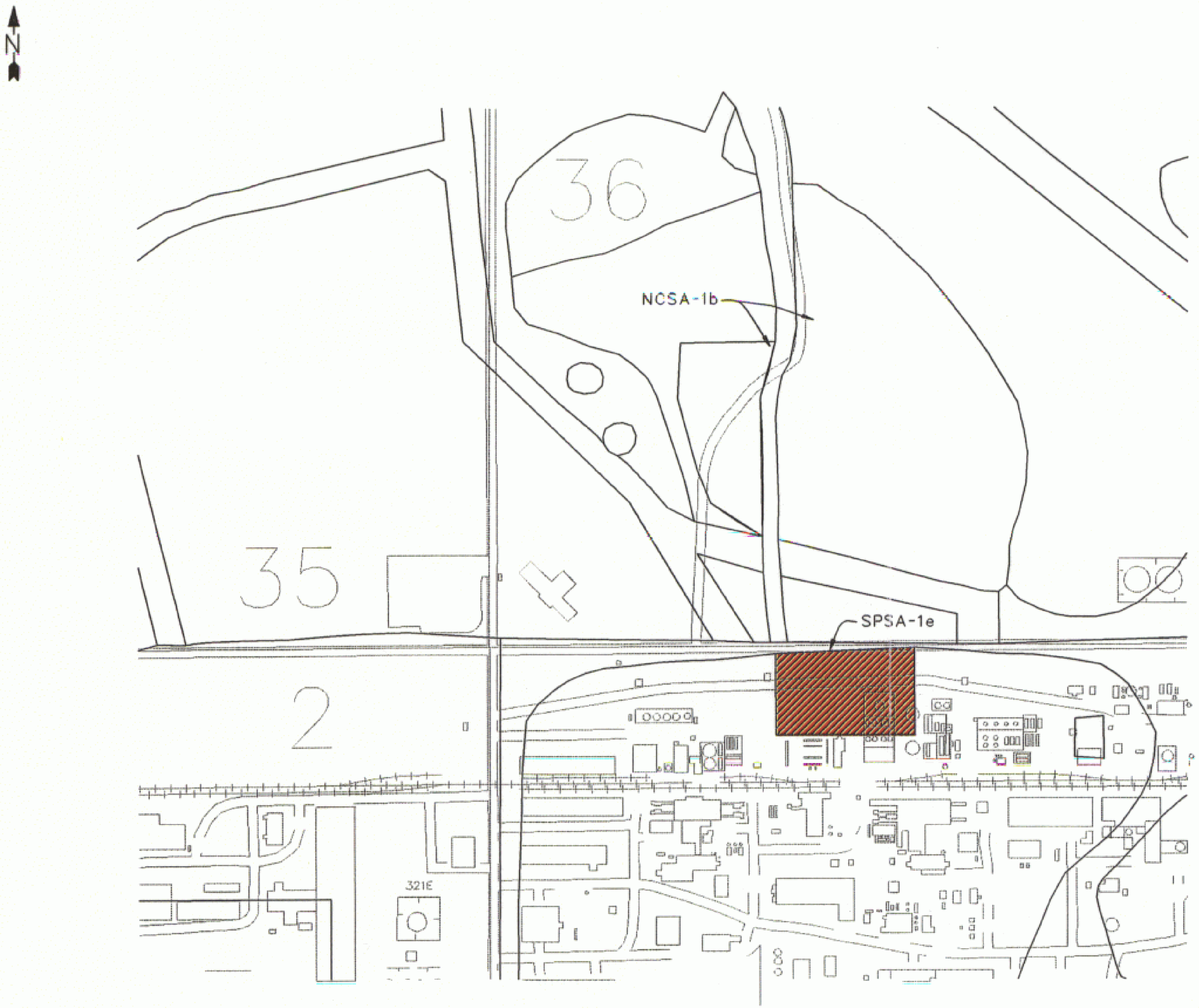
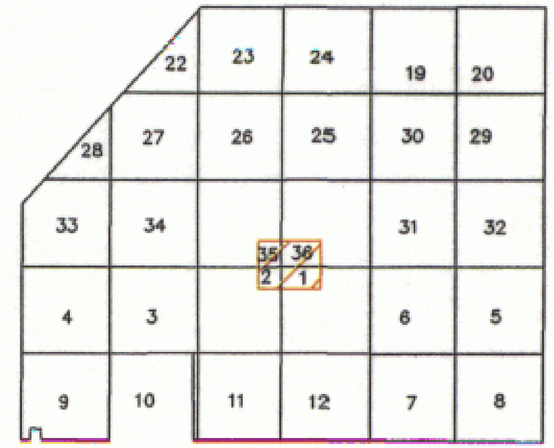


ROCKY MOUNTAIN ARSENAL
INDEX MAP



LEGEND

- Human Health Exceedance Area
- Potential Agent Presence Area
- Site Boundary
- Buildings and Roads
- 36 Section Number

150 0 150 300 FEET

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 16.4-2

Potential Agent Presence Area
Buried M-1 Pits Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

17.0 DETAILED ANALYSIS OF ALTERNATIVES FOR THE SOUTH PLANTS MEDIUM GROUP

The South Plants Medium Group consists of 30 sites located within the South Plants Study Area. Processing areas, drainage ditches, tank farms, and storage area site types are included in this medium group. Contamination in the South Plants manufacturing complex is a result of agent manufacturing or demilitarization and chemical manufacturing, storage, or disposal processes. The sites are grouped together by type and contamination pattern to form three subgroups: South Plants Central Processing Area, South Plants Ditches, and South Plants Balance of Areas. A fourth subgroup—the South Plants Tank Farm Subgroup—was moved into the South Plants Balance of Areas Subgroup because the final IEA/RC report (EBASCO 1994a) indicated minimal risk of indirect exposure from VOCs in the area, which did not justify the development of separate alternatives (see Section 17.7). The volatiles that do exist in the area are associated with light nonaqueous phase liquid (LNAPL), and are addressed in the Water DAA. Soil from subgroups located in the north-central portion of South Plants potentially contain agent, and a small portion of the soil in some parts of the South Plants Balance of Areas Subgroup potentially contains UXO. Figure 17.0-1 shows the locations of the subgroups and their related sites.

Sites within this medium group are identified as being principal threat areas and potential sources of groundwater contamination, and portions of the medium group contain soil with concentrations that may pose a potential risk to biota. OCPs, VOCs, and ICP metals are the primary Human Health COCs and the primary contaminants posing potential risk to biota, although CLC2A, DBCP, HCCPD, arsenic, and mercury are also present at concentrations exceeding the Human Health SEC (EBASCO 1994a). Table 17.0-1 presents the characteristics of the subgroups, including exceedance volumes and areas and COCs, and Appendix A of Volume IV presents a summary of volume and exceedance area calculations.

In the DSA (EBASCO 1992b), alternatives were developed and screened based on the general characteristics of the medium group. In the DAA, the characteristics of the three subgroups—including contaminants and concentrations, site configuration, and depth of contamination—were evaluated to determine the subset of applicable alternatives from the range of alternatives retained in the DSA (EBASCO 1992b) for the medium group. The alternative involving soil vapor extraction was removed based on a re-evaluation of the risks associated with indirect exposure from VOCs as presented in the final IEA/RC report (EBASCO 1994a) as discussed in Section 17.7. An alternative involving the installation of a single low-permeability soil cap was considered for all three subgroups to evaluate the effectiveness of demolishing structures and containing the structural debris in place along with the soil. The area required for the low-permeability soil cap for the South Plants Balance of Areas Subgroup is larger than the exceedance area to allow for the demolition of structures and in-place containment of the exceedance soil and debris.

The following sections present the characteristics of each subgroup, an evaluation of the retained alternatives against the DAA criteria listed in the NCP (EPA 1990a), and the selection of alternatives, based on a comparative analysis that was considered in the development of the sitewide alternatives (Section 20).

17.1 SOUTH PLANTS CENTRAL PROCESSING AREA SUBGROUP CHARACTERISTICS

The South Plants Central Processing Area Subgroup is composed of site SPSA-1a (Central Processing Area) (Figure 17.0-1). This site contains soil that was contaminated by manufacturing or processing activities in South Plants. Approximately 38,000 BCY of contaminated soil within this subgroup are considered a principal threat (Table 17.0-1), and the remaining 72,000 BCY of human health exceedances are generally located beneath the principal threat volume. In addition, 27,000 BCY of soil that pose a potential risk to biota. The principal threat, human health, and potential biota risk areas are shown in Figure 17.1-1. There are 98,000 SY of soil that potentially contain agent in this subgroup (Figure 17.0-1). The potential agent area is shown in Figure 17.1-2.

Table 17.1-1 provides a summary of contaminants, concentrations, and corresponding exceedance volumes for the South Plants Central Processing Area Subgroup, and Table 17.1-2 summarizes the frequency of detections. OCPs, VOCs, CLC2A, DBCP, HCCPD, arsenic, mercury, and ICP metals are present in 110,000 BCY at maximum concentrations typically one to two orders of magnitude above the Human Health SEC (EBASCO 1994a). These COCs are detected at depths ranging from 0 to 10 ft below ground surface. However, due to the unique nature of this area (buried utilities and sewers), a depth unit of 5 feet was selected for excavation in this site. The average concentrations of all COCs do not exceed the principal threat criteria. There are 27,000 BCY of soil within this subgroup that contain contaminants at concentrations that only pose a potential risk to biota.

The area within the South Plants Central Processing Area Subgroup exhibits areas of disturbed vegetation although some mammals and birds use the structures in the area for shelter. Remedial actions involving caps/covers therefore do reduce the amount of available habitat as the types of vegetation and the maintenance activities performed are designed to restrict animals from the area. However, the areas disturbed during the actions are revegetated with native grasses, thereby improving the overall habitat quality.

Site SPSA-1a has been identified as the source of several groundwater contamination plumes that occur in the unconfined aquifer and migrate away from the site. Groundwater alternatives that address the installation of individual plume remediation systems are being evaluated. Coordination of alternatives developed for the soil medium with those developed for the water medium is limited to excavation or capping. Due to the contaminant mass already in the aquifer, it is unlikely that the remediation of this subgroup would impact the groundwater quality in the short term, although it would prevent additional contaminant loading of the groundwater.

Some of the contaminated soil in the South Plants Central Processing Area Subgroup is located beneath structures (Figure 17.1-1) which belong to the No Future Use, Significant Contamination History Subgroup, No Future Use, Other Contamination History Subgroup, and No Future Use, Agent History Medium Group in the structures medium. The treatment or landfilling of contaminated soil beneath these structures requires the demolition of the structures and removal of structural debris. The capping of soil within the South Plants Central Processing Area Subgroup also requires the demolition of structures, but the structural debris from the No Future Use, Other Contamination History Subgroup could be contained beneath the cap. The structures alternatives developed for this area consider the backfill of the foundation excavations with borrow material; however, timing the backfilling of the excavations and the backfill materials used is dependent upon which soil alternative is selected for the South Plants Central Processing Area Subgroup.

17.2 SOUTH PLANTS CENTRAL PROCESSING AREA SUBGROUP EVALUATION OF ALTERNATIVES

The eight alternatives for the South Plants Central Processing Area Subgroup involve no action, containment, and treatment. The alternatives retained from the DSA (EBASCO 1992b) were modified as follows to account for the treatment of principal threat volumes and containment of residual contamination. The containment alternative (Alternative 6) was modified to exclude slurry walls based on the evaluation of groundwater removal and dewatering alternatives; in addition this alternative addresses the containment of the South Plants Medium Group as a whole. The vacuum extraction alternative was not evaluated for this subgroup since VOCs, which are the focus of vacuum extraction, are not present in a significant portion of the exceedance volume and the air permeability of the soil in this area (based on an in situ treatability study) is too low. The in situ surface soil treatment alternative (Alternative 20), which consists of multiple direct treatment technologies addressing predominantly surficial contamination, was not evaluated since high levels of contamination are located at greater depths below ground surface. The following subsections present a description of each retained alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a). The alternatives for this subgroup consist of a component to address human health exceedances (which is listed first), a component to address areas that pose potential risk to biota (the "B" alternative), and a component to address potential agent presence (the "A" alternative).

17.2.1 Alternative 1/B1/A1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA), along with Alternatives B1: No Additional Action (Provisions of FFA) and A1: No Additional Action (Provisions of FFA), applies to all 220,000 SY of soil with human health exceedances and potential risk to biota in the South Plants Central Processing Area Subgroup. The 140,000 BCY of soil with human health exceedances, potential risk to biota, and potential agent presence remain in place. No action is taken to reduce human health or biota exposure to COCs, prevent the acute chemical hazards from agent, or reduce migration of contaminants to groundwater from sites in this subgroup. Exceedance areas are monitored (an average of 27 samples per year), annual groundwater monitoring is conducted, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.2.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve RAOs since no controls are implemented and soil with potential agent presence remains at the site. Long-term reduction in toxicity of contaminants is due to natural attenuation/degradation only. Impacts to groundwater are not reduced.

17.2.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs since long-term monitoring and site reviews are conducted and the Central Processing Area is not located in wetlands or a 100-year flood plain. In addition to ARARs, the alternative complies with provisions of the FFA (EPA et al. 1989), but does not achieve Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding the control of agent-contaminated materials. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.2.1.3 Long-Term Effectiveness and Permanence

The residual risk for human health and biota exposure is high since OCPs, volatiles, CLC2A, DBCP, HCCPD, arsenic, mercury, and ICP metals above the Human Health SEC (EBASCO 1994a) remain in the soil and continue to potentially impact human health and biota. In addition, soil with the potential presence of agent remains. Site reviews and long-term soil and groundwater monitoring are required. The existing habitat is not impacted by this remedial alternative.

17.2.1.4 Reduction in TMV

There is no reduction in TMV except by natural attenuation/degradation. The 140,000 BCY of untreated soil remain as does residual contamination more than 5 ft below ground surface. In addition, there is no reduction in potential hazard related to agent. There are no treatment residuals associated with this alternative.

17.2.1.5 Short-Term Effectiveness

Workers and the community are not affected by this alternative, and fugitive dust and vapor emissions are not anticipated. There are no additional environmental impacts, but migration of contaminants to groundwater continues. The existing habitat is not impacted by the alternative. The time frame to achieve RAOs is greater than 30 years since natural attenuation/degradation is the only process by which contamination can be reduced.

17.2.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are readily available.

17.2.1.7 Cost

The total present worth cost is $2,130,000 and includes only long-term O&M costs associated with long-term monitoring and site reviews. Table B4.13-1 details the costing for this alternative. The cost uncertainty associated with site reviews and monitoring is low.

17.2.2 Alternative 1b/B1/A1: Direct Thermal Desorption and Direct Solidification/Stabilization of Principal Threat Volume; No Additional Action

Alternative 1b: Direct Thermal Desorption (Direct Heating) and Direct Solidification/Stabilization (Cement-Based Solidification) of Principal Threat Volume; No Additional Action (Provisions of FFA), along with Alternative B1: No Additional Action (Provisions of FFA) and Alternative A1:

No Additional Action (Provisions of FFA), involves the treatment of 38,000 BCY of principal threat exceedances in the South Plants Central Processing Area Subgroup. During excavation, the principal threat soil is screened for the presence of agent with real-time monitoring equipment. If agent is identified, the soil is placed in a controlled stockpile and agent presence is confirmed by RMA laboratory analysis. The soil containing agent is treated by caustic solution washing (Alternative A3). This treated soil is then landfilled.

Alternatives developed for structures located in this subgroup must be coordinated with this alternative because remediation of the principal threat areas requires demolition and removal of overlying structures. Existing buried utilities are removed during excavation and consolidated with the structural debris. Due to the potential for odor problems, excavation is conducted so that a minimal area is uncovered and exposed at any one time, and daily soil covers or plastic liners are installed over excavated areas to further minimize odor emissions. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed.

The principal threat volume of 38,000 BCY is excavated and transported to the centralized treatment facility for thermal desorption and solidification. (Sections 4.6.24 and 4.6.23 discuss details of these technologies.) The principal threat soil is considered to be close to saturation (i.e., moisture content of 20 percent). Based on this moisture content, the thermal desorber processes the soil at a rate of approximately 1,300 BCY/day at a discharge temperature of 300°C, assuming a total soil residence time of 50 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) The 380 BCY of particulates from the scrubber blowdown equipment, approximately 1 percent of the solids feed, are disposed in the on-post hazardous waste landfill. Construction of the thermal desorber facility takes 1 year, and 1 additional year is required for testing.

The 1,500 BCY of principal threat soil with high concentrations of inorganic contamination (Volume IV, Table 14-3) are treated in the adjacent cement-based solidification facility (Section 4.6.23). The inorganic contaminants in the soil are immobilized by mixing cement with the soil at a ratio of 0.2 tons of cement per 1 ton of soil. The solidified soil expands to a volume of 2,100 BCY due to the addition of the binding materials and bulking from excavation. Treated soil from both treatment processes is returned as backfill to the sites. A minimum of 4 ft of treated soil from thermal desorption is recontoured over the solidified soil to ensure the integrity of the solidified materials and to prevent freeze/thaw degradation of the materials. Since thermal desorption removes much of the organic content in the soil, the disturbed area is covered with 6 inches of reconditioned soil and revegetated with native grasses to improve the quality of the habitat at the site. Long-term monitoring of the solidified materials and maintenance of the soil cover is required.

No action is taken for the remaining 100,000 BCY to reduce potential human or biota exposure to COCs or to prevent potential acute chemical hazards from agent. The potential for groundwater contamination via continued leaching from the residual contamination is not reduced. Based on the volume of soil and average concentration of COCs removed, the residual risk is low. Exceedance areas are monitored (an average of 27 samples per year), annual groundwater monitoring is conducted, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.2.2.1 Overall Protection of Human Health and the Environment

Although the principal threat volume is treated, this alternative does not achieve RAOs since untreated soil remains without controls being implemented. Long-term reduction in the toxicity of the contaminants is achieved through natural attenuation/degradation in the areas not treated. RAOs are achieved for the principal threat volume through treatment/immobilization. Blowdown solids are placed in an on-post hazardous waste landfill. Groundwater impacts are reduced through treatment of the principal threat volume, but impacts continue since residual shallow and deeper contaminated soil remains on site. The short-term risks associated with agent clearance and excavation of contaminated soil are significant.

17.2.2.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources and landfill siting, design, and operation and with the FFA (EPA et al. 1989). Endangered species are not impacted. Monitoring of solidified material is required. The Central Processing Area, treatment facilities, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. With the exception of the 100,000 BCY that are not treated or contained, this alternative also complies with Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.2.2.3 Long-Term Effectiveness and Permanence

The residual risk is moderate since 38,000 BCY of principal threat soil are thermally desorbed to achieve PRGs and 1,500 BCY are solidified and backfilled. The 100,000 BCY of shallow, untreated soil and the deeper residual contamination are not controlled, but natural attenuation/degradation is ongoing. Approximately 1 percent of soil feed recovered from off-gas treatment equipment is placed in an on-post landfill. Most of the areas potentially containing agent are located within the principal threat area and are screened during excavation. However, soil with potential agent presence remains on site. There is high confidence in engineering controls associated with the immobilization of the inorganic compounds, although monitoring of solidified soil is required. In addition, site reviews and long-term soil and groundwater monitoring are required for the remaining untreated soil. Habitat is improved for the principal threat area through revegetation, but the existing habitat at the untreated area is not changed.

17.2.2.4 Reduction in TMV

The 38,000 BCY of principal threat volume are thermally desorbed to degrade organic compounds, thereby interrupting human exposure pathways. The mobility of contaminants in 1,500 BCY is reduced by solidification. There is no reduction in contaminant volume or mobility except by natural attenuation/degradation for the balance of the site. Most of the areas potentially containing agent are screened during the excavation of the principal threat volume, and any agent identified is treated by caustic washing. There is no reduction in potential hazards related to agent in the balance of the site. The organic compounds in the principal threat volume are reduced to below detection levels or >99.99 percent DRE, and the mobility of the inorganic compounds is eliminated in the solidified principal threat volume. Quench blowdown solids from off-gas treatment equipment are contained in an on-post landfill. TMV reduction by thermal desorption is irreversible. TMV reduction by solidification is only reversible should the integrity of the solidified mass be compromised.

17.2.2.5 Short-Term Effectiveness

This alternative entails significant short-term risks to workers and the community during agent screening and excavation, transportation, and treatment of the principal threat volume. These risks are reduced through the use of personal protective equipment and engineering controls, but they cannot be completely removed. Dust potentially generated during preparation of the feedstock is addressed by conducting materials-handling activities in an enclosed building. In addition, fugitive dust that may affect the community is controlled through water sprays, and odor emissions are controlled by limited excavation and daily soil covers or plastic covers. However, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards, the emissions from the thermal desorber contain low but acceptable levels of some contaminants. There are minimal impacts to the existing habitat. Migration of contaminants to the groundwater is reduced through treatment of the principal threat volume. However, the time frame to achieve RAOs for the residual untreated soil is greater than 30 years. Thermal desorption of 38,000 BCY is feasible within 1 year after 2 years for construction of the thermal desorption facility and landfill, assuming that there are no operational problems with the thermal desorber. Solidification of 1,500 BCY is feasible within 1 year. In addition, natural attenuation of the contamination in the untreated soil is ongoing. Soil with potential agent remains in the untreated volume.

17.2.2.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited applicability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the contaminated soil. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, high moisture content, high clay content, presence of debris remaining in the soil feed after structures demolition, and materials-handling problems. Administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. Demolition and removal of structures, monitoring of solidified soil, and landfill-cell monitoring are required. Additional remedial actions are easily undertaken for soil left in place. The alternative is administratively feasible relative to landfill siting, design, and operating regulations. Equipment, specialists, and materials are readily available for construction of the landfill and for solidification, and both the landfill and solidification technologies have been well demonstrated at full scale. Resources for groundwater compliance are available.

17.2.2.7 Cost

The total present worth cost is $8,090,000 including $1,133,000, $5,020,000, and $1,940,000 for capital, operating and long-term costs, respectively. Table B4.13-1b details the costing for this alternative. There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate. Second, there is little operating experience at other sites upon which to base an evaluation of the costs and performance of the vapor/odor controls, and their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high moisture and clay content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

17.2.3 Alternative 3b/B5/A3: Landfill; Caps/Covers

For the South Plants Central Processing Area Subgroup, Alternative 3b: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap), combined with Alternative B5: Caps/Covers (Multilayer Cap) and Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), consists of landfilling 110,000 BCY of soil with human health exceedances. After landfilling, the area is covered with a soil cover to contain residual contamination (more than 5 ft below ground surface) and soil that may pose a risk to biota.

Prior to excavation, all of the structures (including foundations) within the South Plants Central Processing Area must be demolished and removed, which limits the alternatives currently being evaluated for structures in this area. Utilities under the South Plants Central Processing Area are also excavated (to a depth of 5 ft) and consolidated with the structural debris. Dewatering is not anticipated to be required based on the projected reduction in groundwater elevation after the manmade influences (i.e., leaking sewers) are removed. During excavation, a minimal area is exposed at any one time to reduce potential odor problems, and daily soil cover or plastic liners are placed over each excavation to further control odor emissions.

The 110,000 BCY of human health exceedances are excavated and placed in the centralized, multiple-cell landfill. Construction of the first cell and associated facilities takes 1 year. (Section 4.6.6 discusses construction of the landfill in detail.) After disposal is complete, the landfill cover is installed and revegetated. Access restrictions (fencing and biota barriers) eliminate the landfill as available habitat. The landfill requires long-term maintenance of the cover, leachate collection and treatment, and monitoring of potential leachate migration.

Following excavation operations, the area is backfilled with material from the on-post borrow area and prepared for the installation of a soil cover. Approximately 560,000 BCY of gradefill materials are required to achieve the design grade for the cover. Alternatively, soil posing risk to biota from other portions of South Plants (380,000 BCY) may be utilized as backfill and/or gradefill within the South Plants Central Processing Area prior to capping. The levels of contamination in the consolidated soil used as gradefill would be lower than the contaminated soil remaining in the South Plants Central Processing Area. The cover consists of a 1-ft-thick biota barrier of crushed concrete and a 4-ft-thick soil/vegetation layer that includes 6 inches of soil supplemented with conditioners to promote the growth of vegetation. After placement of the cover, the area is revegetated with native grasses. The types of vegetation and maintenance activities are designed to discourage burrowing animals from using the covered area as habitat. The covering operations take 1 year to complete following the demolition of structures and clearing of debris, and excavation of the human health exceedance volume.

The South Plants Central Processing Area contains 98,000 SY of soil with potential agent presence. This soil volume is screened for agent during excavation using real-time field analytical methods. Any soil with potential agent presence is stockpiled in a secure area while the presence of agent is confirmed by RMA laboratory. Any confirmed agent-contaminated soil is treated by caustic washing. (Section 4.4.3 discusses the details of caustic washing.) Operating parameters of the caustic washing unit include a processing rate of 35 BCY/day and a liquid waste stream of approximately 1,800 gallons/day. The liquid waste stream is evaporated with an evaporator/crystallizer. The evaporator/crystallizer generates approximately 1 pound of salts for every 7.5 gallons of liquid evaporated; these salts are placed in the on-post hazardous waste landfill. The treated soil is also landfilled on post.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.2.3.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through containment and treatment of agent-contaminated soil. Contaminated soil is contained in an on-post landfill, and residual contamination (more than 5 ft below ground surface) and soil that may pose a risk to biota is contained by a soil cover. Soil identified as containing agent is treated by caustic soil washing and is landfilled. Groundwater impacts are reduced. The short-term risks associated with agent clearance and excavation of contaminated soil are significant.

17.2.3.2 Compliance with ARARS

This alternative complies with action-specific ARARs regarding the construction of covers, monitoring of contained material, and landfill siting, design, and operation. Endangered species are not impacted. The South Plants Central Processing Area, caustic washing facility, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AR PAM 385-61) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.2.3.3 Long-Term Effectiveness and Permanence

The residual risk is minimal at the site since 110,000 BCY of untreated human health exceedance soil are removed and contained in an on-post landfill and since residual contamination (more than 5 ft below ground surface) and soil that may pose risk to biota is contained by a soil cover. There is high confidence in the engineering controls for the landfill and cover, and there are no expected difficulties associated with landfill or cover maintenance. Landfill-cell monitoring is required to ensure the integrity of the controls. For the covered area, erosion-control activities and vegetative-cover maintenance are required. The existing habitat at the site is improved by revegetation of disturbed areas; however, habitat at the landfill is eliminated. The types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat.

17.2.3.4 Reduction in TMV

Exposure pathways are interrupted and the mobility of contaminants is reduced through containment of 110,000 BCY in an on-post landfill. Mobility reduction is only reversible should the landfill fail. The soil cover reduces the mobility of contaminants, but toxicity and volume are only reduced by natural attenuation/degradation. Mobility reduction is only reversible should the cover degrade. Soil with agent is identified and treated. There are no treatment residuals associated with this alternative other than the salts from caustic washing.

17.2.3.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance and excavation, transportation, and landfilling of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Engineering controls for dust (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are initiated to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated and the possibility exists for vapor/odor emissions during excavation despite these controls. There are minimal impacts to the existing habitat. Migration of contaminants to the groundwater is reduced. The time frame until RAOs are achieved is 3 years. Once the structures have been removed, excavation of 110,000 BCY is feasible within 1 year after 1 year for construction of the landfill and the caustic washing facility for agent treatment. Installation of the soil cover is feasible within 1 year following excavation.

17.2.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained with periodic landfill-cell monitoring thereafter. However, vapor/odor controls are not well demonstrated and some controls, such as foams, have limited applicability. The use of soil covers increases the volume to be excavated and requires double handling to access the contaminated soil. Additional remedial actions require removal of the landfill cover and the soil cover. Demolition and removal of structures is also required. The alternative is administratively feasible since the substantive requirements of cap/cover design and construction and Subtitle C landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill and soil cover, and both technologies have been well demonstrated at full scale.

17.2.3.7 Cost

The total present worth cost is $19,800,00 including $2,890,000, $15,000,000, and $1,040,000 for capital, operating, and long-term costs, respectively. Table B4.13-3b details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate. Second, there is little operating experience at other sites upon which to base an evaluation of the costs and performance of the vapor/odor controls, and their impact on excavation and equipment productivity.

17.2.4 Alternative 3d/B5/A3: Direct Thermal Desorption and Direct Solidification/ Stabilization of Principal Threat Volume; Landfill; Caps/Covers

Alternative 3d: Direct Thermal Desorption (Direct Heating) and Direct Solidification Stabilization (Cement-Based Solidification) of Principal Threat Volume; Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap), along with Alternative B5: Caps/Covers (Multilayer Cap) and Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), involves the treatment of the principal threat volume (38,000 BCY) by thermal desorption and cement-based solidification, placement of 110,000 BCY of treated principal threat soil as well as untreated soil with human health exceedances in the on-post hazardous waste landfill, and containment of residual contamination (more than 5 ft below ground surface) and soil that may pose potential risk to biota with a low-permeability soil cap.

Due to the potential for odor problems, excavation is conducted so that a minimal area is uncovered and exposed at any one time, and daily soil covers or plastic liners are installed over excavated areas to further minimize odor emissions. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed. The demolition and removal of structures within the South Plants Central Processing Area is required to allow the excavation of contaminated soil.

The 38,000 BCY of principal threat volume are excavated and transported to the centralized facility for thermal desorption and solidification. (Sections 4.6.24 and 4.6.23 discuss these technologies in detail.) The soil for this subgroup is close to saturation, i.e., it has a moisture content of 20 percent. Based on this moisture content, the thermal desorber processes the soil at a rate of approximately 1,300 BCY/day. The soil is discharged at a temperature of 300°C, assuming a total soil residence time of 50 minutes. The thermal desorber takes 1 year to construct and requires an additional year for testing. (Section 4.6.24 discusses off-gas treatment in detail.) Approximately 1 percent of the total soil feed (380 BCY) from scrubber blowdown is disposed in the on-post hazardous waste landfill along with the treated soil.

The 1,500 BCY of principal threat soil with high levels of inorganic contaminants (Volume IV, Table A-3) are treated in the adjacent cement-based solidification facility (Section 4.6.23). The inorganic contaminants in the soil are immobilized by mixing cement with the soil at a ratio of 0.2 tons cement per ton soil. Due to bulking during excavation and swelling during solidification, the volume of solidified soil is increased by approximately 38 percent, resulting in a total solidified mass of 2,100 BCY. Treated soil from both treatment processes is transported for disposal in the on-post hazardous waste landfill.

The principal threat area is screened for the presence of agent during excavation. Any soil with potential agent is stockpiled in a secure area while the presence of agent is confirmed by RMA laboratory analysis. Any confirmed agent-contaminated soil is treated by caustic solution washing (Alternative A3), as discussed in Section 4.4.3.

The remaining 72,000 BCY of soil with human health exceedances are excavated and placed in the centralized, multiple-cell on-post landfill along with the 38,000 BCY of treated principal threat soil. Construction of the first cell and associated facilities takes 1 year. (Section 4.6.6 discusses construction of the landfill in detail.) After disposal is complete, the landfill cover is installed and revegetated. Access restrictions (fencing and biota barriers) eliminate the landfill area as available habitat. The landfill requires long-term maintenance of the cover, leachate collection and treatment, and monitoring of potential leachate migration.

Following treatment of the principal threat volume and excavation of the remaining human health exceedances, a low-permeability soil cap is installed over the entire site to contain residual contamination (more than 5 ft below ground surface) and soil that poses potential risk to biota. Prior to capping, the subsurface is compacted and regraded to minimize variations in the subgrade. The excavations are backfilled with borrow materials since the entire 110,000 BCY of human health exceedances are landfilled. The containment of the South Plants Central Processing Area requires placing a total of approximately 560,000 BCY of gradefill (depending on the final grade required) to achieve a design grade of 3 to 5 percent as described in the Technology Descriptions Volume. The gradefill material may be either on-post borrow or consolidated soil posing risk to biota from other sites in South Plants. The levels of contamination in the consolidated soil used as gradefill would be lower than the contaminated soil remaining in the South Plants Central Processing Area. The cap consists of a 2-ft-thick layer of compacted low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and 4-ft-thick of soil/vegetation layer that includes 6 inches of reconditioned soil to promote the growth of vegetation. Site remediation is completed by revegetation of the cover with native grasses to improve the habitat quality of the site, although the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.2.4.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment/immobilization of the principal threat volume and containment of the balance of the human health exceedance volume. Organic compounds in the principal threat volume are treated by thermal desorption and inorganic compounds are solidified, thus preventing exposure. The remaining human health exceedance soil is excavated and contained in the on-post landfill. Residual contaminated soil (more than 5 ft below ground surface) and soil that may pose a potential risk to biota are addressed by the installation of a multilayer cap to prevent exposure and reduce mobility. Groundwater impacts are also reduced. The short-term risks associated with agent clearance and excavation of contaminated soil are significant.

17.2.4.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding the construction of covers and the monitoring of contained and solidified material as well as state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The South Plants Central Processing Area, the treatment facilities, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AR PAM 385-61) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.2.4.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since 38,000 BCY are thermally desorbed to achieve PRGs and 1,500 BCY of principal threat soils with high levels of inorganic contamination are solidified. Human and biota exposure pathways are interrupted through excavation and landfilling of human health exceedance soil and the installation of a 220,000-SY low-permeability cap for contaminants remaining at depth and soil that may pose risk to biota. Approximately 1 percent of the soil feed recovered from the off-gas treatment equipment is also placed in an on-post landfill, as are the salts generated by caustic solution washing. Site reviews are required for untreated soil, and erosion-control activities and vegetative-cover maintenance are conducted. There is high confidence in engineering controls associated with the landfill and cap, and there are no expected difficulties associated with maintenance. Landfill-cell monitoring is required to ensure the integrity of the controls. Revegetation of disturbed areas improves existing habitat. The types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat.

17.2.4.4 Reduction in TMV

The 38,000 BCY of principal threat soil are thermally desorbed to degrade OCPs, volatiles, CLC2A, DBCP, and HCCPD, and 1,500 BCY of principal threat soil are solidified to immobilize inorganic compounds. In addition, confirmed agent-contaminated soil is treated by caustic solution washing. Human and biota exposure pathways are interrupted, and the mobility of contaminants is reduced by landfilling contaminated soil and installing a 220,000-SY low-permeability soil cap. Organic compounds are reduced to below detection levels or >99.99 percent DRE in the principal threat volume. TMV of organic compounds is eliminated in the principal threat volume, and ICP metals, mercury, and arsenic are immobilized during treatment. Quench blowdown solids from the off-gas treatment equipment and salts are placed in an on-post landfill. TMV reduction by thermal desorption and caustic solution washing is irreversible, and TMV reduction by solidification is only irreversible should the integrity of the solidified material fail. The low-permeability cap reduces the mobility of residual contaminants in deeper soil, which is only reversible should the cap degrade.

17.2.4.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance and excavation, and transportation, landfilling, and thermal desorption of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Engineering dust controls (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. In addition, the preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and vapors/odors. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards the emissions from the thermal desorber contain low but acceptable levels of some contaminants. There are minimal impacts to the existing habitat, although the types of vegetation and maintenance activities are designed to discourage burrowing animals from using the covered area as habitat. Migration of contaminants to the groundwater is reduced. The time frame until RAOs are achieved is 4 years. Excavation, treatment, and landfilling of 38,000 BCY of soil is feasible within 1 year after 2 years for construction of the thermal desorption facility and landfill (assuming that the thermal desorber does not encounter operational problems). Solidification of 1,500 BCY is also feasible within a year, and the installation of a 220,000-SY multilayer cap is feasible within 1 year following landfilling and treatment. Natural attenuation of untreated soil is ongoing.

17.2.4.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited applicability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the contaminated soil. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, high clay content, high moisture content, materials-handling problems, and presence of debris remaining in the soil feed after structures demolition. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. Demolition of structures and removal of structural debris is required prior to excavation or capping. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The containment portion of the alternative is administratively feasible since the substantive requirements of landfill design and construction regulations are achieved. Equipment, specialists, and materials are readily available for solidification, cap/cover, and landfill construction, and capping, solidification, and landfills have been well demonstrated at full scale.

17.2.4.7 Cost

The total present worth cost is $25,100,000 including $3,880,000, $20,800,000, and $435,000 for capital, operating, and long-term costs, respectively. Table B4.13-3d details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate and so increase uncertainties relative to excavation costs. Second, there is little operating experience at other sites upon which to base an evaluation of the costs and performance of the vapor/odor controls, and their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high moisture and clay content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

17.2.5 Alternative 6/B5/A1: Caps/Covers

Alternative 6: Caps/Covers (Multilayer Cap), combined with Alternative B5: Caps/Covers (Multilayer Cap) and Alternative A1: No Additional Action (Provisions of FFA), involves the containment of the entire South Plants Medium Group (2,100,000 SY) under one cap. This includes the 220,000 SY of human health and potential biota exceedance area as well as the potential agent presence area for the South Plants Central Processing Area Subgroup.

Before cap materials are installed, existing structures are demolished and either contained in place or removed. The subgrade is compacted, and the surface is crowned with 1,400,000 BCY of gradefill to control surface-water runoff as part of the overall South Plants cap. (Only 560,000 BCY of gradefill would be required to cap the South Plants Central Processing Area alone; the higher volume of fill is required to construct the proper contour for the larger South Plants cap.) The human health exceedance area and area that poses potential risk to biota are covered by a 2-ft-thick layer of low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and a 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil to promote the growth of vegetation. The covered area is then revegetated with native grasses to restore the habitat. The fill materials for the cap are excavated from the on-post borrow area. The capping operations take 2 years to complete based on the placement of 1,400,000 BCY of gradefill. The types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat. Maintenance activities, such as mowing and replacement of eroded cap materials, ensures the continued integrity of the soil cap. Five-year site reviews are conducted to review the effectiveness of the alternative and to assess potential migration of contaminants. Groundwater compliance monitoring is performed to evaluate the continued protectiveness of the alternative.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.2.5.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through containment. Contaminated soil exceeding the Human Health SEC (EBASCO 1994a) and soil potentially posing risk to biota are covered by a low-permeability soil cap to prevent exposure and reduce mobility. Groundwater impacts are reduced, and the short-term impacts associated with installing a cap are low.

17.2.5.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of contained material. Endangered species are not impacted. Location-specific ARARs are met as sites in the South Plants Medium Group are not located in wetlands or a 100-year flood plain. In addition to the ARARs, this alternative complies with provisions of the FFA (EPA et al. 1989). Soil with potential agent presence is contained and is not subjected to Army Materiel Command regulations governing agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.2.5.3 Long-Term Effectiveness and Permanence

The residual risk is low since 140,000 BCY of untreated human health exceedance and biota risk soil and residual contamination more than 5 ft below ground surface are contained through installation of a low-permeability soil cap with a biota barrier over the whole of South Plants. Long-term monitoring and site reviews are required for untreated soil, as are erosion-control activities and vegetative-cover maintenance. There is high confidence in the engineering controls for the multilayer cap. Revegetation of the cap with native grasses improves the habitat quality, although the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat.

17.2.5.4 Reduction in TMV

Exposure pathways are interrupted and the mobility of the contaminants is reduced through installation of a multilayer cap. Agent-contaminated soil is also contained within the cap. The mobility reduction is only reversible should the cap/cover degrade or leak. There are no treatment residuals associated with this alternative.

17.2.5.5 Short-Term Effectiveness

This alternative entails low short-term risks since no intrusive activities are conducted. Dust controls are adequate for addressing uncontaminated fugitive dust from cap construction, and vapor/odor emissions are not anticipated. Impacts to the existing habitat are minimal, but the borrow area is disturbed. Installation of the cap is feasible within 2 years, which includes the placement of 1,400,000 BCY of soil as gradefill. Natural attenuation of untreated soil is ongoing.

17.2.5.6 Implementability

The alternative is technically feasible and can be constructed within the required time frame and reliably operated and maintained thereafter. Demolition of structures is required, and structural debris can either be removed or consolidated as gradefill prior to capping. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible since the substantive requirements of the cap/cover design and construction regulations are achieved. Equipment, specialists, and materials are readily available for the construction of the cap, and multilayer caps have been well demonstrated at full scale. Personnel and equipment are available for groundwater compliance.

17.2.5.7 Cost

The total present worth cost is $22,300,000 including $21,300,000, and $1,020,000 for operating and long-term costs, respectively. The cost for installing a cap over the South Plants is high since a larger volume of gradefill is required for contouring the cap for this subgroup into a single cap that covers all of South Plants. The installation of this additional gradefill increases the cost by approximately $8.8 million over the capping components of other alternatives. Table B4.13-6 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required for cap construction are available on post and the area to be covered is well defined.

17.2.6 Alternative 6a/B5/A1: Direct Thermal Desorption and Direct Solidification/ Stabilization of Principal Threat Volume; Caps/Covers

Alternative 6a: Direct Thermal Desorption (Direct Heating) and Direct Solidification/Stabilization (Cement-Based Solidification) of Principal Threat Volume; Caps/Covers (Multilayer Cap), along with Alternative B5: Caps/Covers (Multilayer Cap) and Alternative A1: No Additional Action (Provisions of FFA), involves the treatment of 38,000 BCY of principal threat soil and containment of 220,000 SY of human health exceedances and soil posing potential risk to biota. The principal threat volume is screened for the presence of agent during excavation. If any agent is identified in soil during the screening it is placed in a secured area while the presence of agent contamination is confirmed by RMA laboratory analysis. Any agent-contaminated soil is treated by caustic solution washing (Alternative A3) and placed in the on-post hazardous waste landfill.

Due to the potential for odor problems, excavation is conducted so that a minimal area is uncovered and exposed at any one time, and soil covers or plastic liners are installed daily over excavated areas to further eliminate odor emissions. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed. Prior to excavation, all of the structures (including foundations) within the South Plants Central Processing Area must be demolished and removed, which limits the alternatives currently being evaluated for structures in this area. Utilities under the South Plants Central Processing Area are also excavated and consolidated with the structural debris.

The 38,000 BCY of soil with principal threat exceedances are excavated and transported to the centralized treatment facility for thermal desorption and solidification. The soil in this subgroup is close to saturation (moisture content of 20 percent). Based on this moisture content, the thermal desorber processes the soil at a rate of approximately 1,300 BCY/day. The soil is discharged at a temperature of 300°C, assuming a total soil residence time of 50 minutes. The thermal desorber takes 1 year to construct, and requires an additional year for testing. (Section 4.6.24 discusses off-gas treatment in detail.) Approximately 1 percent of the total soil feed (380 BCY) from scrubber blowdown is disposed in the on-post hazardous waste landfill.

The 1,500 BCY of principal threat soil with high concentrations of inorganic contaminants are treated in the adjacent cement-based solidification facility (Section 4.6.23). The inorganic contaminants in this soil are immobilized by mixing cement with the soil at a ratio of 0.2 tons cement per 1 ton soil. Due to bulking during excavation and swelling during solidification, the volume of solidified soil is increased by approximately 38 percent, resulting in a total solidified mass of 2,100 BCY. Treated soil from both processes is returned to the excavation sites and backfilled. The multilayer cap is installed over the solidified soil to prevent freeze/thaw degradation and preserve the integrity of the solidified mass.

Following treatment of the principal threat volume, a low-permeability soil cap is installed over the entire human health exceedance volume and soil posing a potential risk to biota. The contaminated volume includes some soil with potential agent presence. Prior to capping, the subsurface is compacted and regraded to minimize variations in the subgrade. The cap consists of a 2-ft-thick layer of compacted low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil to promote the growth of vegetation. Site remediation is completed by revegetation of the cap with native grasses to improve the habitat quality of the site, although the types of vegetation placed at the site and the maintenance activities performed there discourage burrowing animals from using the covered area for habitat. The containment of the South Plants Central Processing Area requires placing approximately 560,000 BCY of gradefill to achieve a design grade of 3 to 5 percent as described in the Technology Descriptions Volume (Section 6).

Instead of using borrow material for the gradefill, contaminated soil from other portions of South Plants that poses a potential risk to biota may be consolidated within the South Plants Central Processing Area prior to capping. The levels of contamination in the consolidated soil would be lower than the contaminated soil remaining in the South Plants Central Processing Area. Figure 17.2-1 presents a schematic representation of this alternative that includes the demolition and removal of structures and foundations, backfill of excavations, installation of gradefill, and installation of a low-permeability soil cap. The excavated areas are then recontoured and revegetated, restoring the habitat. If the consolidation alternatives are not selected for the other areas in South Plants, then borrow materials are used as gradefill. Annual groundwater compliance monitoring will be conducted to evaluate the potential for contaminant migration.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.2.6.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment/immobilization of the principal threat volume and containment of the balance of the site. Organic compounds in the principal threat volume are treated through thermal desorption and inorganic compounds are solidified, thus preventing exposure. Contaminated soil in the balance of the site is contained by installation of a multilayer soil cap to prevent human and biota exposure and to reduce mobility. Groundwater impacts are also reduced. The short-term risks associated with agent clearance and excavation of contaminated soil are significant.

17.2.6.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of contained and solidified material as well as state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The South Plants Central Processing Area, the treatment facilities, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with provisions of the FFA (EPA et al. 1989). The alternative complies with Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization for the principal threat areas. The balance of contaminated soil, which is contained, is not subject to the demilitarization regulations. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.2.6.3 Long-Term Effectiveness and Permanence

The residual risk is low since 38,000 BCY of principal threat soil are thermally desorbed and 1,500 BCY of principal threat soil with high levels of inorganic contaminants are solidified. Human and biota exposure pathways are interrupted for the residual contamination through installation of a 220,000-SY multilayer cap. Approximately 1 percent of the soil feed recovered from the off-gas treatment equipment is placed in an on-post landfill. Long-term monitoring is required for the solidified soil, as are site reviews for untreated soil, erosion-control activities, and vegetative-cover maintenance. There is high confidence in engineering controls associated with the landfill and the cap, and there are no expected difficulties associated with maintenance. Revegetation of disturbed areas improves existing habitat, although the types of vegetation and maintenance activities are designed to discourage burrowing animals from using the covered area as habitat.

17.2.6.4 Reduction in TMV

The 38,000 BCY of principal threat volume are thermally desorbed to degrade OCPs, VOCs, CLC2A, DBCP, and HCCPD, and 1,500 BCY of principal threat volume with high levels of inorganic contaminants are solidified to immobilize inorganic compounds. Organic compounds are reduced to detection levels or >99.99 percent DRE. TMV of organic compounds is eliminated in the principal threat volume, and ICP metals, mercury, and arsenic are immobilized during treatment. Quench blowdown solids from the off-gas treatment equipment are placed in an on-post landfill. TMV reduction by thermal desorption is irreversible. In addition, TMV reduction of solidified materials is irreversible so long as the integrity of the solidified mass is maintained. Human and biota exposure pathways are interrupted and mobility of contaminants is reduced through installation of a 220,000-SY low-permeability soil cap. Soil with agent outside the principal threat area is contained within the cap. Mobility reduction is only reversible should the cap/cover degrade or leak. Most of the areas potentially containing agent are screened during the excavation of the principal threats and any agent identified is treated by caustic solution washing.

17.2.6.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance and excavation, transportation, landfilling, and thermal desorption of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Engineered dust controls (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. In addition, preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and vapors/odors. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards the emissions from the thermal desorber contain low but acceptable levels of some contaminants. For the balance of the site, which is covered, the risks are low since no intrusive activities are conducted. There are minimal impacts to the existing habitat, although the types of vegetation placed at the site and maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat. Migration of contaminants to groundwater is reduced. The time frame until RAOs are achieved is 4 years. Excavation and treatment of 38,000 BCY is feasible within 1 year after 2 years for construction of the thermal desorption facility, assuming that the thermal desorber does not experience any operational problems. Solidification of 1,500 BCY of principal threat volume with inorganic contaminants is feasible within 1 year, and installation of a 220,000-SY multilayer cap is feasible within 1 year following thermal desorption and solidification. Natural attenuation/degradation of untreated soil is ongoing.

17.2.6.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited applicability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the contaminated soil. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, high moisture content, high clay content, difficulties with materials handling, and presence of debris remaining in the soil feed after structures demolition. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. Demolition and removal of structures is required for the excavation of the principal threat volume. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The landfilling portion of the alternative is administratively feasible since the substantive requirements of landfill design and construction regulations are achieved. Equipment, specialists, and materials are readily available for solidification, cap/cover, and landfill construction. Caps, solidification, and landfills have been well demonstrated at full scale. Equipment and personnel are available for groundwater compliance monitoring.

17.2.6.7 Cost

The total present worth cost is $21,600,000 including $1,130,000, $19,500,000, and $963,000 for capital, operating, and long-term costs, respectively. Table B4.13-6a details the costing for this alternative. The actual cost of consolidating the gradefill materials from other portions of South

Plants is not included in these estimated costs, but is incorporated in the cost for the subgroup where the contaminated soil to be consolidated is located.

There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate and so increase uncertainties relative to excavation costs. Second, there is little operating experience at other sites upon which to base an evaluation of the costs and performance of the vapor/odor controls, and their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high moisture and clay content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

17.2.7 Alternative 13d/B5/A3: Direct Thermal Desorption; Direct Solidification/Stabilization; Caps/Covers

Alternative 13d: Direct Thermal Desorption (Direct Heating); Direct Solidification/Stabilization (Cement-Based Solidification); Caps/Covers (Multilayer Cap), paired with Alternative B5: Caps/Covers (Multilayer Cap) and Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), consists of treating 93,000 BCY of soil with human health organic exceedances by thermal desorption, treating 21,000 BCY of soil with human health inorganic exceedances by solidification, and containing 27,000 BCY of soil that may pose risk to biota and residual contamination (more than 5 ft below ground surface) with a low-permeability soil cap. (Sections 4.6.24, 4.6.23, and 4.6.14 discuss the details of these technologies.)

Before treating the contaminated soil, demolition and removal of a number of structures are required, which limits alternatives currently being evaluated for structures in this area. Existing utilities are removed during excavation and consolidated with the structural debris. Due to the potential for odor problems, excavation is conducted so that minimal area is exposed at any one time, and soil covers or plastic liners are installed daily over excavated areas to further eliminate odor emissions. Dewatering is not anticipated to be required based on the projected reduction in groundwater elevation after manmade influences (i.e., leaking sewers) are removed.

During excavation, soil is screened for agent with real-time monitoring equipment, and soil with the potential presence of agent is placed in a secure stockpile. Any of this soil confirmed to contain agent by RMA laboratory analysis is treated by caustic solution washing, as discussed in Section 17.2.3, and landfilled.

The 93,000 BCY of organic exceedance volume, after being screened for agent, are transported to the thermal desorber for treatment. The soil for this subgroup is close to saturation (i.e., a soil moisture content of 20 percent). Based on this moisture content, the thermal desorber has a processing rate of 1,300 BCY/day, a discharge temperature of 300°C, and a total soil residence time of 50 minutes. The thermal desorber takes 1 year to build, and requires an additional year for testing prior to operation. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) Approximately 1 percent of the soil feed (930 BCY) is recovered as particulates from the scrubber blowdown equipment and is placed in the on-post hazardous waste landfill. The treated soil without inorganic exceedances is returned to the excavation as backfill and the soil with inorganic exceedances is transported to the solidification facility for further treatment.

The 21,000 BCY of soil with inorganic exceedances are solidified using a portable pug mill capable of treating 210 BCY/hour (Section 4.6.23). The contaminated soil is treated by adding cement as a binder in order to immobilize inorganic exceedances in the soil. During excavation and solidification, the total volume of contaminated soil increases by approximately 38 percent, which results in a total volume of 29,000 BCY. The low-permeability soil cap is installed over the solidified soil to ensure the integrity of the solidified materials and to prevent freeze/thaw degradation.

Following treatment of exceedance volumes, a 220,000-SY low-permeability soil cap is installed over the entire site to contain soil that may pose a risk to biota and residual contamination at depths below 5 ft. Prior to capping, the subsurface is compacted and regraded to minimize variations in the subgrade. The gradefill material may be either on-post borrow or consolidated soil posing risk to biota from other sites in South Plants. The levels of contamination in the consolidated soil used as gradefill would be lower than the contaminated soil remaining in the South Plants Central Processing Area. The cap consists of a 2-ft-thick layer of compacted low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil to promote the growth of vegetation. Site remediation is completed by revegetation of the cap with native grasses to improve the habitat quality of the site, although the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat. The containment of the South Plants Central Processing Area requires placing approximately 560,000 BCY of gradefill to achieve the design grade of 3 to 5 percent as described in the Technology Descriptions Volume.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.2.7.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment of human health exceedances and containment of the remaining contamination. Contaminated soil is treated through thermal desorption, and the mobility of contaminants and exposure pathways are interrupted through solidification. Residual contaminated soil (more than 5 ft below ground surface) and soil that may pose a potential risk to biota are addressed by the installation of a low-permeability soil cap to prevent exposure and reduce mobility. Groundwater impacts are reduced. The short-term risks associated with agent clearance and excavation of contaminated soil are significant.

17.2.7.2 Compliance with ARARS

This alternative complies with action-specific ARARs regarding the construction of covers and monitoring of contained and solidified material as well as state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The South Plants Central Processing Area,, the treatment facilities, and the landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.2.7.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since 93,000 BCY of soil with organic exceedances are thermally desorbed to achieve PRGs, 21,000 BCY of inorganic exceedances are solidified, and any soil with agent is treated through caustic solution washing and landfilling. The entire area is then contained by a cap. Approximately 1 percent of the soil feed recovered from the off-gas treatment equipment is placed in an on-post landfill. Monitoring of solidified soil is required. There is high confidence in engineering controls associated with the landfill and cap, and there are no expected difficulties associated with maintenance. Revegetation of disturbed areas improves the existing habitat, offsetting the temporary loss of use during excavation. The types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat.

17.2.7.4 Reduction in TMV

The 93,000 BCY are thermally desorbed to degrade OCPs, HCCPD, VOCs, DBCP, DCPD, and CLC2A. Organic compounds are reduced to below detection levels or >99.99 percent DRE, eliminating TMV. Scrubber blowdown solids from the off-gas treatment equipment containing inorganic compounds and salts are contained in an on-post landfill. The TMV reduction in 21,000 BCY by solidification/stabilization is irreversible so long as the integrity of the solidified soil is maintained.

17.2.7.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with agent clearance and excavation, transportation, landfilling, and thermal desorption of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Engineered dust controls (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. In addition, preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and vapors/odors. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards, the emissions from the thermal desorber contain low but acceptable levels of some contaminants. There are minimal impacts to the environment at the sites due to the existing habitat, but the borrow area is disturbed during excavation. Migration of contaminants to the groundwater is reduced. The time frame until RAOs are achieved is 4 years. Excavation and treatment of 93,000 BCY is feasible within 1 year after 2 years for construction of the thermal desorption facility, and the landfill, assuming there are no operational problems with the thermal desorber. Solidification of 21,000 BCY is feasible within 1 year and is conducted concomitantly with thermal desorption. The cap installation requires 1 year.

17.2.7.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited applicability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the contaminated soil. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, high moisture content, high clay content, materials-handling difficulties, and presence of debris remaining in the soil feed after structures demolition. Administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. Demolition and removal of structures is required, and the solidified soil is monitored to ensure its integrity. The alternative is administratively feasible since the substantive requirements of the treatment system and landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for the solidification, landfill, and cap construction. Solidification, landfills, and caps/covers have been well demonstrated at full scale.

17.2.7.7 Cost

The total present worth cost is $30,600,000 including $2,850,000, $27,100,000, and $625,000 for capital, operating, and long-term costs, respectively. Table B4.13-13d details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate and so increase uncertainties relative to excavation costs. Second, there is little operating experience at other sites upon which to base an evaluation of the costs and performance of the vapor/odor controls, and their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high moisture and clay content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

17.2.8 Alternative 19b/B5/A3: In Situ Thermal Treatment; In Situ Solidification/ Stabilization; Caps/Covers

Alternative 19b: In Situ Thermal Treatment (RF/Microwave Heating); In Situ Solidification Stabilization (Cement-Based Solidification); Caps/Covers (Multilayer Cap), along with Alternative B5: Caps/Covers (Multilayer Cap) and Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), treats 93,000 BCY of human health exceedance soil with organic contaminants by in situ heating and 21,000 BCY with inorganic contaminants by in situ solidification and contains 220,000 SY of soil that poses potential risk to biota and residual contamination at depths more than 5 ft below ground surface with a low-permeability soil cap. Dewatering is not anticipated to be required based on the projected reduction in groundwater elevation after manmade influences (i.e., leaking sewers) are removed. Existing structures in the South Plants Central Processing Area must be demolished and removed so that this alternative may be implemented, which limits alternatives currently being evaluated for structures in this area. Utilities are removed and consolidated with the structural debris.

During remedial construction, any excavated soil is screened using real-time field analytical methods. If agent is identified and confirmed by RMA laboratory analysis, the agent-contaminated soil is excavated and treated on-post by caustic solution washing as discussed in Section 4.4.3.

After agent screening, 93,000 BCY of soil with human health organic exceedances are treated by in situ RF heating. RF heating volatilizes the organic contaminants by raising the temperature of the soil to more than 250°C. The volatilized contaminants are then collected and treated in the off-gas treatment system (Section 4.6.31). One RF unit is used for the South Plants Central Processing Area. Soil in this subgroup is assumed to have a moisture content of 20 percent and to be contaminated from 0 to 5 ft below ground surface. Based on these assumptions, the unit treats a 100-ft-long, 48-ft-wide, 10-ft-deep block of soil at a treatment rate of approximately 130 BCY/day. The liquid sidestream, which contains predominantly salts, is transported to the thermal desorption facility for treatment along with the effluent from the scrubber. (Alternatively, an evaporator/crystallizer is added to the emissions-control system to evaporate the liquid sidestream.) RF heating only treats the organic contaminants; therefore, soil containing inorganic contaminants requires treatment by in situ cement-based solidification.

The 21,000 BCY of soil with human health inorganic exceedances are solidified using a transportable track-mounted boring/mixing unit and a cement batch plant capable of processing 600 BCY/day. Portland cement is mixed with soil at a ratio of 20 percent by weight. The soil, upon solidification, swells approximately 10–25 percent due to the incorporation of the cement. The low-permeability soil cover is placed over the solidified soil to ensure the integrity of the solidified materials and minimize freeze/thaw degradation as discussed below.

Following treatment of the 110,000 BCY of human health exceedance soil, a low-permeability soil cap is installed over the entire site to contain areas with potential risk to biota and residual contamination at depths below 5 ft. Prior to capping, the subsurface is compacted and regraded to minimize variations in the subgrade. The gradefill material may be either on-post borrow or consolidated soil posing risk to biota from other sites in South Plants. The levels of contamination in the consolidated soil used as gradefill would be lower than the contaminated soil remaining in the South Plants Central Processing Area. The cap consists of a 2-ft-thick layer of compacted low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and 4-ft-thick of soil/vegetation layer that includes 6 inches of reconditioned soil to promote the growth of vegetation. Site remediation is completed by revegetation of the cover with native grasses to improve the habitat quality of the site, although the types of vegetation placed at the site and maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat. The containment of the South Plants Central Processing Area requires placing approximately 560,000 BCY of gradefill to achieve the design grade of 3 to 5 percent as described in the Technology Descriptions Volume. Groundwater compliance monitoring will be conducted to evaluate the potential for contaminant migration.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.2-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.2.8.1 Overall Protection of Human Health and the Environment

RF heating does not achieve PRGs, but does reduce the concentrations of the organic contaminants. This alternative ultimately achieves RAOs through the containment of the treated soil, soil that poses risks to biota, and residual contamination (more than 5 ft below ground surface). Solidification of inorganic compounds eliminates the mobility of the contaminants and interrupts the exposure pathways of humans and biota. Soil with potential agent is removed and treated. Migration of contaminants to the groundwater is reduced through the installation of the cap. Although this alternative does not entail a large amount of intrusive activities, the short-term impacts are high based on the long duration of treatment activities.

17.2.8.2 Compliance with ARARS

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of contained and solidified material as well as state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The South Plants Central Processing Area, the treatment facilities, and the landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.2.8.3 Long-Term Effectiveness and Permanence

The residual risk is low since the entire site is contained and the human health exceedances are treated to concentrations near Human Health PRGs. The residual contamination (more than 5 ft below ground surface), as well as soil that may pose a risk to biota, are contained with the cap. Long-term groundwatering monitoring, 5-year site reviews, and cap-maintenance operations are conducted to ensure the effectiveness of the controls. The overall habitat quality for the site is improved through revegetation, offsetting the habitat loss incurred during implementation of the alternative, although the types of vegetation and the maintenance activities discourage burrowing animals from using the covered area for habitat.

17.2.8.4 Reduction in TMV

RF heating can theoretically achieve Human Health and Biota RAOs with low residual risk since OCPs and volatile metals can be driven from the soil by this form of in situ thermal treatment. However, the pilot-scale test of the RF technology at RMA, as described in the Technology

Descriptions Volume, failed to confirm the temperature distribution and OCP removal efficiencies required for confident treatment of soil to achieve PRGs. The contaminant removal through RF heating is irreversible for 93,000 BCY. Soil with agent is treated and landfilled along with the salts from the treatment of the washing solution. The 21,000 BCY of soil with inorganic exceedances are solidified in place and the balance of the soil with residual contamination and areas with potential risk to biota are covered, which reduces the mobility of contaminants and interrupts the exposure pathways.

17.2.8.5 Short-Term Effectiveness

The in situ thermal treatment of soil also entails moderate short-term impacts. The long duration of treatment operations (4 years) results in the continuing migration of contaminants to groundwater and potential exposure of humans and biota to contaminated soil. Although the off-gas control system for in situ heating is designed to achieve air quality standards, the emissions from the in situ heating unit contain low but acceptable levels of some contaminants. There are minimal impacts to the environment due to the existing habitat. Migration of contaminants to the groundwater is reduced. The time frame until RAOs are achieved is 4 years. RF heating of 93,000 BCY is feasible within 4 years, and solidification of 21,000 BCY is feasible within 1 year. Solidification occurs in year 4.

17.2.8.6 Implementability

In situ thermal heating is currently not implementable since full-scale in situ heating units have not been constructed or demonstrated. The technology was demonstrated at a pilot-scale at RMA; however, several problems were identified in the pilot-scale test regarding the durability of the equipment and demonstration of removal efficiencies. The resolution of these problems may lead to delays in the construction of full-scale units and in the operation of the in situ heating units over the estimated 4 years it will take to complete the treatment process. In addition, administrative difficulties associated with demonstrating compliance with permits and performing O&M may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of in situ thermal treatment and the thermal treatment portion of the off-gas control system. Additional remedial actions require removal of the cover for treated soil that does not achieve PRGs. Demolition and removal of structures is required. Solidified soil must be monitored to ensure integrity. The landfill portion of this alternative is administratively feasible since the substantive requirements of the landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available from several vendors for solidification and capping, and both solidification and capping have been well demonstrated at full scale. Equipment and personnel resources are available for groundwater compliance monitoring.

17.2.8.7 Cost

The total present worth cost is $58,800,000 including $13,100,000, $44,800,000, and $869,000 for capital, operating, and long-term costs, respectively. Table B4.13-19b details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, the extent of agent presence is difficult to estimate and so increases uncertainties relative to excavation costs. Second, there are no full-scale demonstrations of the in situ heating technology at other hazardous wastes sites by which actual construction and operational costs can be documented. This uncertainty is especially noteworthy because the pilot-scale demonstration of the technology at RMA indicated there were potential problems regarding the durability of the equipment. Thirds, the lack of full-scale implementation data increases uncertainties relative to maintaining the assumed on-line percentage of the heating unit. The concentration and depth of contamination at RMA may result in changes in treatment times or delays in implementation, both which may impact treatment costs.

17.3 SOUTH PLANTS CENTRAL PROCESSING AREA SUBGROUP COMPARISON OF ALTERNATIVES

The South Plants Central Processing Area Subgroup has 140,000 BCY of exceedance volume containing primarily OCPs, arsenic, and mercury, along with other organic compounds and ICP metals. This contamination is a result of manufacturing and processing activities conducted in South Plants. Approximately 8 percent of all soil samples exceed the Human Health SEC

(EBASCO 1994a) for OCPs (Table 17.1-2). The average concentrations of OCPs, DBCP, and chloroform within the human health exceedance volume are greater than the Human Health SEC (EBASCO 1994a) (Table 17.1-1). This subgroup, therefore, presents a significant potential risk to human health and biota.

Principal threat criteria are exceeded by maximum concentrations of arsenic, DBCP, and some OCPs. Based on these analyses and historical information, 38,000 BCY of the subgroup are designated as principal threats. Agent is potentially present in 98,000 SY of the South Plants Central Processing Area based on site history, and the site is also identified as the source of several groundwater contamination plumes.

The habitat within the South Plants Central Processing Area consists of disturbed areas of vegetation. Alternatives that disrupt habitat include revegetation and restoration following remediation, so no significant habitat impacts are expected; however, for alternatives that involve containment, the types of vegetation placed at the site and the maintenance activities performed there discourage burrowing animals from using the covered area for habitat. During the excavation of soil at this site, the soil is sampled to identify agent presence, an activity that requires health and safety protection for site workers. In addition, to reduce odor emissions, minimal soil area is exposed to the atmosphere at any one time, and a soil cover or plastic liner is used daily to prevent odor emissions from impacting the community.

In summary, this subgroup contains soil that exceeds the Human Health SEC (EBASCO 1994a), soil that may pose a potential risk to biota, and an area of principal threat exceedances that encompasses much of the site. In selecting alternatives for this subgroup, the short-term risks of worker exposure and community impacts from the potential release of vapors must be weighed against the long-term risks of contaminant migration should contaminants be left in place.

Alternative 1: No Additional Action does not achieve RAOs as untreated soil remains and no controls are implemented; this alternative was eliminated from further consideration. Alternative 1b: Direct Thermal Desorption and Direct Solidification/Stabilization of Principal Threat

Volume; No Additional Action treats the highest levels of contamination, but does not achieve RAOs in the remaining volume and was also eliminated from further consideration. The remaining six alternatives achieve RAOs and meet the two DAA threshold criteria, protection of human health and the environment and compliance with action-specific and location-specific ARARs.

The landfill alternatives (Alternative 3b: Landfill; Caps/Covers and Alternative 3d: Direct Thermal Desorption and Direct Solidification/Stabilization of Principal Threat Volume; Landfill; Caps/Covers) achieve RAOs at the site since the potential exposure and mobility of contaminants are reduced through containment, and for Alternative 3d, through treatment. Landfilling, solidification, and capping have been well demonstrated and there is high confidence in the engineering controls for maintenance of these operations. However, thermal desorption has not been performed on this scale with these types of materials at other sites, and there is a high level of uncertainty regarding the estimated costs for thermal desorption. In addition, there are significant short-term risks associated with excavation, transportation, and treatment operations and with the clearance and treatment of agent. The cost of $19,800,000 for Alternative 3b is below the average cost of the remaining intrusive alternatives, while the cost of Alternative 3d is similar to other treatment alternatives. Based on the cost effectiveness and permanent containment offered by landfilling and capping, these alternatives were carried forward for consideration for the development of sitewide alternatives (see Section 20).

Alternative 6: Caps/Covers provides low long-term residual risks without incurring short-term risks. This alternative involves capping the entire South Plants area, which interrupts exposure pathways and reduces the impacts of contaminants on groundwater. This technology has also been well demonstrated and entails low short-term risks since South Plants Central Processing Area soil is not excavated. In addition, there are no treatment residuals associated with this alternative. The cost of $22,300,000 includes costs for capping the remaining 2 million SY of South Plants so it cannot be compared to other alternatives for this subgroup. This alternative was carried forward for consideration for the development of sitewide alternatives (See Section 20).

Alternative 6a: Direct Thermal Desorption and Direct Solidification/Stabilization of Principal Threat Volume; Caps/Covers consists of excavating the principal threat volume, treating it, and capping it. This alternative entails a slightly lower cost ($21,600,000) than the other alternatives involving treatment; however, this alternative does not offer additional long-term protection over in-place containment (Alternative 6). Therefore, this alternative was not retained for further consideration.

Alternative 13d: Direct Thermal Desorption; Direct Solidification/Stabilization; Caps/Covers addresses contamination through treatment that achieves PRGs and containment of the residual contamination. This alternative poses significant risks during excavation, treatment, and agent clearance. The cost for this alternative is similar to Alternative 3d: Direct Thermal Desorption and Direct Solidification/Stabilization of Principal Threat Volume; Landfill; Caps/Covers. Alternative 13d treats a larger volume of soil, but Alternative 3d landfills all human health exceedances. Any delays in construction of the thermal desorber or operational problems would impact both alternatives, but ultimately results in a larger cost uncertainty for Alternative 13d. Since the alternative relies on containment, the risk reduction for the additional thermal desorption of soil that does not exceed principal threat criteria does not warrant the higher cost of this alternative compared to other treatment/containment alternatives. This alternative was not retained since it is not cost-effective.

Alternative 19b: In Situ Thermal Treatment; In Situ Solidification/Stabilization; Caps/Covers is not capable of achieving PRGs based on the DREs of the in situ technologies. Additionally, the in situ thermal treatment process is not yet available for full-scale operation and is the most expensive ($58,800,000). This alternative is not retained based on the lack of equipment for full-scale operation and its high cost.

Consequently, the following alternatives that were retained to represent the South Plants Central Processing Area, in the development of sitewide alternatives (Section 20) are the following:

- Alternative 3b: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap)

- Alternative 3d: Direct Thermal Desorption (Direct Heating) and Direct Solidification/Stabilization (Cement-Based Solidification) of Principal Threat Volume; Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap)

- Alternative 6: Caps/Covers (Multilayer Cap)

The installation of the cap must be coordinated with the groundwater alternatives developed for the South Plants Plume Group as discussed in the Water DAA. The demolition and removal of structures within the South Plants Central Processing Area is required to allow the excavation of contaminated soil. However, the structural debris from the Other Contamination History Subgroup can be contained beneath the cap as gradefill as described in Section 6 of the Structures DAA. Abandoned utilities encountered during excavation are removed and consolidated with the structural debris. The structures alternatives developed for this area consider the backfill of the foundation excavations with borrow material; however, the timing of the backfilling operations and the choice of backfill materials to be used depend upon which soil alternative is selected for the South Plants Central Processing Area.

17.4 SOUTH PLANTS DITCHES SUBGROUP CHARACTERISTICS

The South Plants Ditches Subgroup is composed of sites SPSA-1d (Drainage Ditches), SPSA-2d (Drainage Ditches), SPSA-3a (Drainage Ditches), SPSA-4a (Drainage Ditches), SPSA-5a (Drainage Ditches), SPSA-7a (Drainage Ditches), SPSA-8b (Drainage Ditches), and SPSA-9a (Drainage Ditches) (Figure 17.0-1). These sites contain soil that was contaminated by surface-water runoff from areas of manufacturing or processing activities in South Plants. Agent-contaminated soil is not anticipated in this subgroup.

The South Plants Ditches Subgroup contains 33,000 BCY of soil contaminated with OCPs and ICP metals exceeding the Human Health SEC (EBASCO 1994a). These contaminants are present at depths ranging from 0 to 5 ft below ground surface. Table 17.4-1 provides a summary of contaminants, concentrations, and corresponding exceedance values for this subgroup while Table 17.4-2 summarizes the frequency of detections. The Human Health SEC (EBASCO 1994a) are exceeded by the maximum concentrations of OCPs and chromium. Approximately 3,400 BCY of soil in this subgroup are considered principal threat exceedances; however, average concentrations for all COCs within the human health exceedance volume except aldrin (270 ppm) and dieldrin (58 ppm) are below the Human Health SEC (EBASCO 1994a). A total of 23,000 BCY of soil contains COCs at concentrations that may pose potential risk to biota (Table 17.0-1). Figure 17.4-1 shows the location of the exceedance areas.

The habitat within the South Plants Ditches Subgroup consists of areas of disturbed vegetation. The areas disturbed during remediation are revegetated with native grasses, so the overall habitat value is improved through remedial actions. Sites in this subgroup are considered potential sources of surface-water contamination, so the remediation of the soil in these ditches would prevent the possible migration of contaminants to surface water during precipitation events. These sites are not considered sources of groundwater contamination.

17.5 SOUTH PLANTS DITCHES SUBGROUP EVALUATION OF ALTERNATIVES

The eight alternatives developed for the South Plants Ditches Subgroup vary in approach from no action to treatment. The retained alternatives from the DSA (EBASCO 1992b) were modified to account for the treatment of principal threat volumes and to clarify the nomenclature to indicate that solidification is not required following treatment of organic contaminants. The alternatives were modified as follows: a containment/consolidation alternative (Alternative 3g) was added to landfill human health exceedance soil and consolidate potential biota risk soil as gradefill in the South Plants Central Processing Area; a treatment/containment alternative (Alternative 6c) was added to thermally desorb principal threat volumes and cap remaining exceedance soil; the vacuum extraction alternative was removed from consideration for this subgroup since VOCs, which are the focus of this alternative, do not exceed the Human Health SEC (EBASCO 1994a); the in situ thermal treatment alternative (Alternative 19a) was eliminated from consideration since the equipment for RF heating is not amenable to the physical configuration of the ditches; the in situ surface soil heating and direct treatment alternative (Alternative 20), consisting of multiple technologies that predominantly address surficial contamination, was eliminated from consideration since most of the contamination is not located in the surficial soil; and the capping alternative (Alternative 6) was modified to include the containment of the entire South Plants Medium Group. The following subsections present a description of each retained alternative and an evaluation of the alternative against the EPA criteria for the DAA. The alternatives developed for this subgroup consist of a component to address areas of human health exceedances (which is listed first) and a component to address potential biota exceedances (the "B" alternative).

17.5.1 <u>Alternative 1/B1: No Additional Action</u>

Alternative 1: No Additional Action (Provisions of FFA), along with Alternative B1: No Additional Action (Provisions of FFA), applies to 120,000 SY of soil with human health exceedances and soil posing a potential risk to biota. The 56,000 BCY of contaminated soil remain in place without the implementation of controls. No actions are taken to reduce potential human or biota exposure to COCs or to reduce the potential for surface-water contamination from the ditches. Exceedance areas are monitored (an average of 17 samples per year), annual groundwater monitoring is conducted, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.5.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve RAOs within the required time frame since no controls are implemented and untreated soil remains at the sites. Long-term reduction in toxicity of contaminants is due to natural attenuation/degradation only. Impacts to surface water are not reduced.

17.5.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and sites in the South Plants Ditches Subgroup are not located in wetlands or a 100-year flood plain. This alternative also complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.5.1.3 Long-Term Effectiveness and Permanence

The residual risk for human health and biota exposure is moderate since OCPs and ICP metals exceeding the Human Health SEC (EBASCO 1994a) and soil posing a potential risk to biota remain and may impact human health and biota. Site reviews, soil monitoring, and groundwater monitoring are required. The existing habitat is not impacted by this remedial alternative.

17.5.1.4 Reduction in TMV

There is no reduction in contaminant toxicity, volume or mobility except by natural attenuation or degradation. The 56,000 BCY of untreated soil remain in place. There are no treatment residuals associated with this alternative.

17.5.1.5 Short-Term Effectiveness

No worker exposure is involved in implementing this alternative, and there is no fugitive dust or vapor emissions. Existing habitat is not impacted by this alternative. Migration of contaminants to surface water is not reduced. The time frame to achieve RAOs is greater than 30 years since natural attenuation/degradation is the only process by which contaminant concentrations can be reduced.

17.5.1.6 Implementability

The alternative is technically and administratively feasible. Soil and groundwater monitoring services are readily available.

17.5.1.7 Cost

The total present worth cost is $1,300,000 and includes only long-term O&M costs associated with long-term monitoring and site reviews. Table B4.14-1 details the costing for this alternative. The cost uncertainty associated with monitoring and site reviews is low.

17.5.2 Alternative 1a/B1: Direct Thermal Desorption of Principal Threat Volume; No Additional Action

Alternative 1a: Direct Thermal Desorption (Direct Heating) of Principal Threat Volume; No Additional Action (Provisions of FFA), along with Alternative B1: No Additional Action (Provisions of FFA), involves treating 3,400 BCY of principal threat exceedances in the South Plants Ditches Subgroup. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed. The principal threat volume is excavated and transported to the centralized thermal desorption facility for treatment. (Section 4.6.24 discusses thermal desorption in detail.)

The soil in this subgroup is classified as dry (i.e., moisture content of 10 percent). Based on this moisture content, the soil is processed through the desorber at a rate of approximately 2,000 BCY/day and the solids are discharged at a temperature of 300°C with a total soil residence time of 30 minutes. The thermal desorber requires 1 year to build, and an additional year is required for testing prior to operation. Particulates from the scrubber blowdown, amounting to approximately 1 percent of the soil feed (34 BCY), are disposed in the on-post hazardous waste landfill. The treated soil is returned as backfill to the sites. Thermal desorption removes much of the organic content of the soil, so the 5,500 SY of disturbed soil are supplemented with conditioners and revegetated with native grasses.

The 53,000 BCY of remaining human health exceedances and soil posing potential risk to biota in the South Plants Ditches Subgroup fall under the no additional action part of the alternative. No action is taken in the remainder of the subgroup to reduce human or biota exposure to COCs or potential surface-water contamination. Exceedance areas are monitored (an average of 17 samples per year annual groundwater monitoring is conducted) and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.5.2.1 Overall Protection of Human Health and the Environment

Even though the principal threat volume is treated, this alternative does not achieve RAOs since no controls are implemented and untreated soil remains at the site. The principal threat volume is treated through thermal desorption, but long-term reduction in toxicity of contaminants is due only to natural attenuation/degradation for the majority of the sites. Impacts to surface water are not reduced, except for the principal threat volume. There are short-term impacts associated with the excavation of contaminated soil.

17.5.2.2 Compliance with ARARs

This alternative complies with action-specific ARARs including air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. Location-specific ARARs are also met since the South Plants Ditches Subgroup, the thermal desorption facility, and the landfill are not located in wetlands or a 100-year flood plain. This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.5.2.3 Long-Term Effectiveness and Permanence

The residual risk for human health and biota exposure is moderate due to the remaining levels of OCPs in the soil, which exceed the Human Health SEC (EBASCO 1994a) and pose a potential risk to biota. The 3,400 BCY of principal threat volume are thermally desorbed and returned to the sites as backfill. Approximately 1 percent of the soil feed is recovered from the off-gas treatment equipment and placed in an on-post landfill. No controls are implemented for the balance of the sites. There is high confidence in engineering controls associated with the landfill where treatment residuals are disposed, and there are no difficulties anticipated for landfill maintenance. Habitat quality is not improved for the balance of the sites since the existing habitat is not impacted. Habitat is restored for the principal threat area through revegetation.

17.5.2.4 Reduction in TMV

The 3,400 BCY of principal threat volume are thermally desorbed to degrade OCPs. OCPs are reduced below detectable levels or >99.99 percent DRE, eliminating TMV. There is no reduction in TMV except by natural attenuation/degradation for the balance of the sites, and 53,000 BCY of untreated soil remain. Scrubber blowdown solids from the off-gas treatment equipment are contained in an on-post landfill.

17.5.2.5 Short-Term Effectiveness

This alternative entails low short-term risks associated with excavation, transportation, and thermal desorption of contaminated soil. These risks are addressed through use of personal protective equipment and dust controls such as water sprays. In addition, preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and odors. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards, emissions of low but acceptable levels of some contaminants will occur. Vapor emissions are not anticipated from excavation. There are minimal impacts to the existing habitat. Migration of contaminants to surface water is reduced for the principal threat area. The time frame to treat 3,400 BCY is 3 years, assuming that the thermal desorber does not experience any operational problems. Excavation and treatment of 3,400 BCY is feasible within 1 year after 2 years for construction of a thermal desorption facility. Natural attenuation/degradation of untreated soil is ongoing, but more than 30 years are required to achieve RAOs.

17.5.2.6 Implementability

Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame and should be reliably operated given the contaminants and levels of contamination in the soil feed for this subgroup. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to public perceptions regarding the safety of thermal treatment. Additional remedial actions can easily be undertaken for soil left in place. The alternative is administratively feasible regarding the landfill siting, design, and operating regulations. Equipment, specialists, and materials are readily available for the landfill construction, and landfills have been well demonstrated at full scale. Resources are available to implement the groundwater monitoring program.

17.5.2.7 Cost

The total present worth cost is $1,540,000 including $100,000, $278,000, and $1,160,000 for capital, operating, and long-term costs, respectively. Table B4.14-1b details the costing for this alternative. There are two major cost uncertainties associated with this alternative. First, the excavation of contaminated soil entails a cost uncertainty relative to identifying the extent and depth of contamination. Second, the thermal desorption of contaminated soil also entails cost uncertainties relative to maintaining the assumed on-line percentage, materials handling problems, and possible delays in implementation. However, the overall magnitude of these uncertainties is small based on the small volume of soil to be treated for this subgroup.

17.5.3 Alternative 3/B3: Landfill

For the South Plants Ditches Subgroup, Alternative 3: Landfill (On-Post Landfill), combined with Alternative B3: Landfill (On-Post Landfill), consists of excavating 56,000 BCY of soil with human health exceedances and potential risk to biota and placing this soil in a centralized on-post landfill. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed.

The construction of the first cell of the multiple-cell landfill and associated facilities requires 1 year. (Section 4.6.6 discusses the details of landfill construction.) The excavations are backfilled with borrow soil from the on-post borrow area to return the site to its original grade. The uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses to improve the habitat quality at the site. The borrow area is also recontoured and revegetated to restore habitat. After disposal of the contaminated soil is complete, the landfill cover is installed and the area revegetated. Fencing and biota barriers eliminate habitat at the landfill.

The landfill requires long-term maintenance, leachate collection and treatment, and monitoring of potential leachate migration.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.5.3.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through containment. Contaminated soil is contained in an on-post landfill, thus preventing human and biota exposure. Surface-water impacts are reduced. There are short-term risks are associated with the excavation of contaminated soil.

17.5.3.2 Compliance with ARARS

This alternative complies with action-specific ARARs including state regulations on landfill siting, design, and operation. Endangered species are not impacted. Location-specific ARARs are met since the South Plants Ditches Subgroup and landfill are not located in wetlands or a 100-year flood plain. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.5.3.3 Long-Term Effectiveness and Permanence

The residual risk from this alternative is low since 56,000 BCY of untreated soil are contained in an on-post landfill. There is high confidence in the engineering controls for the landfill, and there are no difficulties anticipated with landfill maintenance. Habitat is restored at the site, but the habitat is eliminated at the landfill.

17.5.3.4 Reduction in TMV

Exposure pathways are interrupted and the mobility of contaminants reduced through containment of 56,000 BCY in an on-post landfill. The mobility reduction is reversible only if the landfill should fail. There are no treatment residuals associated with this alternative.

17.5.3.5 Short-Term Effectiveness

This alternative entails moderate short-term risks associated with excavation, transportation, and landfilling of contaminated soil. Use of personal protective equipment adequately protects workers during excavation and transportation. Fugitive dust is controlled by water sprays, and vapor emissions are not anticipated. Impacts to the existing habitat are minimal. Migration of contaminants to surface water is greatly reduced. The time frame for completion of the alternative is 2 years. Excavation of 56,000 BCY is feasible within 1 year after 2 years for construction of an on-post landfill.

17.5.3.6 Implementability

The alternative is technically feasible and can be constructed within the required time frame and reliably operated thereafter. Additional remedial actions require removal of the landfill cover. Landfill-cell monitoring is required. The alternative is administratively feasible since the substantive requirements of the Subtitle C landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials (including clay) are readily available for the construction of the landfill, and landfills have been well demonstrated at full scale.

17.5.3.7 Cost

The total present worth cost is $3,290,000 including $1,460,000, $1,800,000, and $39,000 for capital, operating, and long-term costs, respectively. Table B4.14-3 details the costing for this alternative. The excavation of contaminated soil entails a cost uncertainty relative to identifying the extent and depth of contamination; however, the magnitude of this uncertainty is small based on the small volume of soil involved and the shallow depth of the excavation.

17.5.4 Alternative 3a/B3: Direct Thermal Desorption of Principal Threat Volume; Landfill

Alternative 3a: Direct Thermal Desorption (Direct Heating) of Principal Threat Volume; Landfill (On-Post Landfill), along with Alternative B3: Landfill (On-Post Landfill), addresses the treating of 3,400 BCY of principal threat exceedances by thermal desorption and the containment of 56,000 BCY of soil with human health exceedances (including the treated soil) and potential risk to biota in the on-post hazardous waste landfill. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed.

The principal threat volume (3,400 BCY) is excavated and transported to the centralized thermal desorption facility. (Section 4.6.24 discusses the details of thermal desorption.) The soil for this subgroup is classified as dry (i.e., moisture content of 10 percent). Based on this moisture content, the thermal desorber processes the soil at a rate of approximately 2,000 BCY/day, and the solids are discharged at a temperature of 300°C with a total soil residence time of 30 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption). Approximately 34 BCY of particulates from scrubber blowdown (1 percent of the total soil feed) are disposed in the on-post landfill along with the treated soil.

The balance of the sites, 53,000 BCY of soil with human health exceedances and potential risk to biota, are excavated and placed in the centralized, multiple-cell hazardous waste landfill, along with the 3,400 BCY of treated soil. Construction of the first cell and associated facilities takes 1 year. (Section 4.6.6 discusses construction of the landfill in detail.) After disposal is complete, the landfill cover is installed and revegetated, although access restrictions (fencing and biota barriers) eliminate the habitat value of the landfill. The landfill requires long-term cover maintenance, leachate collection and treatment, and monitoring of potential leachate migration. The site excavations are backfilled with soil from the on-post borrow area, and the uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses. The borrow area is also recontoured and revegetated.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.5.4.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment of the principal threat volume and containment of the balance of the exceedance volume. The principal threat volume is treated by thermal desorption, and the rest of the contaminated soil is excavated and disposed in the on-post landfill. Surface-water impacts are reduced. Some short-term risks are associated with the excavation of contaminated soil.

17.5.4.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The subgroup, thermal desorption facility, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.5.4.3 Long-Term Effectiveness and Permanence

The residual risk is low since 3,400 BCY of soil are thermally desorbed to achieve PRGs or detection levels, and the remainder of the contaminated soil is contained in the on-post landfill. Approximately 1 percent of the soil feed is recovered from the off-gas treatment equipment and placed in an on-post landfill. There is high confidence in engineering controls associated with the landfill, and there are no anticipated difficulties associated with landfill maintenance. Revegetation of disturbed areas improves the existing habitat.

17.5.4.4 Reduction in TMV

The 3,400 BCY of principal threat volume are thermally desorbed to degrade OCPs, and exposure pathways are interrupted and the mobility of contaminants are reduced through disposal of 56,000 BCY of contaminated soil (including treated soil) in the on-post landfill. Organic compounds are reduced to detection levels or >99.99 percent DRE in the principal threat volume, which eliminates the TMV. Scrubber blowdown solids from the off-gas treatment equipment are contained in an on-post landfill. TMV reduction by thermal desorption is irreversible.

17.5.4.5 Short-Term Effectiveness

This alternative entails moderate short-term risks associated with excavation, transportation, and thermal desorption of contaminated soil. These risks are addressed through use of personal protective equipment and dust controls (such as water sprays). In addition, the preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust. Although the off-gas control system for the thermal desorber is designed to achieve emissions standards, there will be low but acceptable emissions of some contaminants. There are minimal impacts to the existing habitat. Migration of contaminants to the surface water is reduced. The time frame to achieve RAOs is 3 years, assuming that the thermal desorber does not experience any operational problems. Excavation and treatment of 3,400 BCY and landfilling of 56,000 BCY (including treated soil) is feasible within 1 year after 2 years for construction of the thermal desorption facility and landfill.

17.5.4.6 Implementability

Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame and should be reliably operated given the contaminants and levels of contamination in the soil feed in this subgroup. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. Landfill-cell monitoring is required. The alternative is administratively feasible regarding landfill siting, design, and operating regulations. Equipment, specialists, and materials are readily available for construction of the landfill, and landfills have been well demonstrated at full scale.

17.5.4.7 Cost

The total present worth cost is $3,530,000 including $1,490,000, $2,000,000, and $37,000 for capital, operating, and long-term costs, respectively. Table B4.14-3a details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, the excavation of contaminated soil entails a cost uncertainty relative to identifying the extent and depth of contamination. Second, the thermal desorption of contaminated soil entails cost uncertainties relative to maintaining the assumed on-line percentage, materials handling problems, and potential delays in implementation due to community acceptance and performance of the trial burns. However, the overall magnitude of these uncertainties is small based on the small volume of soil to be treated.

17.5.5 Alternative 3g: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap) with Consolidation; Caps/Covers (Multilayer Cap)

Alternative 3g: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap) with Consolidation; Caps/Covers (Multilayer Cap) addresses 33,000 BCY of soil with human health and principal threat exceedances, and 22,000 BCY of soil that potentially poses risk to biota for the South Plants Ditches Subgroup. The 33,000 BCY of human health exceedance soil are excavated for placement in the on-post hazardous waste landfill (Section 4.6.6). The 22,000 BCY of soil that potentially poses risk to biota is excavated and consolidated as gradefill in the Central Processing Area (this soil may also be consolidated as fill for the excavated human health exceedance areas or in the lower 2 feet of cover over the former human health exceedance areas). The former human health exceedance area is then covered with a 3-ft thick soil cover following backfilling, and the South Plants Central Processing Area is capped with a multilayer cap. The former potential risk to biota area is covered with a 1-ft thick soil cover.

The 33,000 BCY of soil with human health exceedances are excavated (0 to 5 ft below ground surface) and placed in the centralized, multiple-cell on-post landfill. Construction of the first cell and associated facilities takes 1 year. (Section 4.6.6 discusses construction of the landfill in detail.) After disposal is complete, the landfill cover is installed and revegetated. Access restrictions (fencing and biota barriers) eliminate the landfill area as available habitat. The landfill requires long-term maintenance of the cover, leachate collection and treatment, and monitoring of potential leachate migration.

The 23,000 BCY of soil that potentially pose risk to biota are excavated (0 to 1 ft below ground surface) and transported to the South Plants Central Processing Area for consolidation (some of this soil may also be used to fill in the excavated human health exceedance areas or in the lower two feet of cover over the former human health exceedance areas). Following consolidation and gradefilling, the South Plants Central Processing Area will be capped. The multilayer cap consists of a 1-ft-thick biota barrier of crushed concrete and a 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil to promote the growth of vegetation. Maintenance activities, such as mowing and replacement of eroded cap materials, ensures the continued integrity of the cap.

The subgrade of the excavated South Plants Ditches Subgroup is then compacted, and the former human health exceedance area is backfilled with 33,000 BCY of on-post borrow material or consolidated potential biota risk soil from this subgroup. The former human health exceedance area is covered with a 3-ft-thick soil cover. The former potential risk to biota area is covered with a 1-ft-thick soil cover. (Prior to placing this cover, two composite samples per acre will be collected to ensure that the soil to be covered does not exceed human health or principal threat criteria. If the residual soil is found to exceed these levels, the 3-ft-thick cover will be extended over these areas, or the exceedance soil will be excavated and landfilled). The 1-ft to 3-ft-thick soil/vegetation layer include 6 inches of soil supplemented with conditioners to promote the growth of vegetation. After placement of the cover, the area is revegetated with native grasses. The types of vegetation and maintenance activities are designed to discourage burrowing animals from using the covered area as habitat. The covering operations take less than 1 year to complete following excavation.

The following discussion presents detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.5-1 summarizes the evaluation for all the alternatives developed for this subgroup.

17.5.5.1 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. RAOs are achieved because contaminated soil is excavated and contained by landfilling and consolidation and a 1-ft to 3-ft-thick soil cover is installed. The impacts to surface water are greatly reduced by removing the contaminated soil from the principal threat and human health exceedance areas. There are short-term risks associated with excavating contaminated soil.

17.5.5.2 Compliance with ARARs

This alternative complies with action-specific ARARs that apply to state regulations on landfill siting, design, and operation, the construction of covers and the monitoring of contained material. Neither the landfill nor the South Plants Central Processing Area consolidated soil are located within wetlands or a 100-year flood plain, thus complying with location-specific ARARs as well. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU, and consolidation to the South Plants Central Processing Area does not trigger LDRs since all sites in this medium group are located within the on-post AOC (as defined in Section 1.4). Materials within the consolidation volume may be landfilled based on visual observations such as soil stains, barrels, or newly discovered evidence of contamination; this landfill volume will be part of the 150,000-CY contingent volume. The alternative also complies with provisions of the FFA (EPA et al. 1989) and regulations pertaining to endangered species protection. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.5.5.3 Long-Term Effectiveness and Permanence

Soil that exceeds the Human Health SEC (EBASCO 1994a) or potentially poses risk to biota is removed from the South Plants Ditches Subgroup site, so residual risk at the site is low. Long-term groundwater monitoring and site reviews are required as part of the consolidation alternative in the South Plants Central Processing Area, but the controls are adequate and there is high confidence in the design and controls for the cap. There is high confidence in the engineering controls for the landfill and there are no expected difficulties associated with landfill maintenance, although landfill-cell monitoring is required. Habitat quality at the site is improved by revegetation of the soil cover, offsetting losses from excavation.

17.5.5.4 Reduction in TMV

Mobility is reduced by containment in the landfill of 33,000 BCY of human health exceedances and consolidation and containment in the South Plants Central Processing Area of 23,000 BCY of soil posing potential risk to biota. Mobility reduction is irreversible so long as the integrity of the landfill and the South Plants Central Processing Area cap are maintained. Since no materials are treated, the toxicity and volume are reduced only by natural attenuation. There are no treatment residuals since there is no treatment.

17.5.5.5 Short-Term Effectiveness

This alternative entails moderate short-term risks during the excavation, transportation, and consolidation of contaminated soil. These risks are mitigated by personal protective equipment for workers and water sprays to control fugitive dust. Vapor emissions are not anticipated. The time frame until RAOs are achieved is 2 years, including the 1 year required to move the contaminated soil to the South Plants Central Processing Area and the landfill, following 1 year for the construction of the landfill. The installation of the soil cover is feasible within 1 year.

17.5.5.6 Implementability

This alternative is technically feasible and has been well demonstrated at full scale. The alternative can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken, but the cap adds to the overall site volume in the South Plants Central Processing Area. The alternative is administratively feasible because it meets the design requirements and construction regulations. Materials, specialists, and equipment are readily available.

17.5.5.7 Costs

The total estimated present worth cost of this alternative is $3,200,000, including $858,000, $2,320,000, and $24,000 for capital, operating, and long-term costs, respectively. Table B4.14-3g details the costing for this alternative. The excavation of contaminated soil entails a cost uncertainty relative to identifying the extent and depth of contamination. However, the overall magnitude of uncertainty is small based on the small volume of soil excavated and the shallow depth of excavation.

17.5.6 Alternative 6/B5: Caps/Covers

Alternative 6: Caps/Covers (Multilayer Cap), in combination with Alternative B5: Caps/Covers (Multilayer Cap), involves the containment of the entire South Plants Medium Group (2,100,000 SY) under one cap. This includes the 120,000 SY of human health exceedances and soil posing potential risk to biota of the South Plants Ditches Subgroup. (Section 4.6.14 discusses low-permeability soil caps in detail.)

Before any cap materials are installed, existing structures are demolished and either contained in place or removed, the subgrade compacted, and the surface crowned with 240,000 BCY of gradefill to achieve the design grades of 3 to 5 percent as part of the overall South Plants cap. The cap consists of a 2-ft-thick layer of compacted low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and a 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil to promote the growth of vegetation. The cap is then revegetated, and the types of vegetation and maintenance activities are designed to discourage burrowing animals from using the covered area as habitat. The borrow area is recontoured and revegetated. Maintenance activities, such as mowing and replacement of eroded cap materials, ensures the continued integrity of the soil cap. Five-year site reviews are conducted to review the effectiveness of the alternative and to assess potential migration of contaminants. Groundwater compliance monitoring is performed to evaluate the continued protectiveness of the alternative.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.5.6.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through containment in place. Contaminated soil is contained by a low-permeability soil cap, thus preventing human and biota exposure. Surface-water impacts are also reduced, and the short-term impacts are low since intrusive activities are not conducted.

17.5.6.2 Compliance with ARARS

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of contained material. Endangered species are not impacted. Location-specific ARARs are met as the South Plants Ditches Subgroup is not located in wetlands or a 100-year flood plain. This alternative also complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.5.6.3 Long-Term Effectiveness and Permanence

The residual risk is low since 56,000 BCY of untreated soil are contained through installation of a low-permeability soil cap with a biota barrier over the whole of South Plants. Long-term monitoring and site reviews are required for untreated soil, as are erosion-control activities and vegetative-cover maintenance. There is high confidence in the engineering controls for the cap, and there are no difficulties anticipated with maintenance. Revegetation of disturbed areas improves the existing habitat, although the types of vegetation and maintenance activities are designed to discourage burrowing animals from using the covered area as habitat.

17.5.6.4 Reduction in TMV

Exposure pathways are interrupted and the mobility of the contaminants is reduced through installation of the multilayer cap. The mobility reduction is reversible only if the cap should degrade or leak. There are no treatment residuals associated with this alternative.

17.5.6.5 Short-Term Effectiveness

The short-term risks associated with this alternative are low, since no intrusive activities are conducted. Personal protective equipment adequately protects workers during installation of the cap. Uncontaminated fugitive dust associated with cap construction is controlled by water sprays, and vapor emissions are not anticipated. Impacts to the existing habitat are minimal; however, the borrow area will be disturbed. The time frame for completion of the alternative is 1 year since installation of the multilayer cap is feasible within 1 year.

17.5.6.6 Implementability

The alternative is technically feasible and can be constructed within the required time frame and reliably operated thereafter. Additional remedial actions can be easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible since the substantive requirements of the cap/cover design and construction regulations are achieved. Equipment, specialists, and materials are readily available for the cap construction, and low-permeability soil caps have been well demonstrated at full scale. Resources are available for long-term groundwater monitoring.

17.5.6.7 Cost

The total present worth cost is $7,380,000 including $6,840,000 and $547,000 for operating and long-term costs, respectively. The cost for installing the multilayer cap is high based on the linear nature of the ditches that comprise this subgroup. Table B4.14-6 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the cap are available on post and the area to be covered is defined.

17.5.7 Alternative 6c/B5: Direct Thermal Desorption of Principal Threat Volume; Caps/Covers (Multilayer Cap)

Alternative 6c: Direct Thermal Desorption (Direct Heating) of Principal Threat Volume; Caps/Covers (Multilayer Cap), along with Alternative B5a: Caps/Covers (Multilayer Cap) addresses the treatment of 3,400 BCY of principal threat exceedance soil through direct thermal desorption and the in-place containment of 53,000 BCY of soil with human health exceedances and potential risk to biota. Like Alternative 6, this alternative involves containment of the entire South Plants Medium Group under one cap (2,100,000 SY).

The principal threat volume is excavated and transported to the centralized thermal desorption facility. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed. The soil in this subgroup is classified as dry (i.e., moisture content of 10 percent). Based on this moisture content, the soil is processed through the desorber at a rate of approximately 2,000 BCY/day and discharged at a temperature of 300°C with a total residence time of 30 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) The 34 BCY of particulates from the scrubber blowdown, approximately 1 percent of the total soil feed, are placed into the on-post hazardous waste landfill. The treated soil is returned to the site as backfill.

The 56,000 BCY of exceedance soil (including the backfilled treated soil) and soil that poses a risk to biota will be capped using a low-permeability soil cap. Prior to capping, the subsurface is compacted and regraded to minimize variations in the subgrade. The cap consists of a 2-ft-thick layer of compacted low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and a 4-ft soil/vegetation layer than includes 6 inches of reconditioned soil to promote growth of vegetation. Site remediation is completed by revegetation of the cover with native grasses to improve the habitat quality of the site, although the type of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the capped area as habitat. Groundwater compliance monitoring is performed to evaluate the long-term protectiveness of the remedy. Approximately 240,000 BCY of gradefill are required to achieve the design grades for capping.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.5.7.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment of the principal threat volume and containment of the remainder of the contaminated soil. The principal threat volume is treated through thermal desorption. The remaining contaminated soil is contained by a low-permeability soil cap.

Surface-water impacts are greatly reduced, but there are short-term risks associated with the excavation of contaminated soil.

17.5.7.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of contained material, as well as state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The South Plants Ditches Subgroup, thermal desorption facility, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.5.7.3 Long-Term Effectiveness and Permanence

The residual risk is low since 3,400 BCY of soil are thermally desorbed to achieve PRGs, and 56,000 BCY, including the treated soil, is contained under a low-permeability soil cap over the whole of South Plants. Approximately 1 percent of the soil feed recovered from the off-gas treatment equipment is placed in an on-post landfill. Long-term monitoring and site reviews are required for untreated soil, but there is high confidence in engineering controls associated with the multilayer cap. Revegetation of disturbed areas improves the existing habitat, offsetting the loss incurred during excavation and capping.

17.5.7.4 Reduction in TMV

The 3,400 BCY of principal threat volume is thermally desorbed to degrade OCPs. For the remaining 53,000 BCY of contaminated soil, human exposure pathways are interrupted and mobility of contaminants is reduced through containment below the multilayer cap. OCPs will be reduced to below detection levels or >99.99 percent DRE in the principal threat volume, eliminating the TMV. Scrubber blowdown solids from the off-gas treatment equipment are contained in an on-post landfill. TMV reduction by thermal desorption is irreversible. Mobility reduction is only reversible should the cap degrade or leak.

17.5.7.5 Short-Term Effectiveness

This alternative entails some moderate short-term risks associated with excavation, transportation, and thermal desorption of contaminated soil. These risks are addressed through personal protective equipment and dust controls (such as water sprays). In addition, the preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust. Although the off-gas control system for the thermal desorber is designed to achieve emissions standards, there will be emissions of low but acceptable levels of some contaminants. There are minimal impacts to biota due to the existing habitat. Migration of contaminants to the surface water is reduced. The time frame to achieve RAOs is 3 years; excavation and treatment of 3,400 BCY is feasible within 1 year after 2 years for construction of the thermal desorption facility, assuming that the thermal desorber does not experience any operational problems. The installation of the 120,000-SY cap is feasible within 1 year.

17.5.7.6 Implementability

Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame and should be reliably operated given the types and levels of contamination in the soil feed in this subgroup. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. The substantive requirements of capping are achieved. Equipment, specialists, and materials are readily available for construction the cap, and low-permeability soil caps have been well demonstrated at full scale. Resources are available for long-term groundwater monitoring.

17.5.7.7 Cost

The total present worth cost is $7,260,000 including $100,000, $6,650,000, and $513,000 for capital, operating and long-term costs, respectively. The cost for installing the cap is high based on the linear nature of the ditches that comprise this subgroup. Table B4.14-6c details the costing for this alternative. The excavation of contaminated soil entails a cost uncertainty relative to identifying the extent and depth of contamination. The thermal desorption of contaminated soil entails cost uncertainties relative to maintaining the assumed on-line percentage, materials handling problems, and potential delays in implementation due to community acceptance and performance of the trial burns. However, the overall magnitude of these uncertainties is small based on the small volume of soil to be treated. The installation of the cap entails a low level of cost uncertainty.

17.5.8 Alternative 13a/B3: Direct Thermal Desorption

Alternative 13a: Direct Thermal Desorption (Direct Heating), paired with Alternative B3: Landfill (On-Post Landfill), treats 33,000 BCY of soil with human health exceedances by thermal desorption and contains 23,000 BCY of soil that may pose potential risk to biota in the on-post hazardous waste landfill. Human health exceedance soil is excavated for treatment at the centralized thermal desorption facility. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed.

Section 4.6.24 discusses the details of thermal desorption. Assuming a soil moisture content of 10 percent, the thermal desorber processes approximately 2,000 BCY/day with a discharge temperature of 300°C and a total soil residence time of 30 minutes. The thermal desorber requires 1 year to build and an additional year for testing. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) The 330 BCY of blowdown particulates, approximately 1 percent of the soil feed, are placed in the on-post hazardous waste landfill. The treated soil is returned to the site and backfilled. Since thermal desorption destroys the natural organic content of the soil, the uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses.

The 23,000 BCY of soil that may pose a potential risk to biota are excavated and placed in the on-post hazardous waste landfill. The construction of the first cell of the multiple-cell landfill and associated facilities requires 1 year. (Section 4.6.6 discusses the details of landfill construction.) The excavations are backfilled with borrow soil from the on-post borrow area to return the site to its original grade. The uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses to improve the habitat quality at the site. The borrow area is also recontoured and revegetated to restore habitat. After the disposal of the contaminated material is complete, the landfill cover is installed and the area revegetated. Fencing and biota barriers eliminate habitat at the landfill. The landfill requires long-term cover maintenance, leachate collection and treatment, and monitoring of potential leachate migration.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.5-1 summarizes the evaluation of all the alternatives developed for this subgroup.

17.5.8.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment and containment. Contaminated soil is treated through thermal desorption, and soil that poses a potential risk to biota is landfilled. Blowdown solids are placed in an on-post landfill. Surface-water impacts are reduced. The excavation and treatment of contaminated soil entails short-term risks.

17.5.8.2 Compliance with ARARS

This alternative complies with action-specific ARARs including state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The South Plants Ditches Subgroup, the thermal desorption facility, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.5.8.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since 33,000 BCY are thermally desorbed to achieve PRGs and since 23,000 BCY of soil posing potential risk to biota are removed and placed in the on-post landfill. In addition, approximately 1 percent of the soil feed recovered from the off-gas treatment equipment is placed in an on-post landfill. Backfill monitoring is not required. There is high confidence in engineering controls associated with the landfill, and there are no expected difficulties associated with maintenance. Revegetation of disturbed areas improves the existing habitat offsetting the losses incurred during excavation, but habitat at the landfill is eliminated.

17.5.8.4 Reduction in TMV

33,000 BCY is thermally desorbed to degrade OCPs to detection levels or >99.99 percent DRE, thereby eliminating the TMV. Scrubber blowdown solids from the off-gas treatment equipment is contained in an on-post landfill. TMV reduction by thermal desorption is irreversible. The mobility of contaminants is reduced for 23,000 BCY contained in the on-post landfill. Mobility reduction is reversible only if the landfill should fail.

17.5.8.5 Short-Term Effectiveness

This alternative entails moderate short-term risks associated with excavation, transportation, and thermal desorption of contaminated soil. These risks are addressed through use of personal protective equipment and dust controls (such as water sprays). In addition, the preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards, and space the contaminants are not completely removed from the thermal desorber emissions. Vapor emissions are not anticipated from excavation. There are minimal impacts to the existing habitat. Migration of contaminants to the surface water is reduced. The time frame until RAOs are achieved is 3 years, excavation and treatment of 33,000 BCY is feasible within 1 year after 2 years for construction of the thermal desorption facility and the landfill, assuming that the thermal desorber does not experience any operational problems.

17.5.8.6 Implementability

Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame and should be reliably operated given the contaminants and levels of contamination in the soil feed for this subgroup. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. Landfill-cell monitoring is required. The alternative is administratively feasible with regard to landfill siting, design, and operating regulations. Equipment, specialists, and materials are readily available for the construction of the landfill. Landfills have been well demonstrated at full scale.

17.5.8.7 Cost

The total present worth cost is $5,010,000 including $1,540,000, $3,450,000, and $15,000 for capital, operating, and long-term costs, respectively. Table B4.14-13a details the costing for this alternative. There are two major uncertainties associated with the costing of this alternative. First, the excavation of contaminated soil entails a cost uncertainty relative to identifying the extent and depth of contamination. Second, the thermal desorption of contaminated soil entails cost uncertainties relative to maintaining the assumed on-line percentage, materials handling problems, and possible delays in implementation. Difficulties with materials handling also entail a cost uncertainty. However, the overall magnitude of these uncertainties is small based on the small volume of soil to be treated.

17.6 SOUTH PLANTS DITCHES SUBGROUP COMPARISON OF ALTERNATIVES

The South Plants Ditches Subgroup contains 56,000 BCY of exceedance volume. OCPs are the primary exceedances. Contamination is a result of surface-water runoff from areas of manufacturing and processing activities in South Plants. The OCPs aldrin and dieldrin were detected above the Human Health SEC (EBASCO 1994a) in approximately 10 percent of the samples (Table 17.4-2). However, the average concentrations of the remaining OCPs are less than the Human Health SEC (EBASCO 1994a), which results in a principal threat volume of

3,400 BCY for aldrin and dieldrin exceedances only. Agent, UXO, and groundwater contamination are not associated with this subgroup, but migration of contaminants to surface water flowing through the ditches is possible.

The area within the subgroup contains areas of disturbed vegetation. Alternatives that disrupt habitat include revegetation and restoration following remediation, so no significant habitat impacts are expected. For alternatives that involve containment with a cap/cover, the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat.

Alternatives that involve excavation of human health exceedances require protection for site workers during remedial activities, but the short-term risk to workers is reduced by the use of proper personal protective equipment. The degree of contamination in sites in this subgroup does not necessitate special measures for odor control or community protection during remediation.

In summary, the South Plants Ditches Subgroup contains levels of contamination that exceed Human Health SEC (EBASCO 1994a), soil that may pose a risk to biota, and isolated exceedances of the principal threat criteria. There is potential for surface-water contamination from this subgroup. Habitat impacts and community protection are not significant issues for this subgroup.

Alternative 1: No Additional Action does not achieve RAOs since untreated soil remains on site, and so was eliminated from further consideration. Alternative 1a: Direct Thermal Desorption of Principal Threat Volume; No Additional Action treats the highest levels of contamination, but still does not achieve RAOs for all of the exceedance volume and was also eliminated from further consideration. The remaining six alternatives achieve RAOs and meet the two DAA threshold criteria: protection of human health and the environment and compliance with action-specific and location-specific ARARs for the DAA.

The landfill alternatives (Alternative 3: Landfill, Alternative 3a: Direct Thermal Desorption of Principal Threat Volume; Landfill and Alternative 3g: Landfill; Caps/Covers with Consolidation; Caps/Covers) achieve RAOs, although the majority of materials are untreated. The potential exposure and mobility of contaminants are reduced through containment in each case. Landfilling has been well demonstrated and there is high confidence in the engineering controls and maintenance of this operation. However, significant short-term risks during excavation operations are incurred. The costs of $3,290,000 and $3,530,0000, and $3,200,000, for Alternatives 3, 3a, and 3g, respectively, are below the average cost of the full treatment alternative (Alternative 13a). Based on the cost effectiveness and permanent containment offered by consolidating and/or landfilling, these alternatives were carried forward for consideration in the development of the sitewide alternatives (see Section 20).

Alternative 6: Caps/Covers provides low long-term residual risks by interrupting exposure pathways and reducing the mobility of contaminants. This technology has also been well demonstrated and entails low short-term risks since contaminated soil is not excavated. In addition, there are no treatment residuals associated with this alternative. This alternative was carried forward for development of the sitewide alternatives (see Section 20) to allow for the development of a capping alternative for the entirety of South Plants.

Alternative 6c: Direct Thermal Desorption of Principal Threat Volume; Caps/Covers entails limited excavation and treatment prior to capping at a cost of $7,260,000. The capping of the South Plants Ditches is performed in conjunction with the installation of a cap over South Plants. Drawbacks of the alternative compared to Alternative 6 include short-term impacts associated with excavation and the difficulty in gaining public acceptance for thermal desorption. Furthermore, this alternative relies on containment to achieve RAOs. As a result, this alternative does not provide significantly greater long-term risk reduction compared to in place containment and was not retained for consideration in the development of sitewite alternatives.

Alternative 13a: Direct Thermal Desorption achieves RAOs through treatment and containment. However, the added long-term risk reduction through additional treatment and its higher cost in comparison to alternatives involving consolidation or landfilling, with or without treatment of principal threats are not cost-effective. Therefore, this alternative was not retained for consideration in development of sitewide alternatives.

Consequently, the alternatives that were retained to represent the South Plants Ditches Subgroup in the development of the sitewide alternatives (Section 20) are the following:

- Alternative 3: Landfill (On-Post Landfill);
- Alternative 3a: Direct Thermal Desorption (Direct Heating) of Principal Threat Volume; Landfill (On-Post Landfill);
- Alternative 3g: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap) with Consolidation; Caps/Covers (Multilayer Cap); and
- Alternative 6: Caps/Covers (Multilayer Cap)

17.7 SOUTH PLANTS BALANCE OF AREAS SUBGROUP CHARACTERISTICS

The South Plants Balance of Areas Subgroup consists of sites SPSA-1b (Mounded Material), SPSA-1c (Lime Pits), SPSA-1g (Balance of Subarea), SPSA-2a (South Tank Farm), SPSA-2b (Open Storage Yard), SPSA-2c (Salvage Yard), SPSA-2e (Balance of Subarea), SPSA-3b (Salt Storage Pad), SPSA-3c (Former Tank Storage Area), SPSA-3d (Revetted Tank Storage), SPSA-3e (Balance of Subarea), SPSA-4b (Balance of Subarea), SPSA-5b (Balance of Subarea), SPSA-6 (Hydrazine Facility), SPSA-7b (Lagoon), SPSA-7c (Balance of Subarea), SPSA-8a (Sanitary Landfill), SPSA-8c (Balance of Subarea), SPSA-9b (Balance of Subarea), SPSA-12a (Aeration Basin), and SPSA-12b (Sedimentation Pond) (Figure 17.0-1.) These sites contain soil that was contaminated as a result of miscellaneous operations in South Plants. There are 48,000 SY of soil with potential agent presence, and 15,000 SY of soil, primarily in the southern portion of South Plants, with potential UXO presence (Table 17.0-1).

Table 17.7-1 provides a summary of contaminants, concentrations, and exceedance values for this subgroup, and Table 17.7-2 summarizes the frequency of detections. The maximum concentration of OCPs, HCCPD, mercury, and chromium exceed the Human Health SEC (EBASCO 1994a) in

130,000 BCY of soil in this subgroup. The maximum detections of aldrin and dieldrin (15,000 ppm and 2,600 ppm, respectively) also exceed the principal threat criteria (10^{-3} excess cancer risk, HI of 1,000) in 11,000 BCY of soil. OCPs were found throughout the 0- to 10-ft depth interval; however, a majority of the exceedances were detected in the 0- to 2-ft depth interval. ICP metals were detected at only a few locations at depths from 0 to 7 ft below ground surface. There are 510,000 BCY of soil that may pose potential risk to biota in the 0- to 1-ft depth interval. Figure 17.7-1 presents exceedance areas for this subgroup. Figure 17.7-2 presents the overlap between areas potentially containing agent or UXO and the exceedance areas.

The South Plants Balance of Areas Subgroup primarily consists of areas of disturbed vegetation. The areas disturbed during remediation are revegetated with native grasses, so the overall habitat value is improved through remedial actions. For alternatives involving containment with a cap/cover, however, the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat.

Sites in the South Plants Balance of Areas Subgroup are identified as being the source of several groundwater contamination plumes. These plumes occur in the unconfined aquifer and migrate away from the South Plants Central Processing Area. Groundwater alternatives that address the installation of individual plume group remediation systems are being evaluated. Coordination of alternatives developed for the soil medium with those developed for the water medium is limited to excavation or capping. In situ soil treatment can complement groundwater alternatives by reducing contamination.

Due to the contaminant mass already in the aquifer, it is unlikely that the remediation of this subgroup would impact the groundwater quality in the near term, although it would prevent additional contaminant loading of the groundwater. Excavation and capping alternatives require the demolition of structures and removal of debris. All structural debris must either be contained in place under a cap, removed from the area for consolidation in the South Plants Central

Processing Area, or disposed in the on-post hazardous waste landfill as discussed in Section 6 of the Structures DAA.

17.8 SOUTH PLANTS BALANCE OF AREAS SUBGROUP EVALUATION OF ALTERNATIVES

The nine alternatives developed for the South Plants Balance of Areas Subgroup vary in approach from no action to treatment. The retained alternatives from the DSA (EBASCO 1992b) were modified to account for the treatment of principal threat volumes as follows. A treatment/containment alternative (Alternative 6c) was added to thermally desorb principal threat volumes and cap remaining exceedance soil. A containment/consolidation alternative (Alternative 3g) was added to landfill human health exceedance soil and consolidate biota risk soil as gradefill in the South Plants Central Processing Area. Alternative 6: Caps/Covers was modified to consist of the containment in place of the entire South Plants Medium Group beneath a single cap. The alternative involving soil vapor extraction was removed based on a re-evaluation of the risks associated with indirect exposure from VOCs in the IEA/RC (EBASCO 1994a). The in situ surface soil heating and direct treatment alternative (Alternative 20) was not evaluated for this subgroup since the surficial contamination contains contaminant levels that are too low to be cost-effectively addressed by in situ surface soil heating (Section 4.6.17). The following subsections present a description of each alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a). The alternatives for this subgroup consist of an alternative that addresses areas of human health exceedances (which is listed first), an alternative that addresses potential biota exceedances (the "B" alternative), an alternative that addresses potential agent presence (the "A" alternative), and an alternative that addresses potential UXO presence (the "U" alternative).

17.8.1 Alternative 1/B1/A1/U1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA), along with Alternative B1: No Additional Action (Provisions of FFA), Alternative A1: No Additional Action (Provisions of FFA), and Alternative U1: No Additional Action (Provisions of FFA), applies to all 1,700,000 SY of exceedance area in the South Plants Balance of Areas Subgroup. The

640,000 BCY of soil with human health exceedance or potential risk to biota, as well as the potential for agent and UXO, remains in place. No action is taken to reduce potential human or biota exposure to COCs, physical and acute chemical hazards from agent and UXO, or migration of contaminants to groundwater from these sites. Exceedance areas are monitored (an average of 204 samples per year), annual groundwater sampling is performed, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.8-1 summarizes the evaluation of all alternatives for this subgroup.

17.8.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve RAOs since no controls are implemented and untreated soil remains at the site. Soil with potential agent and UXO presence also remains on site. Long-term reduction in toxicity of contaminants is due to natural attenuation. Impacts to groundwater are not reduced.

17.8.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and South Plants Balance of Areas Subgroup is not located in wetlands or a 100-year flood plain. The alternative also complies with provisions of the FFA (EPA et al. 1989), but does not comply with Army regulations regarding the control of agent-containing materials or UXO. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.8.1.3 Long-Term Effectiveness and Permanence

The residual risk for human health and biota exposure is moderate since human health exceedances of OCPs, HCCPD, and ICP metals posing potential risk to biota remain and may impact human health and biota. Soil with potential presence of agent/UXO also remains in place. Site reviews, soil monitoring, and groundwater compliance monitoring are required. The existing habitat is not impacted by this remedial alternative.

17.8.1.4 Reduction in TMV

There is no reduction in contaminant volume or mobility except by natural attenuation. The 640,000 BCY of untreated soil remain. In addition, hazards associated with potential agent and UXO presence are not reduced. There are no treatment residuals associated with this alternative.

17.8.1.5 Short-Term Effectiveness

There are no impacts on workers under this alternative. Neither fugitive dust nor vapor emissions are expected. In addition, the existing habitat is not impacted by this alternative. Migration of contaminants to groundwater is not reduced. The time frame to achieve RAOs is greater than 30 years since natural attenuation/degradation is the only process by which contaminants are reduced. Agent-contaminated soil and UXO remain in the soil.

17.8.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are readily available.

17.8.1.7 Cost

The total present worth is cost $12,600,000 and includes only long-term O&M costs associated with long-term monitoring and site reviews. Table B4.15-1 details the costing for this alternative. The cost uncertainty associated with site reviews and monitoring is low.

17.8.2 <u>Alternative 1a/B1/A1/U1: Direct Thermal Desorption of Principal Threat Volume; No Additional Action</u>

Alternative 1a: Direct Thermal Desorption (Direct Heating) of Principal Threat Volume; No Additional Action (Provisions of FFA), along with Alternative B1: No Additional Action (Provisions of FFA), Alternative A1: No Additional Action (Provisions of FFA), and Alternative U1: No Additional Action (Provisions of FFA), involves treatment of 11,000 BCY of principal threat exceedances in the South Plants Balance of Areas Subgroup. The principal threat area is cleared of UXO using geophysical techniques or other methods prior to excavation and screened for agent using real-time field analytical methods during excavation. Any excavated soil confirmed to contain agent by RMA laboratory analysis is treated on-post by direct caustic solution washing (Alternative A3).

The demolition of structures is required to allow the excavation of contaminated soil. The structural debris is removed from the site along with any abandoned utilities encountered during excavation. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed. Due to the potential for odor problems, excavation is conducted so that only minimal area is uncovered and exposed at any one time, and a daily soil cover or plastic liner is installed over the excavated areas.

Once the principal threat area is cleared, principal threat exceedance soil is excavated and transported to the centralized thermal desorption facility for treatment. (Section 4.6.24 discusses the details of thermal desorption.) The soil for this subgroup is classified as dry (i.e., moisture content of 10 percent). Based on the moisture content, the thermal desorber processes the soil at a rate of approximately 2,000 BCY/day and discharges them at a temperature of 300°C after a total soil residence time of 30 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) Particulates from scrubber blowdown, amounting to approximately 1 percent of the total soil feed (110 BCY), are placed into the on-post hazardous waste landfill. Treated soil is returned and backfilled into the excavations. Thermal desorption removes much of the organic content in the soil, so the uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses.

The 630,000 BCY of remaining exceedance soil from the balance of the site fall under the no additional action portion of the alternative. No action is taken in these areas to reduce potential human or biota exposure to COCs, potential physical and acute chemical hazards from agent or UXO, or potential groundwater contamination from sites in this subgroup. Exceedance areas left in place are monitored (an average of 204 samples per year), annual groundwater sampling is performed, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.8-1 summarizes the evaluation of all alternatives for this subgroup.

17.8.2.1 Overall Protection of Human Health and the Environment

This alternative does not achieve Human Health or Biota RAOs since untreated soil remains without controls being implemented, although the principal threat volume is treated. Soil with potential agent and UXO presence remains. Long-term reduction in toxicity of contaminants is through natural attenuation/degradation for the balance of the exceedance areas. The principal threat volume is treated through thermal desorption. Except for the principal threat volume, groundwater impacts are not reduced. There are short-term risks associated with agent clearance and excavation of contaminated soil.

17.8.2.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The South Plants Balance of Areas Subgroup, thermal desorption facility, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative complies with the provisions of the FFA (EPA et al. 1989), but does not comply with Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding the control of agent contaminated materials and UXO for the areas not excavated. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.8.2.3 Long-Term Effectiveness and Permanence

The residual risk is moderate since contaminants exceeding the Human Health SEC (EBASCO 1994a) remain in the soil, and soil with potential agent/UXO presence remains on-site. The 11,000 BCY of principal threat soil are thermally desorbed and returned to the site as backfill. Approximately 1 percent of the soil feed (110 BCY), recovered from the off-gas treatment equipment, is placed in an on-post landfill. There is high confidence in engineering controls associated with the landfill, and there are no difficulties anticipated with maintenance of the landfill. Habitat quality is not improved for the balance of the sites. Habitat is improved for the principal threat volume through revegetation.

17.8.2.4 Reduction in TMV

The 11,000 BCY of principal threat volume are thermally desorbed to degrade OCPs and HCCPD. There is no reduction in contaminant volume or mobility for the remaining 630,000 BCY of untreated soil except by natural attenuation. There is also no reduction in potential hazards related to agent or UXO presence for the balance of the exceedance areas. Organic compounds will be reduced to detection levels or >99.99 percent DRE in the principal threat volume, eliminating the TMV. Scrubber blowdown solids from off-gas treatment equipment are contained in an on-post landfill.

17.8.2.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with UXO/agent clearance, and excavation, transportation, and thermal desorption of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Engineered dust controls (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. In addition, the preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and vapors/odors. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards, the emissions from the thermal desorber contain low but acceptable levels of some contaminants. There are minimal impacts to the existing habitat. Migration of contaminants to the groundwater is reduced through treatment of the principal threat volume. The time frame to achieve RAOs in the principal threat volume is 3 years; RAOs are not achieved for the remaining human health or potential biota risk volume. Excavation and treatment of 11,000 BCY is feasible within 1 year after 2 years for construction of the thermal desorption facility and landfill, assuming that the thermal desorber does not experience any operational problems. Natural attenuation/degradation of contaminants in untreated soil is ongoing. Soil with potential agent/UXO remains on site.

17.8.2.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the contaminated soil. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, materials handling problems, and presence of debris remaining in the soil feed after structures demolition. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. Landfill-cell monitoring and demolition and removal of structures are required. Additional remedial actions can be easily undertaken for soil left in place. The alternative is administratively feasible with regard to landfill siting, design, and operating regulations. Equipment, specialists, and materials are readily available for construction of the landfill. Landfills have been well demonstrated at full scale.

17.8.2.7 Cost

The total present worth cost is $12,500,000 including $324,000, $906,000, and $11,300,000 for capital, operating, and long-term costs, respectively. Table B4.15-1a details the costing for this alternative. There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate. Second, there is little operating experience at other sites upon which to base an evaluation of the costs and performance of the vapor/odor controls, and their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high clay content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

17.8.3 Alternative 3/B3/A3/U4a: Landfill

For the South Plants Balance of Areas Subgroup, Alternative 3: Landfill (On-Post Landfill), combined with Alternative B3: Landfill (On-Post Landfill), Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), and Alternative U4a: Detonation (Off-Post Army Facility), consists of landfilling 640,000 BCY of soil with human health exceedances and soil posing a potential risk to biota. The demolition of structures is required to allow the excavation of contaminated soil. The structural debris is removed from the site along with any abandoned utilities encountered during excavation. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed. Due to the potential odor problems, excavation is conducted so that only minimal area is uncovered and exposed at any one time, and a daily soil cover or plastic liner is installed over the excavated areas.

This subgroup includes 48,000 SY of area with potential agent presence and 15,000 SY of area with potential UXO presence. Prior to excavation, the area with potential UXO presence is cleared using geophysical-screening techniques or other methods. Any identified UXO are excavated, packaged, and transported off post for demilitarization at an existing Army facility. The 5,000 BCY of metallic debris mixed with surface soil are excavated and placed in the on-post hazardous waste landfill. This volume of debris overlaps with soil that may pose risks to biota.

During excavation, the soil is screened for agent using real-time field analytical methods. If agent is identified, the soil is placed in a secure stockpile and agent presence is confirmed by RMA laboratory analysis. Any agent-contaminated soil is treated on post by caustic solution washing as discussed in Section 4.4.3.

Once soil is screened for agent/UXO and cleared, the 640,000 BCY of contaminated soil are excavated and placed in the on-post hazardous waste landfill. (Section 4.6.6 discusses the details of landfill construction.) The construction of the first cell of the multiple-cell landfill and associated facilities requires 1 year. The site excavations are backfilled with borrow soil from the on-post borrow area to return the site to grade. The uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses to improve the habitat at the site. The borrow area is also revegetated and recontoured to restore habitat. After placement of waste, the landfill cover is installed and vegetated, and access controls of fencing and biota barriers are implemented to restrict the site from burrowing animals. The landfill requires long-term maintenance of the cover, leachate collection and treatment, and groundwater monitoring.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.8-1 summarizes the evaluation of all alternatives for this subgroup.

17.8.3.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through containment. Contaminated soil is contained in an on-post landfill, preventing human and biota exposures. Groundwater impacts are also reduced. Soil with potential agent or UXO presence is screened and treated; however, the short-term risks associated with agent/UXO clearance and excavation of contaminated soil are significant.

17.8.3.2 Compliance with ARARS

This alternative complies with action-specific ARARs including state regulations on landfill siting, design, and operation. Endangered species are not impacted. The South Plants Balance of Areas Subgroup, caustic solution washing facility, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.8.3.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since 640,000 BCY of untreated soil are contained in an on-post landfill. There is high confidence in the engineering controls for the landfill, and there are no expected difficulties associated with landfill maintenance. Landfill-cell monitoring is required. The existing habitat at the site is improved by revegetation of disturbed areas; however, habitat at the landfill is eliminated.

17.8.3.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants is reduced through containment of 640,000 BCY in an on-post landfill. Soil with agent/UXO is identified and treated. Mobility reduction is reversible only if the landfill should fail. There are no treatment residuals associated with this alternative.

17.8.3.5 Short-Term Effectiveness

This alternative entails moderate short-term risks associated with UXO/agent clearance and excavation, transportation, and landfilling of a large volume of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Dust controls (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are initiated to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. There are minimal impacts to the existing habitat. Migration of contaminants to the groundwater is reduced. The time frame until RAOs are achieved is 3 years; excavation of 640,000 BCY is feasible within 2 years after 1 year for construction of the landfill and the caustic solution washing facility for agent treatment.

17.8.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter with periodic landfill-cell monitoring. Additional remedial actions require removal of landfill cover. Demolition and removal of structures is also required. Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of soil covers increases the volume to be excavated and would require double handling to access the contaminated soil. The alternative is administratively feasible since the substantive requirements of Subtitle C landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials (including clay) are readily available for construction of the landfill, and landfill technology has been well demonstrated at full scale.

17.8.3.7 Cost

The total present worth cost is $38,700,000 including $16,400,000, $21,900,000, and $423,000 for capital, operating, and long-term costs, respectively. Table B4.15-3 details the costing for this alternative. There is one significant uncertainty associated with the costing of this alternative. The extent and depth of contamination and extent of agent/UXO presence are difficult to estimate.

17.8.4 Alternative 3a/B3/A3/U4a: Direct Thermal Desorption of Principal Threat Volume; Landfill

Alternative 3a: Direct Thermal Desorption (Direct Heating) of Principal Threat Volume; Landfill (On-Post Landfill), along with Alternative B3: Landfill (On-Post Landfill), Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), and Alternative U4a Detonation (Off-Post Army Facility), addresses the treatment of 11,000 BCY of principal threat exceedances by thermal desorption, and the containment of 640,000 BCY of soil with human health exceedances and potential risk to biota, including the treated soil, in the on-post hazardous waste landfill. The demolition of structures is required to allow the excavation of contaminated soil. The structural debris is removed from the site, along with any abandoned utilities encountered, during excavation. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed. Due to the potential odor problems, excavation is conducted so that only minimal area is uncovered and exposed at any one time, and a daily soil cover or plastic liner is installed over the excavated areas to further reduce the odor emissions.

This subgroup includes 48,000 SY of soil with potential agent presence and 15,000 SY of soil with potential UXO presence. Prior to excavation, the soil with potential UXO presence is cleared using geophysical screening or other methods. Any identified UXO are excavated, packaged, and transported off post for demilitarization at an existing Army facility. The 5,000 BCY of metallic debris mixed with surface soil are excavated and placed in the on-post landfill along with the human health exceedances and soil that poses potential risks to biota.

During excavation, the soil is screened for agent using real-time field analytical methods. If agent is identified, the soil is placed in a secure stockpile and agent presence is confirmed by RMA laboratory analysis. Any agent-contaminated soil is treated on-post by caustic solution washing as discussed in Section 4.4.3.

The principal threat volume, 11,000 BCY, is excavated and transported to the centralized thermal desorption facility. (Section 4.6.24 discusses the details of thermal desorption.) The soil for this subgroup is classified as dry (i.e., moisture content of 10 percent). Based on the thermal desorber processing the soil at a rate of approximately 2,000 BCY/day, and discharging it at a temperature of 300°C with a total soil residence time of 30 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) Approximately 110 BCY of particulates from scrubber blowdown (1 percent of the total soil feed) are disposed in the on-post landfill. The treated soil from the thermal desorber is landfilled along with the remaining exceedances.

The remaining 630,000 BCY of soil with human health exceedances and potential risk to biota in the balance of the sites are excavated and placed in the centralized, multiple-cell hazardous waste landfill along with the treated soil. Construction of the first cell and associated facilities takes 1 year. (Section 4.6.6 discusses construction of the landfill in detail.) After disposal is complete, the landfill cover is installed and revegetated, although access restrictions (fencing and biota barriers) eliminate the habitat value of the landfill. The landfill requires long-term maintenance of the cover, leachate collection and treatment, and monitoring of potential leachate migration. The site excavations are backfilled with soil from the on-post borrow area. The uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses. The borrow area is also recontoured and revegetated.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.8-1 summarizes the evaluation of all alternatives for this subgroup.

17.8.4.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment of the principal threat volume and containment of the balance of the exceedance areas. The principal threat volume is treated through thermal desorption. Contaminated soil in the balance of the sites is excavated and contained in the on-post landfill. Soil with potential agent or UXO is identified and treated. Groundwater impacts are reduced. The short-term risks associated with agent/UXO clearance and excavation of contaminated soil are significant.

17.8.4.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The South Plants Balance of Areas Subgroup, thermal desorption facility, caustic solution washing facility, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.8.4.3 Long-Term Effectiveness and Permanence

The residual risk is low since 11,000 BCY of soil are thermally desorbed to achieve PRGs, and 640,000 BCY of soil are contained in the on-post landfill. Approximately 1 percent of the soil feed is recovered from the off-gas treatment equipment and placed in an on-post landfill, along with salts generated by the caustic solution washing process. Long-term monitoring and site reviews are required for the untreated soil. There is high confidence in engineering controls associated with the landfill, and there are no anticipated difficulties associated with the landfill maintenance. Revegetation of disturbed area improves the existing habitat.

17.8.4.4 Reduction in TMV

Human exposure pathways are interrupted and mobility of contaminants is reduced through containment of 640,000 BCY of contaminated soil in the on-post landfill. Soil with agent/UXO is identified and treated. The 11,000 BCY of principal threat volume are thermally desorbed to degrade OCPs and HCCPD. Organic compounds are reduced to detection levels or >99.99 percent DRE in the principal threat volume, eliminating TMV of organic compounds in the principal threat volume. Scrubber blowdown solids from off-gas treatment equipment are contained in an on-post landfill.

17.8.4.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with UXO/agent clearance and excavation, transportation, and thermal desorption of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment but they cannot be completely removed. Engineered dust controls (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. In addition, the preparation of feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and vapors/odors. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards, the emissions from the thermal desorber contain low but acceptable levels of some contaminants. There are minimal impacts to the existing habitat. Migration of contaminants to the surface water is reduced. The time frame to achieve RAOs is 4 years. Excavation and treatment of 11,000 BCY is feasible within 1 year after 2 years for construction of the thermal desorption facility, assuming that the thermal desorber does not experience any operational problems. Construction of the landfill and associated facilities takes 1 year, and 2 years are required for the landfilling of 640,000 BCY. Natural attenuation of contaminants in untreated soil is ongoing.

17.8.4.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the uncontaminated soil. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, materials handling problems, and presence of debris remaining in the soil feed after structures demolition. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. Landfill-cell monitoring is required. Demolition and removal of structures is also required. The alternative is administratively feasible regarding landfill siting, design, and operating regulations. Equipment, specialists, and materials are readily available for construction of the landfill. Landfills have been well demonstrated at full scale.

17.8.4.7 Cost

The total present worth cost is $39,500,000 including $16,800,000, $22,300,000, and $423,000 for capital, operating and long-term costs, respectively. Table B4.15-3a details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent/UXO presence are difficult to estimate and so increase uncertainties relative to excavation costs. Second, there is little operating experience at other sites upon which to base an evaluation of the costs and performance of the vapor/odor controls, and their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high clay content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

17.8.5 Alternative 3g: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap) With Consolidation; Caps/Covers (Multilayer Cap)

Alternative 3g: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap) with Consolidation; Caps/Covers (Multilayer Cap) addresses 130,000 BCY of soil with human health and principal threat exceedances, and 510,000 BCY of soil that potentially poses risk to biota for the South Plants Balance of Areas Subgroup. The 130,000 BCY of human health exceeding soils are excavated for placement in the on-post hazardous waste landfill (Section 4.6.6). The 510,000 BCY of soil that potentially poses risk to biota is excavated and consolidated as gradefill in the South Plants Central Processing Area prior to capping with a multilayer cap. The former human health exceedance area is then backfilled and covered with a 3-ft-thick soil cover. The former potential risk to biota area is covered with a 1-ft-thick soil cover. Figure 17.8-1 shows the extent of the 3-ft-thick soil cover over the former human health area and the 1-ft-thick soil cover area.

The 130,000 BCY of soil with human health exceedances are excavated 0 to 6.5 ft below ground surface and placed in the centralized, multiple-cell on-post landfill. Construction of the first cell and associated facilities takes 1 year. (Section 4.6.6 discusses construction of the landfill in detail). After disposal is complete, the landfill cover is installed and revegetated. Access restrictions (fencing and biota barriers) eliminate the landfill area as available habitat. The landfill requires long-term maintenance of the cover, leachate collection and treatment, and monitoring of potential leachate migration.

The 510,000 BCY of soil that potentially poses risk to biota is excavated 0 to 1 ft below ground surface and transported to the South Plants Central Processing Area for consolidation (some of this soil may also be used as fill in the excavated human health exceedance areas or in the lower two feet of cover over the human health exceedance areas). Following consolidation and gradefilling, the South Plants Central Processing Area will be capped. The multilayer cap consists of a 1-ft-thick biota barrier of crushed concrete and a 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil to promote the growth of vegetation. Maintenance activities, such as mowing and replacement of eroded cap materials, ensures the continued integrity of the soil cap at the South Plants Central Processing Area.

The subgrade of the excavated South Plants Balance of Areas Subgroup is then compacted, and the former human health exceedance area is backfilled with 130,000 BCY of on-post borrow material or consolidated potential biota risk soil from this subgroup. The former human health exceedance area is covered with a 3-ft-thick soil cover. The former potential risk to biota area is covered with a 1-ft-thick uncontaminated soil cover. Prior to placing this cover, two composite samples per acre will be collected to ensure that the soil to be covered does not exceed human health or principal threat criteria. If the residual soil is found to exceed these levels, the 3-ft-thick cover will be extended over these areas, or the exceedance soil will be excavated and landfilled. The 1-ft to 3-ft-thick soil/vegetation layer includes 6 inches of soil supplemented with conditioners to promote the growth of vegetation. The top 1 foot over the entire soil cover area will be constructed using uncontaminated soil from the on-post borrow area. After placement of the cover, the area is revegetation with native grasses. The types of vegetation and maintenance activities are designed to discourage burrowing animals from using the covered area as habitat. The covering operations take less than 1 year to complete following excavation.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.8-1 summarizes the evaluation for all the alternatives developed for this subgroup.

17.8.5.1 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. RAOs are achieved because contaminated soil is excavated and contained by landfilling and consolidation and a 1-ft to 3-ft-thick soil cover is installed. The impacts to groundwater are greatly reduced by removing the contaminated soil from the principal threat and human health exceedance areas. There are short-term risks associated with excavating contaminated soil.

17.8.5.2 Compliance with ARARs

This alternative complies with action-specific ARARs that apply to state regulations on landfill siting, design, and operation, the construction of covers and the monitoring of contained material. Neither the landfill nor the South Plants Central Processing Area consolidated soil are located within wetlands or a 100-year flood plain, thus complying with location-specific ARARs as well. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). The alternative also complies with provisions of the FFA (EPA et al. 1989) and regulations pertaining to endangered species protection. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.8.5.3 Long-Term Effectiveness and Permanence

Soil that exceeds the Human Health SEC (EBASCO 1994a) or potentially poses risk to biota is removed from the South Plants Balance of Areas Subgroup site, so residual risk at the site is minimal. Long-term groundwater monitoring and site reviews are required as part of the consolidation alternative in the South Plants Central Processing Area, but the controls are adequate and there is high confidence in the design and controls for the cap. There is high confidence in the engineering controls for the landfill and there are no expected difficulties associated with landfill maintenance, although landfill-cell monitoring is required. Habitat quality at the site is improved by revegetation of the soil cover, offsetting losses from excavation.

17.8.5.4 Reduction in TMV

Mobility is reduced by containment in the landfill and consolidation and containment in the South Plants Central Processing Area. Mobility reduction is irreversible so long as the integrity of the landfill and the South Plants Central Processing Area cap are maintained. Since no materials are treated, the toxicity and volume are reduced only by natural attenuation. There are no treatment residuals since there is no treatment.

17.8.5.5 Short-Term Effectiveness

This alternative entails moderate short-term risks during the excavation, transportation, and consolidation of contaminated soil. These risks are mitigated by personal protective equipment for workers and water sprays to control fugitive dust. Vapor emissions are not anticipated. The time frame until RAOs are achieved is 3 years, including the 1 year required to move the contaminated soil to the South Plants Central Processing Area and the landfill, following 1 year for the construction of the landfill. The installation of the soil cover is feasible within 2 years.

17.8.5.6 Implementability

This alternative is technically feasible and has been well demonstrated at full scale. The alternative can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken, but the cap adds to the overall site volume in the South Plants Central Processing Area. The alternative is administratively feasible because it meets the design requirements and construction regulations. Materials, specialists, and equipment are readily available.

17.8.5.7 Costs

The total estimated present worth cost of this alternative is $31,100,000, including $3,530,000, $27,500,000, and $95,000 for capital, operating, and long-term costs, respectively. Table B4.15-3g details the costing for this alternative. The excavation of contaminated soil entails a cost uncertainty relative to identifying the extent and depth of contamination. However, the overall magnitude of uncertainty is small based on the small volume of soil excavated and the shallow depth of excavation required.

17.8.6 Alternative 6/B5/A1/U1: Caps/Covers

Alternative 6: Caps/Covers (Multilayer Cap), combined with Alternative B5: Caps/Covers (Multilayer Cap), Alternative A1: No Additional Action (Provisions of FFA), and Alternative U1: No Additional Action (Provisions of FFA), addresses the containment of the entire South Plants Medium Group (2,100,000 SY) under one cap. The area to be included from the South Plants Balance of Areas Subgroup is 1,700,000 SY.

Before any cover materials are installed, a surface sweep is conducted to ensure that UXO are not present in near-surface soil, the existing structures are demolished and either contained in place or consolidated, the subgrade is compacted, and the surface crowned with 4,700,000 BCY of borrow material to control surface-water runoff. The human health, biota, agent, and potential UXO areas are covered by a 2-ft-thick layer of low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and a 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil. The covered area is then revegetated with native grasses to restore the habitat. The fill materials for the cap are excavated from the on-post borrow area. The capping operations take 4 years to complete. The types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the covered area as habitat. Maintenance activities, such as mowing and replacement of eroded cap materials, ensures the continued integrity of the soil cap. Five-year site reviews are conducted to review the effectiveness of the alternative and to assess potential migration of contaminants. Groundwater compliance monitoring is performed to evaluate the continued protectiveness of the alternative.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.8-1 summarizes the evaluation of all alternatives for this subgroup.

17.8.6.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through containment. Contaminated soil is contained by a multilayer cap, thus preventing exposure. Groundwater impacts are also reduced, and the installation of cap entails low short-term impacts.

17.8.6.2 Compliance with ARARS

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of contained material. Endangered species are not impacted. Location-specific ARARs are met as the South Plants Balance of Areas Subgroup is not located in wetlands or a 100-year flood plain. This alternative complies with provisions of the FFA (EPA et al. 1989). Soil potentially containing agent/UXO is contained and is not subjected to Army regulations governing agent/UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.8.6.3 Long-Term Effectiveness and Permanence

The residual risk is low since 640,000 BCY of untreated soil are contained through installation of a multilayer cap over the whole of South Plants. Long-term monitoring and site reviews are required for untreated soil. Including groundwater compliance monitoring to evaluate potential migration of contaminants. In addition, erosion-control activities and vegetative-cover maintenance are required. There is high confidence in the engineering controls for the cap. Revegetation of the cap with native grasses improves the habitat quality. The types of vegetation and maintenance activities are designed to discourage burrowing animals from using the covered area as habitat.

17.8.6.4 Reduction in TMV

Exposure pathways are interrupted and the mobility of the contaminants is reduced through installation of a multilayer cap. Soil with potential agent/UXO is contained with the cap. The mobility reduction is reversible only if the cap/cover should degrade or leak. There are no treatment residuals associated with this alternative.

17.8.6.5 Short-Term Effectiveness

This alternative has low short-term risks since no intrusive activities are conducted. Personal protective equipment adequately protects workers during agent/UXO clearance and installation of the multilayer cap. Fugitive dust is controlled by water sprays, and vapor emissions are not anticipated. Impacts to the existing habitat are minimal. The time frame for completion of the alternative is 4 years. Installation of the cap is feasible within 4 years. Natural attenuation of untreated soil is ongoing.

17.8.6.6 Implementability

The alternative is technically feasible and can be constructed within the required time frame and reliably operated and maintained thereafter. Demolition of structures is required, and structural debris can be consolidated as gradefill prior to capping. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible since the substantive requirements of the cap/cover design and construction regulations are achieved. Equipment, specialists, and materials are readily available for the construction of the cap/cover, and multilayer caps have been well demonstrated at full scale.

17.8.6.7 Cost

The total present worth is cost $108,000,000 including $104,000,000 and $3,900,000 for operating and long-term cost, respectively. Table B4.15-6 details the costing for this alternative. The cost of installing a cap over the South Plants Balance of Areas Subgroup is high because a very large volume of gradefill is required to develop at 3 to 5 percent grade over this 1,700,000 SY area. There is a low level of uncertainty associated with the cost of this alternative since the materials required for the cap are available on-post and the area to be covered is defined.

17.8.7 Alternative 6c/B5/A3/U4a: Direct Thermal Desorption of Principal Threat Volume; Caps/Covers (Multilayer Cap)

Alternative 6c: Direct Thermal Desorption (Direct Heating) of Principal Threat Volume; Caps/Covers (Multilayer Cap), along with Alternative B5: Caps/Covers (Multilayer Cap), Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), and Alternative U4a: Detonation (Off-Post Army Facility), addresses the capping of 640,000 BCY of soil with human health exceedances and potential risk to biota and the treatment of 11,000 BCY of principal threat exceedances by thermal desorption. Like Alternative 6, this alternative involves containment of the entire South Plants Medium Group under one cap (2,100,000 SY).

The demolition of structures is required to allow the excavation of contaminated soil. The structural debris is removed from the site along with any abandoned utilities encountered during excavation. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed. Due to the potential odor problems, excavation is conducted so that only minimal area is uncovered and exposed at any one time, and a daily soil cover or plastic liner is installed over the excavated areas to further reduce the odor emissions.

This subgroup includes 48,000 SY of soil with potential agent presence and 15,000 SY of soil with potential UXO presence. Prior to excavation, the soil with a potential UXO presence is cleared using geophysical screening or other method. Any identified UXO are excavated, packaged, and transported off post for demilitarization at an existing Army facility. The 5,000 BCY of metallic debris mixed with surface soil are excavated and placed in the on-post hazardous waste landfill.

During excavation of the principal threat volume, the soil is screened for agent using real-time field analytical methods. If agent is identified, the soil is placed in a secure stockpile and agent presence is confirmed by RMA laboratory analysis. Any agent-contaminated soil is treated on-post by caustic solution washing as discussed in Section 4.4.3.

The principal threat volume, 11,000 BCY, is excavated and transported to the centralized thermal desorption facility. (Section 4.6.25 discusses the details of thermal desorption.) The soil for this subgroup is classified as dry (i.e., moisture content of 10 percent). Based on the moisture content, the thermal desorber processes the soil at a rate of approximately 2,000 BCY/day, discharging it at a temperature of 300°C with a total soil residence time of 30 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) Approximately 110 BCY of particulates from scrubber blowdown (1 percent of the total soil feed) are disposed in the on-post landfill. The treated soil from the thermal desorber is returned to the sites as backfill.

After treatment of the principal threat soil, a low-permeability soil cap is installed over the 640,000 BCY of exceedance soil and soil (including the backfilled treated soil) that poses risk to biota. Prior to capping, the subsurface is compacted and regraded to minimize variations in the subgrade. The cap consists of a 2-ft-thick layer of compacted low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil to promote growth of vegetation. Site remediation is completed by revegetation of the cover with native grasses to improve the habitat quality of the site, although the types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the capped area as habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.8-1 summarizes the evaluation of all alternatives for this subgroup.

17.8.7.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment of the principal threat volume and containment of the balance of the exceedance soil. The principal threat volume is treated through thermal desorption. Contaminated soil from the balance of the sites is contained by a multilayer cap. Soil with potential agent/UXO presence is identified and treated. Groundwater impacts are reduced. There are moderate short-term risks associated with agent/UXO clearance and excavation of contaminated soil.

17.8.7.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of contained material, and state regulations on air emissions sources. Endangered species are not impacted. The South Plants Balance of Areas Subgroup, thermal desorption facility, and caustic solution washing facility are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations

(AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.8.7.3 Long-Term Effectiveness and Permanence

The residual risk is low since 11,000 BCY of soil are thermally desorbed and 640,000 BCY of soil (including the treated soil) are contained with a multilayer cap over the whole of South Plants. Approximately 1 percent of the soil feed is recovered from the off-gas treatment equipment and placed in an on-post landfill, along with salts generated by the caustic solution washing process. Long-term monitoring and site reviews are required for the untreated soil, including groundwater compliance monitoring to evaluate the long-term protectiveness of the remedy. There is high confidence in engineering controls associated with the multilayer cap in the South Plants Balance of Areas. Revegetation of disturbed areas will improve the existing habitat.

17.8.7.4 Reduction in TMV

Human exposure pathways are interrupted and mobility of contaminants is reduced through the installation of a multilayer cap. The 11,000 BCY of principal threat volume are thermally desorbed to degrade OCPs and HCCPD. Organic compounds are reduced to detection levels or >99.99 percent DRE in the principal threat volume, which irreversibly eliminates TMV of organic compounds in this soil. Scrubber blowdown solids from off-gas treatment equipment will be contained in an on-post landfill (110 BCY). Soil with agent/UXO is identified and treated. Mobility reduction for untreated soil is reversible only if the cap should degrade or leak.

17.8.7.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with UXO/agent clearance and excavation, transportation, and thermal desorption of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Engineered dust controls (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. In addition, the preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and vapors/odors. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards, the emissions from the thermal desorber contain low but acceptable levels of some contaminants from the soil. There are minimal impacts to the biota due to the existing habitat. Migration of contaminants to the surface water is reduced. The time frame to achieve RAOs is 4 years following the demolition of structures. Excavation and treatment of 11,000 BCY is feasible within 1 year after 2 years for construction of the thermal desorption facility, assuming that the thermal desorber does not experience any operational problems. Construction of the caustic solution washing facility will require 1 year. The installation of the 1,700,000 SY multilayer cap requires 4 years.

17.8.7.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of temporary soil covers increases the volume to be excavated and require double handling to access the uncontaminated soil. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, materials handling problems, and presence of debris remaining in the soil feed after structures demolition. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to public perceptions regarding the safety of thermal treatment. The substantive requirements of capping are achieved, and equipment, specialists, and materials are readily available for construction of the multilayer cap. Multilayer caps have been well demonstrated at full scale. Additional remedial actions require removal of the cap/cover.

17.8.7.7 Cost

The total present worth cost is $111,000,000 including $763,000, $106,000,000, and $3,250,000 for capital, operating, and long-term costs, respectively. The cost of installing a cap is high because a very large volume of gradefill is required to develop a 3 to 5 percent grade over this 1,700,000 SY area. Table B4.15-6c details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent presence are difficult to estimate and so increase uncertainties relative to excavation costs. Second, there is little operational experience at other sites upon which to base an evaluation of the costs and performance of the vapor/odor controls, and their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high clay content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

17.8.8 Alternative 13/B3/A3/U4a: Direct Thermal Desorption; Direct Solidification/ Stabilization

Alternative 13: Direct Thermal Desorption (Direct Heating); Direct Solidification/Stabilization (Cement-Based Solidification), paired with Alternative B3: Landfill (On-Post Landfill), Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), and Alternative U4a: Detonation (Off-Post Army Facility), treats 68,000 BCY of soil with human health organic exceedances by thermal desorption and 61,000 BCY of soil with human health inorganic exceedances by solidification, and contains 510,000 BCY of soil with potential risk to biota in the on-post hazardous waste landfill. (Sections 4.6.24, 4.6.23, and 4.6.6 discuss the details of these technologies.) The demolition of structures is required to allow the excavation of contaminated soil. The structural debris is removed from the site along with any abandoned utilities encountered during excavation. Dewatering is not required for safe excavation based on the anticipated decrease in water levels once manmade recharge sources (i.e., leaking water lines) are removed. Due to the potential odor problems, excavation is conducted so that only a minimal area is uncovered and exposed at any one time, and a daily soil cover or plastic liner is installed over the excavated areas to further reduce the emissions.

This subgroup includes 48,000 SY of soil with potential agent presence and 15,000 SY of soil with potential UXO presence. Prior to excavation, the soil with UXO presence is cleared using geophysical screening or other methods. Any identified UXO are excavated, packaged, and transported off-post for demilitarization at an existing Army facility. There are 5,000 BCY of metallic debris mixed with surface soil that are excavated and placed in the on-post landfill as part of soil that potentially poses risks to biota.

In addition to UXO clearance, the soil is screened for agent during excavation using real-time field analytical methods. If agent is identified, the soil is placed in a secure stockpile and agent presence is confirmed by RMA laboratory analysis. Any agent-contaminated soil is treated on-post by caustic solution washing as discussed in Section 4.4.3.

Human health exceedance soil that does not contain agent is transported to the thermal desorber for treatment. The thermal desorber takes 1 year to build and requires an additional year for testing. The soil for this subgroup is classified as dry (i.e., moisture content of 10 percent). Based on the moisture content, the thermal desorber processes the soil at a rate of approximately 2,000 BCY/day, discharging them at a temperature of 300°C with a total soil residence time of 30 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) Approximately 680 BCY of particulates from scrubber blowdown (1 percent of the soil feed) is disposed in the on-post landfill. The treated soil that does not exceed Human Health SEC (EBASCO 1994a) for inorganic compounds is returned to the site excavations as backfill. Soil with residual inorganic exceedances is transported to the solidification facility for further treatment.

The 61,000 BCY of soil with inorganic exceedances are solidified near the thermal desorber using a portable pug mill capable of treating 210 BCY/hour. The contaminated soil is solidified by adding cement as a binder at a 20-percent weight ratio. The total volume of contaminated soil increases by approximately 38 percent, which results in a total solidified volume of 84,000 BCY. The solidified soil is placed in the site excavations and covered with a minimum of 4 ft of soil treated by thermal desorption to ensure the integrity of the solidified materials and prevent freeze/thaw degradation. Since thermal desorption destroys the natural organic content in the soil, the uppermost 6 inches of soil over the disturbed area are supplemented with conditioners and revegetated with native grasses to improve the habitat.

The 510,000 BCY of soil that may pose a potential risk to biota are excavated and placed in the on-post hazardous waste landfill. (Section 4.6.6 discusses the details of landfill construction.) The construction of the first cell of the multiple-cell landfill and associated facilities requires 1 year. The site excavations are backfilled with borrow soil from the on-post borrow area to return the site to grade. The uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses to improve the habitat at the site. The borrow area is also revegetated and recontoured to restore habitat. After placement of waste, the landfill cover is installed and vegetated, and access controls of fencing and biota barriers are implemented to restrict the site from burrowing animals. The landfill requires long-term maintenance of the cover, leachate collection and treatment, and groundwater monitoring.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.8-1 summarizes the evaluation of all alternatives for this subgroup.

17.8.8.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment/immobilization and containment. Human health exceedance soil is treated through thermal desorption and inorganic compounds are immobilized through solidification/stabilization. Exposure pathways are interrupted through landfilling of the balance of the contaminated soil. Groundwater impacts are also reduced. Significant short-term risks are associated with agent/UXO clearance and excavation of contaminated soil.

17.8.8.2 Compliance with ARARS

This alternative complies with action-specific ARARs including state regulations on air emissions sources and landfill siting, design, and operation. Solidified soil is monitored. Endangered species are not impacted. The South Plants Balance of Areas sites, the treatment facilities, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.8.8.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since 68,000 BCY of soil are thermally desorbed to achieve PRGs, 61,000 BCY of soil are solidified, and 510,000 BCY of soil with potential risk to biota are placed in the on-post landfill. Approximately 1 percent of the soil feed recovered from the off-gas treatment equipment is placed in an on-post landfill. Long-term monitoring is required for solidified soil. There is high confidence in engineering controls associated with the landfill, and there are no expected difficulties associated with maintenance. Revegetation of disturbed areas improves existing habitat, off-setting the losses incurred during excavation.

17.8.8.4 Reduction in TMV

The 68,000 BCY of human health exceedance are thermally desorbed to degrade OCPs and HCCPD. Exposure pathways are interrupted and mobility of contaminants is reduced by solidification of 61,000 BCY of soil with inorganic contaminants and by landfilling the balance of the soil (510,000 BCY). Soil with agent and UXO are identified and treated. Organic compounds are reduced to detection levels or >99.99 percent DRE in the principal threat volume, which eliminates TMV of these organic compounds. Scrubber blowdown solids from off-gas treatment equipment are placed in an on-post landfill. TMV reduction by thermal desorption and caustic solution washing is irreversible. Mobility reduction by solidification is irreversible if the integrity of solidified materials is maintained.

17.8.8.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with UXO/agent clearance, and excavation, transportation, and thermal desorption/solidification of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Engineered dust controls (such as water sprays) and vapor/odor controls (such as daily covers, tarps, or foams) are employed to reduce short-term risks; however, the adequacy of these controls has not been fully demonstrated, and the possibility exists for vapor/odor emissions during excavation despite these controls. In addition, the preparation of the feedstock prior to thermal desorption and solidification presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and vapors/odors. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards, the emissions from the thermal desorber will contain low but acceptable levels of some contaminants. There are minimal impacts to the existing habitat. Migration of contaminants to the groundwater is reduced. The time frame until RAOs are achieved is 3 years. Excavation and treatment of 130,000 BCY is feasible within 1 year after 2 years for construction of the thermal desorption and solidification facilities, assuming that the thermal desorber does not experience any operational problems. The landfilling of 510,000 BCY is feasible within 2 years after 1 year for construction of the cell.

17.8.8.6 Implementability

Vapor/odor controls are not well demonstrated and some controls, such as foams, have limited availability. The use of temporary soil covers increases the volume to be excavated and requires double handling to access the uncontaminated soil. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame, but the operation of the unit may be difficult due to the high levels of contamination, materials handling problems, and presence of debris remaining in the soil feed after structures demolition. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of thermal treatment. Demolition and removal of structures is required. Solidified soil is monitored to ensure its integrity. Landfill-cell monitoring is also required. The alternative is administratively feasible relative to landfill siting, design, and operating requirements. Several vendors are available for the design and construction of the solidification unit. Equipment, specialists, and materials are readily available for landfill construction, but not for caustic solution washing. Solidification and landfills have been well demonstrated at full scale, while caustic solution washing of soil has not.

17.8.8.7 Cost

The total present worth cost is $43,100,000 including $15,000,000, $27,300,000, and $828,000 for capital, operating, and long-term costs, respectively. Table B4.15-13 details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of agent/UXO presence are difficult to estimate and so increase uncertainties relative to excavation costs. Second, there is little operating experience at other sites upon which to base an evaluation of the costs and performance of the vapor/odor controls, and their impact on excavation and equipment productivity. Third, the elevated concentrations of the contaminants in the feedstock, the high clay content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions are not typical of previous thermal desorption projects, and may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

17.8.9 <u>Alternative 19/B3/A3/U4a: In Situ Thermal Treatment; In Situ Solidification/ Stabilization</u>

Alternative 19: In Situ Thermal Treatment (RF/Microwave Heating); In Situ Solidification/Stabilization (Cement-Based Solidification), combined with Alternative B3: Landfill (On-Post Landfill), Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), and Alternative U4a: Detonation (Off-Post Army Facility), treats 68,000

BCY of soil with organic human health exceedances by in situ RF heating and 61,000 BCY of soil with inorganic exceedances by in situ solidification/stabilization and contains 510,000 BCY of soil with potential risk to biota in the on-post hazardous waste landfill. Structures located within the area to be treated or landfilled require demolition and subsequent removal of debris prior to treatment or excavation, which limits alternatives currently being evaluated for structures in this area.

This subgroup includes 48,000 SY of soil with potential agent presence and 15,000 SY of soil with potential UXO presence. Prior to in situ treatment, the soil with potential UXO presence is cleared using geophysical screening or other methods. Any identified UXO are excavated, packaged, and transported off post for demilitarization at an existing Army facility. There are 5,000 BCY of metallic debris mixed with surface soil that are excavated and placed in the on-post landfill along with the soil that may pose risks to biota.

Soil with potential agent presence is screened during excavation and construction activities. If agent is identified and confirmed by RMA laboratory analysis, the agent-contaminated soil is treated on-post by caustic solution washing, as discussed in Section 4.4.3.

The 68,000 BCY of organic exceedance soil are treated by RF heating. RF heating raises the temperature of the soil to more than 250°C, which mobilizes the organic contaminants for collection and treatment in the off-gas treatment system. (Section 4.6.31 discusses details of RF heating.) One RF unit treats contamination in a block that is 100 ft long by 48 ft wide by 10 ft deep. Assuming a soil moisture content of 10 percent, the unit treats approximately 180 BCY/day. The liquid sidestream, which contains predominantly salts, is transported to the thermal desorption facility for treatment along with the scrubber effluent, or an evaporator/crystallizer is added to the emissions control system. RF heating only treats the organic contaminants; therefore, soil containing inorganic contaminants requires treatment by in situ cement-based solidification.

The human health inorganic soil volume of 61,000 BCY is solidified using a transportable track-mounted boring/mixing unit and a cement batch plant capable of processing 600 BCY/day. (Section 4.6.23 discusses the details of direct solidification/stabilization.) Portland cement is mixed with the excavated soil at a ratio of 20 percent by weight. Upon solidification, the soil swells approximately 10–25 percent due to incorporation of the cement. A 4-ft-thick layer of borrow material is then recontoured over the area to ensure the integrity of the solidified soil and to guard against freeze/thaw stresses. Conditioners are then applied to the uppermost 6 inches of soil over the treated human health area and the soil is revegetated with native grasses to improve the habitat quality of the site. Long-term maintenance of the cover and monitoring of the solidified soil are required.

The 510,000 BCY of soil that may pose a potential risk to biota are excavated and placed in the on-post hazardous waste landfill. (Section 4.6.6 discusses the details of landfill construction.) The construction of the first cell of the multiple-cell landfill and associated facilities requires 1 year. The site excavations are backfilled with borrow soil from the on-post borrow area to return the site to grade. The uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses to improve the habitat at the site. The borrow area is also revegetated and recontoured to restore habitat. After placement of waste, the landfill cover is installed and vegetated, and access controls of fencing and biota barriers are implemented to restrict the site from burrowing animals. The landfill requires long-term maintenance of the cover, leachate collection and treatment, and groundwater monitoring.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 17.8-1 summarizes the evaluation of all alternatives for this subgroup.

17.8.9.1 Overall Protection of Human Health and the Environment

RF heating does not achieve PRGs but does reduce the concentrations of organic contaminants. Solidification of inorganic compounds eliminates the mobility of the contaminants and interrupts the exposure pathways. RAOs are theoretically achieved through these reductions in concentrations and mobility. Soil posing a potential risk to biota (530,000 BCY) is removed and contained in a landfill, thereby achieving Biota RAOs. Groundwater impacts are also reduced. There are short-term risks associated with in situ treatment and excavation of contaminated soil.

17.8.9.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources and landfill siting, design, and operation. Solidified soil is monitored. Endangered species are not impacted. The South Plants Balance of Areas Subgroup and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

17.8.9.3 Long-Term Effectiveness and Permanence

The residual risk is low since the human health exceedances are treated to near the PRGs, and the residual risk for soil excavated and contained in the landfill is minimal. Habitat quality is restored through revegetation. Habitat at the landfill is restricted by biota controls. The 61,000 BCY inorganic exceedances are solidified in place, and monitoring of solidified soil is required, including groundwater compliance monitoring to evaluate potential migration of contaminants.

17.8.9.4 Reduction in TMV

RF heating can theoretically achieve Human Health RAOs with low residual risk since OCPs and volatile metals can be driven from the soil by this form of in situ thermal treatment. However, the pilot-scale test of the RF technology at RMA, as described in the Technology Descriptions Volume, failed to confirm the temperature distribution and OCP removal efficiencies required for confident treatment of soil to achieve PRGs. The TMV reduction of organic compounds by thermal treatment is irreversible. The liquid blowdown sidestream associated with RF heating treatment is either treated at a thermal desorption facility along with scrubber effluent or by the evaporator/crystallizer. Exposure pathways are interrupted and mobility of contaminants is reduced by solidification of 61,000 BCY of soil with inorganic contaminants. Soil with agent and UXO presence is identified and treated. Mobility reduction is irreversible if the integrity of solidified materials is maintained and the landfill does not fail.

17.8.9.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with UXO/agent clearance and excavation, transportation, and landfilling of a large volume of soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. The in situ thermal treatment of soil also entails short-term impacts. Although the off-gas control system for in situ heating is designed to achieve air quality standards, the emissions from the in situ heating unit will contain low levels of the contaminants removed from the soil. Fugitive dust or odor emissions are not anticipated. There are minimal impacts on the existing habitat. Migration of contaminants to the groundwater is reduced. The time frame until RAOs are achieved is 2 years. RF heating of 68,000 BCY is feasible within 2 years. Solidification of 61,000 BCY is feasible within 1 year. Landfill construction and excavation and disposal of 510,000 BCY of soil can be accomplished in 1 year.

17.8.9.6 Implementability

In situ thermal heating is currently not implementable because no full-scale in situ heating units have been constructed and demonstrated. The technology was demonstrated at pilot-scale at RMA; however, several problems were identified regarding the durability of the equipment. The resolution of these problems may lead to delays in the construction of full-scale units and in the operation of the in situ heating units. In addition, administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of in situ thermal treatment and the thermal treatment portion of the off-gas control system. Additional remedial actions can be easily undertaken for treated soil that does not achieve PRGs. Demolition and removal of structures is required. Solidified soil is monitored to ensure long-term integrity. The alternative is administratively feasible for the substantive requirements of the landfill siting, design, and operating regulations. Equipment, specialists, and materials are readily available from several vendors for solidification and landfilling, and both processes have been well demonstrated at full scale.

17.8.9.7 Cost

The total present worth cost is $73,300,000 including $26,700,000, $44,800,000, and $1,790,000 for capital, operating, and long-term costs, respectively. Table B4.15-19 details the costing for this alternative.

There are three significant uncertainties associated with the costing of this alternative. First, the extent of agent/UXO presence is difficult to estimate and so increases uncertainties relative to excavation costs. Second, there are no full-scale demonstrations of the in situ heating technology at other hazardous waste sites by which actual construction and operating costs can be documented. This uncertainty is especially noteworthy because the pilot-scale demonstration of the technology at RMA indicated there were potential problems regarding the durability of the equipment. Third, the lack of full-scale implementation data increases uncertainties relative to maintaining the assumed on-line percentage of the heating unit. The level and depth of contamination at RMA may result in changes in treatment times or delays in implementation, both of which may impact treatment costs.

17.9 SOUTH PLANTS BALANCE OF AREA SUBGROUP COMPARISON OF ALTERNATIVES

The South Plants Balance of Area Subgroup contains 640,000 BCY of exceedance soil contaminated as a result of miscellaneous operations in the South Plants Study Area. OCPs, HCCPD, and chromium exceedances account for 130,000 BCY of soil with human health exceedances. There are 510,000 BCY of soil containing OCPs, arsenic, and mercury at levels that may pose a potential risk to biota.

Principal threat criteria are exceeded for aldrin and dieldrin in less than 1 percent of the samples, generating a principal threat exceedance volume of 11,000 BCY. This subgroup also contains areas of potential UXO and agent presence, and sites in the subgroup are identified as the source of several groundwater contamination plumes.

The subgroup consists of disturbed areas of vegetation. Alternatives that disrupt habitat include revegetation and restoration following remediation, so significant habitat impacts are not expected. It should be noted that alternatives involving containment with a cap/cover require the exclusion of burrowing animals.

Excavation of soil in the South Plants Balance of Areas Subgroup requires clearing the soil of UXO, screening the soil for agent, and providing health and safety protection for site workers. In addition, only minimal area is open at any one time during excavation, and a daily soil cover or plastic liner is used to prevent odor emissions from impacting the community.

In summary, this subgroup contains human health and potential biota exceedances and limited areas of agent, UXO, and principal threat exceedances. Sites in the subgroup contribute to groundwater contamination. When comparing alternatives the longer-term risks of contaminant migration and exposure if contaminants remain in place should be balanced against the short-term risks to workers and the community if contaminated soil is excavated.

Alternative 1: No Additional Action does not achieve RAOs and was eliminated from further consideration. Alternative 1a: Direct Thermal Desorption of Principal Threat Volume; No Additional Action treats the highest levels of contamination, but does not achieve RAOs for the majority of the contaminated soil volume, and was also eliminated from further consideration. Alternative 19: In Situ Thermal Treatment; In Situ Solidification/Stabilization does not achieve PRG, although the residual risks are low, and is not currently implementable. As a result, this alternative was eliminated from consideration in developing sitewide alternatives. The remaining six alternatives achieve RAOs and meet the two DAA threshold criteria: protection of human health and the environment and compliance with action-specific and location-specific ARARs.

The landfill alternatives (Alternative 3: Landfill, Alternative 3a: Direct Thermal Desorption of Principal Threat Volume; Landfill and Alternative 3g: Landfill; Caps/Covers with Consolidation; Caps/Covers) achieve RAOs, although the majority of materials are untreated. Potential exposures and mobility are reduced through containment under each alternative. Landfilling has been well demonstrated and there is high confidence in the engineering controls and maintenance of this operation. The costs of $38,700,000 and $39,500,000, and $31,100,000 for Alternatives 3, 3a, and 3g, respectively, are below the average cost of the remaining intrusive alternatives. Based on the cost effectiveness and permanent containment offered by consolidation and/or landfilling, these alternatives were carried forward for the development of sitewide alternatives (see Section 20).

Alternative 6: Caps/Covers provides low long-term residual risks without incurring short-term risks. This alternative interrupts exposure pathways and reduces the mobility of contaminants. There are no treatment residuals associated with this alternative. This technology has been well demonstrated and entails low short-term risks since contaminated soil is not excavated. The capping of the South Plants Balance of Areas is performed in conjunction with the installation of a cap over South Plants. The cost of this alternative is high ($108,000,000). Because the alternative involves the capping of the entirety of South Plants, it was carried forward for development of the sitewide alternatives (see Section 20).

Alternative 6c: Direct Thermal Desorption of Principal Threat Volume; Caps/Covers entails limited excavation and in-place containment at a cost of $111,000,000. The drawbacks of this alternative compared to Alternative 6 include short-term impacts associated with excavation and difficulty in gaining public acceptance for thermal desorption. Due to these drawbacks, this alternative was not retained for consideration in the development of sitewide alternative.

Alternative 13: Direct Thermal Desorption; Direct Solidification/Stabilization achieves RAOs through treatment and containment. However, the added long-term risk reduction through additional treatment does not justify its higher cost in comparison to alternatives involving consolidation or landfilling, with or without treatment of principal threats. Therefore, this alternative is not considered cost-effective and was not retained for consideration in sitewide alternatives.

Consequently, the alternatives that were retained to represent the South Plants Balance of Areas Subgroup in the development of the sitewide alternatives (Section 20) are the following:

- Alternative 3/B3/A3/U4a: Landfill (On-Post Landfill)
- Alternative 3a/B3/A3/U4a: Direct Thermal Desorption (Direct Heating) of Principal Threat Volume; Landfill (On-Post Landfill)
- Alternative 3g: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap) with Consolidation; Caps/Covers (Multilayer Cap)
- Alternative 6/B5/A1/U2: Caps/Covers (Multilayer Cap)

The demolition of structures is required to allow the excavation of contaminated soil. The structural debris is removed from the site along with any abandoned utilities encountered during excavation. As described in the Structures DAA, the debris may also be placed in the South Plants Central Processing Area prior to capping. Although the majority of the groundwater control systems evaluated in the DAA for South Plants are to be located in the South Plants Central Processing Area and not in the South Plants Balance of Areas Subgroup, the timing of soil remediation may need to be coordinated with the selected groundwater alternative for this area.

Table 17.0-1 Characteristics of the South Plants Medium Group

Characteristic	South Plants Central Processing Area Subgroup	South Plants Ditches Subgroup	South Plants Balance of Areas Subgroup
Contaminants of Concern			
Human Health	OCPs, VOCs, DBCP, CLC2A, As, Hg, ICP metals	OCPs, ICP metals	OCPs, HCCPD, As, ICP metals
Biota	OCPs, As, Hg	OCPs, Hg, As	OCPs, As, Hg
Exceedance Area (SY)			
Total	220,000	120,000	1,700,000
Human Health	140,000	50,000	170,000
Principal Threat	42,000	5,500	8,100
Biota	80,000	65,000	1,500,000
Potential Agent	98,000	0	48,000
Potential UXO	0	0	15,000
Exceedance Volume (BCY)			
Total	140,000	56,000	640,000
Human Health	110,000	33,000	130,000
Organic	93,000	33,000	68,000
Inorganic	21,000	0	61,000
Principal Threat	38,000	3,400	11,000
Biota	27,000	23,000	510,000
Potential Agent	160	0	160
Potential UXO	0	0	50
Depth of Contamination (ft)			
Human Health	0–5	0–5, mostly 0–1	0–10
Biota	0–1	0–1	0-1

Table 17.1-1 Summary of Concentrations for the South Plants Central Processing Area Subgroup

Contaminants of Concern	Range of Concentration[1] (ppm)	Average Concentration[1] (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL–15,000	580	71	720	3.8
Dieldrin	BCRL–6,300	210	41	410	3.7
Endrin	BCRL–3,700	67	230	230,000	56
Isodrin	BCRL–300	19	52	52,000	Not applicable
Chlordane	BCRL–1,500	15	55	3,700	12
Chloroacetic Acid	BCRL–350	13	77	77,000	3,900
p,p,DDT	BCRL–300	7.5	410	13,500	14
HCCPD	BCRL–5,300	28	1,100	-	13,000
DBCP	BCRL–14,000	275	8	200	140
Carbon Tetrachloride	BCRL–140	1.9	30	2,300	1,400
Chloroform	BCRL–40,000	580	370	48,000	2,000
DCPD	BCRL–970	6.7	3700	-	5,400
Arsenic	BCRL–14,000	230	420	4,200	270
Cadmium	BCRL–540	5.1	530	24,000	140
Chromium	BCRL–280	20	39	7,500	2,400
Lead	BCRL–7,100	310	2,200	1,000,000	Not applicable
Mercury	BCRL–17,000	300	570	570,000	82
Biota Volume					
Aldrin	BCRL–3.4	0.19			
Dieldrin	BCRL–3.4	0.73			
Endrin	BCRL–1.2	0.029			
p,p,DDE	BCRL–1.6	0.023			
p,p,DDT	BCRL–8.6	0.03			
Arsenic	BCRL–289	11			
Mercury	BCRL–56	2.04			

[1] Based on modeled concentrations within the human health exceedance volume or potential biota risk area.

Table 17.1-2 Frequency of Detections for South Plants Central Processing Area Subgroup

	Total Samples	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
	Analyzed	Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	448	310	69.2%	67	15.0%	24	5.4%	30	6.7%	17	3.8%
Benzene	241	226	93.8%	15	6.2%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	241	221	91.7%	19	7.9%	--	--	1	0.4%	0	0.0%
Chlordane	447	422	94.4%	12	2.7%	4	0.9%	8	1.8%	1	0.2%
Chloroacetic Acid	183	179	97.8%	2	1.1%	--	--	2	1.1%	0	0.0%
Chlorobenzene	241	231	95.9%	10	4.1%	--	--	0	0.0%	0	0.0%
Chloroform	241	204	84.6%	36	14.9%	--	--	1	0.4%	0	0.0%
p,p,DDE	448	415	92.6%	33	7.4%	--	--	0	0.0%	0	0.0%
p,p,DDT	448	412	92.0%	27	6.0%	8	1.8%	1	0.2%	0	0.0%
Dibromochloropropane	816	744	91.2%	22	2.7%	--	--	42	5.1%	8	1.0%
1,2-Dichloroethane	241	241	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	10	10	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	645	617	95.7%	28	4.3%	--	--	0	0.0%	0	0.0%
Dieldrin	448	278	62.1%	89	19.9%	35	7.8%	35	7.8%	11	2.5%
Endrin	451	408	90.5%	33	7.3%	3	0.7%	7	1.6%	0	0.0%
Hexachlorocyclopentadiene	448	408	91.1%	39	8.7%	--	--	1	0.2%	0	0.0%
Isodrin	448	362	80.8%	71	15.8%	--	--	15	3.3%	0	0.0%
Methylene Chloride	238	219	92.0%	19	8.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	13	13	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	241	204	84.6%	37	15.4%	--	--	0	0.0%	0	0.0%
Toluene	238	213	89.5%	25	10.5%	--	--	0	0.0%	0	0.0%
Trichloroethylene	241	241	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Arsenic	482	238	49.4%	227	47.1%	2	0.4%	11	2.3%	4	0.8%
Cadmium	385	321	83.4%	63	16.4%	0	0.0%	1	0.3%	0	0.0%
Chromium	386	129	33.4%	252	65.3%	--	--	5	1.3%	0	0.0%
Lead	385	215	55.8%	168	43.6%	--	--	2	0.5%	0	0.0%
Mercury	456	252	55.3%	201	44.1%	2	0.4%	1	0.2%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.

(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.

-- not applicable

CRITERIA	Alternative 1/B1/A1: No Additional Action	Alternative 1b/B1/A Direct Thermal Desorption and Direct Solidification/Stabilization of Principal Threat Volume; No Additional Action	Alternative 3b/B5/A3: Landfill; Caps/Covers	Alternative 3d/B5/A3: Direct Thermal Desorption and Direct Solidification/Stabilization of Principal Threat Volume; Landfill; Caps/Covers	Alternative 6/B5/A1: Caps/Covers
1. Overall protection of human health and the environment	Not Protective: Does not achieve RAOs; impacts to groundwater not reduced	Not Protective: Does not achieve RAOs; impacts to groundwater not reduced	Protective: Achieves RAOs through containment; groundwater impacts reduced	Protective: Achieves RAOs through treatment/ immobilization of principal threat, and containment for balance of areas; groundwater impacts reduced	Protective: Achieves RAOs through containment in place; impacts to groundwater reduced
2. Compliance with ARARs	Does not comply with Army regulations regarding agent- contaminated materials	Does not comply with Army regulations regarding agent-contaminated materials	Complies	Complies	Complies
3. Long-term effectiveness and permanence	High Residual Risk: High levels of contamination remain	PRGs achieved for 38,000 BCY treated; natural attenuation ongoing for untreated soil; moderate residual risk	Minimal Residual Risk: 110,000 BCY removed and contained; contamination at depth contained	Minimal Residual Risk: 38,000 BCY thermally desorbed; contaminants at depth contained by cap	Low Residual Risk: Contaminated soil contained in place
4. Reduction in TMV	140,000 BCY remain untreated; TMV reduction by natural attenuation only	Thermal desorption destroys organics for 38,000 BCY; 1,500 BCY solidified; TMV reduction by natural attenuation for balance of area	Mobility of contaminants reduced by containment; toxicity and volume reduced by natural attenuation	TMV essentially eliminated; thermal desorption destroys organics for 38,000 BCY; 1,500 BCY solidified	Mobility of contaminants reduced by containment in place; toxicity and volume not reduced
5. Short-term effectiveness	Existing habitat not changed; impact to groundwater continues	Significant risk to workers and community during agent screening and excavation, transportation, and treatment of principal threat volume; RAOs not achieved	Significant risk to workers and community during agent screening and excavation and transportation of exceedance soil; RAOs achieved in 3 years	Significant risk to workers and community during agent screening and excavation, transportation, and treatment of contaminated soil; RAOs achieved in 4 years	Low short-term risk; protective of workers and the community, no intrusive actions; RAOs achieved in 2 years
6. Implementability	Feasible; no implementation required	Technically Feasible; Administrative difficulties associated with thermal treatment	Technically Feasible; difficulties with vapor controls administratively feasible	Technically Feasible: administrative difficulties associated with thermal treatment; vapor controls administratively difficult	Technically Feasible; administratively feasible
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$2,130,000 TOTAL—$2,130,000	Capital—$1,133,000 Operating—$5,020,000 Long-term—$1,940,000 TOTAL—$8,090,000	Capital—$2,890,000 Operating—$15,800,000 Long-term—$1,040,000 TOTAL—$19,800,000	Capital—$3,880,000 Operating—$20,800,000 Long-term—$435,000 TOTAL—$25,100,000	Capital—$0 Operating—$21,300,000 Long-term—$1,020,000 TOTAL—$22,300,000
Summary	Not Retained: Not protective of human health and the environment	Not Retained: Not protective of human health and the environment	Retained: Containment provides protection; low cost	Retained: Containment and treatment provides protection	Retained: Containment provides protection; low short-term risks; moderate cost

Criteria	Alternative 6a/B5/A1: Direct Thermal Desorption and Direct Solidification/Stabilization of Principal Threat Volume; Caps/Covers	Alternative 13d/B5/A3: Direct Thermal Desorption; Direct Solidification/Stabilization; Caps/Covers	Alternative 19b/B5/A3: In Situ Thermal Treatment; In Situ Solidification/Stabilization; Caps/Covers
1. Overall protection of human health and the environment	Protective: Achieves RAOs through treatment of principal threat volume and containment in place; groundwater impacts reduced	Protective: Achieves RAOs through treatment and containment; groundwater impacts reduced	Can theoretically achieve RAOs through in situ thermal treatment or solidification and containment; groundwater impacts reduced
2. Compliance with ARARs	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Low Residual Risk: Principal threat volume treated; balance of soil contained in-place	Minimal Residual Risk: Exceedance volume treated and contamination at depth contained	Low residual risk; PRGs not achieved by RF heating; contaminants contained by solidification and capping
4. Reduction in TMV	Thermal desorption destroys OCPs for 38,000 BCY; mobility in balance of soil eliminated by solidification and containment	Thermal desorption destroys OCPs for 93,000 BCY; mobility in balance of soil eliminated by solidification and containment	TMV reduction by RF heating; mobility of contaminants eliminated by solidification and containment
5. Short-term effectiveness	Significant risk to workers and community during agent screening and excavation, transportation, and treatment; RAOs achieved in 4 years	Significant risk to workers and community during agent screening and excavation, transportation, and treatment; RAOs achieved in 4 years	Moderate risk to workers and the community: 110,000 BCY treated in situ; RAOs achieved in 4 years
6. Implementability	Technically Feasible: Administrative difficulties associated with thermal treatment	Vapor controls not demonstrated; technically feasible: administrative difficulties associated with thermal treatment	Not Technically Feasible: RF heating not available at full scale, and pilot-scale studies failed to confirm effectiveness at RMA
7. Present worth costs	Capital—$1,130,000 Operating—$19,500,000 Long-term—$963,000 Total—$21,600,000	Capital—$2,850,000 Operating—$27,100,000 Long-term—$625,000 Total—$30,600,000	Capital—$13,100,000 Operating—$44,800,000 Long-term—$869,000 Total—$58,800,000
Summary	Not Retained: Containment and treatment provides protection although difficult administrative feasibility	Not Retained: High cost although ultimate reliance on containment and higher uncertainties	Not Retained: Not fully protective; not implementable; ultimate reliance on containment at high cost

Table 17.4-1 Summary of Concentrations for the South Plants Ditches Subgroup

Contaminants of Concern	Range of Concentrations[2] (ppm)	Average Concentration[2] (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	0.60–4,400	270	71	720	3.8
Dieldrin	0.71–805	58	41	410	3.7
Isodrin	BCRL–23	2.3	52	52,000	Not applicable
Chlordane	BCRL–6.3	0.4	55	3,700	12
Chromium	BCRL–62	12	39	7,500	2,400
Endrin[1]	BCRL–3.4	0.17	230	230,000	56
p,p,DDE[1]	BCRL–2.1	0.20	1,250	12,500	Not applicable
p,p,DDT[1]	BCRL–10	0.4	410	13,500	14
Arsenic[1]	BCRL–6.1	0.42	420	4,200	270
Mercury[1]	BCRL–15	0.30	570	570,000	82
Biota Volume					
Aldrin	BCRL–2.3	0.11			
Dieldrin	BCRL–2.7	0.69			
Endrin	BCRL–0.31	0.038			
p,p,DDE	BCRL–3.2	0.12			
p,p,DDT	BCRL–0.81	0.047			
Mercury	BCRL–2.5	0.10			

1 Presents biota risk, but was detected in the human health exceedance volume.
2 Based on modeled concentrations within the human health exceedance volume or potential biota risk area.

Table 17.4-2 Frequency of Detections for South Plants Ditches Subgroup

	Total Samples	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
	Analyzed	Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	168	76	45.2%	58	34.5%	17	10.1%	11	6.5%	6	3.6%
Benzene	29	27	93.1%	2	6.9%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	30	30	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlordane	167	143	85.6%	24	14.4%	0	0.0%	0	0.0%	0	0.0%
Chloroacetic Acid	20	20	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlorobenzene	30	30	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chloroform	30	30	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
p,p,DDE	169	121	71.6%	48	28.4%	--	--	0	0.0%	0	0.0%
p,p,DDT	169	123	72.8%	46	27.2%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	102	102	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	30	30	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	9	9	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	92	92	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dieldrin	168	58	34.5%	75	44.6%	16	9.5%	18	10.7%	1	0.6%
Endrin	169	115	68.0%	54	32.0%	0	0.0%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	154	134	87.0%	20	13.0%	--	--	0	0.0%	0	0.0%
Isodrin	169	117	69.2%	52	30.8%	--	--	0	0.0%	0	0.0%
Methylene Chloride	30	30	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	5	5	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	30	30	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Toluene	29	29	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Trichloroethylene	30	30	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Arsenic	86	71	82.6%	15	17.4%	0	0.0%	0	0.0%	0	0.0%
Cadmium	94	90	95.7%	4	4.3%	0	0.0%	0	0.0%	0	0.0%
Chromium	94	14	14.9%	79	84.0%	--	--	1	1.1%	0	0.0%
Lead	94	41	43.6%	53	56.4%	--	--	0	0.0%	0	0.0%
Mercury	108	66	61.1%	42	38.9%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.

(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.

-- not applicable

Table 17.5-1 Comparative Analysis of Alternatives for the South Plants Ditches Subgroup

Criteria	Alternative 1/B1: No Additional Action	Alternative 1a/B1: Direct Thermal Desorption of Principal Threat Volume; No Additional Action	Alternative 3/B3: Landfill	Alternative 3a/B3: Direct Thermal Desorption of Principal Threat Volume; Landfill
1. Overall protection of human health and the environment	Not Protective: Does not achieve RAOs; impacts to surface water not reduced	Not Protective: Does not achieve RAOs; impacts to surface water not reduced	Protective: Achieves RAOs through containment; surface water impacts reduced	Protective: Achieves RAOs through treatment and containment; surface water impacts reduced
2. Compliance with ARARs	Complies	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Moderate residual risk; 56,000 BCY of contaminated soil remain uncontrolled	Moderate residual risk; 3,400 BCY treated, balance of site remains uncontrolled	Low residual risk; contaminated soil removed and contained	Low residual risk; thermal desorption treats 3,400 BCY; balance of exceedance volume contained
4. Reduction in TMV	56,000 BCY remain untreated; TMV reduction by natural attenuation degradation only	Thermal desorption destroys OCPs for 3,400 BCY; TMV reduction by natural attenuation degradation for balance of sites	Mobility of contaminants reduced by containment; toxicity and volume not reduced	Thermal desorption destroys OCPs for 3,400 BCY; balance of area removed, excavated, and contained
5. Short-term effectiveness	Existing habitat not changed	Low short-term risks to workers and the community during excavation, transportation, and treatment of contaminated soil	Moderate short-term risks to workers and the community during excavation and transportation of contaminated soil; RAOs achieved in 3 years	Moderate short-term risks to workers and the community during excavation, transportation, and treatment of contaminated soil; RAOs achieved in 3 years
6. Implementability	Feasible; No implementation required	Technically Feasible: Administrative difficulty associated with thermal treatment	Technically and administratively feasible	Technically Feasible: Administrative difficulty associated with thermal treatment
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$1,300,000 Total—$1,300,000	Capital—$100,000 Operating—$278,000 Long-term—$1,160,000 Total—$1,540,000	Capital—$1,460,000 Operating—$1,800,000 Long-term—$39,000 Total—$3,290,000	Capital—$1,490,000 Operating—$2,000,000 Long-term—$37,000 Total—$3,530,000
Summary	Not Retained: Not protective of human health and the environment	Not Retained: Not protective of human health and the environment	Retained: Containment provides protection; relatively low cost	Retained: Containment and treatment provide protection; relatively low cost

Criteria	Alternative 3g: Landfill; Caps/Covers with Consolidation; Caps/Covers	Alternative 6/B5: Caps/Covers	Alternative 6c/B5: Direct Thermal Desorption of Principal Threat Volume; Caps/Covers	Alternative 13a/B3: Direct Thermal Desorption
1. Overall protection of human health and the environment	Protective: Achieves RAOs through containment; surface water impacts reduced	Protective: Achieves RAOs through in-place containment; surface water impacts reduced	Protective: Achieves RAOs through treatment and containment; surface water impacts reduced	Protective: Achieves RAOs through treatment and containment; surface water impacts reduced
2. Compliance with ARARs	Complies	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Low residual risk; contaminated soil removed and contained	Low residual risk; contaminated soil contained	Low Residual Risk: Principal threat volume treated; balance of areas contained	Minimal Residual Risk: PRGs achieved for human health exceedance soil; soil posing risk to biota is landfilled
4. Reduction in TMV	Mobility of contaminants reduced by containment; toxicity and volume not reduced	Mobility of contaminants reduced by containment; toxicity and volume not reduced	Thermal desorption destroys OCPs for 3,400 BCY; mobility reduced for balance by excavation and containment	TMV eliminated for 33,000 BCY by thermal desorption; mobility reduced for 23,000 BCY by containment
5. Short-term effectiveness	Moderate short-term risks to workers and the community during excavation and transportation of contaminated soil; RAOs are achieved in 2 years	Protective of workers and the community; no intrusive action; RAOs achieved in 1 year	Moderate risks to workers and the community during excavation, transportation, and treatment of principal threat volume; RAOs achieved in 3 years	Moderate risks to workers and the community during excavation, transportation, and treatment; RAOs achieved in 3 years
6. Implementability	Technically Feasible; Administratively feasible	Technically Feasible; Administratively feasible	Technically Feasible: Administrative difficulty associated with thermal treatment	Technically Feasible: Administrative difficulty associated with thermal treatment
7. Present worth costs	Capital—$858,000 Operating—$2,320,000 Long-term—$24,000 Total—$3,200,000	Capital—$0 Operating—$6,840,000 Long-term—$547,000 Total—$7,380,000	Capital—$100,000 Operating—$6,650,000 Long-term—$513,000 Total—$7,260,000	Capital—$1,540,000 Operating—$3,450,000 Long-term—$15,000 Total—$5,010,000
Summary	Retained: Containment provides protection; relatively low cost	Retained: Containment in place provides protection and coordinates with overall South Plants cap, although with high cost	Not Retained: Difficult administrative feasibility without significantly lower long-term risks than in-place containment	Not Retained: Higher cost compared to landfilling not justified by limited risk reduction; limited administrative feasibility

Table 17.7-1 Summary of Concentrations for the South Plants Balance of Areas Subgroup

Contaminants of Concern	Range of Concentrations[2] (ppm)	Average Concentration[2] (ppm)	Human Health SEC (ppm)	Principal Threat Criteria (ppm)	Biota SEC (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL–6,900	14	71	720	3.8
Dieldrin	0.67–1,500	33	41	410	3.7
Endrin	BCRL–46	1.6	230	230,000	56
Isodrin	BCRL–390	18	52	52,000	Not applicable
Chlordane	BCRL–370	4.2	55	3,700	12
p,p,DDT	BCRL–140	1.4	410	13,500	13,000
HCCPD	BCRL–2,000	23	1,100	–	2,400
Chromium	BCRL–2,200	62	39	7,500	Not applicable
Lead	BCRL–4,900	340	2,200	–	Not applicable
p,p,DDE[1]	BCRL–9.7	0.53	1,250	12,500	Not applicable
Mercury	BCRL–8,600	500	570	570,000	82
Biota Exceedance Volume					
Aldrin	BCRL–3.5	0.037			
Dieldrin	BCRL–3.6	0.32			
Endrin	BCRL–1.17	0.011			
p,p,DDE	BCRL–1.02	0.006			
p,p,DDT	BCRL–1.7	0.15			
Arsenic	BCRL–180	0.73			
Mercury	BCRL–41	0.065			

1 Presents biota risk, but was detected in the human health exceedance volume.

2 Based on modeled concentrations within the human health exceedance volume or potential biota risk area

Table 17.7-2 Frequency of Detections for South Plants Balance Of Areas Subgroup

	Total Samples	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
	Analyzed	Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	1228	1002	81.6%	183	14.9%	24	2.0%	9	0.7%	10	0.8%
Benzene	494	479	97.0%	15	3.0%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	557	555	99.6%	2	0.4%	--	--	0	0.0%	0	0.0%
Chlordane	1223	1169	95.6%	52	4.3%	0	0.0%	2	0.2%	0	0.0%
Chloroacetic Acid	107	107	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlorobenzene	557	557	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chloroform	557	554	99.5%	3	0.5%	--	--	0	0.0%	0	0.0%
p,p,DDE	1234	1135	92.0%	99	8.0%	--	--	0	0.0%	0	0.0%
p,p,DDT	1228	1109	90.3%	116	9.4%	3	0.2%	0	0.0%	0	0.0%
Dibromochloropropane	1554	1542	99.2%	12	0.8%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	557	553	99.3%	4	0.7%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	87	87	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	1320	1283	97.2%	37	2.8%	--	--	0	0.0%	0	0.0%
Dieldrin	1225	852	69.6%	310	25.3%	40	3.3%	21	1.7%	2	0.2%
Endrin	1218	1076	88.3%	141	11.6%	1	0.1%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	1170	1101	94.1%	66	5.6%	--	--	3	0.3%	0	0.0%
Isodrin	1235	1106	89.6%	116	9.4%	--	--	13	1.1%	0	0.0%
Methylene Chloride	552	501	90.8%	51	9.2%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	23	23	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	557	544	97.7%	13	2.3%	--	--	0	0.0%	0	0.0%
Toluene	494	483	97.8%	11	2.2%	--	--	0	0.0%	0	0.0%
Trichloroethylene	557	555	99.6%	2	0.4%	--	--	0	0.0%	0	0.0%
Arsenic	941	780	82.9%	160	17.0%	0	0.0%	1	0.1%	0	0.0%
Cadmium	842	819	97.3%	23	2.7%	0	0.0%	0	0.0%	0	0.0%
Chromium	843	289	34.3%	545	64.7%	--	--	9	1.1%	0	0.0%
Lead	840	480	57.1%	358	42.6%	--	--	2	0.2%	0	0.0%
Mercury	1012	834	82.4%	178	17.6%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.

(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.

-- not applicable

Table 17.8-1 Comparative Analysis of Alternatives for the South Plants Balance of Areas

Criteria	Alternative 1/B1/A1/U1: No Additional Action	Alternative 1a/B1/A1/U1: Direct Thermal Desorption of Principal Threat Volume; No Additional Action	Alternative 3/B3/A3/U4a: Landfill	Alternative 3a/B3/A3/U4a: Direct Thermal Desorption of Principal Threat Volume; Landfill	Alternative 3g: Landfill; Caps/Covers with Consolidation; Cap/Covers
1. Overall protection of human health and the environment	Not Protective: Does not achieve RAOs; impacts to groundwater not reduced	Not Protective: Does not achieve RAOs; impacts to groundwater not reduced	Protective: Achieves RAOs through containment; groundwater impacts reduced	Protective: Achieves RAOs through treatment and containment; groundwater impacts reduced	Protective: Achieves RAOs through containment; impacts to groundwater not reduced
2. Compliance with ARARs	Does not comply with Army regulations regarding agent/UXO	Does not comply with Army regulations regarding agent/UXO	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Moderate Residual Risk: Contamination remaining in place	Moderate Residual Risk: 11,000 BCY treated; natural attenuation for balance of soil ongoing	Minimal Residual Risk: Contaminated soil removed and contained	Low Residual Risk: Thermal desorption treats 11,000 BCY; balance of soil contained	Minimal Residual Risk: Contaminated soil removed and contained
4. Reduction in TMV	640,000 BCY remain untreated; TMV by natural attenuation degradation only	Thermal desorption destroys organics for 11,000 BCY; TMV reduction by natural attenuation for balance of area	Mobility of contaminants reduced by containment; toxicity and volume not reduced	Thermal desorption destroys organics for 11,000 BCY; mobility reduced for balance of soil by containment	Mobility of contaminants reduced by containment; toxicity and volume not reduced
5. Short-term effectiveness	Existing habitat not changed; impacts to groundwater continue	Significant risk to workers and the community during agent/UXO screening and excavation, transportation, and treatment of principal threat volume; RAOs not achieved	Moderate risks to workers and the community during agent/UXO screening and excavation and transportation of contaminated soil; RAOs achieved in 3 years	Significant risks to workers and the community during agent/UXO screening and excavation, transportation, and treatment of contaminated soil; RAOs achieved in 4 years	Moderate risks to workers and the community during agent/UXO screening and excavation and transportation of contaminated soil; RAOs achieved in 3 years
6. Implementability	Feasible; No implementation required	Technically Feasible: Administrative difficulty associated with thermal treatment	Technically Feasible; administratively feasible	Technically Feasible; Administrative difficulty associated with thermal treatment	Technically Feasible; administratively feasible
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$12,600,000 Total—$12,600,000	Capital—$324,000 Operating—$906,000 Long-term—$11,300,000 Total—$12,500,000	Capital—$16,400,000 Operating—$21,900,000 Long-term—$423,000 Total—$38,700,000	Capital—$16,800,000 Operating—$22,300,000 Long-term—$423,000 Total—$39,500,000	Capital—$3,530,000 Operating—$27,500,000 Long-term—$95,000 Total—$31,100,000
Summary	Not Retained: Not protective of human health or the environment	Not Retained: Not protective of human health or the environment	Retained: Containment provides protection at relatively low cost	Retained: Containment and treatment provide protection at relatively low cost	Retained: Containment provides protection at relatively low cost

Criteria	Alternative 6/B5/A1/U1: Caps/Covers	Alternative 6c/B5/A3/U4a: Direct Thermal Desorption of Principal Threat Volume; Caps/Covers	Alternative 13/B3/A3/U4a: Direct Thermal Desorption; Direct Stabilization/Solidification	Alternative 19/B3/A3/U4a: In Situ Thermal Treatment; In Situ Solidification/Stabilization
1. Overall protection of human health and the environment	Protective: achieves RAOs through in-place containment; groundwater impacts reduced	Protective: Achieves RAOs through treatment and containment; groundwater impacts reduced	Protective: Achieves RAOs through treatment/ immobilization and containment; groundwater impacts reduced	RAOs not achieved through in situ thermal treatment and solidification; groundwater impacts reduced
2. Compliance with ARARs	Complies	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Low residual risk; contaminated soil contained	PRGs achieved for 11,000 BCY; low residual risk for balance of soil which is contained	Minimal residual risk; PRGs achieved for 68,000 BCY thermally desorbed, 61,000 BCY solidified, and 510,000 BCY contained	Low residual risks; PRGs not achieved by RF heating; contaminants contained by solidification and landfilling
4. Reduction in TMV	Mobility of contaminants reduced by containment; toxicity and volume not reduced	Thermal desorption destroys organics for 11,000 BCY; mobility in balance of area eliminated by containment	Thermal desorption destroys organics for 68,000 BCY; mobility in balance of area eliminated by solidification or containment	TMV reduction by RF heating; mobility of contaminants reduced by solidification and containment
5. Short-term effectiveness	Low short-term risk; protective of workers and the community; no intrusive action; RAOs achieved in 4 years	Significant risk to workers and the community during agent/UXO screening and excavation, transportation, and treatment; RAOs achieved in 3 years	Significant risk to workers and the community during agent/UXO screening and excavation, transportation, and treatment; RAOs achieved in 3 years	Significant risk to workers and the community during agent/UXO screening and treatment, excavation, transportation, and landfilling; RAOs achieved in 2 years
6. Implementability	Technically feasible; administratively feasible	Technically Feasible: Administrative difficulty with concerns regarding thermal treatment	Technically Feasible: Administrative difficulty with on-post facility	Not Technically Feasible for RF heating: no full-scale units are available, and pilot-scale studies failed to confirm effectiveness at RMA
7. Present worth costs	Capital–$0 Operating–$104,000,000 Long-term–$3,900,000 Total–$108,000,000	Capital—$763,000 Operating—$106,000,000 Long-term—$3,250,000 Total—$111,000,000	Capital—$15,000,000 Operating—$27,300,000 Long-term—$828,000 Total—$43,100,000	Capital—$26,700,000 Operating—$44,800,000 Long-term—$1,790,000 Total—$73,300,000
Summary	Retained: Containment in place provides protection and coordinates with overall South Plants cap, although with high cost	Not Retained: Difficult administrative feasibility without significantly lower long-term risks than in-place containment	Not Retained: Higher cost compared to containment and partial treatment although similar residual risk	Not Retained: Not implementable and high cost for treatment; not protective; high cost

LEGEND

South Plants Central Processing Subgroup
SITE: SPSA-1a, Processing Area

South Plants Ditches Subgroup
SITES: SPSA-1d, Drainage Ditches
SPSA-2d, Drainage Ditches
SPSA-3a, Drainage Ditches
SPSA-4a, Drainage Ditches
SPSA-5a, Drainage Ditches
SPSA-7a, Drainage Ditches
SPSA-8b, Drainage Ditches
SPSA-9a, Drainage Ditches

South Plants Balance of Areas Subgroup
SITES: SPSA-1b, Mounded Material
SPSA-1c, Lime Pits
SPSA-1g, Balance of Subarea
SPSA-2a, South Tank Farm
SPSA-2b, Open Storage Yard
SPSA-2c, Salvage Yard
SPSA-2e, Balance of Subarea
SPSA-3b, Salt Storage Pad
SPSA-3c, Former Tank Storage Area
SPSA-3d, Revetted Tank Storage
SPSA-3e, Balance of Subarea
SPSA-4b, Balance of Subarea
SPSA-5b, Balance of Subarea
SPSA-6, Hydrazine Facility
SPSA-7b, Lagoon
SPSA-7c, Balance of Subarea
SPSA-8a, Sanitary Landfill
SPSA-8c, Balance of Subarea
SPSA-9b, Balance of Subarea
SPSA-12a, Aeration Basin
SPSA-12b, Sedimentation Pond

Buried M-1 Pits Subgroup, Lime Basins Medium Group

Hex Pit Subgroup, Disposal Trenches Medium Group

Site Boundary

Buildings and Roads

1 Section Number

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 17.0-1

Site Locations
South Plants Medium Group

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

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DATE 3/2/93
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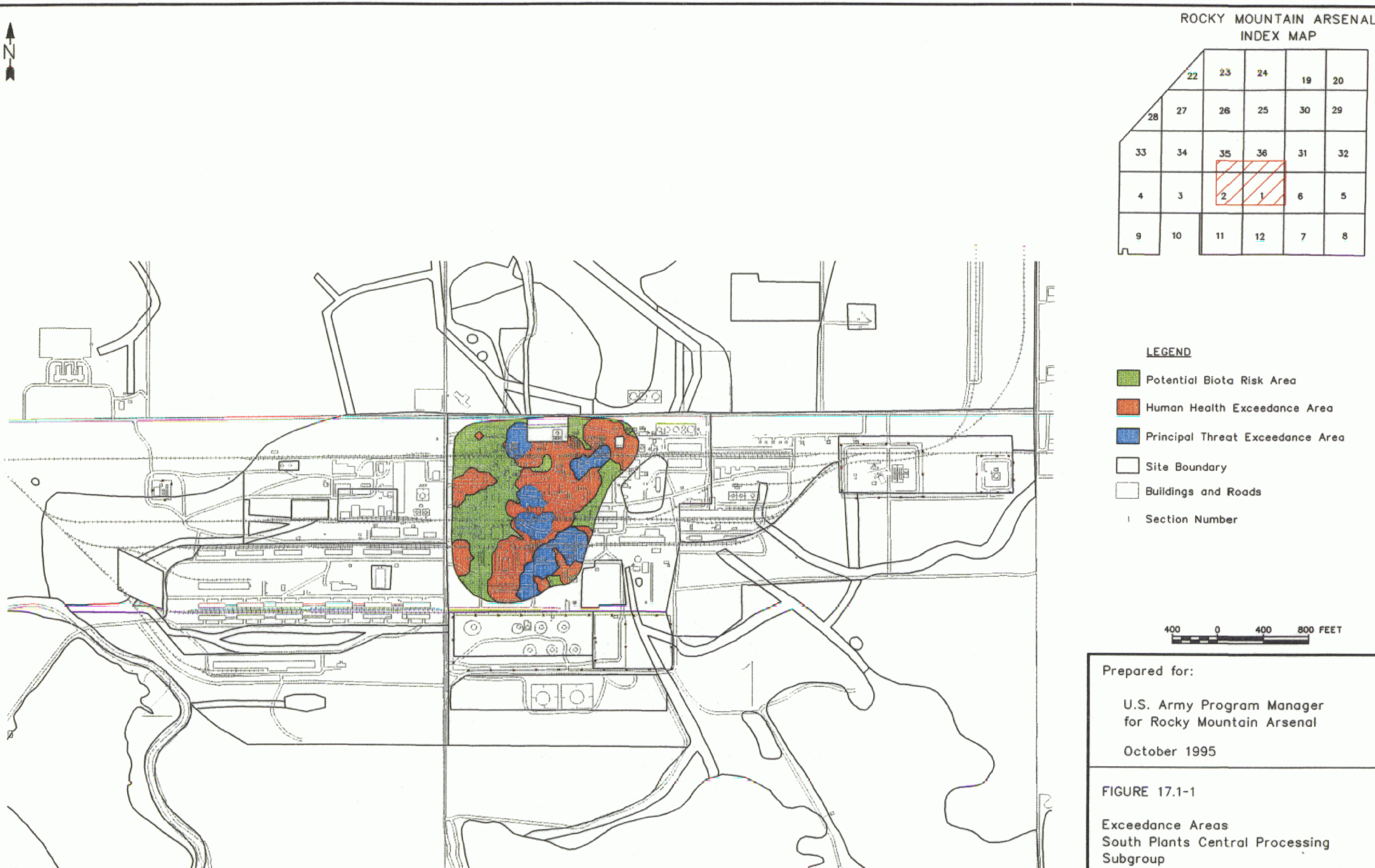
APPROVED BY
CHECKED BY



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Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 17.1-1

Exceedance Areas
South Plants Central Processing
Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

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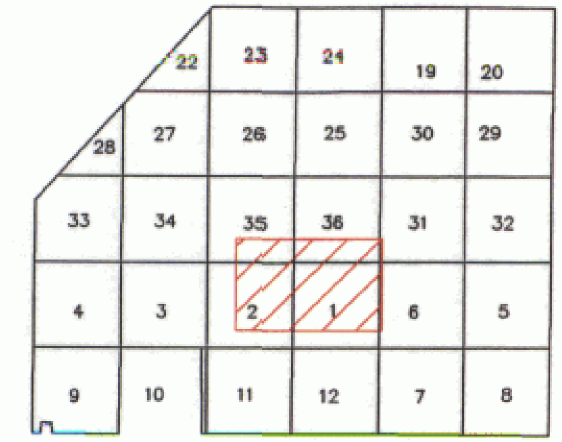
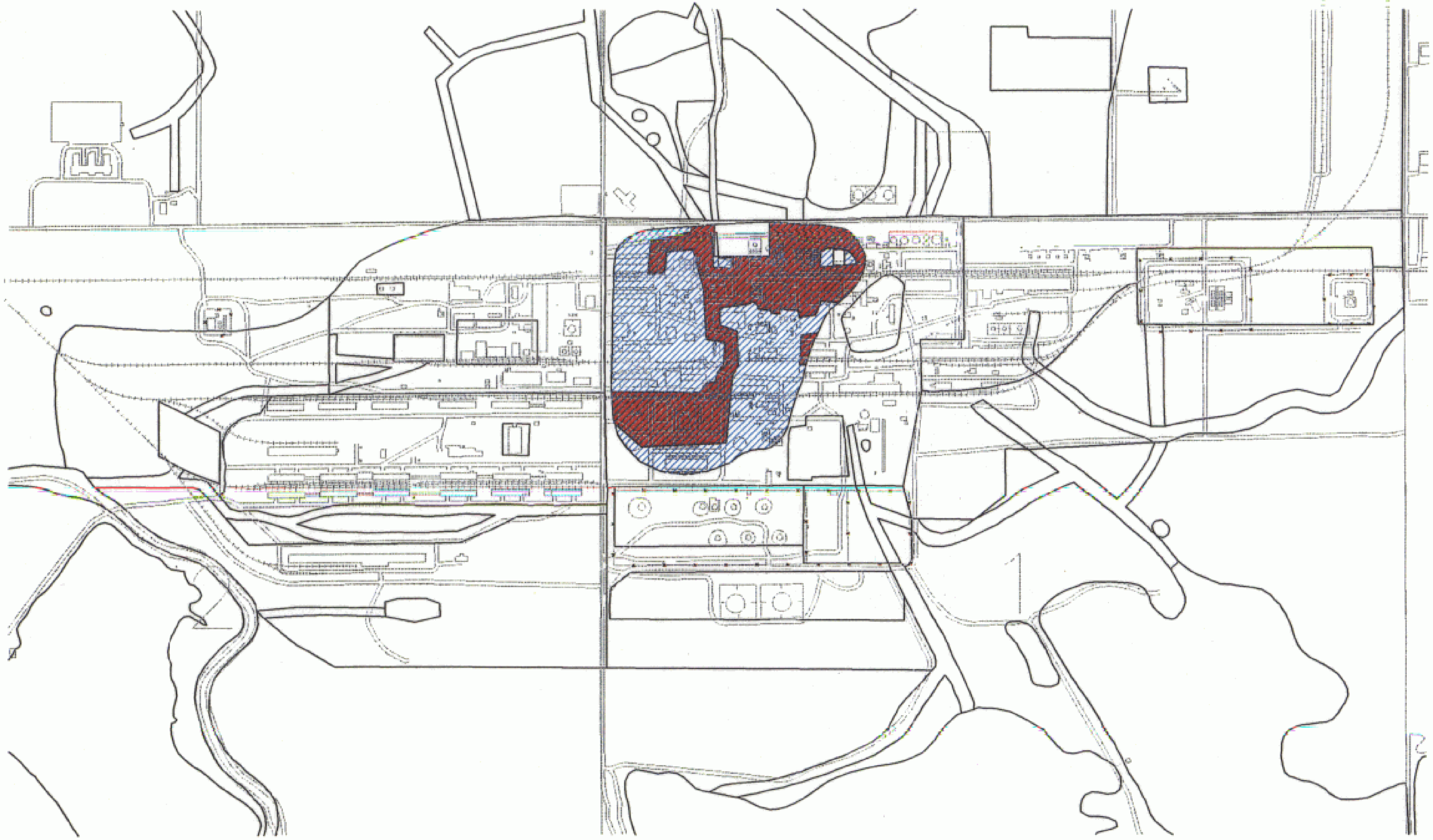
ROCKY MOUNTAIN ARSENAL INDEX MAP





LEGEND

- Human Health Exceedance Area and Potential Biota Risk Area
- Potential Agent Presence Area
- Site Boundary
- Buildings and Roads
- Section Number

400 0 400 800 FEET

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 17.1-2

Potential Agent Presence Area
South Plants Central Processing
Subgroup

Rocky Mountain Arsenal.
Prepared by: Ebasco Services Incorporated

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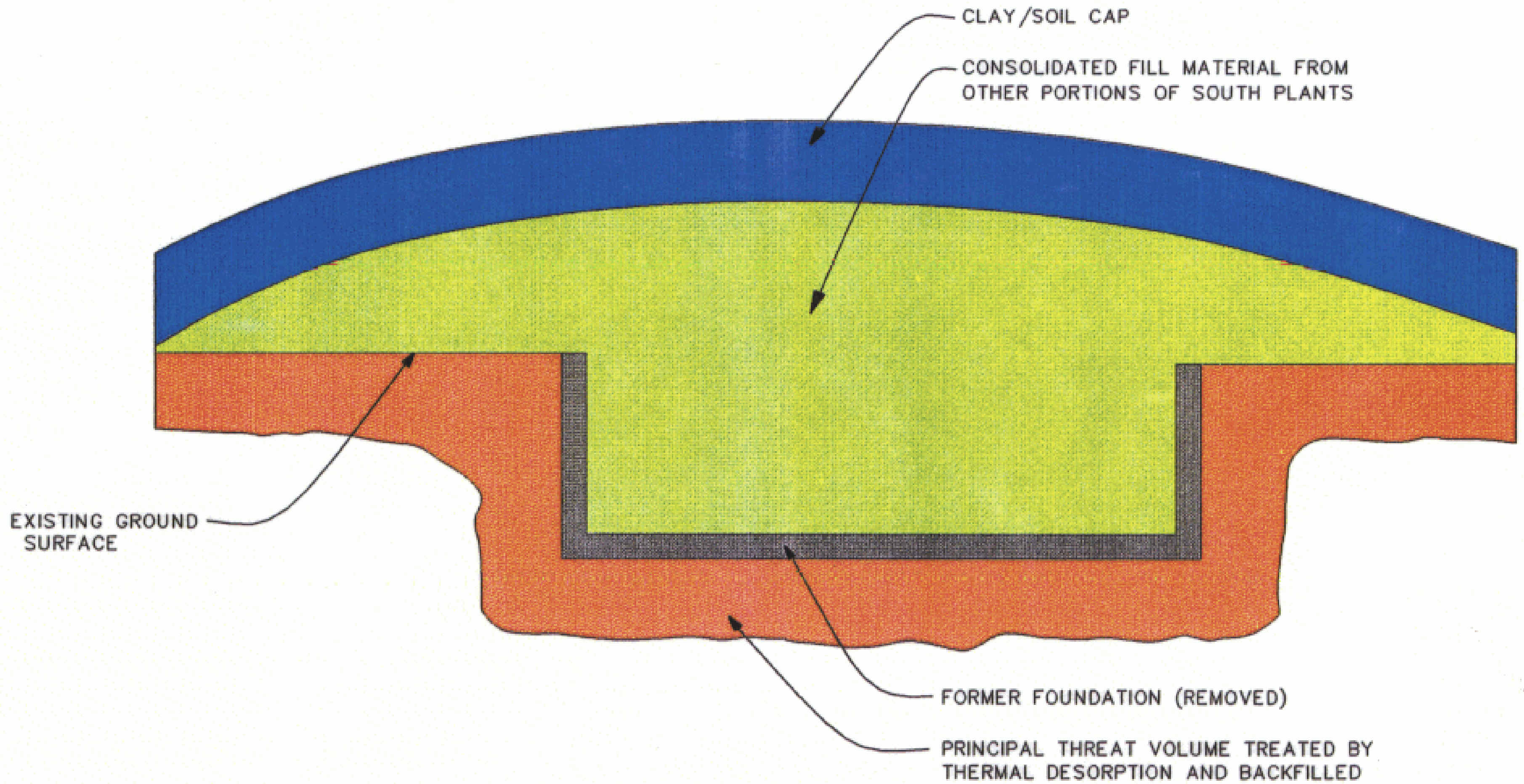
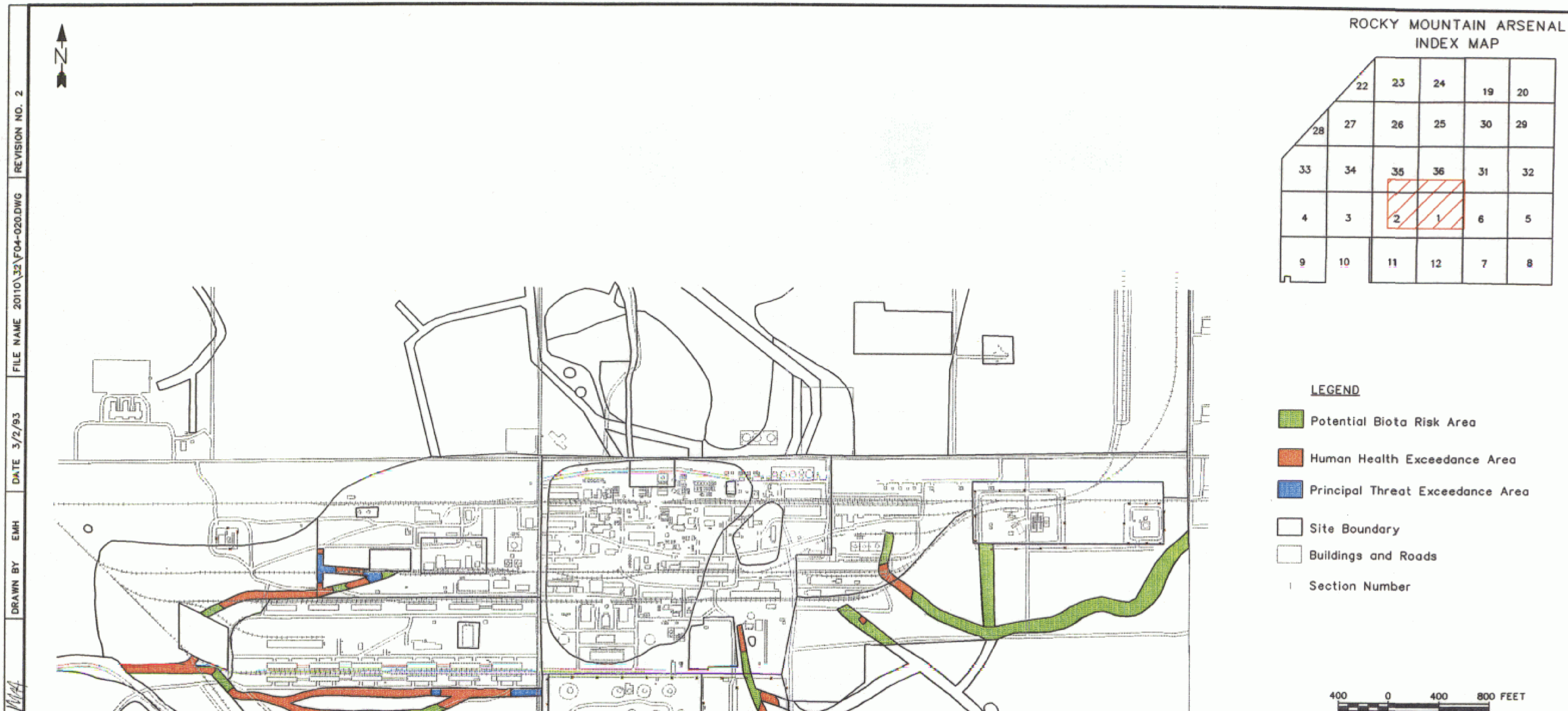


Perpared for: U.S. Army Program Manager for Rocky Mountain Arsenal
October 1995

FIGURE 17.2-1
Schematic of Alternative 6a for South Plants Central Processing Subgroup

Foster Wheeler Environmental Corporation
October 1995



Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

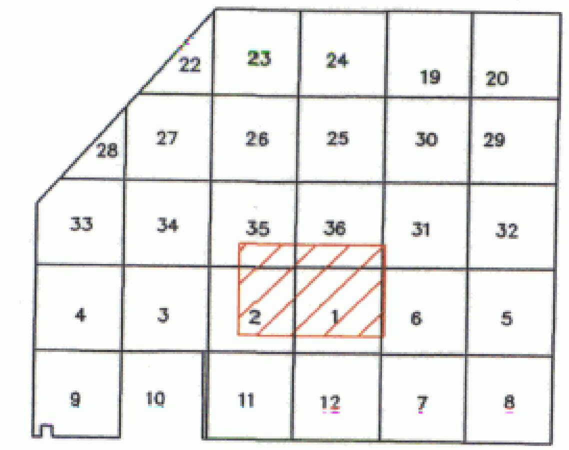
October 1995

FIGURE 17.4-1

Exceedance Areas
South Plants Ditches Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

ROCKY MOUNTAIN ARSENAL
INDEX MAP



LEGEND

Potential Biota Risk Area

Human Health Exceedance Area

Principal Threat Exceedance Area

Site Boundary

Buildings and Roads

1 Section Number

400 0 400 800 FEET

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 17.7-1

Exceedance Areas
South Plants Balance of Areas
Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

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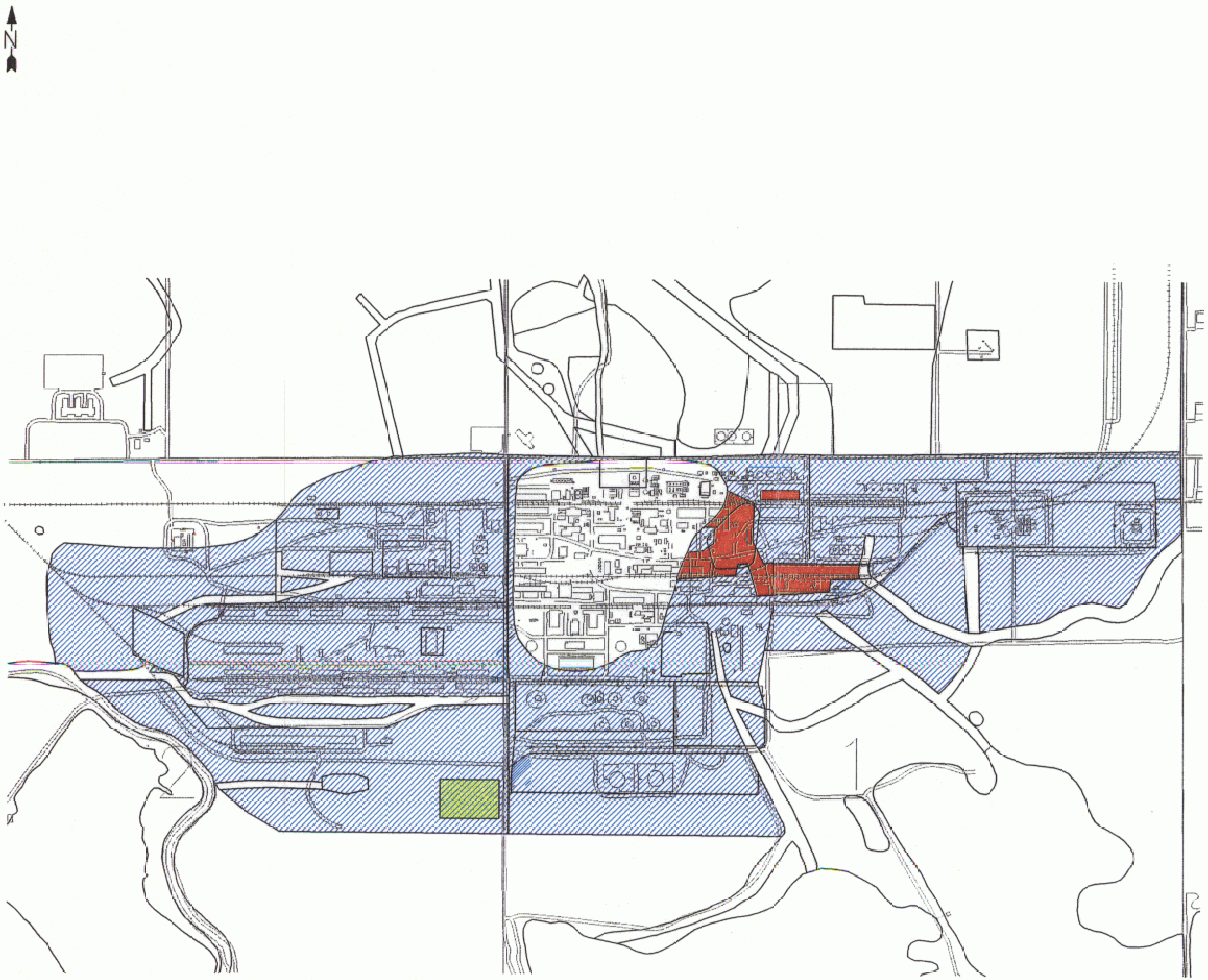
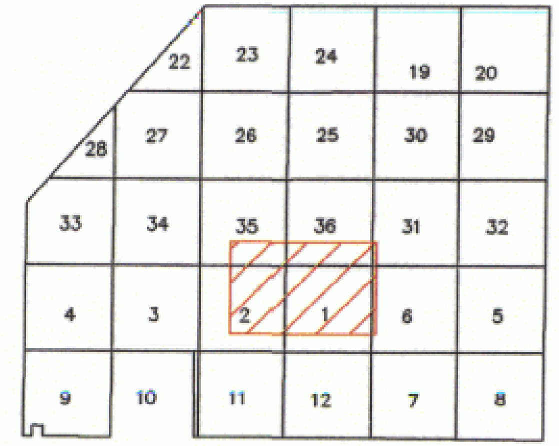


ROCKY MOUNTAIN ARSENAL
INDEX MAP



LEGEND

- Human Health Exceedance Area and Potential Biota Risk Area
- Potential Agent Presence Area
- Potential UXO Presence Area
- Site Boundary
- Buildings and Roads
- 1 Section Number

400 0 400 800 FEET

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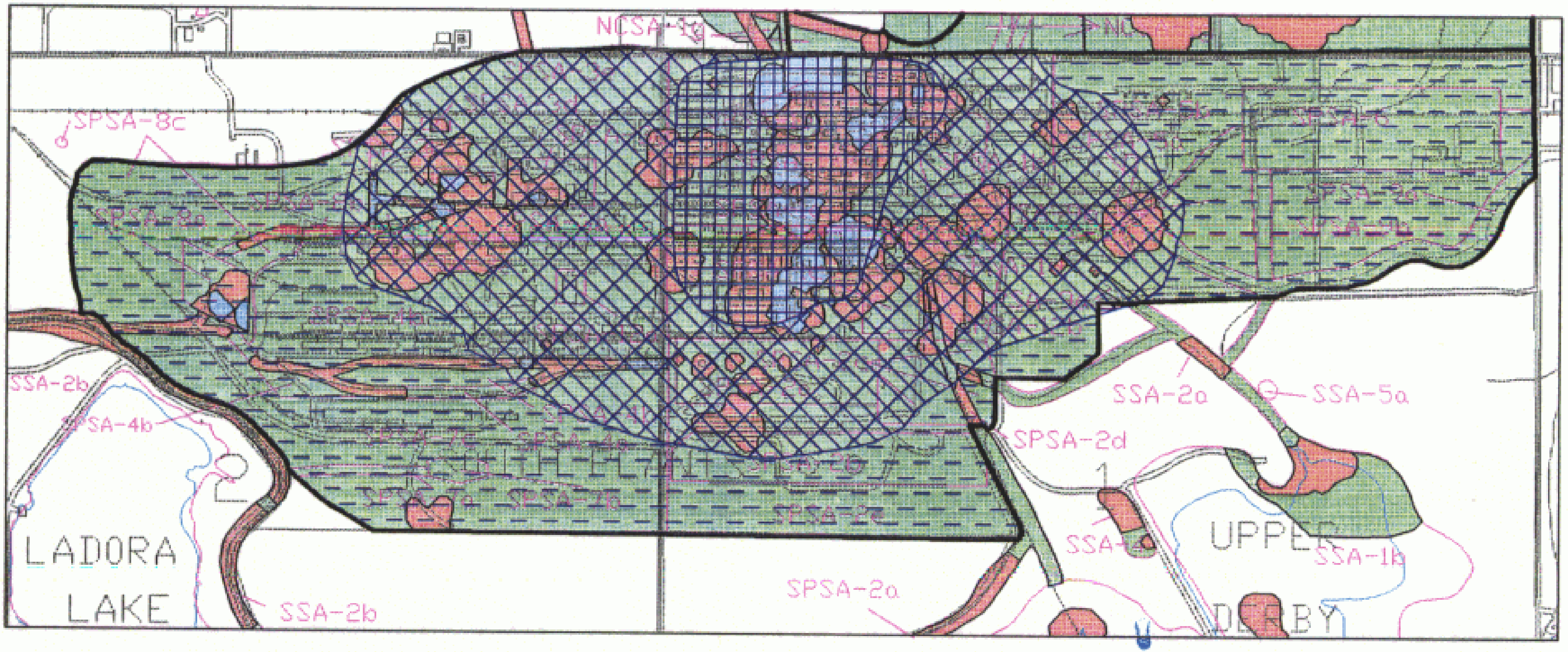
FIGURE 17.7-2

Potential Agent/UXO Presence Areas
South Plants Balance of Areas
Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation



Legend

- Principal Threat Exceedance Area
- Human Health Exceedance Area
- Excess Biota Risk Area
- South Plants Central Processing Area Cover (4 foot soil cover with biota barrier)
- 3 Foot Soil Cover Area
- 1 Foot Soil Cover Area
- Sites with Soil Cover Remedies
- SAR Site and ID
- 31 Section Number
- Section Line
- Drainage
- Road
- Railroad

0 500 1000
Scale in Feet

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Prepared for:
U.S. Army Program Manager
for Rocky Mountain Arsenal
Prepared October 1995

Figure 17.8-1
Soil Cover Areas
South Plants Balance of Areas Subgroup
Rocky Mountain Arsenal
Prepared by: Foster Wheeler Environmental Corp.

18.0 DETAILED ANALYSIS OF ALTERNATIVES FOR THE BURIED SEDIMENTS/ DITCHES MEDIUM GROUP

The Buried Sediments/Ditches Medium Group consists of eleven sites that contain either buried lake sediments or drainage ditches. These sites were grouped by type and contamination pattern to form two subgroups, Buried Sediments and Sand Creek Lateral. Figures 18.0-1 and 18.0-2 show the location of the sites comprising these subgroups.

The primary Human Health and Biota COCs present in this medium group are OCPs. Chromium, CLC2A, and lead also exceed the Human Health SEC (EBASCO 1994a) at scattered locations. Portions of these sites contain soil that pose potential risks to biota in some samples. The Sand Creek Lateral Subgroup is a potential source of groundwater contamination to several groundwater plumes (EBASCO 1992b). The Sand Creek Lateral is also a potential source of surface-water contamination as water flows through ditches in the site. Table 18.0-1 presents the characteristics of each subgroup, including COCs and exceedance volumes, and Appendix A presents a summary of soil volume and area estimates. Neither of these subgroups contain high levels of contamination that are considered principal threat areas.

In the DSA, alternatives were developed and screened based on the general characteristics of the medium group. However, the retained alternatives do not necessarily apply to each subgroup. The characteristics of the two subgroups—including contaminant types and contaminant concentrations, site configuration, and depth of contamination—were evaluated in the DAA to determine the subset of applicable alternatives for each subgroup from the range of alternatives retained in the DSA (EBASCO 1992b) for the medium group. The following sections present the characteristics of each subgroup, an evaluation of the retained alternatives against the DAA criteria listed in the NCP (EPA 1990a), and the selection of alternatives, based on a comparative analysis, that was considered when sitewide alternatives were developed (Section 20).

18.1 BURIED SEDIMENTS SUBGROUP CHARACTERISTICS

The Buried Sediments Subgroup is composed of sites SSA-3a (Lake Ladora Sediments) and SSA-3b (Upper and Lower Derby Lake Sediments) (Figure 18.0-1). These sites contain contaminated sediments that were dredged from the adjacent lakes, deposited in unlined ditches at their current locations, and covered with approximately 18 inches of soil (EBASCO 1989b). There is no clay layer or biota barrier between the cover soil and the contaminated sediments. Since lake dredging was completed (1965), the covered sediment mounds have been allowed to revegetate naturally.

Table 18.1-1 provides a summary of contaminants, concentrations, and exceedance values for this subgroup, and Table 18.1-2 summarizes the frequency of detections of contaminants above the Human Health SEC (EBASCO 1994a). The buried sediments from Lake Ladora (Site SSA-3a) do not contain contaminants above the Human Health SEC (EBASCO 1994a), but the Upper and Lower Derby Lake (Site SSA-3b) sediments contain maximum concentrations of dieldrin above the Human Health SEC (EBASCO 1994a). The COCs at the Upper and Lower Derby Lake sediment mound are found in the 4- to 10-ft depth interval. Since these sediments are buried below clean coversoil, they do not pose a potential risk to biota. The sites in this subgroup are physically well defined and easily accessible. Figure 18.1-1 shows the physical configurations and the distribution of exceedance areas for the Lake Ladora and the Upper and Lower Derby Lake sediment mounds, and Table 18.0-1 gives the exceedance areas and volumes.

The buried sediments are located within the 100-year flood plain and are near the southern lakes. The native grasses present at these sites contribute to the sites' habitat quality, but are replaceable through revegetation after any disturbance. These sites are also located within the Bald Eagle Management Area; therefore, the evaluation of alternatives for this subgroup must consider the impacts of alternatives on the habitat within these sites. Most alternatives consist of revegetating the areas disturbed with native grasses in accordance with a refuge management plan. As such, the habitat quality is restored for most alternatives. The institutional controls alternative prevents the use of the sites as habitat and requires habitat mitigation efforts to offset this loss of habitat.

18.2 BURIED SEDIMENTS SUBGROUP EVALUATION OF ALTERNATIVES

The six alternatives developed for the Buried Sediments Subgroup vary in approach from no action to treatment. Alternative 10: Solidification/Stabilization was deleted for this subgroup because organics (specifically OCPs) are the predominant COCs and this technology is not highly effective for organics. In addition, the treatment alternatives were modified to indicate that treatment of inorganics is not required. The following subsections present a description of each alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a).

18.2.1 Alternative 1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA) applies to all 7,900 SY of human health exceedances in the Buried Sediments Subgroup. Although 16,000 BCY of contaminated sediments remain in place under this alternative, the potential for human exposure to contaminants is relatively low because the human health exceedances occur only in the 4- to 10-ft depth interval. There is no impact to existing habitat. The existing cover soil is monitored for damage to the vegetation or erosional processes as part of the long-term monitoring program. Groundwater compliance sampling is performed, untreated soil is monitored (approximately 42 total samples for the subgroup per year), and 5-year site reviews are conducted to monitor the natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.2-1 summarizes the evaluation of all alternatives of this subgroup.

18.2.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve RAOs, although the untreated soil is covered with uncontaminated soil. The only long-term reduction in toxicity of contaminants is through natural attenuation/degradation.

18.2.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the subgroup is not located in wetlands. The sediments are located within the 100-year flood plain, however, surface-water controls could be constructed to modify the flood plain in order to achieve ARARs. In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

18.2.1.3 Long-Term Effectiveness and Permanence

There is a low residual risk associated with this alternative because soil contaminated with OCPs exceeding Human Health SEC (EBASCO 1994a) is contained below a soil cover. No controls are implemented; however, site reviews, soil monitoring, and groundwater monitoring are required. The existing habitat is not impacted by this alternative.

18.2.1.4 Reduction in TMV

There is no reduction in TMV other than by natural attenuation, and treatment residuals are not generated by this alternative. A total of 16,000 BCY of untreated soil remains.

18.2.1.5 Short-Term Effectiveness

The time frame until RAOs are achieved is greater than 30 years because natural attenuation/degradation is the only process by which contaminants are reduced. The alternative is protective of workers and the community during remedial actions since no actions are taken. The existing habitat is not affected.

18.2.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are available.

18.2.1.7 Cost

The total present worth cost is $639,000 and includes only long-term operations and maintenance costs associated with long-term monitoring and site reviews. Table B4.16-1 details the costing for this alternative. The cost uncertainty associated with soil monitoring and site reviews is low.

18.2.2 Alternative 2: Access Restrictions

Alternative 2: Access Restrictions (Modifications to FFA) applies to all 7,900 SY of human health exceedance area. Human exposure to contaminants is reduced through the installation of 3,400-ft-long perimeter of chain-link fencing. The contaminants remain in place, but the exposure pathways are interrupted through the installation of fencing. Groundwater compliance sampling is performed, long-term monitoring of untreated soil is conducted (approximately 13 samples for the subgroup per year), and 5-year site reviews are conducted to monitor damage to vegetation and damage from erosion processes.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.2-1 summarizes the evaluation of all alternatives for this subgroup.

18.2.2.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs since human exposure pathways are interrupted through access restrictions. In addition, short-term impacts associated with access restrictions are low.

18.2.2.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the subgroup is not located in wetlands. The sediments are located within the 100-year flood plain, however, surface-water controls could be constructed to modify the flood plain in order to achieve ARARs. In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). Endangered species are not impacted, although habitat in the southern tier of RMA is slightly reduced. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

18.2.2.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low. Levels of OCPs above Human Health SEC (EBASCO 1994a) remain in soil. Human exposure, however, is reduced through installation of fencing and land-use restrictions. Long-term maintenance, site reviews, groundwater monitoring, and soil monitoring are required. The controls are adequate for the area. The existing habitat quality is reduced by fencing.

18.2.2.4 Reduction in TMV

By implementing land-use restrictions and fencing, human exposure pathways are interrupted for over 7,900 SY. There is no reduction in contaminant volume or mobility except by natural attenuation/degradation for 16,000 BCY of untreated soil. These exposure controls are reversible if these methods should fail. There are no treatment residuals associated with this alternative.

18.2.2.5 Short-Term Effectiveness

The alternative is entails minimal risk to workers and the community during the remedial action. Workers are adequately protected by personal protective equipment during fence installation. Dust or vapor emissions are not anticipated. There are some environmental impacts due to the reduction of habitat quality by fencing. The alternative can be implemented and RAOs are achieved within 1 year and natural attenuation/degradation of contaminants in soil is ongoing.

18.2.2.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil left in place. The alternative is administratively feasible and materials, specialists, and equipment are readily available for fence installation and habitat modification.

18.2.2.7 Cost

The total present worth cost is $667,000 and includes $45,000, $21,000, and $602,000 for capital, operating, and long-term costs, respectively. Table B4.16-2 details the costing for this alternative.

The cost uncertainty associated with this alternative is low because the areas to be addressed by access restrictions are well defined.

18.2.3 Alternative 3: Landfill

Alternative 3: Landfill (On-Post Landfill) addresses 16,000 BCY of human health exceedance volume associated with the Buried Sediments Subgroup. The contaminated soil is excavated and placed in a centralized on-post hazardous waste landfill (Section 4.6.6). Construction of the first cell of the multiple-cell landfill and associated facilities takes 1 year. The landfill area is revegetated following installation of the cover and fencing. The landfill cell requires annual monitoring, long-term maintenance of the landfill cover, leachate collection and treatment, and groundwater monitoring. The excavations at the sites are backfilled to existing grade with soil from an on-post borrow area. The uppermost 6 inches of the backfilled areas are supplemented with conditioners and revegetated with native grasses, and the borrow area is also recontoured and revegetated to restore habitat. However, fencing at the landfill excludes biota from that area.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.2-1 summarizes the evaluation of all alternatives for this subgroup.

18.2.3.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through removal and containment in an on-post landfill. The containment prevents human exposure, but does entail short-term impacts associated with excavation of contaminated sediments.

18.2.3.2 Compliance with ARARs

This alternative complies with action-specific ARARs and includes state regulations on landfill siting, design, and operation, and impacts to endangered species. Habitat in the southern tier is reduced during excavation, however. Location-specific ARARs are met, as no permanent structures are constructed within the 100-year flood plain, and the landfill is not located in wetlands or a 100-year flood plain. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

18.2.3.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since the 16,000 BCY of contaminated soil are removed and contained in the landfill. There is high confidence in the engineering controls for the landfill and there are no expected difficulties associated with landfill maintenance. Landfill-cell monitoring is required and the controls are felt to be adequate. Habitat quality is restored through revegetation; however, loss in habitat value during excavation requires mitigation.

18.2.3.4 Reduction in TMV

Pathways of exposure are interrupted and mobility of contaminants is reduced through containment in the landfill for 16,000 BCY, although no materials are treated. Mobility reduction is reversible should the landfill fail. There are no treatment residuals associated with this alternative.

18.2.3.5 Short-Term Effectiveness

The alternative entails minimal short-term risks associated with excavation, transportation, and landfilling of contaminated soil. Personal protective equipment adequately protects workers during excavation and transportation. In addition, fugitive dusts are controlled through water sprays, and vapor emissions are not anticipated. The existing habitat is disturbed during excavation, but is restored through revegetation. The time frame until RAOs are achieved is 2 years. Excavation of the 16,000 BCY is feasible within 1 year after 1 year for the construction of the landfill.

18.2.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter with periodic landfill-cell monitoring. Additional remedial actions require removal of the landfill cover. The alternative is administratively feasible since the substantive Subtitle C landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill, and the landfill technology is well demonstrated at full scale.

18.2.3.7 Cost

The total present worth cost is $960,000 including $416,000, $532,000, and $11,000 for capital, operating, and long-term costs, respectively. Table B4.16-3 details the costing for this alternative. The excavation of contaminated soil entails a cost uncertainty relative to identifying the extent and depth of contamination; however, the magnitude of this uncertainty is small based on the small volume of contaminated soil and the known extent of the buried sediments.

18.2.4 Alternative 6: Caps/Covers

Alternative 6: Caps/Covers (Multilayer cap) addresses all human health exceedance soil for the Buried Sediments Subgroup. Exposure pathways for human health are interrupted through the installation of a multilayer cap (7,900 SY in area) with a biota barrier layer as described in Section 4.6.14. Prior to cap installation, the existing vegetation is cleared and the subsurface is compacted to minimize variations in the subgrade. Once the 2-ft-thick layer of compacted, low-permeability soil is installed, a 1-ft-thick biota barrier of crushed concrete and a 4-ft-thick soil/vegetation layer which includes 6 inches of reconditioned soil, are installed. The cap is then vegetated with native grasses. Materials for the cap are excavated from the on-post borrow area. The borrow area is also recontoured and revegetated to restore habitat. Based on the existing grade of the sites, approximately 6,600 BCY of gradefill is required to achieve the design grade of 3 percent. This alternative is readily implemented, but the cap requires long-term management and maintenance of the vegetative cover for the alternative to remain effective. Groundwater compliance monitoring and five-year site reviews are performed.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.2-1 summarizes the evaluation of all alternatives for this subgroup.

18.2.4.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through in place containment. Human and biota exposure pathways are interrupted by installation of a multilayer cap.

18.2.4.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of the contained material. Endangered species are not impacted, although habitat in the southern tier is slightly reduced. Location-specific ARARs are met, even though the subgroup is located within a 100-year flood plain, since the cap layers, especially the biota barrier, provide surface-water controls. The subgroup is not located in wetlands. This alternative complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

18.2.4.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is minimal. Annual groundwater monitoring and site reviews are required for the untreated soil. In addition, erosion-control activities and vegetative-cover maintenance are required. There is high confidence in the engineering controls of the cap, but additional controls are required because the sites are located within the 100-year flood plain. Habitat quality is restored through revegetation; however, loss in habitat value during excavation requires mitigation. In addition, the types of vegetation and the maintenance activities performed there make the area undesirable as habitat for burrowing animals.

18.2.4.4 Reduction in TMV

The installation of the multilayer cap interrupts exposure pathways and reduces the mobility of contaminants for 16,000 BCY of contaminated soil. Reduction of the mobility of contaminants is reversible only if the cap should degrade. There are no treatment residuals associated with this alternative.

18.2.4.5 Short-Term Effectiveness

This alternative has minimal short-term risks since no intrusive activities are conducted. The alternative is protective of workers and the community during the remedial action. Workers are adequately protected by personal protective equipment during installation of the cap. Uncontaminated fugitive dust associated with cap construction is controlled by water sprays; odor and vapor emissions are not anticipated. Environmental impacts are minimal for construction of the cap, but the disturbance of borrow areas is required for capping materials. Installation of the 7,900-SY cap is feasible within 1 year.

18.2.4.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible and materials, specialists, and equipment are readily available. Multilayer caps have been well documented at full scale.

18.2.4.7 Cost

The total present worth cost is $651,000, including $361,000, and $289,000 for operating and long-term costs, respectively. Table B4.16-6 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the cap are available on post and the area to be capped is defined.

18.2.5 Alternative 13a: Direct Thermal Desorption

Alternative 13a: Direct Thermal Desorption (Direct Heating) treats 16,000 BCY of soil with human health organic exceedances by thermal desorption. The human health exceedance soil is excavated and transported to the centralized thermal desorption facility for treatment. The soil in this subgroup is classified as dry (i.e., moisture content of 10 percent). Based on this moisture content, the processing rate for the centralized thermal desorption facility is approximately 2,000 BCY/day, with a discharge temperature of 300°C and a soil residence time of 30 minutes. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.)

Approximately 1 percent of the total soil feed is entrained in the desorber off-gas stream and recovered from the scrubber blowdown equipment. The 160 BCY of blowdown particulates are placed in the on-post hazardous waste landfill. Landfill construction is described in Section 4.6.6. The treated soil is returned as backfill to the sites. Since thermal desorption destroys the organic content in the treated soil, the uppermost 6 inches are supplemented with conditioners and revegetated with native grasses.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.2-1 summarizes the evaluation of all alternatives for this subgroup.

18.2.5.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment of contaminated soil with human health exceedances.

18.2.5.2 Compliance with ARARs

This alternative complies with action-specific ARARs and includes state regulations on air emissions sources, landfill siting, design, and operation, and endangered species. Location-specific ARARs are met as no permanent structures are constructed within the 100-year flood plain and the landfill is not located in wetlands. This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

18.2.5.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since 16,000 BCY of soil are treated to achieve PRGs. The treated soil is returned to the site as backfill; however, approximately 1 percent of soil feed that is recovered from off gas treatment is placed in an on-post landfill. There is high confidence in the engineering controls for the landfill and there are no expected difficulties associated with landfill maintenance. Backfill monitoring is not required. Habitat quality is restored through revegetation; however, loss in habitat value during excavation requires mitigation.

18.2.5.4 Reduction in TMV

Thermal desorption degrades or destroys organics in the waste volume (treatment is to detection levels or >99.99 percent DRE). The TMV reduction of organics by thermal desorption is irreversible. Scrubber blowdown solids from off-gas treatment are the only treatment residuals and account for a volume of approximately 160 BCY.

18.2.5.5 Short-Term Effectiveness

This alternative entails moderate short-term risks associated with excavation, transportation, and treatment of contaminated soil. Personal protective equipment adequately protects workers during excavation, transportation, and treatment. Fugitive dust is controlled by water sprays, and vapor or odor emissions are not anticipated. In addition, the preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust. Vapors associated with the thermal desorber are controlled by emission control equipment. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards, low but acceptable levels of contaminants are contained in the emissions. The time frame for completion of the alternative is 3 years including the 2 years for construction and testing of the thermal desorption facility and construction of the landfill.

18.2.5.6 Implementability

Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame and should be reliably operated for the contaminants and levels of contamination in the soil feed. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the public perceptions regarding the safety of thermal treatment. The landfilling portion of this alternative is technically and administratively feasible. Landfilling can be implemented within the required time frame and reliably operated and maintained thereafter with periodic landfill-cell monitoring and maintenance.

In addition, the substantive requirements associated with Subtitle C landfill siting, design, and operating regulations are achieved.

18.2.5.7 Cost

The total present worth cost is $1,830,000, including $472,000, $1,360,000, and $100 for capital, operating, and long-term costs, respectively. Table B4.16-13a details the costing for this alternative. The overall uncertainty in the cost of this alternative is small based on the small volume of soil to be treated and the known extent of the buried sediments.

18.2.6 Alternative 19a: In Situ Thermal Treatment

Alternative 19a: In Situ Thermal Treatment (RF/Microwave Heating) treats 16,000 BCY of soil with human health exceedances by in situ RF heating. (Section 4.6.31 discusses RF heating.)

To mobilize organic contaminants in the human health exceedance soil, the soil is heated to more than 250°C to a depth of 10 ft. The mobilized contaminants are then collected and treated in the off-gas treatment system as described in Section 4.6.31. The subgroup requires one unit that can treat a 100-ft-long, 12-ft-wide, 10-ft-deep block of soil at a treatment rate of 180 BCY per day (based on a relatively low moisture content). The liquid sidestream from RF heating, which contains predominantly salts, is treated with an evaporator or could be transported to the thermal desorption facility for treatment in the evaporator associated with the scrubber effluent as described in Section 4.6.23. As with thermal desorption, the treated soil exhibit a low residual organic carbon content, requiring the supplementation of the uppermost 6 inches of soil with conditioners in order to revegetate the treated areas with native grasses and thus restore habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.2-1 summarizes the evaluation of all alternatives of this subgroup.

18.2.6.1 Overall Protection of Human Health and the Environment

This alternative does not achieve RAOs since treatment of contaminated soil with human health exceedances by RF heating does not achieve PRGs. Short-term risks are associated with in situ treatment of contaminated soil.

18.2.6.2 Compliance with ARARs

This alternative complies with action-specific ARARs including state regulations on air emissions sources, endangered species are not impacted, and location-specific ARARs are met as no permanent structures are constructed within the 100-year flood plain. This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

18.2.6.3 Long-Term Effectiveness and Permanence

The residual risk is low since the human health exceedances are treated to near the PRGs. Habitat quality is restored through revegetation.

18.2.6.4 Reduction in TMV

RF heating can theoretically achieve Human Health RAOs with low residual risk since OCPs and volatile metals can be driven from the soil by this form of in situ thermal treatment. However, the pilot-scale test of the RF technology at RMA, as described in the Technology Descriptions Volume, failed to confirm the temperature distribution and OCP removal efficiencies required for confident treatment of soil to achieve PRGs. The TMV reduction of organics by in situ thermal treatment is irreversible. The liquid blowdown sidestream associated with RF heating treatment is treated at a thermal desorption facility along with scrubber effluent.

18.2.6.5 Short-Term Effectiveness

The in situ thermal treatment of soil entails short-term impacts, although the off-gas control system for in situ heating is designed to achieve air quality standards. Personal protective equipment adequately protects workers during treatment activities. RF treatment of the 16,000 BCY is completed within 3 years.

18.2.6.6 Implementability

In situ thermal heating is currently not implementable since no full-scale in situ heating units have been constructed or demonstrated. The technology was demonstrated at a pilot-scale at RMA; however, several problems were identified in the pilot-scale test regarding the durability of the equipment. The resolution of these problems may lead to delays in the construction of full-scale units and in the operation of the in situ heating units over the estimated 3 years. In addition, administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the perceptions regarding the safety of in situ thermal treatment and the thermal treatment portion of the off-gas control system. Additional remedial actions are easily undertaken for soil that does not achieve PRGs.

18.2.6.7 Cost

The total present worth cost is $18,200,000 including $13,300,000 and $4,930,000 for capital and operating costs, respectively. Table B4.16-19a details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, there are no full-scale demonstrations of the in situ heating technology at other hazardous waste sites by which actual construction and operational costs can be documented. This uncertainty is especially noteworthy because the pilot-scale demonstration of the technology at RMA indicated there were potential problems regarding the durability of the equipment. Second, the lack of full-scale implementation data increases uncertainties relative to maintaining the assumed on-line percentage of the heating unit. The level and depth of contamination at RMA may result in changes in treatment times or delays in implementation, both of which may impact treatment costs.

18.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Buried Sediments Subgroup contains 16,000 BCY of soil primarily contaminated with OCPs, although there are lower levels of mercury contamination present. The material in these sites is contaminated sediment that was dredged from the adjacent lakes in the 1960s. Only 1 percent of the samples from these sites show OCPs exceeding the Human Health SEC (EBASCO 1994a), and the human health risk is relatively low for this subgroup as the human health exceedances are covered by approximately 18 inches of soil, which limits exposure pathways.

The sites in this subgroup contain native grasses, and they are located near the southern lakes and within the Bald Eagle Management Area; therefore, an analysis to retain alternatives must consider the impacts of alternatives on habitat. Areas disturbed during remediation are to be revegetated to restore the habitat value. In addition, the sites lie within the 100-year flood plain, so exclusion or in-place containment alternatives (Alternatives 2 and 6) would require additional surface-water controls to modify the flood plain area.

Alternatives that involve excavation of human health exceedances require protection for site workers during remedial activities, but the short-term risk to workers is minimal given the use of personal protective equipment. The level of contamination in sites in this subgroup does not necessitate special measures for odor control or community protection during remediation.

In summary, contamination in the Buried Sediments Subgroup poses minimal potential risk to human health; maximum concentrations of dieldrin have been detected above human health criteria at only one site (SSA-3b). Worker and community protection are not significant factors when comparing alternatives for this subgroup, but due to the vegetation present and their location near the lake, the impact of alternatives on habitat is a significant consideration.

Alternative 1: No Additional Action is not protective of human health and the environment as untreated soil remains in place if no controls are implemented, and was eliminated from further consideration as part of the sitewide alternatives.

Alternative 19a: In Situ Thermal Treatment does not achieve RAOs, although the residual risks are low, is not currently implementable and has a higher cost and higher long-term risk. As a result, this alternative was eliminated from consideration in developing sitewide alternatives.

Alternative 2: Access Restrictions achieves RAOs through engineering controls. However, the implementation of this alternative entails modifying habitat (by fencing) within the southern tier and allows untreated soil to remain in place within the 100-year flood plain which does not comply with location-specific ARARs. This alternative is less protective than capping, excavation and treatment, or disposal alternatives. Therefore, this alternative was eliminated from consideration.

The three remaining alternatives achieve RAOs and meet the two DAA threshold criteria: protection of human health and the environment and compliance with action- and location-specific ARARs for the DAA. The alternatives are distinguished, however, by how well they satisfy the five balancing criteria (Table 18.2-1).

Alternative 3: Landfill achieves RAOs through excavation and containment elsewhere on RMA. The short-term impacts associated with excavation are adequately addressed, and the residual risks are minimal. This alternative is considered cost-effective and is retained for development of sitewide alternatives.

Alternative 6: Caps/Covers achieves RAOs through containment in place. Although the capped area is revegetated to restore habitat, the types of vegetation placed at the area and the maintenance activities performed there make the area undesirable as habitat for burrowing animals. This alternative leaves untreated soil in place within the 100-year flood plain, although engineering controls for the cap provides adequate surface-water control. Because it achieves RAOs through containment in place at a low cost ($650,000) and because it is more protective than Alternative 2, Alternative 6 was retained for consideration in developing sitewide alternatives.

Alternative 13a: Direct Thermal Desorption achieves RAOs through treatment; however, the long-term risk is not substantially lower than that for the alternatives involving consolidation or landfilling based on the low levels of contamination present. Moreover, this alternative has a higher cost. As such, this alternative is not considered cost effective and was not retained for consideration in developing sitewide alternatives.

Consequently, the alternatives that were retained to represent the Buried Sediments Subgroup in the development of sitewide alternatives (Section 20.0) are the following:

- Alternative 3: Landfill (On-Post Landfill)
- Alternative 6: Caps/Covers (Multilayer Cap)

It should be noted that the selection of containment alternatives is consistent with NCP guidance (EPA 1990a) regarding the use of engineering controls (containment) for low levels of contamination.

18.4 SAND CREEK LATERAL SUBGROUP CHARACTERISTICS

The Sand Creek Lateral Subgroup consists of sites NCSA-2d (Basin B to Basin C Ditch), NCSA-5b (Drainage Ditches), NCSA-5c (Sand Creek Lateral), NCSA-8b (Sewage Treatment Plant), NPSA-4 (Fuse and Detonator Magazine Ditch), SSA-2a (Process Water Ditch System) SSA-2b (Sand Creek Lateral), WSA-1f (Isolated Detections), and WSA-6a (Motor Pool Ditch). Two of these sites are continuous reaches of the Sand Creek Lateral in Sections 2 and 35 (Figure 18.0-2). The Sand Creek Lateral is an active drainage ditch that enters RMA at the southern boundary, travels north through Sections 2, 26, and 35, and joins First Creek in Section 25. It serves as part of the RMA stormwater management system; flows are intermittent and include runoff from the South Plants Central Processing Area during storm events and snowmelt. Three of these sites are ditches that carried water to and from the secondary basins and drained the South Plants processing area (Figure 18.0-2).

Soil samples collected along these channel sites indicate that COCs are present in the sediments through most of Section 2 and in isolated areas in Section 35. Table 18.4-1 provides a summary of contaminants, concentrations, and exceedance values for this subgroup, and Table 18.4-2 summarizes the frequency of detections for contaminants above the Human Health SEC

(EBASCO 1994a) and at levels that may pose potential risk to biota. Maximum concentrations of OCPs, CLC2A, and ICP metals exceed the Human Health SEC (EBASCO 1994a). Human Health COCs extend to a depth of approximately 5 ft, with the highest contaminant concentrations detected in the upper 2 ft of the soil profile. Soil containing OCPs that may pose potential risk to biota is present through most of the Sand Creek Lateral sites in Section 2 and Section 35 (Figure 18.4-1).

Site NCSA-5c, the northern section of the Sand Creek Lateral, has been suggested as the source of two groundwater contaminant plumes (EBASCO 1992a). The two Sand Creek Lateral Plumes occur in the unconfined aquifer and follow a buried paleochannel northwest into Section 27, where they merge with the Basin A Neck Plume. Sites NCSA-1c and NCSA-5b have been tentatively identified as contributors to the Basin A Neck Plume, which originates in Section 36. The plume occurs in the unconfined aquifer and follows a buried paleochannel northwest into Section 26 (EBASCO 1992a). Both the Sand Creek Lateral Plumes and the Basin A Neck Plume are currently intercepted by the Northwest Boundary Containment System (NWBCS). Although excavation and capping of the contaminated sediments in the Sand Creek Lateral may reduce or remove potential sources to the plumes, it is unlikely the NWBCS could be shut down once soil remedial objectives were completed since the system captures contaminants from additional sources. Coordination of soil alternatives with water alternatives for the Northwest Boundary Plume Group is required for alternatives involving excavation and capping.

Site WSA-6a has been tentatively identified as a contributor of VOCs to the Motor Pool Plume that originates in Section 4. The Motor Pool Plume is intercepted by the Motor Pool IRA and treated at the Irondale Containment System. Groundwater alternatives for the Motor Pool Plume are not affected by remediation alternatives for the Sand Creek Lateral Subgroup.

Three structures are located in site WSA-6a. Therefore, coordination of alternatives developed for the structures medium with those developed for the soil medium is required. The excavation of the ditch requires the demolition of these structures and the removal of structural debris to allow access to subsurface soil.

The habitat within the Sand Creek Lateral Subgroup varies from weedy forbs to native grasses. However, the vegetation in the lateral is burned annually to improve surface-water flow, which reduces the quality of the habitat. Alternatives developed for this subgroup involve revegetation the disturbed areas with native grasses in accordance with a refuge management plan. As such, the habitat quality is improved for most alternatives.

18.5 SAND CREEK LATERAL SUBGROUP EVALUATION OF ALTERNATIVES

The five alternatives for the Sand Creek Lateral Subgroup vary in approach from no action to treatment. Three of the alternatives retained from the DSA for this medium group as a whole were not applied to the Sand Creek Lateral Subgroup. Alternative 2: Access Restrictions was not evaluated for this subgroup because access restriction and biota controls are impractical and ineffective when applied to a linear stream channel or ditch site; Alternative 10: Direct Solidification/Stabilization was not evaluated because the primary COCs are organics, which are not amenable to solidification; and Alternative 19: In Situ Thermal Treatment was not evaluated because the technology cannot be implemented in an active drainage ditch. The following subsections present a description of each alternative considered for the subgroup and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a). The alternatives for this subgroup consist of an alternative to address human health exceedances (which is listed first) and an alternative to address areas of biota exceedance (the "B" alternative).

18.5.1 Alternative 1/B1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA), paired with Alternative B1: No Additional Action (Provisions of FFA), applies to all 300,000 SY of soil with human health exceedances and soil that may pose potential risk to biota for the Sand Creek Lateral Subgroup. No action is taken to reduce human or biota exposures to the contaminants and there is no impact on existing habitat. Contaminants remain in place and are accessible in surface soil, which may result in possible exposure or in the leaching of contamination to groundwater or surface water. Long-term monitoring of untreated soil is required. Soil at the sites is monitored (approximately 36 samples for the subgroup per year), annual groundwater sampling is performed, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.5-1 summarizes the evaluation of all alternatives for this subgroup.

18.5.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve RAOs as untreated soil remains if no controls are implemented. Groundwater and surface-water impacts are not reduced, and the only long-term reduction in toxicity of contaminants is through natural attenuation/degradation.

18.5.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the subgroup is not located in wetlands or a 100-year flood plain. In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

18.5.1.3 Long-Term Effectiveness and Permanence

There are moderate residual risks associated with this alternative. OCPs, ICP metals, and CLC2A that exceed the Human Health SEC (EBASCO 1994a) and contaminants that may pose potential risk to biota remain in the soil. No controls are implemented; however, site reviews, soil monitoring, groundwater monitoring, and surface-water monitoring are required. The existing habitat is not impacted by this alternative.

18.5.1.4 Reduction in TMV

There is no reduction in TMV other than by natural attenuation. Treatment residuals are not generated since no materials are treated or contained. A total of 100,000 BCY of untreated soil remains.

18.5.1.5 Short-Term Effectiveness

The time frame until RAOs are achieved is greater than 30 years because natural attenuation/degradation is the only process by which contaminants are reduced. The alternative is protective of workers and the community during remedial actions since no actions are taken. The existing habitat is not affected.

18.5.1.6 Implementability

The alternative is technically and administratively feasible. Monitoring services are available.

18.5.1.7 Cost

The total present worth cost is $4,090,000 and includes only long-term operations and maintenance costs associated with long-term monitoring and site reviews. Table B4.17-1 details the costing for this alternative. The cost uncertainty associated with monitoring and site reviews is low.

18.5.2 Alternative 3/B3: Landfill

Alternative 3: Landfill (On-Post Landfill), paired with Alternative B3: Landfill (On-Post Landfill), addresses 100,000 BCY of contaminated soil. The soil is excavated and placed in the centralized, on-site hazardous waste landfill (Section 4.6.6). Construction of one landfill cell and support facilities takes 1 year. After placement of waste, a cover and fence are installed and the cover is revegetated. The landfill cell requires long-term maintenance of the cover, leachate collection and treatment, and monitoring of potential leachate migration. The borrow area for this fill is located on site. The uppermost 6 inches of soil at the backfilled excavations are supplemented with conditioners and revegetated with native grasses. The borrow area is also recontoured and revegetated to restore habitat. Implementation of this alternative reduces the potential for groundwater and surface-water contamination for the Sand Creek Lateral.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.5-1 summarizes the evaluation of all alternatives for this subgroup.

18.5.2.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through containment of contaminated soil in an on-post landfill. Removal of the contaminated soil interrupts exposure pathways and prevents the contamination of groundwater and surface water. Short-term impacts are associated with excavation of contaminated soil.

18.5.2.2 Compliance with ARARs

This alternative complies with action-specific ARARs and includes state regulations on landfill siting, design, and operation and potential impacts on endangered species. The subgroup and the landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

18.5.2.3 Long-Term Effectiveness and Permanence

The residual risk for the 100,000 BCY of untreated soil removed and contained in the landfill is minimal. There is high confidence in the engineering controls for the landfill, and there are no expected difficulties associated with landfill maintenance. Landfill-cell monitoring is required and the controls are felt to be adequate. Habitat at the site is improved by revegetation; however, habitat at the landfill is eliminated.

18.5.2.4 Reduction in TMV

Although no materials are treated, pathways of exposure are interrupted and mobility of 100,000 BCY of contaminants is reduced through containment in the landfill. Mobility reduction is reversible only if the event landfill should fail. There are no treatment residuals associated with this alternative.

18.5.2.5 Short-Term Effectiveness

This alternative entails moderate short-term risks associated with excavation, transportation, and landfilling of contaminated soil. Personal protective equipment adequately protects workers during excavation and transportation. In addition, fugitive dust is controlled through water sprays, and vapor emissions are not anticipated. There are minimal impacts to the environment since the vegetation in the lateral is normally controlled on an annual basis. Migration of the contaminants to the groundwater are reduced. The time frame until RAOs are achieved is 2 years. Excavation of the 100,000 BCY is feasible within 1 year after 1 year for the construction of the landfill.

18.5.2.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter with periodic landfill-cell monitoring. Additional remedial actions would require removal of landfill cover. The alternative is administratively feasible since the substantive requirements associated with Subtitle C landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill, and landfill technology are well demonstrated at full scale.

18.5.2.7 Cost

The total present worth cost is $6,680,000 including $2,860,000, $3,750,000, and $77,000 for capital, operating, and long-term costs, respectively. Table B4.17-3 details the costing for this alternative. The excavation of contaminated soil entails a cost uncertainty relative to identifying the extent and depth of contamination; however, the magnitude of uncertainty is small based on the small volume of soil involved, the shallow depth of the excavation, and the well-defined ditch areas.

18.5.3 Alternative 3f/B5a: Landfill; Caps/Covers with Consolidation

Alternative 3f: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap) with Consolidation, along with Alternative B5a: Caps/Covers with Consolidation, addresses 15,000 BCY of soil with human health exceedances and 90,000 BCY of soil that potentially poses risk to biota. The human health exceedance soil is placed in a centralized on-post hazardous waste landfill (Section 4.6.6), while the less contaminated soil that poses a risk to biota is consolidated as gradefill in Basin A prior to containment with a multilayer cap (Section 4.6.14 discusses multilayer caps in detail).

Construction of the first cell of the multiple-cell landfill and associated facilities takes 1 year. The landfill area is revegetated following installation of the cover and fencing. The landfill requires annual monitoring, long-term cover maintenance, leachate collection and treatment, and groundwater monitoring. As discussed in Section 10.2.3, the containment of Basin A requires a large amount of gradefill (2,500,000 BCY) to achieve the design grade of 3 to 5 percent. Excavating soil from areas with low levels of contamination and consolidating the soil in areas of higher contamination, such as Basin A, helps meet the requirement for gradefill to achieve a cap design of 3 to 5 percent while reducing the overall impact of the large borrow area at RMA (compared to a landfilling alternative).

The site excavations within the Sand Creek Lateral subgroup are backfilled with clean borrow material from the on-post borrow area and the uppermost 6 inches of soil are supplemented with conditioners to promote the growth of vegetation. Site remediation is completed by revegetation with native grasses. The borrow area is also recontoured and revegetated. No maintenance activities are required at the site because all of the soil that exceeds the Human Health SEC (EBASCO 1994a) or that potentially poses risk to biota is removed.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.5-1 summarizes the evaluation of all of the alternatives for this subgroup.

18.5.3.1 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment. RAOs are achieved because contaminated soil is excavated and contained. The impacts to groundwater and surface water are greatly reduced by removing the contaminated soil from the Sand Creek Lateral sites. There are short-term risks associated with excavating contaminated soil.

18.5.3.2 Compliance With ARARs

This alternative complies with action-specific ARARs that apply to state regulations on landfill siting, design, and operation, the construction of covers, and the monitoring of contained material. The Sand Creek Lateral Group, Basin A, and the landfill are not located within wetlands or a 100-year flood plain, thus complying with location-specific ARARs as well. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). Consolidation to Basin A does not trigger LDRs since the sites in this medium group are either located within the on-post AOC (as defined in Section 1.4), or they do not contain hazardous waste (based on historical records and TCLP results). Materials within the consolidation volume may be landfilled based on visual observations such as soil stains, barrels, or newly discovered evidence of contamination; this landfill volume will be part of the 150,000-CY contingent volume. The alternative also complies with provisions of the FFA (EPA et al. 1989) and regulations pertaining to endangered species protection. ARARs are listed in Appendix A of the Technology Descriptions Volume.

18.5.3.3 Long-Term Effectiveness and Permanence

Soil that exceeds the Human Health SEC (EBASCO 1994a) or potentially poses risk to biota is removed from the site, so residual risk at the site is minimal. Long-term groundwater monitoring and site reviews are required as part of the consolidation alternative in Basin A, but the controls are adequate and there is high confidence in the design and controls for the cap. There is high confidence in the engineering controls for the landfill and there are no expected difficulties associated with landfill maintenance, although landfill-cell monitoring is required. Habitat quality at the site is improved by revegetation, offsetting losses from excavation.

18.5.3.4 Reduction in TMV

Mobility is reduced for 100,000 BCY by containment in the landfill and consolidation and containment in Basin A. Mobility reduction is irreversible so long as the integrity of the landfill and the Basin A cap are maintained. Because no materials are treated, the toxicity and volume are reduced only by natural attenuation. There are no treatment residuals because there is no treatment.

18.5.3.5 Short-Term Effectiveness

This alternative entails moderate short-term risk to workers and the community during the excavation, transportation, and consolidation of contaminated soil. These risks are mitigated by personal protective equipment for workers and water sprays to control fugitive dust. Vapor emissions are not anticipated. The time frame until RAOs are achieved is 2 years, including the 1 year required to move the contaminated soil to Basin A and the landfill following the 1 year required for the construction of the landfill.

18.5.3.6 Implementability

This alternative is technically feasible and has been well demonstrated at full scale. The alternative can be implemented within the required time frame and reliably maintained thereafter. Additional remedial actions are easily undertaken, but the cap adds to the overall site volume in Basin A. The alternative is administratively feasible because it meets the design requirements and construction regulations. Materials, specialists, and equipment are readily available.

18.5.3.7 Costs

The total estimated present worth cost of this alternative is $3,510,000 consisting of $390,000, $3,110,000, and $11,000 of capital, operating, and long-term O&M costs, respectively. Table B4.4-6e details the costing for this alternative.

18.5.4 Alternative 6/B5: Caps/Covers

Alternative 6: Caps/Covers (Multilayer Cap), paired with Alternative B5: Caps/Covers (Multilayer Cap), addresses containment of 300,000 SY of soil with a low-permeability soil cap for the Sand Creek Lateral Subgroup. Exposure pathways, both human and biota, are interrupted through the installation of a multilayer cap (300,000 SY in area) with a biota-barrier layer as described in Section 4.6.14. Prior to cap installation, the existing vegetation is cleared and the subsurface is compacted to minimize variations in the subgrade. Once the 2-ft-thick layer of compacted, low-permeability soil is installed, a 1-ft-thick biota barrier of crushed concrete and a 4-ft soil/vegetation layer, which includes 6 inches of reconditioned soil revegetated with native grasses, are installed. Materials for the cap are excavated from an on-post borrow area. The borrow area is also recontoured and revegetated to restore habitat. Based on the existing grade of the sites, 290,000 BCY of gradefill are required to achieve the design grade of 3 to 5 percent. This alternative is readily implemented, but the cap requires long-term management and maintenance of the vegetative cover for the alternative to remain effective. In addition, the active drainage ditches would have to be replaced. Five-year site reviews are performed and annual groundwater sampling is required.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.5-1 summarizes the evaluation of all alternatives for this subgroup.

18.5.4.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs. Human and biota exposure pathways are interrupted by installation of a multilayer cap. Impacts to groundwater and surface water are reduced through containment. The short-term impacts are minimal since intrusive activities are not conducted in contaminated areas. However, drainage ditches will have to be constructed in other areas of RMA to manage the runoff that had previously been controlled by the ditches.

18.5.4.2 Compliance with ARARs

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of the contained material. Location-specific ARARs are met as the subgroup is not located within a 100-year flood plain or wetlands. This alternative complies with the provisions of the FFA (EPA et al. 1989), and does not impact endangered species. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

18.5.4.3 Long-Term Effectiveness and Permanence

The residual risk associated with this alternative is low. Long-term monitoring and site reviews are required for the untreated soil. In addition, erosion-control activities and vegetative-cover maintenance are required. There is high confidence in the engineering controls for the cap, and there are no expected difficulties with maintenance. Habitat quality is restored through revegetation; however, the types of vegetation placed at the site and the maintenance activities performed there make the area undesirable as habitat for burrowing animals. In addition, habitat is altered to construct the replacement ditches.

18.5.4.4 Reduction in TMV

The installation of the multilayer cap interrupts exposure pathways and reduces the mobility of 100,000 BCY of contaminants. Reduction of the mobility of contaminants is reversible only if the cap should degrade. There are no treatment residuals associated with this alternative.

18.5.4.5 Short-Term Effectiveness

This alternative entails minimal short-term risks since no intrusive actions are conducted in contaminated soil. Workers are adequately protected by personal protective equipment during installation of the cap. Uncontaminated fugitive dust associated with cap construction is controlled by water sprays, and odor and vapor emissions are not anticipated. Environmental impacts are minimal for cap construction, but borrow areas are disturbed. In addition, other areas of RMA are disturbed to construct replacement ditches. Installation of the existing 300,000-SY multilayer cap is feasible within 1 year, and natural attenuation/degradation of contaminants is ongoing.

18.5.4.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably maintained thereafter, although maintenance of an extremely long, narrow cap over the ditches and lateral will be more costly than normal cap maintenance. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible, and materials, specialists, and equipment are readily available. Multilayer caps are well documented at full scale.

18.5.4.7 Cost

The total present worth cost is $17,200,000, including $14,500,000, and $2,680,000 for operating and long-term costs, respectively. Table B4.17-6 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the cap are available on post and the area to be capped is well defined.

18.5.5 Alternative 13/B3: Direct Thermal Desorption; Direct Solidification/Stabilization

Alternative 13: Direct Thermal Desorption (Direct Heating); Direct Solidification/Stabilization (Cement-Based Solidification), paired with Alternative B3: Landfill (On-Post Landfill), treats 15,000 BCY of soil with human health exceedances by thermal desorption and solidification. The 90,000 BCY of soil that may pose potential risk to biota are excavated and placed in the on-post hazardous waste landfill. (Sections 4.6.24, and 4.6.6 discusses the details of these technologies.)

The 14,000 BCY of human health organic exceedance volume are transported to the thermal desorber for treatment. The soil for this subgroup is classified as dry (i.e., soil moisture content of 10 percent). Based on this moisture content, the thermal desorber has a processing rate of 2,000 BCY/day, a discharge temperature of 300°C, and a total soil residence time of 30 minutes. The thermal desorber takes 1 year to build, and requires an additional year for testing prior to operation. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) The treated soil is returned to the site except for soil with inorganic exceedances, which is transported to the solidification facility for further treatment. Approximately 1 percent of the soil feed (140 BCY) is recovered as particulates from the scrubber blowdown equipment and is placed in the on-post hazardous waste landfill. The treated soil is used as backfill and to cover the solidified soil.

The 1,100 BCY of soil with human health inorganic exceedances are solidified using a portable pug mill capable of treating 1,500 BCY/day (Section 4.6.23). The contaminated soil is treated by adding cement as a binder at a 20 percent weight ratio in order to immobilize inorganics exceedances in the soil. During excavation and solidification, the total volume of contaminated soil increases by approximately 38 percent, which results in a total volume of 1,500 BCY. The solidified soil is backfilled in the site excavations. The soil is then covered with a minimum of 4 ft of thermally treated soil to ensure the integrity of the solidified materials and prevent freeze/thaw degradation. Since thermal desorption destroys the natural organic content of the treated soil, the uppermost 6 inches of soil are supplemented with conditioners and revegetated with native grasses to improve habitat quality. Long-term maintenance of the cover and monitoring of the solidified soil is required.

The remaining 90,000 BCY of soil that may pose a potential risk to biota are excavated and placed in a centralized on-post hazardous waste landfill (Section 4.6.6). Construction of the first cell of the multiple-cell landfill and associated facilities takes 1 year. The landfill area is revegetated following installation of the cover and fencing. The landfill cell requires annual monitoring, long-term maintenance of the landfill cover, leachate collection and treatment, and groundwater monitoring. The excavations at the sites are backfilled to existing grade with soil from an on-post borrow area. The uppermost 6 inches of the backfilled areas are supplemented with conditioners and revegetated with native grasses, and the borrow area is also recontoured and revegetated to restore habitat. However, fencing at the landfill excludes biota from that area.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 18.5-1 summarizes the evaluation of all alternatives for this subgroup.

18.5.5.1 Overall Protection of Human Health and the Environment

This alternative achieves RAOs through treatment and containment. Exposure pathways are interrupted through thermal desorption and solidification of contaminated soil and through landfilling of 90,000 BCY of soil that poses risk to biota. Blowdown solids are placed in an on-post landfill. Groundwater and surface-water impacts are also reduced, but short-term impacts are associated with excavation.

18.5.5.1 Compliance with ARARS

This alternative complies with action specific ARARs including state regulations on air emissions sources and landfill siting, design, and operation. Solidified soil is monitored. Endangered species are not impacted. Sand Creek Lateral Subgroup, the treatment facilities, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs.

Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989). (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

18.5.5.2 Long-Term Effectiveness and Permanence

The residual risk is minimal since soil is treated or landfilled. The 14,000 BCY of organic exceedance volume are thermally desorbed to achieve PRGs and returned to the site as backfill, and 1,100 BCY of inorganic exceedance volume are solidified and returned to the site. Approximately 1 percent of soil feed recovered from off-gas treatment equipment is placed in an on-post landfill. The residual risk for 90,000 BCY of soil removed and contained in a landfill is low. Long-term monitoring is required for solidified soil. There is high confidence in engineering controls associated with the landfill and the clay/soil cap, and there are no expected difficulties associated with maintenance. Revegetation of disturbed areas improves habitat, offsetting losses incurred during excavation.

18.5.5.3 Reduction in TMV

The 14,000 BCY are thermally desorbed to degrade organic contamination and remove mercury. Human and biota exposure pathways are interrupted, and mobility of contaminants is reduced by solidification of 1,100 BCY of soil with inorganic contaminants. Organics are reduced to detection levels or >99.99 percent DRE, and the TMV of organics is eliminated. Arsenic and ICP metals are solidified, thereby interrupting exposure pathways and reducing mobility of contamination. Scrubber blowdown solids and salts from off-gas treatment equipment are placed in an on-post landfill. TMV reduction by thermal desorption is irreversible. Mobility reduction by solidification is irreversible if the integrity of solidified materials is maintained. The exposure pathways and mobility of contaminants are reduced for the landfilled soil (90,000 BCY), and these reductions are irreversible so long as the integrity of the landfill is maintained.

18.5.5.4 Short-Term Effectiveness

This alternative entails short-term risks associated with excavation, transportation, treatment, and landfilling of contaminated soil. Personal protective equipment adequately protects workers during excavation, transportation, and treatment operations. Fugitive dust is controlled by water sprays, and vapors and odors are not anticipated. The short-term risks associated with materials handling prior to thermal desorption are addressed by conducting the activities in an enclosed building to control dust. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards, low but acceptable levels of contaminants are in the emissions. Environmental impacts of the remedial actions are minimal since the vegetation in the lateral is normally controlled on an annual basis. Migration of the contaminants to groundwater is reduced. The time frame until RAOs are achieved is 3 years. Excavation and treatment of 15,000 BCY is feasible within 1 year after 2 years for construction of the thermal desorption facility, and landfilling of 90,000 BCY is feasible within 2 years, including 1 year for construction of the landfill.

18.5.5.5 Implementability

Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame and should be reliably operated for the contaminants and levels of contamination in the soil feed. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to the poor perceptions regarding the safety of thermal treatment. Solidification is a widely available and proven technology. Solidified soil is monitored to ensure integrity. The landfilling portion of this alternative is technically and administratively feasible. Landfilling can be implemented within the required time frame and reliably operated and maintained with periodic landfill-cell monitoring and maintenance.

18.5.5.6 Cost

The total present worth cost is $6,960,000 including $2,660,000, $4,180,000, and $127,000 for capital, operating, and long-term costs, respectively. Table B4.17-13 details the costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination are difficult to estimate and so increase uncertainties relative to excavation costs. Second, the need for materials handling increases uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. The operating conditions may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs. However, the magnitude of the cost uncertainty is relatively small based on the small volume of soil treated and the shallow depth of the excavation.

18.6 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Sand Creek Lateral Subgroup contains 100,000 BCY of exceedance soil primarily contaminated with OCPs, CLC2A, and ICP metals. This subgroup contains ditches contaminated by wastewater and runoff from site facilities and waste disposal basins. Approximately 2 percent of the samples for the subgroup exceed the Human Health SEC (EBASCO 1994a) for OCPs and 4 percent of the samples exceed the Human Health SEC (EBASCO 1994a) for CLC2A (Table 18.4-2). In general, the average concentrations of COCs in the human health exceedance volume are less than the Human Health SEC (EBASCO 1994a), indicating a relatively low human health risk. There are no principal threat exceedances, but the ditches have been identified as sources or contributors to groundwater contamination plumes.

Habitat in the subgroup varies from natural grasses to weedy forbs The vegetation found in the Sand Creek Lateral sites is burned every year to increase surface-water flow, which reduces the quality of the habitat. Areas disturbed during remediation are to be revegetated to restore and improve habitat value.

Alternatives that involve excavation of human health exceedances require protection for site workers, but the short-term risk to workers is minimal with the use of proper personal protective equipment. The degree of contamination in sites in this subgroup does not necessitate special measures for odor control or community protection during remediation.

In summary, the Sand Creek Lateral Subgroup contains low levels of contamination that pose potential risk to biota, and in limited areas, also exceed the Human Health SEC (EBASCO 1994a). Habitat impacts and community protection are not deciding factors for consideration in selecting the preferred alternative for this subgroup.

Alternative 1: No Additional Action does not achieve RAOs and is not protective of human health and the environment. It was therefore eliminated from further consideration. The remaining four alternatives achieve RAOs and meet the two DAA threshold criteria: protection of human health and the environment and compliance with action- and location-specific ARARs for the DAA. Thus, the alternatives are distinguished by how well they satisfy the balancing criteria.

Alternative 3: Landfill and Alternative 3f: Landfill; Caps/Covers with Consolidation both achieve RAOs through excavation and containment elsewhere on RMA. The short-term impacts associated with excavation are adequately addressed, and the residual risks are minimal. The consolidation of contaminated soil in Basin A entails a lower cost than landfilling and reduces the volume of gradefill required for Basin A. Both of these alternatives are considered cost-effective and were retained for development of sitewide alternatives.

Alternative 6: Caps/Covers achieves RAOs through containment in place. Although the capped area is revegetated to restore habitat, the types of vegetation placed at the area and the maintenance activities performed there make the area undesirable as habitat for burrowing animals. This alternative also entails leaving untreated soil in place within the 100-year flood plain, although engineering controls direct surface-water runoff. Because the cap for the sites in this subgroup could potentially be integrated with caps proposed for other proximate sites, this alternative was retained for further consideration, despite its high cost ($17,200,000).

Alternative 13: Direct Thermal Desorption; Direct Solidification/Stabilization achieves RAOs through treatment and containment. However, this alternative is more costly, \$6,970,000, than the consolidation or landfilling alternatives and does not provide less long-term risk than these alternatives. Therefore, this alternative is not considered cost effective and was not retained for consideration in the development of sitewide alternatives.

Consequently, the alternatives that were retained to represent the Sand Creek Lateral Subgroup in the development sitewide alternatives (Section 20) are the following:

- Alternative 3: Landfill (On-Post Landfill)
- Alternative 3f: Landfill (On-Post Landfill); Caps/Cover (Multilayer Cap) with Consolidation
- Alternative 6: Caps/Covers (Multilayer Cap)

It should be noted that the selection of containment alternatives is consistent with NCP guidance (EPA 1990a) regarding the use of engineering controls (containment) for low levels of contamination.

Characteristic	Buried Sediments	Sand Creek Lateral
<u>Contaminants of Concern</u>		
Human Health	OCPs	CLC2A, OCPs, Cr
Biota	OCPs, Hg	OCPs, As, Hg
<u>Exceedance Area (SY)</u>		
Total	7,900	300,000
Human Health	7,900	34,000
Biota	0	270,000
Potential Agent	Not applicable	Not applicable
Potential UXO	Not applicable	Not applicable
<u>Exceedance Volume (BCY)</u>		
Total	16,000	100,000
Human Health	16,000	15,000
Organic	16,000	14,000
Inorganic	0	1,100
Principal Threat	0	0
Biota	0	90,000
Potential Agent	Not applicable	Not applicable
Potential UXO	Not applicable	Not applicable
<u>Depth of Contamination (ft)</u>		
Human Health	4–10	0–5, mostly 0–1
Biota	Not Applicable	0–1

Table 18.1-1 Summary of Concentrations for the Buried Sediments Subgroup

Contaminants of Concern	Range of Concentrations[1] (ppm)	Average Concentration[1] (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Dieldrin	26.1–53	40	41	410	3.7
Chlordane	BCRL–8.9	0.8	55	3,700	12
Biota Volume					
Aldrin	BCRL–52	3.7	56		
Dieldrin	BCRL–39	5.7	40		
Endrin	BCRL–2.7	0.22	15		
p,p,DDE	BCRL–0.51	0.012	130		
p,p,DDT	BCRL–0.70	0.034	26		
Mercury	BCRL–2.2	0.31	470		

1 Based on modeled concentrations within the human health exceedance volume or potential biota risk area.

Table 18.1-2 Frequency of Detections for Buried Sediments Subgroup

	Total Samples	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
	Analyzed	Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	359	271	75.5%	88	24.5%	0	0.0%	0	0.0%	0	0.0%
Benzene	11	11	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	11	11	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlordane	191	154	80.6%	37	19.4%	0	0.0%	0	0.0%	0	0.0%
Chloroacetic Acid	0	0	--	0	--	--	--	0	--	0	--
Chlorobenzene	11	11	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chloroform	11	11	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
p,p,DDE	196	153	78.1%	43	21.9%	--	--	0	0.0%	0	0.0%
p,p,DDT	198	159	80.3%	39	19.7%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	137	136	99.3%	1	0.7%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	11	11	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	7	7	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	77	77	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dieldrin	353	235	66.6%	112	31.7%	0	0.0%	6	1.7%	0	0.0%
Endrin	372	322	86.6%	50	13.4%	0	0.0%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	194	189	97.4%	5	2.6%	--	--	0	0.0%	0	0.0%
Isodrin	192	167	87.0%	25	13.0%	--	--	0	0.0%	0	0.0%
Methylene Chloride	4	4	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	0	0	--	0	--	--	--	0	--	0	--
Tetrachloroethylene	11	11	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Toluene	4	4	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Trichloroethylene	11	11	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Arsenic	124	109	87.9%	15	12.1%	0	0.0%	0	0.0%	0	0.0%
Cadmium	124	123	99.2%	1	0.8%	0	0.0%	0	0.0%	0	0.0%
Chromium	124	34	27.4%	90	72.6%	--	--	0	0.0%	0	0.0%
Lead	124	74	59.7%	50	40.3%	--	--	0	0.0%	0	0.0%
Mercury	396	274	69.2%	122	30.8%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.

(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.

-- not applicable

Table 18.2-1 Comparative Analysis of Alternatives for the Buried Sediments Subgroup

Criteria	Alternative 1: No Additional Action	Alternative 2: Access Restrictions	Alternative 3: Landfill	Alternative 6: Caps/Covers
1. Overall protection of human health and the environment	Does not achieve RAOs	Protective: achieves RAOs and interrupts exposure pathways through access restrictions	Protective: RAOs achieved through removal and containment	Protective: RAOs achieved through in-place containment
2. Compliance with ARARs	Complies	Does not comply with location ARARs	Complies	Complies
3. Long-term effectiveness and permanence	Low Residual Risk: Low concentrations below soil cover	Low Residual Risk: Low concentrations and exposure pathways interrupted; habitat eliminated	Minimal Residual Risk: Contaminated soil removed from the site and landfilled	Minimal Residual Risk: Contaminated soil contained
4. Reduction in TMV	Natural attenuation only for 16,000 BCY	Natural attenuation only for 16,000 BCY	Exposure pathways and mobility reduced for all 16,000 BCY through containment	Exposure pathways and mobility reduced for all 16,000 BCY through in-place containment
5. Short-term effectiveness	No implementation required; RAOs not achieved within 30 years	Minimal short-term risk during limited activity adequately mitigated; RAOs achieved in 1 year	Minimal short-term risk associated with excavation and transport of contaminated soil; adequately mitigated; RAOs achieved in 2 years	Minimal short-term risk: no intrusive activity; RAOs achieved in 1 year
6. Implementability	Feasible: No implementation required	Feasible	Feasible	Feasible
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$639,000 Total—$639,000	Capital—$45,000 Operating—$21,000 Long-term—$602,000 Total—$667,000	Capital—$416,000 Operating—$532,000 Long-term—$11,000 Total—$960,000	Capital—$0 Operating—$361,000 Long-term—$289,000 Total—$651,000
Summary	Not Retained: Not protective of human health and the environment	Not Retained: No significant risk reduction and habitat eliminated; less protective	Retained: Containment provides protection; cost effective	Retained: Containment provides in place protection at low cost

Table 18.2-1 Comparative Analysis of Alternatives for the Buried Sediments Subgroup

Criteria	Alternative 13a: Direct Thermal Desorption	Alternative 19a: In Situ Thermal Treatment
1. Overall protection of human health and the environment	Protective: Achieves RAOs through treatment and containment	Not Protective: In situ treatment does not achieve PRGs or RAOs
2. Compliance with ARARs	Complies	Complies
3. Long-term effectiveness and permanence	Minimal Residual Risk: PRGs achieved for 16,000 BCY treated	Low Residual Risk: Human health exceedance treated although PRGs not achieved
4. Reduction in TMV	TMV eliminated for 16,000 BCY	TMV reduced by treatment but not eliminated
5. Short-term effectiveness	Short-term risk associated with excavation, transport, and treatment of contaminated soil; adequately mitigated; RAOs achieved in 3 years	Short-term risk associated with in situ treatment; RAOs not achieved
6. Implementability	Technically Feasible: Administrative difficulty associated with thermal desorption	Not Currently Implementable: In situ thermal treatment not proven at full scale
7. Present worth costs	Capital—$472,000 Operating—$1,360,000 Long-term—$100 Total—$1,830,000	Capital—$13,300,000 Operating—$4,930,000 Long-term—$0 Total—$18,200,000
Summary	Not Retained: Higher cost for treatment without reducing risk compared to containment	Not Retained: Not currently implementable and high cost at higher long-term risk than containment

Table 18.4-1 Summary of Concentrations for the Sand Creek Lateral Subgroup

Contaminants of Concern	Range of Concentrations[1] (ppm)	Average Concentration[1] (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL-400	27.8	71	720	3.8
Dieldrin	BCRL-140	18.5	41	410	3.7
Isodrin	BCRL-4.0	0.24	52	52,000	Not applicable
Chlordane	BCRL-9.7	0.42	55	3,700	12
Chloroacetic Acid[1]	230	Not applicable	77	77	3,900
Chromium	BRCL-490	180	39	7,500	2,400
Lead	BCRL-2,000	800	2,200	1,000,000	Not applicable
p,p,DDE[2]	BCRL-4.7	0.04	1,250	12,500	Not applicable
p,p,DDT[2]	BCRL-6.0	1.0	410	13,500	14
Biota Volume					
Aldrin	BCRL-3.7	0.30			
Dieldrin	BCRL-3.6	0.44			
Endrin	BCRL-3.8	0.087			
p,p,DDE	BCRL-4.7	0.095			
p,p,DDT	BCRL-6.0	0.10			
Arsenic	BCRL-190	5.8			
Mercury	BCRL-2.3	0.13			

1 Based on concentrations of contaminants of concern above SEC within the human health exceedance volume, and on concentrations within the potential biota risk area for the biota volume.

2 Presents biota risk only, but was detected in the human health exceedance volume.

Table 18.4-2 Frequency of Detections for Sand Creek Lateral Subgroup

	Total Samples	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
	Analyzed	Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	395	296	74.9%	80	20.3%	14	3.5%	5	1.3%	0	0.0%
Benzene	119	118	99.2%	1	0.8%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	167	166	99.4%	0	0.0%	--	--	1	0.6%	0	0.0%
Chlordane	393	370	94.1%	23	5.9%	0	0.0%	0	0.0%	0	0.0%
Chloroacetic Acid	25	23	92.0%	1	4.0%	--	--	1	4.0%	0	0.0%
Chlorobenzene	167	163	97.6%	4	2.4%	--	--	0	0.0%	0	0.0%
Chloroform	167	164	98.2%	3	1.8%	--	--	0	0.0%	0	0.0%
p,p,DDE	395	351	88.9%	44	11.1%	--	--	0	0.0%	0	0.0%
p,p,DDT	393	337	85.8%	56	14.2%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	391	390	99.7%	1	0.3%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	167	166	99.4%	1	0.6%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	69	68	98.6%	0	0.0%	--	--	1	1.4%	0	0.0%
Dicyclopentadiene	303	303	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dieldrin	395	226	57.2%	133	33.7%	29	7.3%	7	1.8%	0	0.0%
Endrin	397	341	85.9%	56	14.1%	0	0.0%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	379	364	96.0%	15	4.0%	--	--	0	0.0%	0	0.0%
Isodrin	395	358	90.6%	37	9.4%	--	--	0	0.0%	0	0.0%
Methylene Chloride	155	150	96.8%	5	3.2%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	14	14	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	167	166	99.4%	1	0.6%	--	--	0	0.0%	0	0.0%
Toluene	111	109	98.2%	2	1.8%	--	--	0	0.0%	0	0.0%
Trichloroethylene	167	163	97.6%	4	2.4%	--	--	0	0.0%	0	0.0%
Arsenic	373	281	75.3%	92	24.7%	0	0.0%	0	0.0%	0	0.0%
Cadmium	351	307	87.5%	44	12.5%	0	0.0%	0	0.0%	0	0.0%
Chromium	351	74	21.1%	267	76.1%	--	--	10	2.8%	0	0.0%
Lead	351	177	50.4%	174	49.6%	--	--	0	0.0%	0	0.0%
Mercury	342	278	81.3%	64	18.7%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.
(2) Table 1 4-1 presents acute criteria, HH SEC, and principal threat criteria.
-- not applicable

Table 18.5-1 Comparative Analysis of Alternatives for the Sand Creek Lateral Subgroup

Criteria	Alternative 1: No Additional Action	Alternative 3: Landfill	Alternative 3f: Landfill; Caps/Covers with Consolidation
1. Overall protection of human health and the environment	Not Protective: RAOs not achieved; impacts to groundwater and surface water not reduced	Protective: RAOs achieved and impacts to groundwater and surface water reduced through removal and containment	Protective: RAOs achieved and impacts to groundwater and surface water reduced through removal and containment
2. Compliance with ARARs	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Moderate Residual Risk: Low concentrations remain	Minimal Residual Risk: Contaminated soil removed from the site and contained	Minimal Residual Risk: Contaminated soil removed from the site and contained
4. Reduction in TMV	Natural attenuation only for 100,000 BCY	Exposure pathways and mobility reduced for all 100,000 BCY through containment	Exposure pathways and mobility reduced for all 100,000 BCY through containment
5. Short-term effectiveness	No implementation required; RAOs not achieved	Moderate short-term risk associated with excavation and transport of contaminated soil; adequately mitigated; RAOs achieved in 2 years	Moderate short-term risk associated with excavation and transport of contaminated soil; adequately mitigated
6. Implementability	Feasible: No implementation required	Feasible	Feasible
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$4,090,000 Total—$4,090,000	Capital—$2,860,000 Operating—$3,750,000 Long-term—$77,000 Total—$6,380,000	Capital—$390,000 Operating—$3,110,000 Long-term—$11,000 Total—$3,510,000
Summary	Not Retained: Not protective of human health and the environment	Retained: Containment provides protection; cost effective	Retained: Containment provides protection; cost effective

Table 18.5-1 Comparative Analysis of Alternatives for the Sand Creek Lateral Subgroup

Criteria	Alternative 6: Caps/Covers	Alternative 13: Direct Thermal Desorption; Direct Solidification/Stabilization
1. Overall protection of human health and the environment	Protective: RAOs achieved and impacts to groundwater and surface water reduced through in-place containment	Protective: RAOs achieved and groundwater and surface water impacts reduced
2. Compliance with ARARs	Complies	Complies
3. Long-term effectiveness and permanence	Low Residual Risk: Contaminated soil contained in place	Minimal Residual Risk: PRGs achieved at the site through treatment
4. Reduction in TMV	Exposure pathways and mobility reduced for all 100,000 BCY through containment	TMV eliminated for 14,000 BCY thermally desorbed; exposure pathways and mobility reduced for 1,100 BCY solidified, and 90,000 BCY landfilled
5. Short-term effectiveness	Minimal short-term risk; no intrusive activity	Short-term risk during excavation, transport, treatment, and landfilling; adequately mitigated
6. Implementability	Feasible	Technically Feasible: Administrative difficulty associated with thermal desorption
7. Present worth costs	Capital—$0 Operating—$14,500,000 Long-term—$2,680,000 Total—$17,200,000	Capital—$2,660,000 Operating—$4,180,000 Long-term—$127,000 Total—$6,960,000
Summary	Retained: Containment in place provides protection although higher cost than landfilling	Not Retained: High cost for treatment as compared to landfilling; does not reduce residual risk compared to containment

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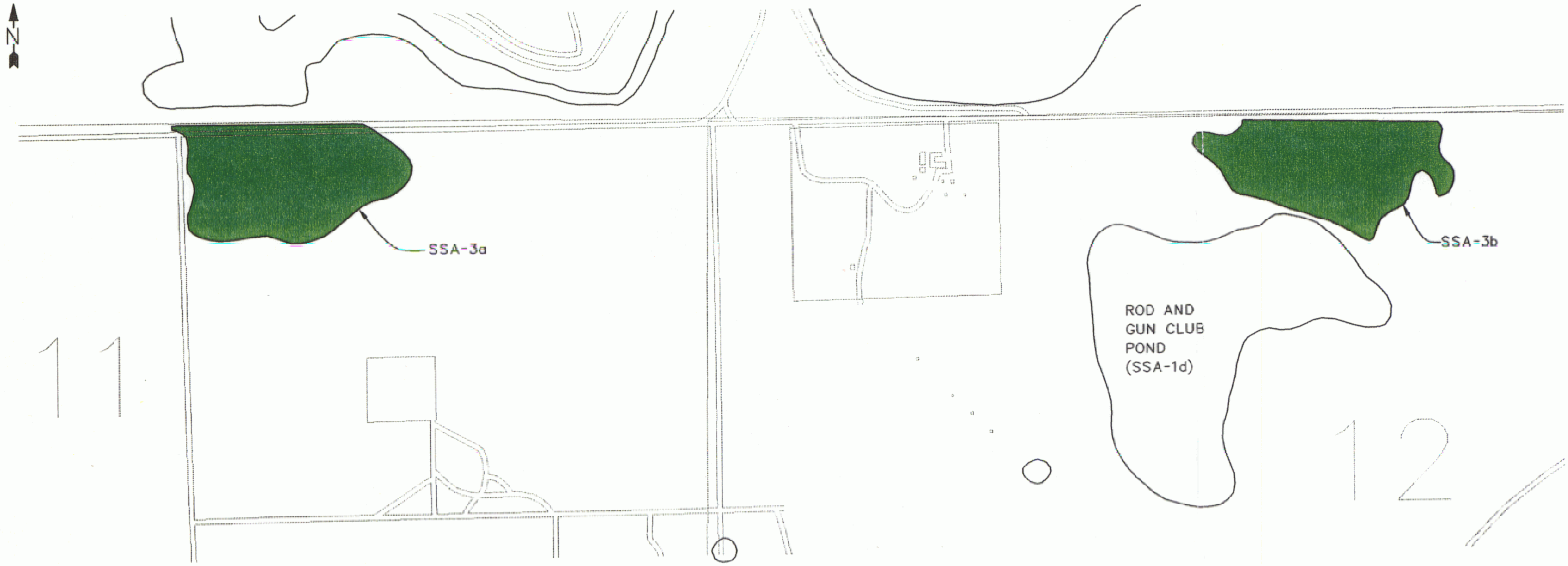
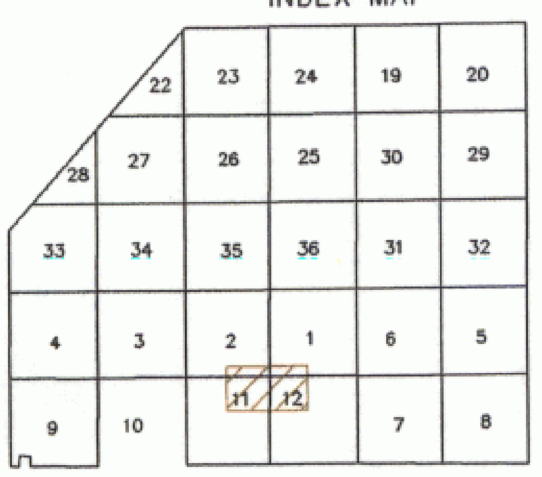


ROCKY MOUNTAIN ARSENAL
INDEX MAP



LEGEND

Buried Sediments Subgroup
SITES: SSA-3a, Lake Ladora Sediments
SSA-3b, Derby Lakes Sediments

Site Boundary

Buildings and Roads

11 Section Number

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 18.0-1

Site Locations
Buried Sediments Subgroup

Rocky Mountain Arsenal.
Prepared by: Ebasco Services Incorporated

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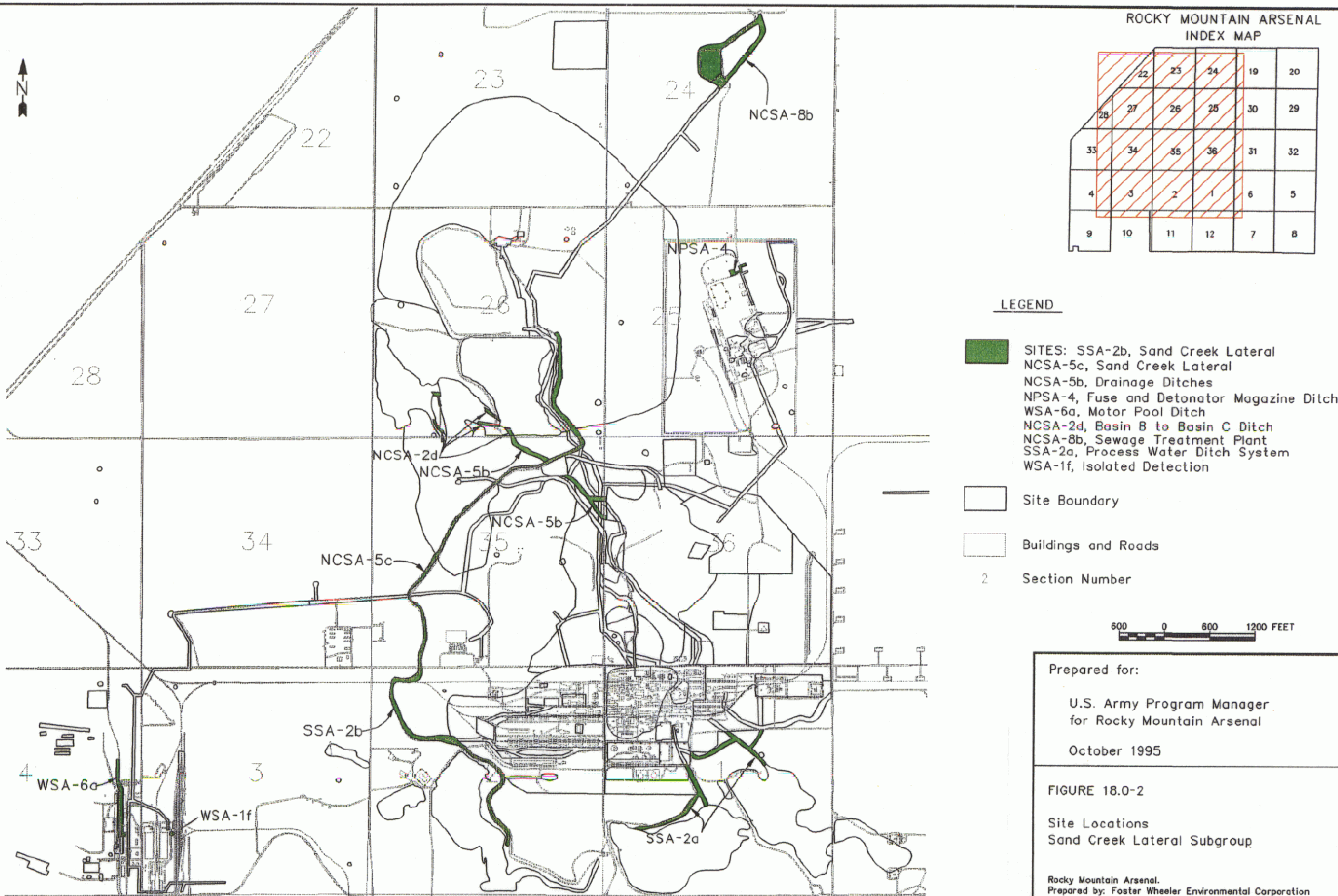

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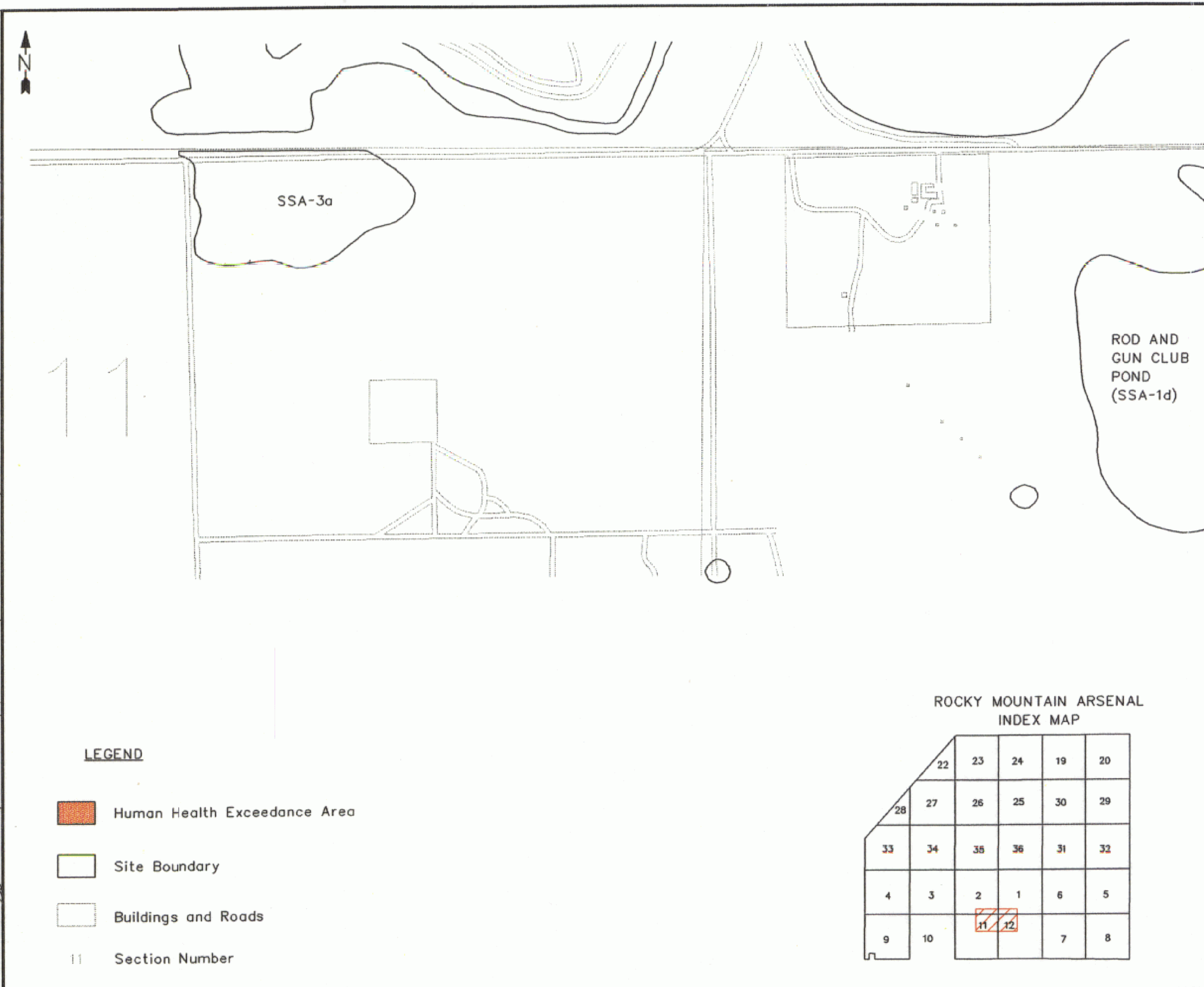
FIGURE 18.0-2

Site Locations
Sand Creek Lateral Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation



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U.S. Army Program Manager
for Rocky Mountain Arsenal

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FIGURE 18.1-1

Exceedance Areas
Buried Sediments Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

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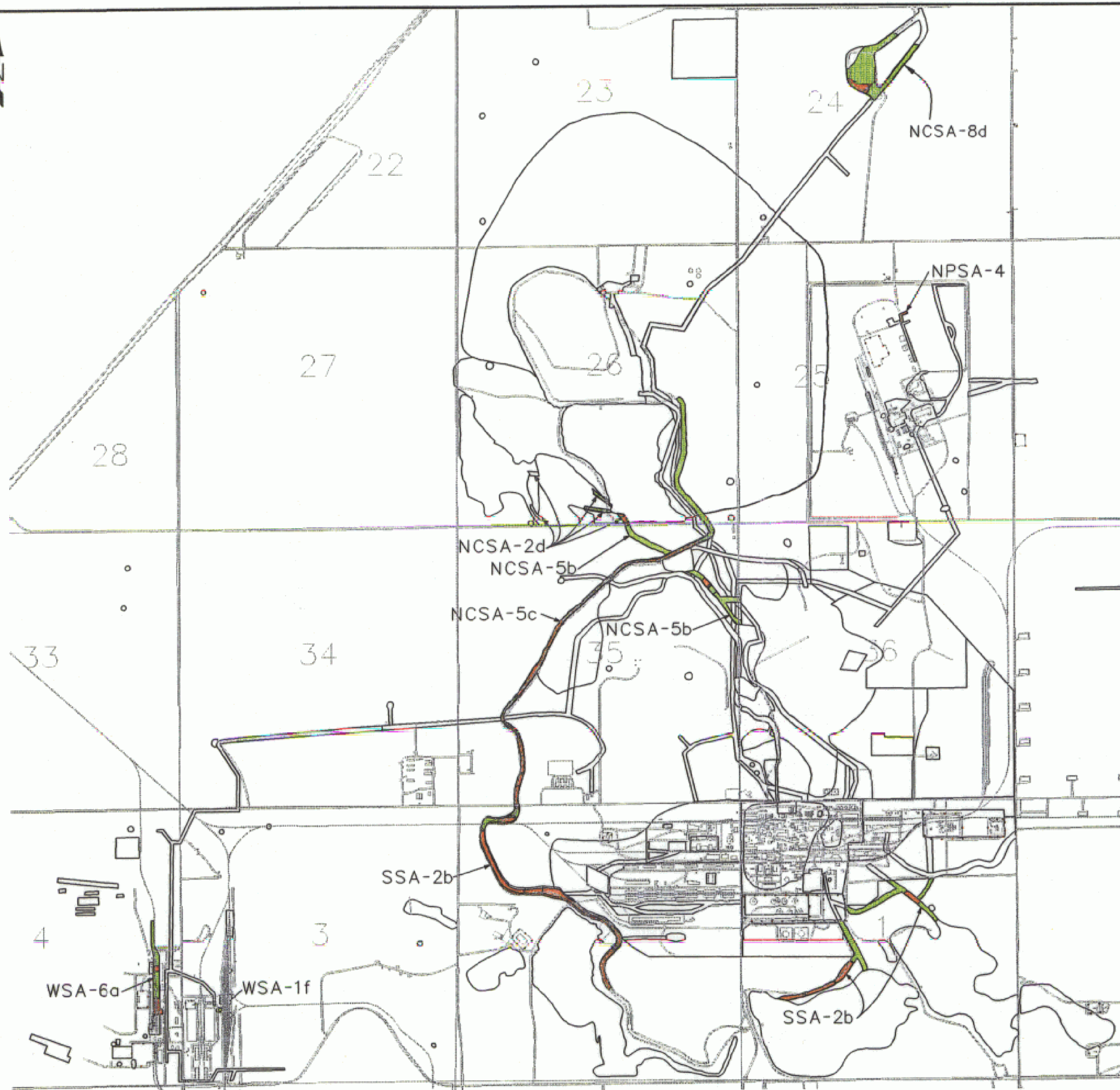

ROCKY MOUNTAIN ARSENAL
INDEX MAP

LEGEND

- Potential Biota Risk Area
- Human Health Exceedance Area
- Site Boundary
- Buildings and Roads
- 2 Section Number

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Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 18.4-1

Exceedance Areas
Sand Creek Lateral Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

FIGURE 18.10-1

Exceedance Areas
Motor Pool Ditch Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

19.0 DETAILED ANALYSIS OF ALTERNATIVES FOR THE UNDIFFERENTIATED MEDIUM GROUP

The Undifferentiated Medium Group consists of six sites with varying site-type characteristics or contamination patterns. These sites are located either in the southeast corner of Section 36 or in the Eastern Study Area and were divided into two subgroups—Section 36 Balance of Areas and Burial Trenches—on the basis of their geographic distribution. Figure 19.0-1 shows the location of the subgroups and their related sites.

The primary COCs in this medium group are OCPs, although CLC2A and ICP metals were also found at concentrations that exceed the Human Health SEC (EBASCO 1994a). Portions of the Undifferentiated Medium Group contain soil that may pose a potential risk to biota. Most sites within this medium group also exhibit the potential for UXO and agent presence. Sites within the Section 36 Balance of Areas Subgroup are also potential sources of groundwater contamination based upon the migration pathways identified in the RISR (EBASCO 1992a). Table 19.0-1 presents the characteristics of this medium group, including exceedance areas and volumes and COCs, and Appendix A of Volume IV of this report presents a summary of volume and area calculations.

In the DSA (EBASCO 1992b), alternatives were developed and screened based on the general characteristics of the medium group, so they do not necessarily apply to each subgroup. The characteristics of the two subgroups—including contaminant types and contaminant concentrations, site configuration, and depth of contamination—were evaluated to determine the subset of applicable alternatives for each subgroup from the range of alternatives retained in the DSA (EBASCO 1992b) for this medium group.

The following sections present the characteristics of each subgroup, an evaluation of the retained alternatives against the DAA criteria listed in the NCP (EPA 1990a), and the selection of alternatives, based on a comparative analysis, that was considered when sitewide alternatives were developed (Section 20).

19.1 SECTION 36 BALANCE OF AREAS SUBGROUP CHARACTERISTICS

The Section 36 Balance of Areas Subgroup consists of sites CSA-1b (Complex Disposal Area South), CSA-2a (Munitions Testing Area), CSA-4 (Balance of Areas Investigated), and NCSA-1g (Balance of Areas) (Figure 19.0-1). Although the contamination at each of these sites varies on a site-specific basis, each of these areas exhibit the potential for UXO or agent presence. The principal threat criteria were not exceeded at any of the sites in this subgroup.

Table 19.1-1 provides a summary of contaminants, concentrations, and exceedance values for this subgroup, and Table 19.1-2 summarizes the frequency of detections of contaminants above the Human Health SEC and that pose potential risk to biota. Maximum concentrations of OCPs and CLC2A exceed the Human Health SEC (EBASCO 1994a) in 79,000 BCY in 0- to 10-ft depth interval. Site CSA-1b contains the majority of the human health exceedances (Figure 19.1-1). Figure 19.1-2 presents the overlap of areas potentially containing agent or UXO with the human health exceedance area and area that may pose risk to biota. As shown in Figure 19.1-1, the majority of the 600,000-SY area posing potential risk to biota is located within site CSA-4.

The area within the Section 36 Balance of Areas Subgroup contains disturbed habitat. The disturbed areas are revegetated with native grasses following remediation, so the overall habitat value is improved through remedial actions. However, the institutional controls alternative results in the removal of 750,000 SY from use as habitat.

Site CSA-1b within the Section 36 Balance of Areas Subgroup has been identified as a contributing source to a groundwater contamination plume. The plume occurs in the unconfined aquifer and is part of the Basin A Plume Group, which follows the Basin A Neck paleochannel to the northwest where it is intercepted and treated by the Basin A Neck IRA treatment system. Groundwater alternatives that address improved performance of the Basin A Neck IRA treatment system or the interception or mass reduction of individual plumes or groups are being evaluated for the Basin A Plume Group. Coordination of alternatives developed for the soil medium with those for the water medium is limited to the excavation or capping of sources. Coordination of alternatives developed for the water medium is also required for those alternatives that include dewatering during excavation. Due to the contaminant mass loading already in the aquifer, it is unlikely that the remediation of the Section 36 Balance of Areas Subgroup will allow the Basin A Neck system or the boundary systems to be shut down.

Site CSA-2a contains several structures included in the Other Contamination History and Agent History Medium Groups in the structures medium. To excavate the contaminated soil that may be present beneath these structures, the structures are demolished and the resulting debris removed from the site.

19.2 SECTION 36 BALANCE OF AREAS SUBGROUP EVALUATION OF ALTERNATIVES

The seven alternatives developed for the Section 36 Balance of Area Subgroup vary in approach from no action to treatment. An additional alternative was developed during the DAA to include the consolidation of contaminated soil into Basin A. In addition, an in situ thermal treatment alternative, Alternative 19a, was added for this subgroup. The treatment alternatives were modified to indicate that inorganics treatment is not required. The following subsections present a description of each alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a). The alternatives for this subgroup consist of a component to address human health exceedance areas (which is listed first), a component to address areas with potential risk to biota (the "B" alternative), and alternatives to address areas with potential agent or UXO presence (the "A" and "U" alternatives, respectively).

19.2.1 Alternative 1/B1/A1/U1: No Additional Action

Alternative 1: No Additional Action (Provisions of FFA), along with Alternative B1: No Additional Action (Provisions of FFA), Alternative A1: No Additional Action (Provisions of FFA), and Alternative U1: No Additional Action (Provisions of FFA), applies to all 750,000 SY of exceedance area in the Section 36 Balance of Areas Subgroup. The soil with human health exceedances, soil that may pose a potential risk to biota, and soil with potential agent and potential UXO remain in place. No action is taken to reduce potential human or biota exposure to COCs, prevent potential physical and acute chemical hazards from agent and UXO, or reduce groundwater contamination. Exceedance areas are monitored (an average of 102 samples per year over the entire exceedance area), annual groundwater monitoring is conducted, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.2-1 summarizes the evaluation for all alternatives in this subgroup.

19.2.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve Human Health or Biota RAOs as controls are not implemented and untreated soil remains in place. Natural attenuation/degradation is the only means by which long-term reduction in toxicity of contaminants is achieved. Groundwater impacts are not reduced.

19.2.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted and the Section 36 Balance of Areas Subgroup is not located in wetlands or a 100-year flood plain. In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). Army Materiel Command regulations regarding control of agent contamination and UXO (AMC-R 385-131) (AMC 1987) are not achieved since potential agent and UXO remain in place without controls. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.2.1.3 Long-Term Effectiveness and Permanence

There is moderate residual risk since the human health exceedance volume and soil that may pose risk to biota remain in place and continue to potentially impact human health and biota. There is also the potential for agent and UXO to be present in the soil. Site reviews and long-term soil and groundwater monitoring are required. The existing habitat is not impacted by this alternative.

19.2.1.4 Reduction in TMV

There is no reduction in TMV except by natural attenuation/degradation. The 280,000 BCY of untreated soil remain. There is also no reduction in hazards due to agent or UXO presence. There are no treatment residuals associated with the alternative.

19.2.1.5 Short-Term Effectiveness

There is no short-term risk to workers and the community during remedial action since no action is taken. In addition, there are no short-term impacts on habitat. However, contaminant migration to groundwater is not reduced. Natural attenuation/degradation is the only process by which contamination is reduced. Soil with potential agent and UXO presence remains on site.

19.2.1.6 Implementability

The alternative is technically and administratively feasible. Soil and groundwater monitoring services are required and readily available.

19.2.1.7 Cost

The total present worth cost is $6,360,000 and includes only long-term operations and maintenance costs associated with long-term monitoring and site reviews. Table B4.18-1 details the costing for this alternative. The cost uncertainty associated with monitoring and site reviews is low.

19.2.2 <u>Alternative 2/B2/A1/U1: Access Restrictions</u>

Alternative 2: Access Restrictions (Modifications to FFA), along with Alternative B2: Biota Management (Exclusion, Habitat Modification), Alternative A1: No Additional Action (Provisions of FFA), and Alternative U1: No Additional Action (Provisions of FFA), applies to the total exceedance area of 750,000 SY in the Section 36 Balance of Areas Subgroup. The 280,000 BCY of soil with human health exceedances, potential risk to biota, and potential agent and UXO presence remain in place, but exposure pathways are interrupted. Human and biota access to the sites is restricted by the installation of a 15,000-ft-long perimeter of chain-link fence posted with warning signs. To prevent inadvertent exposures, the importance of maintaining and respecting access restrictions is presented in an ongoing public education program. In addition, biota exclusion is promoted by revegetating exceedance areas with grasses that are unappealing to biota, thus reducing the value of the habitat. Revegetation of 750,000 SY is accomplished over a 3-year period. Long-term activities include maintaining fences, mowing, and spot herbiciding revegetated areas, and monitoring for damage to the vegetation or damage caused by erosion. No actions are taken to reduce groundwater contamination from sites in this group, and no action is taken to address potential agent/UXO exceedances. The entire area is monitored (an average of 102 samples per year), annual groundwater monitoring is conducted, and 5-year site reviews are conducted to review the effectiveness of the alternative and to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.2-1 summarizes the evaluation of all alternatives for this subgroup.

19.2.2.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs since human and biota exposure pathways are interrupted through access restrictions and biota controls. However, groundwater impacts are not reduced. The short-term impacts associated with implementing access restrictions are minimal.

19.2.2.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as access is controlled, site reviews are conducted, and Section 36 Balance of Areas Subgroup is not located in wetlands or a 100-year flood plain. In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). Army Materiel Command regulations regarding control of agent-contaminated materials and UXO (AMC-R 385-131) (AMC 1987) are not achieved since potential agent and UXO remain in place without containment. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.2.2.3 Long-Term Effectiveness and Permanence

The residual risk is moderate since OCPs, CLC2A, arsenic, and mercury above the Human Health SEC and soil that may pose a potential risk to biota remain if institutional controls alone are implemented. Fencing, land-use restrictions, and cultivation of lower-quality habitat reduce human and biota exposures, but the potential for agent/UXO presence remains. Long-term maintenance, site reviews, long-term monitoring, and monitoring of wildlife exclusion is required. The controls of fencing and cultivation eliminate habitat for biota.

19.2.2.4 Reduction in TMV

Human and biota exposure pathways are interrupted over 750,000 SY through land-use restrictions, fencing, and biota controls, but there is no reduction in hazards for agent or UXO presence. These exposure controls are reversible only if fencing or biota controls should fail. TMV is reduced only through natural attenuation/degradation for 280,000 BCY of untreated soil.

19.2.2.5 Short-Term Effectiveness

This alternative entails a low short-term risk due to the limited nature of the remedial activity. Environmental impacts are minimal, but migration of contaminants to groundwater is not reduced. The time frame for completion of the alternative is 3 years. Installation of the perimeter fencing is feasible within several months, but cultivation of lower-quality habitat requires 3 years. Natural attenuation/degradation of contaminants in untreated soil is ongoing, but soil with potential agent and UXO presence remains on site.

19.2.2.6 Implementability

The alternative is technically feasible, and can be constructed within the required time frame and reliably operated and maintained. Additional remedial actions are easily undertaken for soil left in place. The alternative is administratively feasible since no permitting is required. Equipment, specialists, and materials are readily available for the fence installation and habitat modifications.

19.2.2.7 Cost

The total present worth cost is $6,890,000 and including $483,000, $271,000, and $6.140,000 for capital, operating and long-term costs, respectively. Table B4.18-2 details the costing for this alternative. The cost uncertainty associated with access restrictions is low.

19.2.3 Alternative 3/B3/A3/U4: Landfill

For the Section 36 Balance of Areas Subgroup, Alternative 3: Landfill (On-Post Landfill), combined with Alternative B3: Landfill (On-Post Landfill), Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), and Alternative U4: Detonation (Off-Post Army Facility); Incineration/Pyrolysis (Off-Post Incineration), involves of placing 280,000 BCY of soil with human health exceedances and potential risk to biota in the on-post hazardous waste landfill. If dewatering has not been initiated as part of the Basin A groundwater remedial action, or has not sufficiently lowered the water table to facilitate excavation, dewatering is initiated 2 years prior to the start of excavation and continues throughout the excavation period. The groundwater is removed at 1 gpm and pumped to the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA System, or a new treatment facility.

The Section 36 Balance of Areas Subgroup consists of 94,000 SY of soil with potential agent presence and 230,000 SY of soil with potential UXO presence. Prior to excavation, the areas with potential UXO presence are cleared using geophysical or other methods. Identified UXO are excavated, packaged, and transported to an off-post Army facility for demilitarization. Approximately 78,000 BCY of metallic debris mixed with surface soil from the UXO clearance operation are excavated and placed in the on-post hazardous waste landfill. Of the 78,000 BCY of metallic debris and soil, 15,000 BCY overlap with the volume of human health exceedances, and 54,000 BCY overlap with the volume of soil posing potential risks to biota. An additional 9,000 BCY of metallic debris and soil are present outside the human health and potential biota risk area. As a result, a total of 290,000 BCY of contaminated soil are landfilled.

In addition to UXO clearance, soil is screened for the presence of agent during excavation with real-time field analytical monitoring equipment. If agent is identified and confirmed by RMA laboratory analysis, the agent-contaminated soil is excavated and treated on post by caustic solution washing. (Section 4.4.3 discusses the details of caustic solution washing.) The waste salts generated are placed in the on-post hazardous waste landfill. The treated soil is placed in the on-post landfill as well.

Construction of the first cell of the multiple-cell landfill and associated facilities takes 1 year. Construction starts during year 1 to have the same completion date as the caustic washing facility used for the agent-contaminated soil. (Section 4.6.6 discusses the details of landfills.) A final cover is placed over the landfill upon closure. The cover contains a biota barrier to restrict burrowing animals and a leachate collection and treatment system to prevent the migration of leachate into the groundwater. The cover is revegetated with native grasses that limit erosion and percolation of surface water. The landfill area is secured with perimeter fencing

The excavations are backfilled with soil from the on-post borrow area. The uppermost 6 inches over the backfilled area are supplemented with conditioners and then revegetated with native grasses to improve the habitat at the site. The borrow area is also recontoured and revegetated to restore habitat. Since the entire volume of contaminated soil and debris (290,000 BCY) is excavated and landfilled, long-term maintenance and monitoring, i.e., cover maintenance and leachate collection and treatment, is only required at the landfill.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.2-1 summarizes the evaluation of all alternatives for this subgroup.

19.2.3.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs through containment of contaminated soil. Human and biota exposure are prevented by containment in an on-post landfill, and groundwater impacts are greatly reduced. The clearance of agent/UXO and excavation of contaminated soil entails significant short-term impacts.

19.2.3.2 Compliance with ARARS

This alternative complies with action-specific ARARs including state regulations on landfill siting, design, and operation. Endangered species are not impacted. The Section 36 Balance of Areas Subgroup, UXO incinerator, and landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.2.3.3 Long-Term Effectiveness and Permanence

There is minimal residual risk associated with this alternative since the entire 290,000 BCY of untreated soil and debris are contained in an on-post landfill. There is high confidence in the engineering controls for the landfill, and difficulties associated with landfill maintenance are not expected. Landfill-cell monitoring is required. The existing habitat at the site is improved by revegetation; however, habitat at the landfill is eliminated.

19.2.3.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants is reduced through containment in the landfill. Soil with agent and UXO presence is identified and treated; TMV is eliminated by treatment for these materials. The mobility reduction is reversible only if the landfill should fail. Groundwater removed by the dewatering system is treated at the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new treatment plant.

19.2.3.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with UXO/agent clearance and excavation, transportation, and landfilling of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Dust controls, such as water sprays, are initiated to reduce short-term risks, and vapor/odor emissions are not anticipated during excavation. There are impacts to the existing habitat. Migration of contaminants to groundwater is reduced. The time frame until RAOs are achieved is 2 years. Excavation of 290,000 BCY is feasible within 1 year after 1 year for construction of the landfill and caustic solution washing facility.

19.2.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter with periodic landfill-cell monitoring. Additional remedial actions require removal of the landfill cover. Dewatering is also required. The alternative is administratively feasible since the Subtitle C substantive requirements of the landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials (including clay) are readily available for construction of the landfill. The landfill technology is well demonstrated at full scale.

19.2.3.7 Cost

The total present worth cost is $18,700,000 including $7,820,000, $10,700,000, and $194,000 for capital, operating, and long-term costs, respectively. Table B4.18-3 details the costing for this alternative. The excavation of contaminated soil and clearance of UXO/agent entails a large cost uncertainty relative to identifying the extent and depth of contamination and evaluating the presence of UXO/agent.

19.2.4 Alternative 3g/B5a/A3/U4: Landfill; Caps/Covers with Consolidation; Soil Cover

Alternative 3g: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap) with Consolidation; Caps/Cover (Soil Cover) along with Alternative B5a: Caps/Covers (Multilayer Cap) with Consolidation, Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), and Alternative U4: Detonation (Off-Post Army Facility); Incineration/Pyrolysis (Off-Post Incineration), involves the containment of 290,000 BCY and installation of a 750,000 SY soil cover. The human health exceedance soil (79,000 BCY) and metallic debris are landfilled and soil posing potential risk to biota (200,000 BCY) is consolidated and contained under a low-permeability cap in Basin A. A 1- to 2-ft-thick soil cover is then placed over the entire site. If dewatering related to Basin A groundwater remedial action has not lowered the water table sufficiently to facilitate excavation, dewatering is initiated 2 years prior to the start of excavation and continues throughout the excavation period. Groundwater is removed at 1 gpm and pumped to the CERCLA Wastewater Treatment Plant, the Basin A Neck Treatment System, or a new system.

There are approximately 230,000 SY of soil with potential UXO presence. Prior to excavation the area is cleared of UXO by geophysics or other methods. Identified UXO is excavated and packaged for shipment to an off-post Army facility for demilitarization. During the removal of UXO, 78,000 BCY of metallic debris mixed with surficial soil are also removed and placed in the on-post hazardous waste landfill. The human health exceedances are excavated and placed in an on-post landfill as discussed in Section 19.2.3. Of the 78,000 BCY of metallic debris and soil, 15,000 BCY overlap with the volume of human health exceedances, and 54,000 BCY overlap with the volume of soil posing potential risks to biota. In addition, 9,000 BCY of metallic debris and soil are present outside the human health and potential biota risk area. Therefore, a total of 150,000 BCY of soil posing risk to biota is consolidated in Basin A and a total of 140,000 BCY (78,000 BCY of metallic debris mixed with soil and 64,000 BCY of human health exceedance soil) are landfilled. Construction of the landfill and support facilities requires 1 year. The landfill has a capacity for multiple cells as discussed in Section 4.6.6. The landfill cover is revegetated after installation and fencing are installed to exclude biota and to prevent damage to the system. Long-term maintenance activities at the landfill include collecting and treating leachate and monitoring potential leachate migration from the landfill.

In addition to UXO clearance, this area is screened for agent during excavation using real-time field analytical equipment. Approximately 94,000 SY of the Section 36 Balance of Areas Subgroup potentially contain agent. If agent is identified and confirmed by RMA laboratory analysis, the agent-contaminated soil is excavated and treated on-post by caustic solution washing. (Section 4.4.3 discusses the details of caustic solution washing.) Waste salts and the treated soil are placed in the on-post hazardous waste landfill.

The remaining soil potentially posing risk to biota (150,000 BCY) is excavated and transported to Basin A to be consolidated and capped. Basin A requires a large volume of fill (approximately 3,050,000 BCY) to bring the basin to design grade for capping as described in Section 10.2.3. Consolidating 150,000 BCY of soil posing potential risks to biota from the Section 36 Balance of Area Subgroup over the more highly contaminated soil in Basin A helps meet this need for gradefill and reduces the amount of clean borrow material that would otherwise be moved into Basin A. Consolidation also minimizes the overall area requiring long-term maintenance at RMA since the Basin A is capped and the cap is maintained whether or not soil from this subgroup is consolidated at the basin. The cap at Basin A provides a physical barrier to protect humans and biota from directly contacting contaminated soil.

The site excavations for human health exceedances are backfilled with clean borrow material (79,000 BCY) from the on-post borrow area. A variable thickness soil cover is then placed over the entire site. A 2-ft-thick soil/vegetation layer is placed over the areas that had human health exceedances and at least one foot is placed over the areas that posed risk to biota (Figure 19.2-1). A total of 460,000 BCY of soil are required for constructing the soil cover. The uppermost 6 inches of the soil cover are supplemented with conditioners and revegetated with native grasses to improve the habitat. The borrow area is also regraded and revegetated to restore the habitat. Maintenance activities are required at sites to ensure the integrity of the soil cover. Maintenance operations in Basin A ensures the integrity of the multilayer cap.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.2-1 summarizes the evaluation of all alternatives for this subgroup.

19.2.4.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs through containment. Contaminated soil above Human Health SEC (EBASCO 1994a) is landfilled and soil that may pose a potential risk to biota is excavated and consolidated in Basin A for containment with a multilayer soil cap to prevent exposure. Groundwater impacts are also reduced by the removal of contaminated soil and installation of a soil cover, but there are short-term impacts associated with agent and UXO clearance and excavation of contaminated soil.

19.2.4.2 Compliance with ARARS

This alternative complies with action-specific ARARs regarding construction of covers and monitoring of contained material. Endangered species are not impacted. Location-specific ARARs are met as the Section 36 Balance of Areas Subgroup, Basin A, and the landfill are not located in wetlands or a 100-year flood plain. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU, and consolidation to Basin A does not trigger LDRs since all sites in this medium group are located within the on-post AOC (as defined in Section 1.4). Materials within the consolidation volume may be landfilled based on visual observations such as soil stains, barrels, or newly-discovered evidence of contamination; this landfill volume will be part of the 150,000 CY contingent volume. In addition to the ARARs, this alternative complies with provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.2.4.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since 150,000 BCY of soil are removed and contained in Basin A by a low-permeability soil cap, 140,000 BCY of soil and metallic debris are landfilled, and a 750,000 SY soil cover is installed. Long-term monitoring and site reviews are required for Basin A. Revegetation of the soil cover improves the existing habitat, offsetting the losses incurred during excavation.

19.2.4.4 Reduction in TMV

Exposure pathways are interrupted and the mobility of the contaminants is reduced through consolidation of 150,000 BCY of contaminated soil in Basin A, landfilling of 140,000 BCY of metallic debris and soil, and installation of a soil cover. Soil with agent/UXO is also identified and treated; TMV is eliminated for these materials through treatment. Groundwater removed at

1 gpm by a dewatering system is treated at the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA system, or a new groundwater treatment system.

19.2.4.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with UXO/agent clearance and excavation, transportation, and consolidation of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Dust controls, such as water sprays, are initiated to reduce short-term risks; vapor/odor emissions are not anticipated during excavation. There are minimal impacts to the existing habitat, and migration of contaminants to groundwater is reduced. The time frame until RAOs are achieved is 2 years. Consolidation in Basin A or landfilling of 290,000 BCY and installation of a soil cover are feasible within 1 year after 1 year for the construction of the caustic washing facility.

19.2.4.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter. Long-term cap/cover monitoring and dewatering prior to excavation and is required. Additional remedial actions are easily undertaken for untreated soil under the Basin A cap, although the cap adds to the overall site volume. The substantive requirements of capping and landfill siting, design, and operating regulations are achieved.

19.2.4.7 Cost

The total present worth cost is $17,900,000 including $4,190,000, $13,600,000, and $93,000 for capital, operating, and long-term costs, respectively. Table B4.18-3g details the costing for this alternative. The excavation of contaminated soil and clearance of UXO/agent entails a large cost uncertainty relative to identifying the extent and depth of contamination and evaluating the presence of UXO/agent.

19.2.5 Alternative 6/B5/A2/U2: Caps/Covers

Alternative 6: Caps/Covers (Multilayer Cap), combined with Alternative B5: Caps/Covers (Multilayer Cap), Alternative A2: Caps/Covers (Soil Cover), and Alternative U2: Caps/Covers (Multilayer Cap), involves the containment of 750,000 SY of human health exceedance soil, soil posing potential risk to biota, and soil with potential agent and UXO presence. A surface sweep is conducted to ensure that UXO are not present in near-surface soils prior to cap construction. Before any cap materials are installed, the subgrade is crowned with 1,400,000 BCY of gradefill to control surface-water runoff.

The area is covered by a 2-ft-thick layer of low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and a 4-ft-thick soil/vegetation layer that includes 6 inches of conditioned soil. Section 4.6.14 discusses details of the multilayer cap. The fill materials for the cap are excavated from the on-post borrow area. The capping operations take less than 1 year to complete. Maintenance activities (mowing and replacing eroded soils) ensure the continued integrity of the soil cap. Groundwater compliance monitoring will be conducted to evaluate the potential for contaminant migration.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.2-1 summarizes the evaluation of all alternatives for this subgroup.

19.2.5.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs through containment. Exposures to contaminated soil above Human Health SEC and soil posing a potential risk to biota are interrupted by the low-permeability soil cap that includes a biota barrier and a vegetative layer. Groundwater impacts are also greatly reduced, and short-term impacts are minimal.

19.2.5.2 Compliance with ARARS

This alternative complies with action-specific ARARs, including construction of covers and monitoring of contained material. Endangered species are not impacted. Location-specific

ARARs are met as Section 36 Balance of Areas Subgroup is not located in wetlands or a 100-year flood plain. In addition to the ARARs, this alternative complies with provisions of the FFA (EPA et al. 1989). The alternative is not subject to Army Materiel Command regulations regarding agent or UXO demilitarization (AMC-R 385-131) (AMC 1987) since neither agent nor UXO are removed but are contained in-place. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.2.5.3 Long-Term Effectiveness and Permanence

The residual risk is low since 280,000 BCY of untreated soil are contained through installation of an 750,000-SY low-permeability soil cap with a biota barrier. Long-term groundwater monitoring and site reviews are required for untreated soil. Erosion-control activities and vegetative-cover maintenance are also required. There is high confidence in engineering controls for the cap. The overall habitat quality of the site is improved by revegetation, although the types of vegetation placed at the site and the maintenance activities performed there discourage burrowing animals from using the capped area for habitat.

19.2.5.4 Reduction in TMV

Exposure pathways are interrupted and the mobility of the contaminants is reduced through the installation of an 750,000-SY low-permeability soil cap. Soil with agent/UXO is also contained by the cap. The mobility reduction is reversible only if the cap/cover should degrade or leak. There are no treatment residuals associated with the alternative.

19.2.5.5 Short-Term Effectiveness

This alternative entails low short-term risks since no intrusive activities are conducted. Dust controls are adequate for addressing uncontaminated dusts from cap construction, and vapor/odor emissions are not anticipated. Environmental impacts are minimal for the construction of a cap, but the disturbance of borrow areas is required for gradefill and capping materials. The time frame until RAOs are achieved is 2 years. Installation of the 750,000-SY low-permeability cap is feasible within 2 years. Natural attenuation/degradation of contaminants in untreated soil is ongoing.

19.2.5.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter. Additional remedial actions are easily undertaken for soil left in place, although the cap adds to the overall site volume. The alternative is administratively feasible since the substantive requirements associated with the cap/cover design and construction regulations are achieved. Equipment, specialists, and materials are readily available for the construction of the cap/cover. Cap/covers are well demonstrated at full scale.

19.2.5.7 Cost

The total present worth cost is $43,600,000 including $40,800,000 and $2,750,000 for operating and long-term costs, respectively. Table B4.18-6 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the cap are available on post and the area to be capped is a well defined (i.e., the uncertainty commonly associated with excavation does not exist).

19.2.6 Alternative 13a/B3/A3/U4: Direct Thermal Desorption

Alternative 13a: Direct Thermal Desorption (Direct Heating), combined with Alternative B3: Landfill (On-Post Landfill), Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill), and Alternative U4: Detonation (Off-Post Army Facility); Incineration/Pyrolysis (Off-Post Incineration), treats 54,000 BCY of soil with human health exceedances by thermal desorption and contains 150,000 BCY of soil with potential risk to biota in the on-post hazardous waste landfill. If dewatering related to Basin A groundwater remedial actions has not lowered the water table sufficiently to facilitate excavation, dewatering is initiated 2 years prior to the start of excavation and continues throughout the excavation period. The groundwater is removed at 1 gpm and pumped to the CERCLA Wastewater Treatment Plant, Basin A Neck IRA, or a new treatment system for Basin A/South Plants (see Water DAA) for treatment.

Prior to excavation, 230,000 SY of soil with potential UXO presence are cleared by geophysics or other methods. The identified UXO is excavated, packaged, and transported to an existing off-post Army facility for demilitarization. The 78,000 BCY of metallic debris mixed with surficial soil are also excavated and placed in the on-post hazardous waste landfill. Of the 78,000 BCY of metallic debris and soil, 15,000 BCY overlap with the volume of human health exceedances, and 54,000 BCY overlap with the volume of soil posing potential risks to biota, which reduce the volume of contaminated soil treated by thermal desorption to 54,000 BCY and the volume of soil with potential biota risk only, that is landfilled, to 150,000 BCY.

The 94,000 SY of soil with potential agent presence are screened prior to excavation with real-time field analytical equipment. The potential agent soils are stockpiled and covered. If agent is identified and confirmed by RMA laboratory analysis, the agent-contaminated soil is excavated and treated on post by caustic solution washing. (Section 4.4.3 discusses the details of caustic solution washing.) Waste salts and the treated soil are placed in the on-post hazardous waste landfill.

The 64,000 BCY of soil with human health exceedances are excavated and treated by thermal desorption. (Section 4.6.24 discusses thermal desorption in detail.) Construction of the centralized thermal desorber takes approximately 1 year, and requires an additional year for testing. The thermal desorber has a soil processing rate of 1,300 BCY/day since saturated soil is anticipated for this subgroup. This unit operates with a discharge temperature of 300°C and soil residence time of 50 minutes. Approximately 1 percent of the soil feed (640 BCY) is recovered from the scrubber blowdown as particulates and are placed in the on-post landfill. (Section 4.6.24 discusses emission controls for off gases from thermal desorption.) The treated soil is then returned to the site excavations as backfill. Since thermal desorption destroys the natural organic content in the soil, the uppermost 6 inches are supplemented with conditioners to promotes the growth of vegetation. The area is revegetated with native grasses to restore the habitat.

The remaining 150,000 BCY of soil that potentially poses a risk to biota are excavated and placed in the on-post hazardous waste landfill. The 78,000 BCY of metallic debris and surface soil is also placed in the on-post hazardous waste landfill for a total volume landfilled of 230,000 BCY.

Construction of the first cell of the multiple-cell landfill and associated facilities takes 1 year. (Section 4.6.6 discusses the details of landfills.) A final cover is placed over the landfill upon closure. The cover contains a biota barrier to restrict burrowing animals and a leachate collection and treatment system to prevent the migration of leachate into the groundwater. The cover is revegetated with native grasses that limit erosion and percolation of surface water. The landfill area is secured with a fence around the perimeter. The excavations are backfilled with borrow soil from the on-post borrow area. The uppermost 6 inches over the backfilled area are supplemented with conditioners and then revegetated with native grasses to improve the habitat at the site. The borrow area is also recontoured and revegetated to restore habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.2-1 summarizes the evaluation of all alternatives for this subgroup.

19.2.6.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs through treatment and containment. Contaminated soil is treated through thermal desorption or it is contained in the on-post hazardous waste landfill, thus preventing exposures and reducing impacts to groundwater. There are short-term impacts associated with the excavation and treatment of contaminated soil and with agent and UXO clearance.

19.2.6.2 Compliance with ARARS

This alternative complies with action-specific ARARs including state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The Section 36 Balance of Areas Subgroup, the treatment facilities, and the landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.2.6.3 Long-Term Effectiveness and Permanence

The long-term residual risk is minimal since PRGs are achieved for 64,000 BCY of soil thermally desorbed soil, and 230,000 BCY of soil and debris are excavated and contained in an on-post landfill. Monitoring of the backfilled sites is not required. There is high confidence in the engineering controls for the landfill, and there are no expected difficulties associated with landfill maintenance. Landfill-cell monitoring is required to ensure integrity of controls. The existing habitat is improved by revegetation with native grasses, offsetting losses incurred during excavation.

19.2.6.4 Reduction in TMV

The 64,000 BCY of human health exceedances are thermally desorbed to degrade OCPs and CLC2A and remove mercury, and 230,000 BCY of soil with potential risk to biota and munitions debris are contained in the on-post landfill. Soil with agent and UXO are identified and treated as appropriate. Organics are reduced to detection levels or >99.99% DRE by thermal desorption. Scrubber blowdown solids from off-gas treatment equipment, and salts, are contained in the on-post hazardous waste landfill. TMV reduction by thermal desorption is irreversible. Pathways of exposure are interrupted and mobility of contaminants is reduced through containment in the landfill. The mobility reduction is reversible only if the landfill should fail. Soil with agent and UXO presence is identified and treated; TMV is eliminated through the treatment of these materials. Groundwater removed at 1 gpm by a dewatering system is treated at the CERCLA Wastewater Treatment Plant, the Basin A Neck IRA, or a new treatment plant.

19.2.6.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with UXO/agent clearance and excavation, transportation, and thermal desorption of contaminated soil. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Dust controls, such as water sprays, are employed to reduce short-term risks; vapor/odor emissions are not anticipated during excavation. In addition, the preparation of the feedstock prior to thermal desorption presents short-term risks, although the materials handling is conducted in an enclosed building to control dust and vapors/odors. Although the off-gas control system for the thermal desorber is designed to achieve air quality standards the emissions from the thermal desorber contain low but acceptable levels of some contaminants. There are minimal impacts to the environment due to the existing disturbed habitat, and migration of the contaminants to groundwater is reduced. The time frame until RAOs are achieved is 4 years. Excavation and treatment of 64,000 BCY and landfilling of 230,000 BCY is feasible within 1 year after 2 years for the construction of a thermal desorption facility, caustic washing facility, and the landfill.

19.2.6.6 Implementability

The landfilling portion of this alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter. Landfill-cell monitoring, groundwater monitoring, and leachate treatment are required. Landfilling is administratively feasible since the substantive requirements associated with the treatment system and landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for the landfill construction, and landfills are well demonstrated at full scale. Thermal desorption is widely available and has been used to treat similar contaminants; however, the technology has not been demonstrated at the scale required for RMA. The thermal desorption facility can be constructed within the required time frame and should be reliably operated for the contaminants and levels of contamination present in the soil feed. Administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to public perceptions regarding the safety of thermal treatment. Equipment, specialists, and materials are readily available for the landfill construction, and landfills are well demonstrated at full scale.

19.2.6.7 Cost

The total present worth cost is $25,100,000 including $7,830,000, $17,100,000, and $143,000 for capital, operating, and long-term costs, respectively. Table B4.18-13a details costing for this alternative. There are two significant uncertainties associated with the costing of this alternative. First, the extent and depth of contamination and extent of UXO/agent presence are difficult to estimate. Second, the elevated concentrations of the contaminants in the feedstock, the high moisture content of the soil, and the need for materials handling increase uncertainties relative to maintaining the assumed on-line percentage of the thermal desorption unit. These operating conditions may result in changes in maintenance requirements or delays in implementation, both of which may impact treatment costs.

19.2.7 <u>Alternative 19a/B3/A3/U4: In Situ Thermal Treatment</u>

Alternative 19a: In Situ Thermal Treatment (RF/Microwave Heating), combined with Alternatives B3: Landfill (On-Post Landfill), A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill) and U4: Detonation (Off-Post Army Facility); Incineration/Pyrolysis (Off-Post Incineration), involves treating 64,000 BCY of soil with human health exceedances by thermal desorption and containment of 150,000 BCY of soil with potential risk to biota and 78,000 BCY of metallic debris mixed with surface soil in the on-post hazardous waste landfill. If dewatering related to Basin A groundwater remedial action has not lowered the groundwater table sufficiently to facilitate the excavation process, dewatering is initiated 2 years prior to the start of excavation and continues throughout the excavation period. The groundwater is removed at 1 gpm and pumped to the CERCLA Wastewater Treatment Plant, Basin A Neck IRA system, or a new groundwater treatment system. Groundwater compliance monitoring will be conducted to evaluate the potential for contaminant migration.

Prior to treatment, the soil with potential UXO presence is cleared by geophysical survey or other methods. The identified UXO is excavated, packaged, and transported to an existing off-post Army facility for demilitarization. The 78,000 BCY of metallic debris mixed with surficial soil are excavated and transported to the on-post hazardous waste landfill. Of the 78,000 BCY of metallic debris and soil, 15,000 BCY overlap with the volume of human health exceedances, and 54,000 BCY overlap with the volume of soil posing potential risks to biota.

Approximately 94,000 SY of soil have the potential for agent presence. Monitoring is conducted during excavation alternatives by screening for agent using real-time field analytical equipment. If agent is identified and confirmed by RMA laboratory analysis, the agent-contaminated soil is excavated and treated on post by caustic solution washing. (Section 4.4.3 discusses the details of caustic solution washing.) Waste salts and treated soil are placed in the on-post hazardous waste landfill.

RF heating raises the temperature of the soil to more than 250°C, mobilizing the organic contaminants. Only 64,000 BCY are treated by RF heating because approximately 15,000 BCY of soil with human health exceedances are landfilled along with the metallic debris. The mobilized contaminants are collected and treated in the off-gas treatment system as described in Section 4.6.31. The RF heating unit treats a block of soil with dimensions of 100 ft long by 48 ft wide by 10 ft deep. The soil moisture content of the Section 36 Balance of Areas sites is approximately 20 percent; therefore, the RF treatment rate is 130 BCY/day. The liquid sidestream from in situ heating, predominantly salts, is transported to the thermal desorption facility for treatment. The uppermost 6 inches of soil over the treated human health exceedance area of 110,000 SY are supplemented with conditioners to provide a medium for vegetation. The treated area is then revegetated with native grasses.

Approximately 150,000 BCY of soil posing a potential risk to biota are excavated and placed in the on-post hazardous waste landfill. The 78,000 BCY of metallic debris and surface soil is also placed in the on-post hazardous waste landfill for a total volume landfilled of 230,000 BCY. Construction of the first cell of the multiple-cell landfill and associated facilities takes 1 year. (Section 4.6.6 discusses the details of landfills.) A final cover is placed over the landfill upon closure. The cover contains a biota barrier to restrict burrowing animals and a leachate collection and treatment system to prevent the migration of leachate into the groundwater. The cover is revegetated with native grasses that limit erosion and percolation of surface water. The landfill area is secured with perimeter fencing. The excavations are backfilled with borrow soil from the on-post borrow area. The uppermost 6 inches over the backfilled area are supplemented with conditioners and then revegetated to improve the habitat at the site. The borrow area is also recontoured and revegetated to restore habitat.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.2-1 summarizes the evaluation of all alternatives for this subgroup.

19.2.7.1 Overall Protection of Human Health and the Environment

This alternative is not fully protective since treatment of contaminated soil with human health exceedances by RF heating does not achieve PRGs. Soil posing a potential risk to biota is removed and contained in a landfill, thereby achieving Biota RAOs. Short-term risks are associated with in situ treatment and agent/UXO clearance.

19.2.7.2 Compliance with ARARS

This alternative complies with action-specific ARARs including state regulations on air emissions sources and landfill siting, design, and operation. Endangered species are not impacted. The Section 36 Balance of Areas Subgroup and the landfill are not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.2.7.3 Long-Term Effectiveness and Permanence

The residual risk is low since the human health exceedances are treated to levels near the Human Health PRGs, and the residual risk for soil excavated and contained in the landfill is minimal. Habitat quality is restored through revegetation, offsetting the loss in habitat excavation and treatment. Habitat at the landfill is restricted by biota controls.

19.2.7.4 Reduction in TMV

RF heating can theoretically achieve Human Health and Biota RAOs with low residual risk since OCPs and volatile metals can be driven from the soil by this form of in situ thermal treatment. However, the pilot-scale test of the RF technology at RMA, as described in the Technology

Descriptions Volume, failed to confirm the temperature distribution and OCP removal efficiencies required for confident treatment of soil to achieve PRGs. The TMV reduction of organic compounds by in situ thermal treatment is irreversible. The liquid blowdown sidestream associated with RF heating treatment is treated using an evaporation/crystallizer or at a thermal desorption facility along with scrubber effluent.

19.2.7.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with UXO/agent clearance. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. The in situ thermal treatment of soil also entails short-term impacts. Although the off-gas control system for in situ heating is designed to achieve air quality standards, the emissions from the in situ heating unit contain low levels of the contaminants removed from the soil. There are minimal impacts to the existing habitat. Migration of the contaminants to the groundwater is reduced. RAOs are not met. RF heating of 64,000 BCY is feasible within 2 years, and landfill construction requires 1 year.

19.2.7.6 Implementability

In situ thermal heating is currently not implementable because no full-scale in situ heating units have been constructed or operated. The technology was demonstrated at a pilot-scale at RMA, but several problems were identified regarding the durability of the equipment. These problems may lead to delays in the construction of full-scale units and in the operation of the in situ heating units over the 2-year operating period. In addition, administrative difficulties associated with demonstrating compliance with permits and operating and maintenance regulations may lead to delays, and it may be difficult to implement this alternative due to public perceptions regarding the safety of in situ thermal treatment and the thermal treatment portion of the off-gas control system. The landfill portion of this alternative is administratively feasible since the substantive requirements associated with landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill, and landfill technology is well demonstrated at full scale. Additional remedial actions require removal of landfill cover. Dewatering is also required.

19.2.7.7 Cost

The total present worth cost is $51,800,000 including $19,500,000, $32,100,000, and $152,000 for capital, operating, and long-term costs, respectively. Table B4.18-19a details costing for this alternative.

There are two significant uncertainties associated with the costing of this alternative. First, there are no full-scale demonstrations of the in situ heating technology at other hazardous waste sites by which actual construction and operational costs can be documented. This uncertainty is especially noteworthy because the pilot-scale demonstration of the technology at RMA indicated there were potential problems regarding the durability of the equipment. Second, the lack of full-scale implementation data increases uncertainties relative to maintaining the assumed on-line percentage of the heating unit. The concentration and depth of contamination at RMA may result in changes in treatment times or delays in implementation, both which may impact treatment costs.

19.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Section 36 Balance of Areas Subgroup consists of 280,000 BCY of exceedance soil contaminated with OCPs, CLC2A, and low levels of mercury. Although the contamination present at each of these sites is varied, each site has the potential for UXO or agent presence. OCPs exceed the Human Health SEC in approximately 7 percent of the samples. However, the human health risk is relatively low as the average concentrations in the human health exceedance volume are substantially less than the Human Health SEC (EBASCO 1994a). Mercury is present in low levels and presents a potential risk to biota only. There are no exceedances of the principal threat criteria in this subgroup, but one site does contribute to a groundwater contamination plume that is intercepted and treated by the Basin A Neck IRA.

The vegetation types within the subgroup vary from weedy forbs to areas with disturbed vegetation. Alternatives that disrupt habitat include revegetation and restoration following remediation, so no significant habitat impacts are expected. An exception is the institutional controls alternative, which involves the removal of habitat.

Alternatives that involve excavation of human health exceedances require clearing UXO, screening for agent presence, and providing health and safety protection for site workers during remedial activities. The degree of contamination in sites in this subgroup does not necessitate special measures for odor control or community protection during remediation.

In summary, this subgroup contains potential risk to biota and relatively low-level human health exceedances. Agent and UXO are potentially present and one site in the subgroup is a source of groundwater contamination. When comparing alternatives, the long-term risks regarding the presence of UXO or agent and the potential for migration of contaminants left in place should be considered against the short-term risks of worker exposure to physical and acute chemical hazards during remedial activities.

Alternative 1: No Additional Action is not protective of human health or biota as untreated soil remains without controls being implemented, and was eliminated from further consideration. Alternative 19a: In Situ Thermal Treatment does not achieve RAOs (although the residual risks are low) and the technology is not currently implementable. As a result, this alternative was also eliminated from consideration. The five remaining alternatives achieve RAOs and meet the two DAA threshold criteria: protection of human health and the environment and compliance with action-specific and location-specific ARARs for the DAA. These alternatives are distinguished, however, by how well they satisfy the five balancing criteria (Table 19.2-1).

Alternative 2: Institutional controls achieves RAOs through engineering controls and habitat modifications. However, the implementation of this alternative entails eliminating habitat and allows agent and UXO to remain in place under only institutional controls. Therefore, this alternative was eliminated from consideration.

Alternative 3: Landfill achieves RAOs through excavation and containment elsewhere at RMA. The short-term impacts associated with excavation are adequately addressed, and the residual risks are minimal. As a result, this alternative is considered cost-effective and was retained for development of sitewide alternatives.

Alternative 3g: Landfill; Caps/Covers with Consolidation; Soil Cover achieves RAOs and reduces exposure pathways and groundwater contamination through engineering controls. This alternative is considered to be effective and is retained for development of sitewide alternatives.

Alternative 6: Caps/Covers achieves RAOs through containment in place. Although the capped area is revegetated to restore habitat, the types of vegetation and maintenance activities for the capped area make the area undesirable as habitat for burrowing animals. In addition, this alternative has low short-term impacts since there are no intrusive activities. Therefore, this alternative was retained for consideration in developing sitewide alternatives.

Alternative 13a: Direct Thermal Desorption achieves RAOs through treatment and containment. However, the long-term risk is not significantly lower than for the alternatives involving consolidation or landfilling, and this alternative has a higher cost than the alternatives involving landfilling. This alternative is not considered cost-effective and was not retained for consideration in the development of sitewide alternatives.

Consequently, the alternatives that were retained to represent the Section 36 Balance of Areas Subgroup in the development of the sitewide alternatives (Section 20) are the following:

- Alternative 3: Landfill (On-Post Landfill)
- Alternative 3g: Landfill (On-Post Landfill); Caps/Covers (Multilayer Cap) with Consolidation; Caps/Covers (Soil Cover)
- Alternative 6: Caps/Covers (Multilayer Cap)

The structures within site CSA-2a are demolished prior to treatment to allow access to the contaminated soil. In accordance with the preferred alternative for structures, structural debris is removed from the site for treatment and/or containment. Dewatering is also required prior to excavation to allow the excavation of soil near the water table.

19.4 BURIAL TRENCHES SUBGROUP CHARACTERISTICS

The Burial Trenches Subgroup is composed of sites ESA-2a (Section 32 Burn Pits) and ESA-2c (Open Trenches) (Figure 19.0-1). These sites, located in Sections 32 and 30 of the Eastern Study Area, may contain agent and HE-filled UXO based on the operations that occurred there. Site ESA-2a was not used for the detonation of agent-filled UXO and consequently is assumed to potentially contain only HE-filled UXO. Site ESA-2c potentially contains agent. The principal threat criteria were not exceeded for any soil within this subgroup, and none of the sites within this subgroup are associated with groundwater plumes.

Table 19.4-1 provides a summary of contaminants and concentrations for this subgroup. Table 19.4-2 summarizes the frequency of contaminant detections in the samples for this subgroup. The first table shows that maximum concentration of lead equals or exceeds the Human Health SEC in one sample. Soil within these sites may pose a potential risk to biota; however, the potential UXO presence area and associated metallic debris volume overlap this area. As such, alternatives were not developed to address potential risks to biota. Figure 19.4-1 shows the distribution of human health exceedance areas for the Burial Trenches Subgroup, Table 19.0-1 lists the exceedance areas and volumes, and Figure 19.4-2 presents the overlap of these exceedance areas with those potentially containing agent and UXO presence. Several of the individual burn pits in ESA-2a potentially contain HE-filled UXO, but do not contain either human health exceedances or areas that pose a potential risk to biota.

The sites within the Burial Trenches Subgroup contain vegetation ranging from weedy forbs to native grasses. Some of the sites are located within prairie dog colonies. The overall habitat value is improved through remedial actions since the areas that are disturbed are revegetated with native grasses, although the types of vegetation and the maintenance activities are designed to discourage burrowing animals from using the capped area as habitat for alternatives involving caps/covers. Since this area is located within the Bald Eagle Management Area, the evaluation of alternatives for this subgroup must consider the impacts of alternatives on habitat.

19.5 BURIAL TRENCHES SUBGROUP EVALUATION OF ALTERNATIVES

The four alternatives for the Burial Trenches Subgroup vary in approach from no action to treatment. An alternative involving containment (Alternative 6) was added to contain areas with low levels of contamination and potential HE-filled UXO; however, Alternative 13 (thermal desorption) was removed from consideration due to the absence of any organic exceedances. The following subsections present a description of each alternative and an evaluation of the alternative against the DAA criteria listed in the NCP (EPA 1990a). The alternatives for this subgroup consist of a component to address human health exceedance areas (which is listed first), and components to address areas with potential agent and UXO presence (the "A" and "U" alternatives, respectively).

Biota alternatives are not included for the Burial Trenches Subgroup because the soil volume posing potential risk to biota is addressed by the remedial actions proposed for the potential UXO and associated debris volumes.

19.5.1 <u>Alternative 1/A1/U1: No Additional Action</u>

Alternative 1: No Additional Action (Provisions of FFA), along with Alternative A1: No Additional Action (Provisions of FFA) and Alternative U1: No Additional Action (Provisions of FFA), applies to all 170,000 SY of exceedance area in the Burial Trenches Subgroup. The 32,000 BCY of human health exceedances, including potential HE-filled UXO and agent, remain in place. This alternative complies with the provisions of the FFA (EPA et al. 1989). No action is taken to reduce potential human or biota exposure to COCs or to physical or acute chemical hazards. The 170,000-SY area is monitored (an average of 22 samples per year), annual groundwater sampling is conducted, and 5-year site reviews are conducted to assess natural attenuation/degradation and potential migration of contaminants.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.5-1 summarizes the evaluation of all alternatives for this subgroup.

19.5.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve Human Health or Biota RAOs since controls are not implemented and untreated soil remains. Natural attenuation/degradation, which is not effective for inorganics, is the only means by which long-term reduction in TMV for organics is achieved. There are no impacts on groundwater, surface water, or air quality.

19.5.1.2 Compliance with ARARs

This alternative complies with action- and location-specific ARARs as long-term monitoring and site reviews are conducted. The Burial Trenches Subgroup is not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. In addition to ARARs, the alternative also complies with provisions of the FFA (EPA et al. 1989). Army Materiel Command regulations regarding the control of agent-containing materials or UXO (AMC-R 385-131) (AMC 1987) are not achieved. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.5.1.3 Long-Term Effectiveness and Permanence

The residual risk is moderate since lead above the Human Health SEC remain in the soil. There is also the potential for agent/UXO to be present in the soil. Site reviews and soil monitoring are required. The existing habitat is not changed by this alternative.

19.5.1.4 Reduction in TMV

There is no reduction in TMV except by natural attenuation/degradation. The 32,000 BCY of untreated soil remain. There is also no reduction in potential hazards related to agent or UXO presence. There are no treatment residuals associated with the alternative.

19.5.1.5 Short-Term Effectiveness

This alternative entails a low short-term risk due to the limited nature of the remedial actions. In addition, there are no environmental impacts since the existing habitat is not changed by the remedial alternative. Natural attenuation is the only process by which contaminant reduction is achieved. Soil with potential agent and UXO presence remains on site. The time frame for RAOs to be met is greater than 30 years.

19.5.1.6 Implementability

The alternative is technically and administratively feasible. Soil and groundwater monitoring services are required and readily available.

19.5.1.7 Cost

The total present worth is cost $1,090,000 including only long-term operations and maintenance costs associated with long-term monitoring and site reviews. Table B4.19-1 details the costing for this alternative. The cost uncertainty associated with monitoring and site reviews is low.

19.5.2 Alternative 3/A3/U4a: Landfill

For the Burial Trenches Subgroup, Alternative 3: Landfill (On-Post Landfill), combined with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill) and Alternative U4a: Detonation (Off-Post Army Facility), addresses 32,000 BCY of contaminated soil. This contaminated soil is excavated and placed in the on-post landfill.

The Burial Trenches Subgroup contains 170,000 SY of soil with the potential presence of HE-filled UXO. Prior to excavation, the areas with potential UXO presence are cleared using geophysics or other methods. The UXO is excavated, packaged, and transported to an Army off-post facility for treatment. TCLP samples will be used to help identify soil to be landfilled. Approximately 57,000 BCY of metallic debris mixed with surficial soil are excavated and placed in the on-post landfill along with 28,000 BCY of soil with human health exceedances (since 4,000 BCY of human health exceedances overlap with the debris). A total of 85,000 BCY of soil and debris is landfilled.

The Burial Trenches Subgroup also contains 7,100 SY of soil with potential agent presence which is screened during excavation with real-time field analytical equipment. The soil is stockpiled and covered until it undergoes laboratory analysis. If agent is confirmed by RMA laboratory analysis, the agent-contaminated soil is excavated and treated on post by caustic solution washing. (Section 4.4.3 discusses the details of caustic solution washing.) Waste salts and the treated soil are placed in the on-post hazardous waste landfill.

Construction of the first cell of the multiple-cell landfill and associated facilities takes 1 year (Section 4.6.6 discusses landfills in detail). A final cover is placed over the landfill upon closure. The cover, which contains a biota barrier to restrict burrowing animals and a leachate collection and treatment system to prevent the migration of leachate into the groundwater, is vegetated to limit erosion and percolation of surface water. The perimeter of the landfill area is secured with a fence.

The excavations are backfilled with borrow soil taken from the on-post borrow area. The uppermost 6 inches of soil are supplemented with conditioners and revegetated, thus improving the habitat at the site. The borrow area is also recontoured and revegetated to restore habitat. Since 85,000 BCY of untreated soil and debris are contained in the landfill, long-term leachate collection and treatment and cover maintenance are required.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.5-1 summarizes the evaluation of all alternatives for this subgroup.

19.5.2.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs through containment. Contaminated soil is contained in an on-post landfill preventing human health and biota exposure. There are no impacts on groundwater, surface water, or air quality associated with this alternative. There are short-term impacts associated with agent and UXO clearance and excavation of contaminated soil.

19.5.2.2 Compliance with ARARS

This alternative complies with action specific ARARs including state regulations on landfill siting, design, and operation. Endangered species are not impacted. Location-specific ARARs are met as the Burial Trenches Subgroup is not located in wetlands or a 100-year flood plain. Disposal in the landfill does not trigger LDRs since the landfill is a CAMU (as defined in Section 1.4). In addition to ARARs, this alternative complies with provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.5.2.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since 85,000 BCY of untreated soil and debris are contained in an on-post landfill. There is high confidence in engineering controls for the landfill, and no difficulties associated with maintenance of the landfill are expected. Landfill-cell monitoring is required. Revegetation of disturbed areas improves the existing habitat, but habitat is eliminated at the landfill.

19.5.2.4 Reduction in TMV

Exposure pathways are interrupted and the mobility of the contaminants is reduced through containment of 85,000 BCY in an on-post landfill. Soil with agent/UXO is also identified and treated. Mobility reduction is reversible only if the landfill should fail. Treatment residuals include salts from caustic washing to treat agent.

19.5.2.5 Short-Term Effectiveness

This alternative entails significant short-term risks associated with UXO/agent clearance and excavation, transportation, and landfilling of contaminated soils. These risks are reduced through engineering controls and use of personal protective equipment, but they cannot be completely removed. Dust controls (such as water sprays) are initiated to reduce short-term risks, and vapor/odor emissions are not expected to be associated with excavation. There are minimal impacts to the existing habitat. In fact, habitat quality is improved by revegetation. The time frame until RAOs are achieved is 2 years. Excavation of 85,000 BCY is feasible within 1 year after 1 year for the construction of the caustic washing facility and landfill.

19.5.2.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter. Landfill-cell monitoring is required. Additional remedial actions require removal of the landfill cover. This alternative is administratively feasible since the substantive requirements associated with landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials (including clay) are readily available for the construction of the landfill. Landfills have been well demonstrated at full scale.

19.5.2.7 Cost

The total present worth cost is $5,410,000 including $2,210,000, $3,130,000, and $59,000 for capital, operating and long-term costs, respectively. Table B4.19-3 details the costing for this alternative. The excavation of contaminated soil and clearance of UXO/agent entails a large cost uncertainty relative to identifying the extent and depth of contamination and evaluating the presence of UXO/agent.

19.5.3 Alternative 6/A2/U2: Caps/Covers

Alternative 6: Caps/Covers (Multilayer Cap), combined with Alternative A2: Caps/Covers (Soil Cover) and Alternative U2: Caps/Covers (Multilayer Cap), includes the containment of 170,000 SY of area that includes human health exceedances and the potential presence of agent and HE-filled UXO. A surface sweep is conducted to ensure UXO are not present in near-surface soil prior to preparation of the subgrade. The subgrade is crowned with 32,000 BCY of gradefill to control surface-water runoff. The human health exceedance area is covered by a 2-ft-thick layer of low-permeability soil, a 1-ft-thick biota barrier of crushed concrete, and a 4-ft-thick soil/vegetation layer that includes 6 inches of reconditioned soil. The areas with potential agent and UXO presence that are outside the human health exceedance area are covered with a 2-ft-thick layer of general fill including 6 inches of reconditioned soil to promote the growth of vegetation. The cover provides a physical barrier to protect humans and biota from directly contacting soil with potential HE-filled UXO or agent. These areas are then revegetated with native grasses to restore the habitat. The fill materials for the cap and cover are excavated from the on-post borrow area. The capping operations take less than 1 year to complete. Maintenance activities (mowing and replacing eroded soils) ensure the continued integrity of the soil cap. Groundwater compliance monitoring will be conducted to evaluate the potential for contaminant migration.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.5-1 summarizes the evaluation of all alternatives for this subgroup.

19.5.3.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs through containment. Contaminated soil above Human Health SEC is contained by a low-permeability soil cap that includes a biota barrier and vegetative layer to prevent exposure, and areas with the potential for agent or HE-filled UXO presence are contained with a soil cover. There are no impacts on groundwater, surface water, or air quality associated with this alternative. The short-term impacts associated with the installation of a cap are low.

19.5.3.2 Compliance with ARARS

This alternative complies with action-specific ARARs regarding construction of caps/covers, monitoring of contained material, and impacts to endangered species. Location-specific ARARs are met as the Burial Trenches Subgroup is not located in wetlands or a 100-year flood plain (see Appendix A of the Technology Descriptions Volume). In addition to the ARARs, this alternative complies with provisions of the FFA (EPA et al. 1989). Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization do not apply since soil with agent/UXO presence is not disturbed but is contained in-place. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.5.3.3 Long-Term Effectiveness and Permanence

The residual risk is low for this alternative since 32,000 BCY of untreated soil are contained through installation of 12,000-SY low-permeability soil cap with a biota barrier, and 160,000 SY of soil with potential agent and UXO presence is contained with a soil cover. Long-term monitoring and site reviews are required for untreated soil, and erosion-control activities and vegetative-cover maintenance are required. There is high confidence in engineering controls for the cap/cover, and no difficulties are associated with maintenance. Revegetation of the cap/cover with native grasses improves the habitat quality. The types of vegetation placed at the site and the maintenance activities performed there are designed to discourage burrowing animals from using the capped area as habitat.

19.5.3.4 Reduction in TMV

Exposure pathways are interrupted and the mobility of the contaminants is reduced through installation of 12,000-SY low-permeability soil cap. Soil with potential agent/UXO is also contained with a 160,000-SY soil cover to prevent exposure to humans or biota. Mobility reduction is reversible only if the cap/cover should degrade or leak. There are no treatment residuals associated with this alternative.

19.5.3.5 Short-Term Effectiveness

This alternative entails low risks to workers and the community during surficial UXO clearance and cap/cover installation since no intrusive activities are conducted. Personal protective equipment protects workers from physical and chemical risks, and fugitive dust that may affect the community is controlled through water sprays. Odor/vapor emissions are not anticipated. There are minimal impacts to the existing habitat. The time frame until RAOs are achieved is 1 year. Installation of 170,000-SY cap/cover is feasible within 1 year. Natural attenuation/degradation of contaminants in untreated soil is ongoing.

19.5.3.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained thereafter. Additional remedial actions are easily undertaken for soil left in place, although the cap/cover adds to the overall site volume. This alternative is administratively feasible since the substantive requirements of the cap/cover design and construction regulations are achieved. Equipment, specialists, and materials are readily available for the construction of the cap/cover. Multilayer caps have been well demonstrated at full scale.

19.5.3.7 Cost

The total present worth cost is $4,050,000 including $3,210,000 and $836,000 for operating and long-term costs, respectively. Table B4.19-6 details the costing for this alternative. There is a low level of uncertainty associated with the cost of this alternative since the materials required to construct the cap are available on post and the area to be capped is relatively well defined (i.e., the uncertainty commonly associated with excavation does not exist).

19.5.4 Alternative 10/A3/U4a: Direct Solidification/Stabilization

Alternative 10: Direct Solidification/Stabilization (Cement-Based Solidification), combined with Alternative A3: Direct Soil Washing (Caustic Solution Washing); Landfill (On-Post Landfill) and Alternative U4a: Detonation (Off-Post Army Facility), treats 28,000 BCY of human health exceedance soil by cement-based solidification.

Prior to excavation, 170,000 SY are cleared for UXO by using geophysical surveys or other methods. Identified UXO is excavated, packaged, and shipped off post for demilitarization. The 57,000 BCY of metallic debris mixed with surficial soil (including 4,000 BCY that overlap the human health exceedance volume) are excavated and placed in the on-post hazardous waste landfill. TCLP samples will be used to help identify soil to be landfilled. Construction of the first cell of the multiple-cell landfill and associated facilities takes 1 year. (Section 4.6.6 discusses landfills in detail). After placement of contaminated materials, the landfill is covered, revegetated, and secured with a fence. The debris excavation is backfilled with borrow soil taken from the on-post borrow area. The uppermost 6 inches of soil over the backfilled area are supplemented with conditioners and revegetated to improve the habitat at the site. The borrow area is also revegetated to restore habitat. Long-term monitoring and maintenance of the landfill cell is required to ensure the integrity of the cover and the leachate collection and treatment system.

In addition to UXO clearance, 7,100 SY that potentially contain agent are screened during excavation with real-time field analytical equipment. The soil is stockpiled and covered until it undergoes RMA laboratory analysis. If agent presence is confirmed, the agent-contaminated soil is excavated and treated on-post by caustic solution washing. (Section 4.4.3 discusses the details of caustic solution washing.) Waste salts and treated soil are placed in the on-post hazardous waste landfill.

The remaining 28,000 BCY of soil with human health inorganic exceedances are excavated and solidified using a portable pug mill capable of treating 150 ton/hour. The contaminated soil is treated by adding cement as a binder at a 20-percent ratio to immobilize ICP metals in the soils. During excavation and solidification, the volume of contaminated soil increases by about 38 percent, which results in a total volume of 39,000 BCY. The solidified soil is placed in the site excavations and covered with borrow material from the on-post borrow area. The solidified soil requires a soil cover a minimum of 4 ft thick to ensure the integrity of the solidified materials and to prevent freeze/thaw degradation of the materials. The cover is revegetated, thereby improving habitat quality, and the borrow area is revegetated to restore habitat. In all, 12,000 SY of backfilled area are revegetated with native grasses.

The following discussion presents a detailed evaluation of this alternative against the DAA criteria listed in the NCP (EPA 1990a). For purposes of comparison, Table 19.5-1 summarizes the evaluation of all alternatives for this subgroup.

19.5.4.1 Overall Protection of Human Health and the Environment

This alternative achieves Human Health and Biota RAOs through treatment/immobilization and containment. Contaminated soil above Human Health SEC (EBASCO 1994a) is encapsulated to prevent exposure. There are no impacts on groundwater, surface water, or air quality associated with this alternative.

19.5.4.2 Compliance with ARARS

This alternative complies with action- and location-specific ARARs regarding monitoring of solidified material. Location-specific ARARs are met as the Burial Trenches Subgroup is not located in wetlands or a 100-year flood plain, thus complying with location-specific ARARs. This alternative also complies with the provisions of the FFA (EPA et al. 1989) and Army Materiel Command regulations (AMC-R 385-131) (AMC 1987) regarding agent and UXO demilitarization. (ARARs are listed in Appendix A of the Technology Descriptions Volume.)

19.5.4.3 Long-Term Effectiveness and Permanence

The residual risk is minimal since human health exceedances are addressed by treatment/immobilization and metallic debris mixed with surficial soil is addressed by containment. The 39,000 BCY of solidified materials are returned to the site as backfill. Monitoring of solidified soil is required. There is high confidence in the stabilization of contaminants. The existing habitat at the site is improved by revegetation; however, habitat at the landfill is eliminated.

19.5.4.4 Reduction in TMV

Exposure pathways are interrupted and mobility of contaminants reduced by solidification of 28,000 BCY. Soil with agent/UXO presence is identified and treated, eliminating TMV. TMV reduction is irreversible so long as the integrity of the solidified materials is maintained. The landfilling of 57,000 BCY of contaminated soil and debris interrupts exposure pathways.

19.5.4.5 Short-Term Effectiveness

This alternative entails significant risks to workers and the community during agent/UXO clearance and excavation, transportation, and treatment of the contaminated soil; however, the use of personal protective equipment protects workers from physical and chemical risks. In addition, fugitive dust that may affect the community is controlled through water sprays, and odor/vapor emissions are not anticipated. There are minimal impacts to the existing habitat. The time frame until RAOs are achieved is 2 years. Solidification of 28,000 BCY is feasible within 1 year after 1 year for the construction of the landfill and the caustic solution washing facility.

19.5.4.6 Implementability

The alternative is technically feasible and can be implemented within the required time frame and reliably operated and maintained. Monitoring of the solidified soil and the landfill controls are required. The alternative is administratively feasible since the substantive requirements of solidification and landfill siting, design, and operating regulations are achieved. Equipment, specialists, and materials are readily available for construction of the landfill and solidification. The solidification and landfill technologies have been well demonstrated at full scale.

19.5.4.7 Cost

The total present worth cost is $6,610,000 including $1,570,000, $4,830,000, and $206,000 for capital, operating, and long-term costs, respectively. Table B4.19-10 details the costing for this alternative. The excavation of contaminated soil and clearance of agent/UXO entails a large cost uncertainty relative to identifying the extent and depth of contamination and evaluating the presence of agent/UXO.

19.6 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Burial Trenches Subgroup contains 32,000 BCY of exceedance volume based on approximately 1 percent of the samples that exceed the Human Health SEC for lead. The human health risk is relatively low as the average concentrations of COCs in the human health exceedance volume are well below the Human Health SEC (EBASCO 1994a). Based on site histories, these sites may contain agent and HE-filled UXO. In addition, there are approximately 57,000 BCY of metallic debris mixed with surface soil. No contaminant exceeds the principal threat criteria, and none of the sites are associated with groundwater contamination.

This subgroup contains vegetation types ranging from weedy forbs to native grasses and includes areas within prairie dog colonies and the Bald Eagle Management Area, so the evaluation of alternatives must consider the impacts of remediation on habitat. Areas disturbed during remediation are to be revegetated to restore and improve habitat value, although alternatives involving a cap/cover for containment require exclusion of burrowing animals.

Excavation of soil in the Burial Trenches Subgroup requires clearing UXO from the soil, screening the soil for agent, and providing health and safety protection for site workers. The degree of contamination does not necessitate special measures for odor control or community protection during excavation, and the short-term risk to workers is manageable with the use of proper health and safety equipment and procedures.

In summary, this subgroup contains low-level human health exceedances along with the potential presence of agent and HE-filled UXO. When comparing alternatives, the restoration of the moderate-quality habitat following remediation and an assessment of short-term risks to workers from excavation activities against the longer-term risk of leaving exceedances in place should be evaluated.

Alternative 1: No Additional Action does not achieve Human Health RAOs since untreated soil that potentially contains HE-filled UXO and agent remains in place, without controls or treatment being initiated. This alternative was therefore eliminated from further consideration. The remaining three alternatives achieve RAOs and meet the two DAA threshold criteria: protection of human health and the environment and compliance with action-specific and location-specific ARARs for the DAA. The alternatives differ only in how well they satisfy the five balancing criteria. All three of the remaining alternatives use adequate and reliable engineering controls or treatment methods and are readily implemented.

Alternative 3: Landfill achieves RAOs through excavation and containment elsewhere on RMA. The short-term impacts associated with excavation and agent/UXO clearance are addressed, and the residual risks are minimal. This alternative is considered cost-effective and was retained for development of sitewide alternatives.

Alternative 6: Caps/Covers achieves RAOs through in-place containment. Although the capped area is revegetated to restore habitat, the types of vegetation placed at the site and the maintenance activities performed there make the area undesirable as habitat for burrowing animals. The capped area covers 170,000 SY and is located near prairie dog colonies, which results in long-term impacts on habitat. Therefore, this alternative was not retained for consideration in developing sitewide alternatives.

Alternative 10: Direct Solidification/Stabilization exhibits the highest cost of the alternatives ($6,610,000) and requires the separation of debris from the burn trenches prior to treatment. Alternative 10 results in the same long-term risks and higher short-term impacts associated with materials handling than Alternative 3. Based on the higher cost and higher short-term risks for similar long-term risks, Alternative 10 was not retained for further evaluation.

Consequently, the alternative that was retained to represent the Burial Trenches Subgroup in the development of the sitewide alternatives (Section 20) is as follows:

- Alternative 3: Landfill (On-Post Landfill)

Table 19.0-1 Characteristics of the Undifferentiated Medium Group

Characteristic	Section 36 Balance of Areas Subgroup	Burial Trenches Subgroup
Contaminants of Concern		
Human Health	OCPs, CLC2A,	ICP metals
Biota	OCPs, Hg	As
Exceedance Area (SY)		
Total	750,000	170,000
Human Health	150,000	12,000
Biota	600,000	Not Applicable
Potential Agent	94,000	7,100
Potential UXO	230,000	170,000
Exceedance Volume (BCY)		
Total	280,000	32,000
Human Health	79,000	32,000
Organic	79,000	0
Inorganic	0	32,000
Principal Threat	0	0
Biota OCPs	200,000	Not Applicable
Potential Agent	300	12
Potential UXO	160	550
Depth of Contamination (ft)		
Human Health	0–10	0–10
Biota	0–1	Not Applicable

Table 19.1-1 Summary of Concentrations for the Section 36 Balance of Areas Subgroup

Contaminants of Concern	Range of Concentrations[1] (ppm)	Average Concentration[1] (ppm)	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Heatlh Acute Criteria (ppm)
Human Health Exceedance Volume					
Aldrin	BCRL-120	11	71	720	3.8
Dieldrin	BCRL-140	24	41	410	3.7
Endrin	BCRL-46	5.3	230	230,000	56
Isodrin	BCRL-37	1.6	52	5,200	Not applicable
Chlordane	BCRL-140	2.2	55	3,700	12
Chloroacetic Acid	BCRL-320	52	77	77,000	3,900
p,p,DDE	BCRL-1.8	0.10	1,250	12,500	Not applicable
p,p,DDT	BCRL-23	0.20	410	13,500	14
Arsenic	BCRL-16	2.4	420	4,200	270
Mercury	BCRL-50	0.46	570	570	82
Biota Volume					
Aldrin	BCRL-2.2	0.061			
Dieldrin	BCRL-3.5	0.010			
Endrin	BCRL-3.1	0.12			
p,p,DDE	BCRL-1.6	0.010			
p,p,DDT	BCRL-8.6	0.028			
Arsenic	BCRL-289	3.85			
Mercury	BCRL-56	0.5			

[1] Based on modeled concentrations within the human health exceedance volume on potential biota risk area.

Table 19.1-2 Frequency of Detections for Section 36 Balance Of Areas Subgroup

	Total Samples Analyzed	BCRL		CRL-SEC(1)		Acute-HH SEC(2)		HH SEC-Pr. Threat(2)		>Pr. Threat(2)	
		Number	%	Number	%	Number	%	Number	%	Number	%
Aldrin	417	339	81.3%	71	17.0%	6	1.4%	1	0.2%	0	0.0%
Benzene	79	68	86.1%	11	13.9%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	79	79	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlordane	381	300	78.7%	71	18.6%	8	2.1%	2	0.5%	0	0.0%
Chloroacetic Acid	88	84	95.5%	3	3.4%	--	--	1	1.1%	0	0.0%
Chlorobenzene	79	79	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chloroform	79	68	86.1%	11	13.9%	--	--	0	0.0%	0	0.0%
p,p,DDE	417	376	90.2%	41	9.8%	--	--	0	0.0%	0	0.0%
p,p,DDT	417	377	90.4%	39	9.4%	1	0.2%	0	0.0%	0	0.0%
Dibromochloropropane	355	335	94.4%	20	5.6%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	79	75	94.9%	4	5.1%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	42	42	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	288	287	99.7%	1	0.3%	--	--	0	0.0%	0	0.0%
Dieldrin	417	269	64.5%	113	27.1%	29	7.0%	6	1.4%	0	0.0%
Endrin	417	336	80.6%	80	19.2%	1	0.2%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	384	370	96.4%	14	3.6%	--	--	0	0.0%	0	0.0%
Isodrin	417	384	92.1%	33	7.9%	--	--	0	0.0%	0	0.0%
Methylene Chloride	75	56	74.7%	19	25.3%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	23	22	95.7%	1	4.3%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	79	77	97.5%	2	2.5%	--	--	0	0.0%	0	0.0%
Toluene	79	78	98.7%	1	1.3%	--	--	0	0.0%	0	0.0%
Trichloroethylene	79	79	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Arsenic	369	224	60.7%	145	39.3%	0	0.0%	0	0.0%	0	0.0%
Cadmium	276	254	92.0%	22	8.0%	0	0.0%	0	0.0%	0	0.0%
Chromium	276	58	21.0%	218	79.0%	--	--	0	0.0%	0	0.0%
Lead	275	189	68.7%	86	31.3%	--	--	0	0.0%	0	0.0%
Mercury	407	312	76.7%	95	23.3%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-foot depth interval.
(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.
-- not applicable

Table 19.2-1 Comparative Analysis of Alternatives for the Section 36 Balance of Areas Subgroup

Criteria	Alternative 1: No Additional Action	Alternative 2: Access Restrictions	Alternative 3: Landfill	Alternative 3g: Landfill; Caps/Covers with Consolidation; Soil Cover
1. Overall protection of human health and the environment	Not Protective: Does not achieve Human Health or Biota RAOs; Groundwater impacts not reduced	Achieves RAOs but contamination, including potential agent and UXO, remains; impacts on groundwater not reduced	Protective: Achieves RAOs through containment; impacts to groundwater greatly reduced	Protective: Achieves RAOs through containment impacts to groundwater reduced
2. Compliance with ARARs	Does not comply with Army regulations for agent/UXO	Does not comply with Army regulations for agent/UXO	Complies	Complies
3. Long-term effectiveness and permanence	Moderate for agent/UXO residual risk; contaminants including potential agent and UXO remain in place, impacts to groundwater remain	Moderate Residual Risk: Access controls interrupt exposure pathways for humans and biota	Minimal Residual Risk: Contaminated soil removed and contained	Minimal residual risk achieves RAOs through containment; contaminated soil removed and contained; soil cover installed
4. Reduction in TMV	Natural attenuation only for 280,000 BCY	Exposure pathway interrupted; Natural attenuation only for 280,000 BCY	Exposure pathways and mobility reduced for landfilled volume	Exposure pathways interrupted and mobility reduced for landfilled and consolidated soil; soil cover installed
5. Short-term effectiveness	Existing poor-quality habitat not changed; impacts to groundwater not reduced; No short-term risk because no action undertaken	Low short-term risk due to the limited nature of remedial action; RAOs achieved in 3 years	Significant risk to workers and community during agent and UXO clearance and excavation and landfilling of contaminated soil; adequately mitigated; RAOs achieved in 2 years	Significant risk to workers and community during agent/UXO clearance and excavation; consolidating, landfilling of contaminated soil; adequately mitigated; RAOs achieved in 2 years
6. Implementability	Feasible; No implementation required	Feasible	Feasible	Feasible
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$6,360,000 Total—$6,360,000	Capital—$483,000 Operating—$271,000 Long-term—$6,140,000 Total—$6,890,000	Capital—$7,820,000 Operating—$10,700,000 Long-term—$194,000 Total—$18,700,000	Capital—$4,190,000 Operating—$13,600,000 Long-term—$93,000 Total—$17,900,000
Summary	Not Retained: Not protective of human health and the environment	Not Retained: Contaminants, including potential agent and UXO presence remain in place	Retained: Containment of contaminated soil provides protection	Retained: Containment of contaminated soil provides protection and installation of soil cover

Table 19.2-1 Comparative Analysis of Alternatives for the Section 36 Balance of Areas Subgroup

Criteria	Alternative 6: Caps/Covers	Alternative 13a: Direct Thermal Desorption	Alternative 19a: In Situ Thermal Treatment
1. Overall protection of human health and the environment	Protective: Achieves RAOs through in-place containment; impacts to groundwater greatly reduced	Protective: Achieves RAOs through treatment and containment; impacts to groundwater greatly reduced	Not Protective: In situ treatment does not achieve PRGs and RAOs
2. Compliance with ARARs	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Low Residual Risk: Contaminated soil contained in place	Minimal residual risk; PRGs achieved through treatment for human health exceedance; remaining soil landfilled	Low Residual Risk: Human health exceedance treated although PRGs not achieved; minimal residual risk associated with landfilled soil
4. Reduction in TMV	Exposure pathways interrupted and mobility reduced for entire volume through containment	TMV reduced for human health exceedance soil; exposure pathways and mobility reduced for remaining soil	TMV reduced by treatment but not eliminated; exposure pathways and mobility reduced for landfilled soil
5. Short-term effectiveness	Low short-term risk; Protective of workers and the community; no intrusive action; RAOs are achieved in 2 years	Significant risk to workers and community during agent/UXO clearance and excavation, transportation, and treatment; adequately mitigated; RAOs are achieved in 4 years	Significant short-term risk associated with agent/UXO clearance and excavation and landfilling; also associated with in situ treatment; RAOs not completely met
6. Implementability	Feasible	Technically Feasible: Administratively difficult for thermal treatment	Not Implementable: In situ thermal treatment not proven at full scale
7. Present worth costs	Capital—$0 Operating—$40,800,000 Long-term—$2,750,000 Total—$43,600,000	Capital—$7,830,000 Operating—$17,100,000 Long-term—$143,000 Total—$25,100,000	Capital—$19,500,000 Operating—$32,100,000 Long-term—$152,000 Total—$51,800,000
Summary	Retained: Contaminated soil contained in place although high cost compared to landfilling	Not Retained: High cost for treatment without reducing risk compared to landfilling	Not Retained: Not commercially available and higher cost at higher long-term risk than containment; Does not achieve RAOs

Table 19.4-1 Summary of Concentrations for the Burial Trenches Subgroup

Contaminants of Concern	Range of Concentrations (ppm)	Average Concentration[1]	Human Health SEC (ppm)	Human Health Principal Threat Criteria (ppm)	Human Health Acute Criteria (ppm)
Human Health Exceedance Volume					
Chromium	BCRL-39	20	39	7,500	2,400
Lead	BCRL-3,400	190	2,200	Not applicable	Not applicable

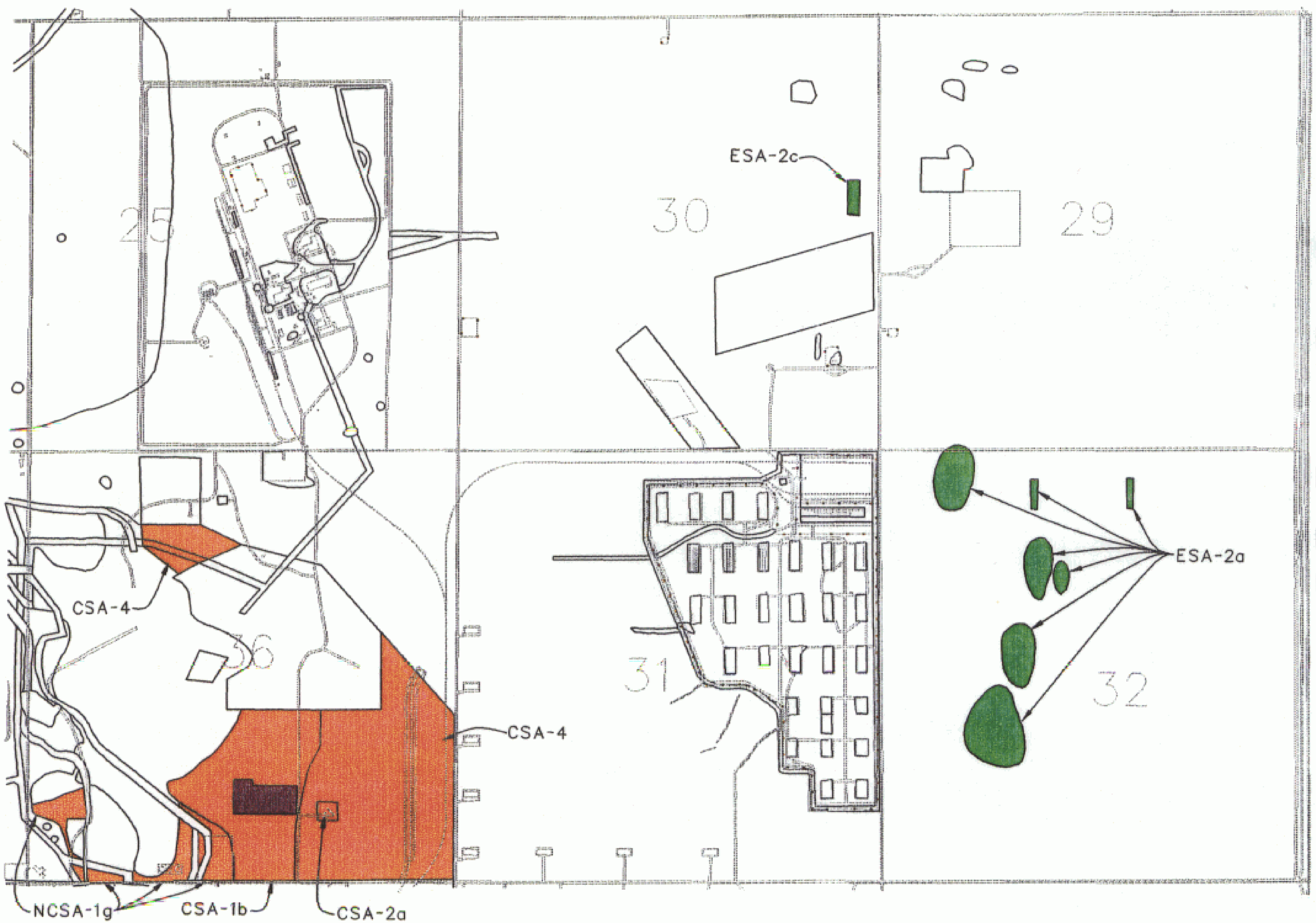
[1] Based on contaminants of concern above SEC within the human health exceedance volume, and on concentrations within the potential biota risk area for the biota volume.

Table 19.4-2 Frequency of Detections for Burial Trenches Subgroup

	Total Samples Analyzed	BCRL Number	BCRL %	CRL-SEC(1) Number	CRL-SEC(1) %	Acute-HH SEC(2) Number	Acute-HH SEC(2) %	HH SEC-Pr. Threat(2) Number	HH SEC-Pr. Threat(2) %	>Pr. Threat(2) Number	>Pr. Threat(2) %
Aldrin	109	104	95.4%	5	4.6%	0	0.0%	0	0.0%	0	0.0%
Benzene	59	55	93.2%	4	6.8%	--	--	0	0.0%	0	0.0%
Carbon Tetrachloride	60	60	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlordane	115	104	90.4%	11	9.6%	0	0.0%	0	0.0%	0	0.0%
Chloroacetic Acid	55	55	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chlorobenzene	60	60	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Chloroform	60	59	98.3%	1	1.7%	--	--	0	0.0%	0	0.0%
p,p,DDE	109	109	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
p,p,DDT	109	109	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Dibromochloropropane	110	110	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,2-Dichloroethane	60	60	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
1,1-Dichloroethene	29	29	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dicyclopentadiene	92	92	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Dieldrin	109	96	88.1%	13	11.9%	0	0.0%	0	0.0%	0	0.0%
Endrin	116	114	98.3%	2	1.7%	0	0.0%	0	0.0%	0	0.0%
Hexachlorocyclopentadiene	109	109	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Isodrin	109	107	98.2%	2	1.8%	--	--	0	0.0%	0	0.0%
Methylene Chloride	38	38	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethane	4	4	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Tetrachloroethylene	60	59	98.3%	1	1.7%	--	--	0	0.0%	0	0.0%
Toluene	52	52	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Trichloroethylene	60	60	100.0%	0	0.0%	--	--	0	0.0%	0	0.0%
Arsenic	120	72	60.0%	48	40.0%	0	0.0%	0	0.0%	0	0.0%
Cadmium	113	90	79.6%	23	20.4%	0	0.0%	0	0.0%	0	0.0%
Chromium	113	22	19.5%	91	80.5%	--	--	0	0.0%	0	0.0%
Lead	113	65	57.5%	47	41.6%	--	--	1	0.9%	0	0.0%
Mercury	100	98	98.0%	2	2.0%	0	0.0%	0	0.0%	0	0.0%

(1) SEC limits for this interval are based on chronic HH SEC, or where appropriate, acute risk-based criteria for the 0- to 1-ft depth interval.
(2) Table 1.4-1 presents acute criteria, HH SEC, and principal threat criteria.
-- not applicable

Criteria	Alternative 1: No Additional Action	Alternative 3: Landfill	Alternative 6: Caps/Covers	Alternative 10: Direct Solidification/Stabilization
1. Overall protection of human health and the environment	Not Protective: Does not achieve RAOs	Protective: Achieves RAOs through containment; No impacts on groundwater	Protective: Achieves RAOs through containment; No impacts on groundwater	Protective: Achieves RAOs through treatment/ immobilization and/or containment; No impact to groundwater
2. Compliance with ARARs	Does not comply with Army regulations regarding Agent/UXO controls	Complies	Complies	Complies
3. Long-term effectiveness and permanence	Moderate Residual Risk: contaminated soil, including potential agent and UXO, remain	Minimal Residual Risk: Entire volume removed and treated and/or contained	Low Residual Risk: Entire volume contained in place; long-term monitoring required	Minimal Long-Term Risk: Human health exceedance immobilized and balance contained in a landfill
4. Reduction in TMV	Natural attenuation only for 31,000 BCY	Exposure pathways interrupted and mobility reduced for remaining volume through landfilling	Exposure pathways interrupted and mobility reduced through containment	Exposure pathway interrupted through containment; Mobility reduced for remaining volume through solidification
5. Short-term effectiveness	Low short-term risk; No implementation required; habitat not changed	Significant short-term risk associated with agent/UXO clearance and excavation and landfilling; RAOs are achieved in 2 years	Low short-term risk to worker health and community; no intrusive action; RAOs achieved in 1 year	Significant short-term risk associated with agent/UXO clearance and excavation, treatment, and transportation of contaminated soil; RAOs are achieved in 2 years
6. Implementability	Feasible; No implementation required	Feasible	Feasible	Feasible: No difficulty anticipated with solidification
7. Present worth costs	Capital—$0 Operating—$0 Long-term—$1,090,000 Total—$1,090,000	Capital—$2,210,000 Operating—$3,130,000 Long-term—$59,000 Total—$5,410,000	Capital—$0 Operating—$3,210,000 Long-term—$836,000 Total—$4,050,000	Capital—$1,570,000 Operating—$4,830,000 Long-term—$206,000 Total—$6,610,000
Summary	Not Retained: Not protective of human health and the environment	Retained: Protection provided by containment	Not Retained: Long-term impact on habitat	Not Retained: High cost for small difference in risk reduction compared to landfill



ROCKY MOUNTAIN ARSENAL
INDEX MAP

LEGEND

Burial Trenches Subgroup
SITES: ESA-2a, Section 32 Burn Pits
ESA-2c, Open Trenches

SECTION 36 Balance of Areas Subgroup
SITES: CSA-1b, Complex Disposal Area South
CSA-2a, Munitions Testing Area
CSA-4, Balance of Areas Investigated
NCSA-1g, Balance of Areas

Shell Trenches Subgroup, Disposal Trenches Medium Group

Site Boundary

Buildings and Roads

32 Section Number

750 0 750 1500 FEET

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 19.0-1

Site Locations
Undifferentiated Medium Group

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

REVISION NO. 2
FILE NAME 20110\32\F03-027.DWG
DATE 3/2/93
DRAWN BY EMH
APPROVED BY
CHECKED BY

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 19.1-1

Exceedance Areas
Section 36 Balance of Areas
Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

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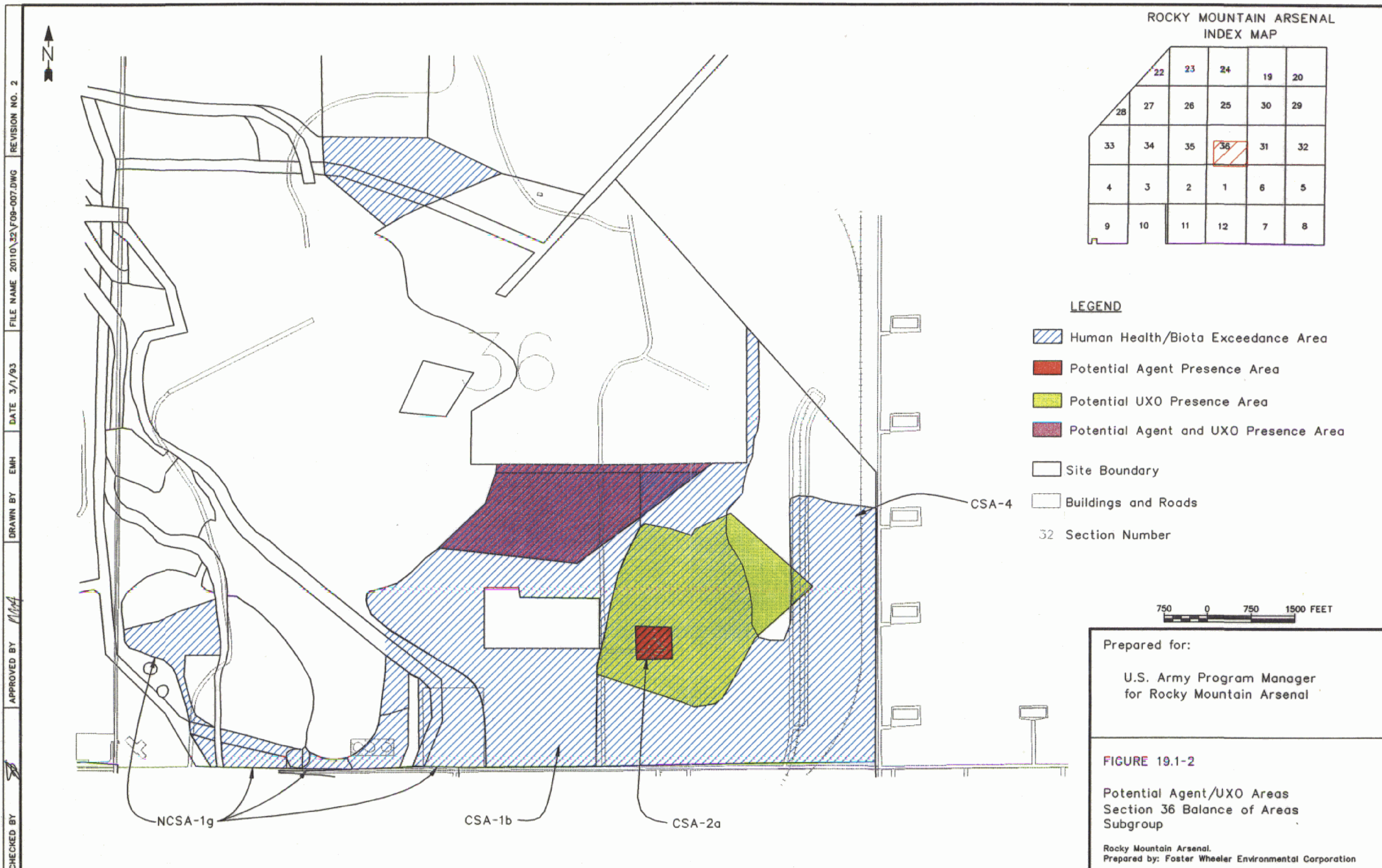
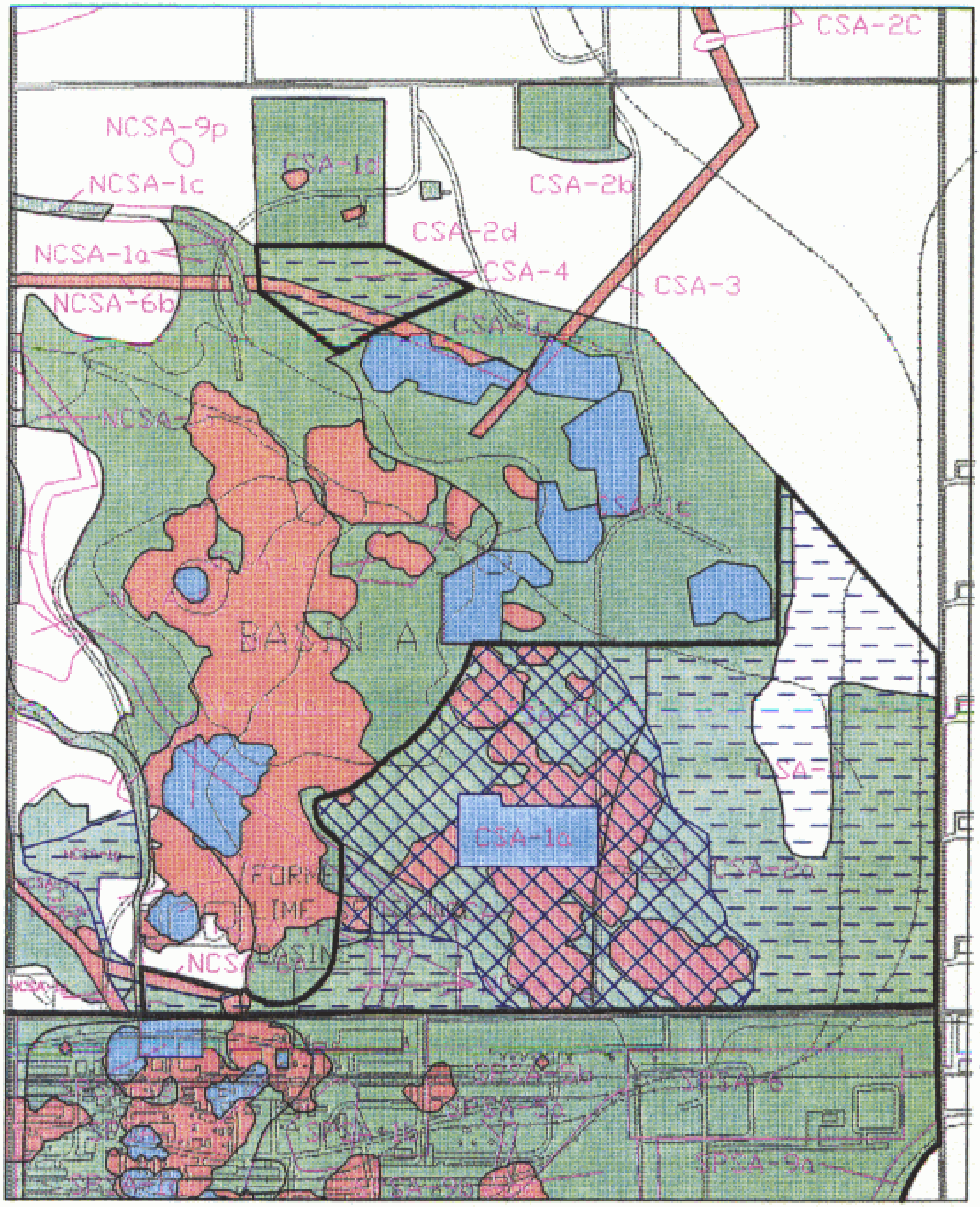


FIGURE 19.1-2

Potential Agent/UXO Areas
Section 36 Balance of Areas
Subgroup



Legend

- Principal Threat Exceedance Area
- Human Health Exceedance Area
- Excess Biota Risk Area
- 2 Foot Soil Cover Area
- 1 Foot Soil Cover Area
- Sites with Soil Cover Remedies
- SAR Site and ID
- 31 Section Number
- Section Line
- Drainage
- Road
- Railroad

-N-

0 500 1000

Scale in Feet

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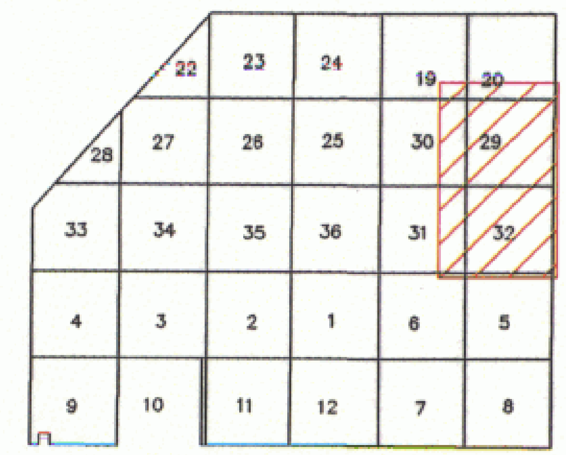
Prepared for:
U.S. Army Program Manager
for Rocky Mountain Arsenal

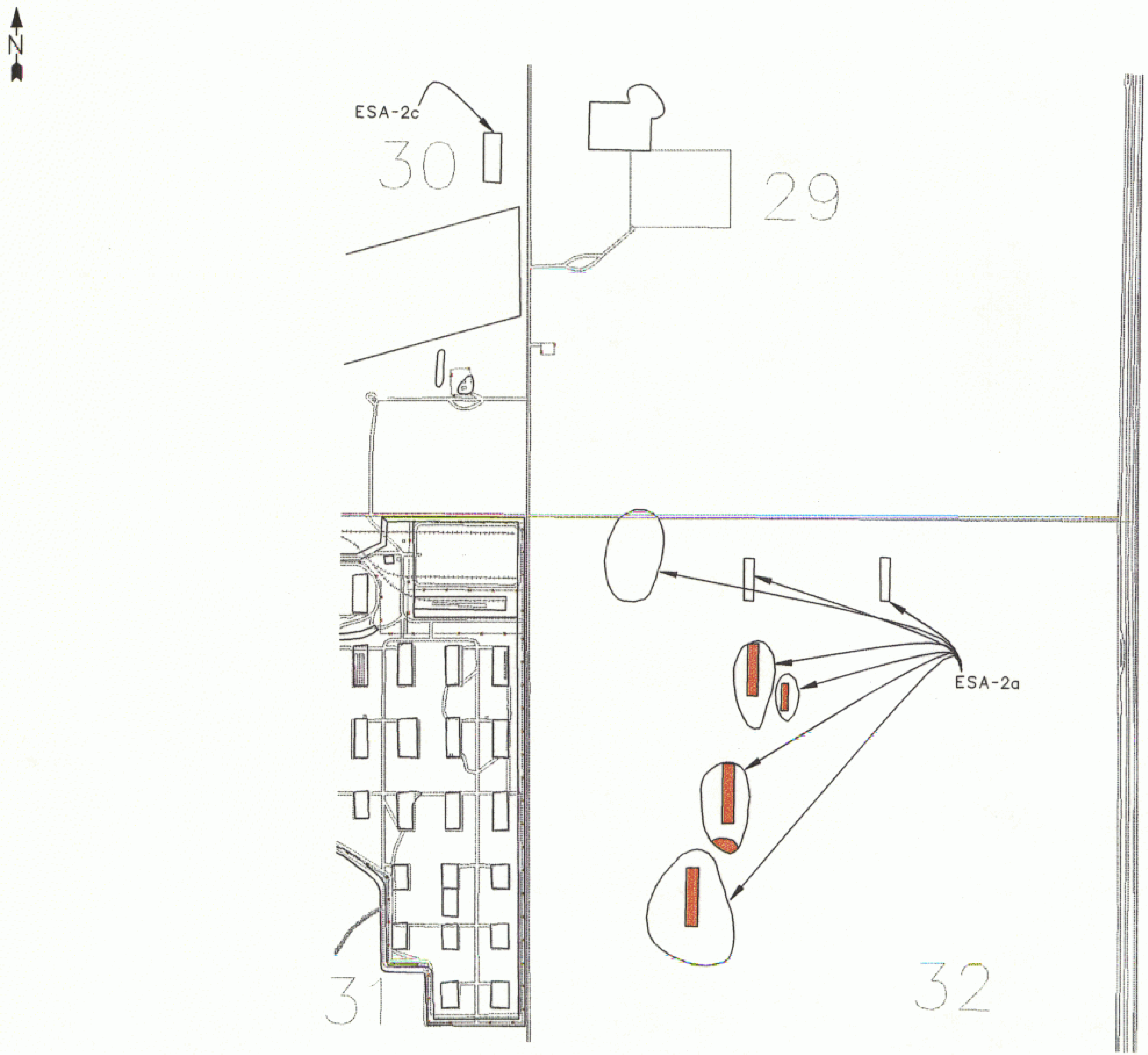
Prepared October 1995

Figure 19.2–1

Soil Cover Areas
Section 36 Balance of Areas Subgroup

Rocky Mountain Arsenal
Prepared by: Foster Wheeler Environmental Corp.





LEGEND

Human Health Exceedance Area

Site Boundary

Buildings and Roads

32 Section Nunber

500 0 500 1000 FEET

Prepared for:

U.S. Army Program Manager
for Rocky Mountain Arsenal

October 1995

FIGURE 19.4-1

Exceedance Area
Burial Trenches Subgroup

Rocky Mountain Arsenal.
Prepared by: Foster Wheeler Environmental Corporation

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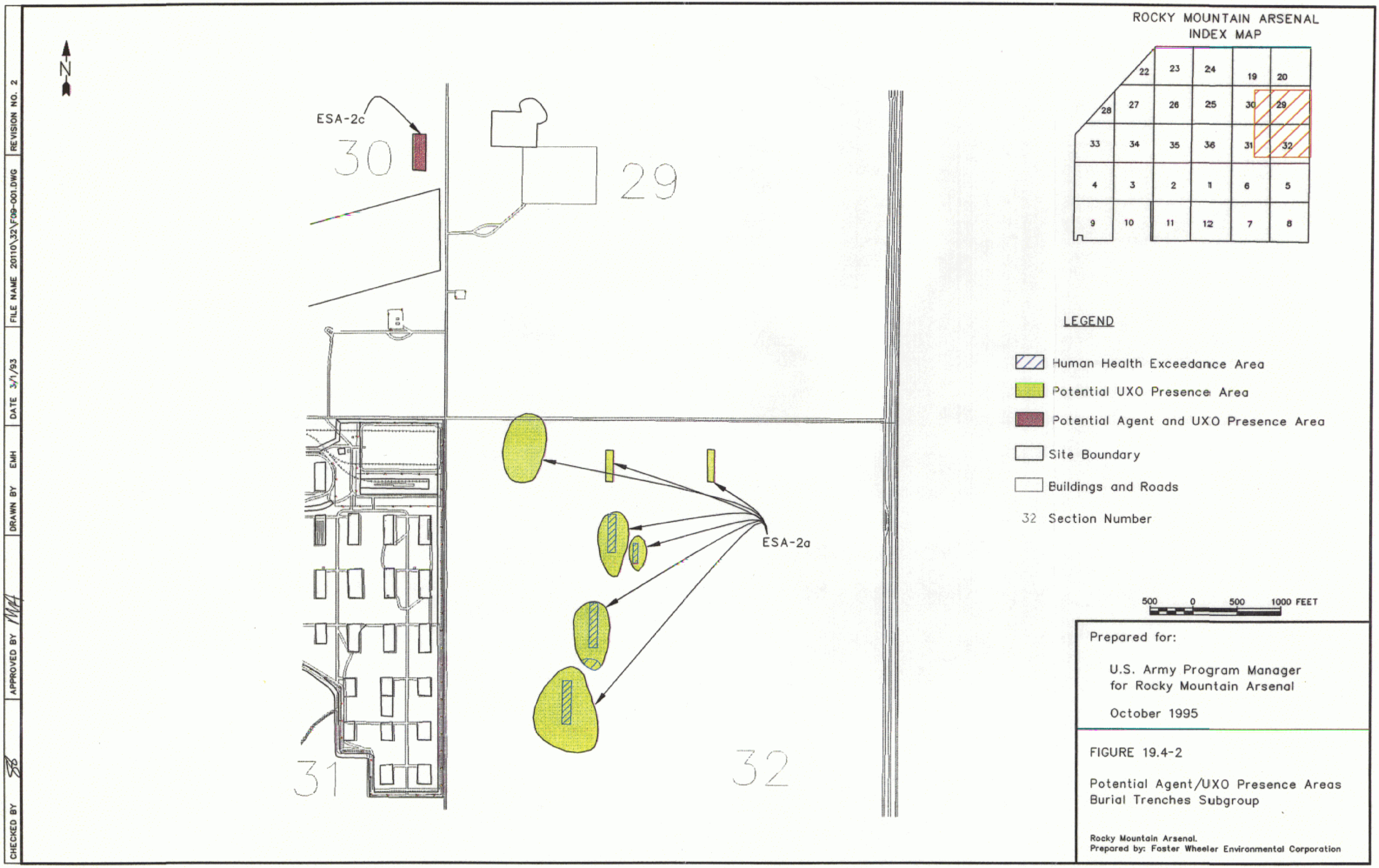


FIGURE 19.4-2

Potential Agent/UXO Presence Areas
Burial Trenches Subgroup

20.0 COMPARATIVE ANALYSIS AND SELECTION OF A PREFERRED SITEWIDE ALTERNATIVE

Five sitewide alternatives, each of which represents a distinct remedial approach, were developed based on the retained alternatives for each medium group/subgroup, which are described in Sections 5 through 19. These alternatives also represent the range of remedial approaches proposed by the Parties for RMA. Table 20.0-1 describes the alternatives for each medium group/subgroup that comprise the sitewide alternatives. The five sitewide alternatives vary from capping most medium groups/subgroups to the treatment and landfilling of most of the contaminated soil that poses potential risks to human health or biota, as shown in Table 20.0-2. All alternatives include treatment of contaminated groundwater and agent-contaminated soil and structures as a principal element. Sections 20.1 through 20.5 describe the five sitewide alternatives. In Section 20.6, the sitewide alternatives are comparatively evaluated against the EPA alternatives evaluation criteria, and in Section 20.7 the alternatives are evaluated with regard to the NCP criteria (EPA 1990a) for the selection of a preferred alternative.

Although the potential interactions among the media were identified in the evaluation of alternatives for each medium group/subgroup, the interactions between soil remedial alternatives and alternatives for groundwater and structures are most effectively addressed through developing sitewide alternatives, since structures and groundwater alternatives affect many soil medium groups/subgroups simultaneously and in interactive ways.

The preferred sitewide structures alternative consists of the demolition of no future use structures and landfilling of structural debris or consolidating the debris in Basin A. The structures that are contaminated with agent are treated by caustic washing prior to landfilling and structures associated with significant historical contamination are landfilled. Approximately 170,000 BCY of structural debris will be landfilled under this alternative and approximately 160,000 BCY will be consolidated in Basin A. The preferred sitewide structures alternative is described in further detail in the Structures DAA (Volume VI), Section 9.

The preferred sitewide alternative for groundwater consists of continued operation of the groundwater pump and treat systems along the boundaries of RMA and the existing on-post IRAs. Additional groundwater extraction systems are installed to intercept the Section 36 Bedrock Ridge groundwater plumes in conjunction with containment of the Complex Trenches Subgroup. In addition, the water levels in the South Lakes are maintained high in order to reduce the migration of contaminated groundwater into the lakes. The preferred sitewide groundwater alternative is described in further detail in the Water DAA (Volume V), Section 9.

The development of sitewide alternatives also permits more accurate sizing of the treatment and disposal facilities so that the cost-efficiencies associated with the centralized treatment and containment facilities can be more accurately estimated, and total estimated costs can be developed on a more consistent basis. Site-specific cost spreadsheets were developed during the DAA to provide detailed cost estimates for soil, structures, and water remediation alternatives. Two commercially available cost-estimating programs were also obtained in order to perform an independent check on the DAA costing and to evaluate whether other cost estimating systems give more usable or more reliable results. These programs are MCACES (MicroComputer-Aided Cost Engineering Support), which was developed by Building Systems Design Company for the U.S. Army Corps of Engineers and can be linked to the Primavera scheduling system, and RACER (Remedial Action Cost Engineering and Requirements), which was developed by Delta Research Corporation for the U.S. Air Force. These programs are described further in Appendix B.5.

For the soil alternatives, the Draft Final DAA preferred sitewide alternative (Consolidation/Caps/Treatment/Landfill Alternative) was costed both in MCACES and in RACER. Based on the comparison between these programs and the Draft Final DAA costing spreadsheets, it was determined that the five soil sitewide alternatives being developed for the Final DAA should be costed in MCACES and scheduled in Primavera to most accurately evaluate the costs, cost efficiencies, and schedule of these complex remedial approaches. These estimated costs and schedules are described briefly in Section 20.6.7. and presented in detail in Appendix B, Sections B.5 and B.6.

20.1 SUMMARY OF CAPS/COVERS SITEWIDE ALTERNATIVE

The Caps/Covers Sitewide Alternative entails the containment of 1,200 acres through the installation of a cap and the landfilling of 290,000 BCY of contaminated soil, as shown in Figure 20.1-1. The specific alternatives for each medium group/subgroup are shown in Table 20.0-1, and material volumes to be handled are listed in Table 20.0-2. Water and structures alternatives are as described in Section 20.0. The estimated remedial costs for this alternative are $542,000,000 for soil, $152,000,000 for structures, and $146,000,000 for water. The total RMA cleanup cost (including pre-ROD cost and Army management during remediation) is $1.9 billion in 1995 dollars. Assuming no funding limitations, approximately 7 years are required to complete implementation (i.e., design and construction) of the alternatives for soil and structures with a high-year cost of almost $200 million (see Appendix B.6). Long-term operation of groundwater extraction and treatment systems will continue for at least 30 years. If remediation funding is capped at $125 million per year due to Army budget limitations, this alternative will take 13 years to implement (see Appendix B.6). The uncertainties in the cost and time to implement this alternative are relatively lower than the last three sitewide alternatives because this alternative does not involve extensive excavation and treatment. Cost uncertainty factors are discussed in Section 20.6.7.

Under this alternative, 1,200 acres of multilayer caps are installed to prevent contact by humans and biota with contaminated soil, and to further reduce the migration of contaminants by limiting infiltration through the soil and eliminating airborne migration. The capped areas are located in the central portions of RMA. The existing covers for the Basin F Wastepile and Former Basin F Subgroups are augmented to improve performance and meet EPA guidance governing caps and covers. Approximately 17,800,000 BCY of borrow materials are required as backfill and gradefill to achieve the design grades for capping, and an additional 11,300,000 BCY of borrow (clay and common fill) are required for construction of the caps.

In addition to capping, all sewer manholes are plugged with cement to prevent the migration of contaminated groundwater through the sewer lines and access restrictions are enacted to control potential exposure pathways. Slurry walls are used in conjunction with caps for the Complex Trenches, Shell Trenches, Hex Pits and Buried M-1 Pits Subgroups to augment the containment of the sites. The groundwater inside the contained area is pumped, thereby lowering the water level inside the slurry walls so that contaminants do not migrate from these sites.

Areas outside the central portions of RMA that are suspected to have potential chemical agent or UXO presence are screened and cleared. Any agent-contaminated soil identified during screening is treated by caustic solution washing and then landfilled. In addition, any identified UXO is excavated, packaged, and transported off post to an existing Army facility for detonation and disposal (unless it is unstable and must be detonated on post). The 200,000 BCY of contaminated soil and debris from several sites in the eastern and western portions of RMA are excavated and placed in the on-post hazardous waste landfill along with debris from munitions screening operations. The 90,000 BCY of human health exceedances from the Surficial Soil and Agent Storage Medium Groups are also landfilled.

Soil posing a potential risk to biota is generally capped as discussed above. No additional action is undertaken for soil that potentially poses risks to biota that is located outside of the capped area in Upper Derby Lake (which is maintained dry), and the Surficial Soil, Ditches/Drainage Areas and Agent Storage medium groups. Although a residual risk to biota exists from not addressing this soil, the magnitude of the residual risk is low, and the disturbance of habitat over wide-spread areas of RMA is avoided. The soil in this area is sampled periodically. No additional action (other than monitoring) is conducted for the aquatic lake sediments since an exposure pathway has not been established between the sediments and aquatic biota. Ongoing monitoring of biota in these areas will be conducted by the USFWS and SFS and additional remedial actions will be implemented if required based on the monitoring results.

20.2 SUMMARY OF LANDFILL/CAPS SITEWIDE ALTERNATIVE

The Landfill/Caps Sitewide Alternative involves containment of approximately 490 acres through the installation of a cap and the landfilling of 2,000,000 BCY of contaminated soil. Figure 20.2-1 depicts the areas to be addressed by this alternative. The specific alternatives for each medium group/subgroup are shown in Table 20.0-1 and material volumes to be handled are listed in Table 20.0-2. Water and structures alternatives are as described in Section 20.0. The estimated remedial costs for this alternative are $383,000,000 for soil, $149,000,000 for structures, and $146,000,000 for groundwater. The total RMA cleanup cost (including pre-ROD costs and Army management during remediation) is $1.7 billion in 1995 dollars. Assuming no funding limitations, 6 years are required to complete implementation of the alternatives for soil and structures with high-year cost of approximately $160 million (see Appendix B.6). Long-term operation of groundwater extraction treatment systems will continue for at least 30 years. If remediation funding is capped at $125 million per year due to Army budget limitations, this alternative will take 9 years to complete (see Appendix B.6). The uncertainties in the cost and time to implement this alternative are relatively lower than the last three sitewide alternatives because this alternative does not involve extensive excavation and treatment. Cost uncertainty factors are discussed in Section 20.6.7.

The areas outside the central portion of RMA are excavated and landfilled, which interrupts exposure pathways. Any agent-contaminated soil identified during screening is treated by caustic washing and then landfilled. In addition, any UXO identified through geophysical surveys or other screening methods are excavated, packaged, and transported off-post to an existing Army facility for detonation and disposal (unless it is unstable and must be detonated on post). Chemical sewer lines in the central portion of the South Plants complex and within the Complex Trenches are plugged with cement to prevent migration of contaminants prior to capping the areas, and the sanitary sewer manholes are plugged to ensure that the sewer lines are not conduits for the migration of groundwater contamination. The remaining chemical sewers and associated contaminated soil are excavated and placed in the on-post hazardous waste landfill. The 110,000

BCY of human health exceedances from the Lake Sediments, Surficial Soil, and Agent Storage Medium Groups are landfilled.

A 390-acre area in the central portion of RMA is covered with multilayer caps to prevent exposure to humans and biota from contaminated soil and to further reduce the migration of contaminants by limiting infiltration through the soil and eliminating airborne migration. The capped areas consist of human health exceedance areas and areas with residual contamination in Section 36, the South Plants Central Processing Area, and the Former Basin F. The existing covers for the Basin F Wastepile and Former Basin F Subgroups are augmented to improve performance and meet EPA guidance governing caps and covers. Approximately 8,790,000 BCY of borrow materials are required as backfill and gradefill to achieve the design grades for capping, and an additional 3,930,000 BCY of borrow (clay and common fill) are required for construction of the cap.

Slurry walls are used in conjunction with caps for the Complex Trenches, Shell Trenches, Hex Pit and Buried M-1 Pits Subgroups to augment the containment of these sites. The groundwater inside the contained area is pumped, thereby lowering the water level inside the slurry walls so that contaminants do not migrate from these sites.

Soil posing a potential risk to biota is generally excavated and landfilled as discussed above. No additional action is undertaken for soil that potentially poses risks to biota in Upper Derby Lake (which is maintained dry), and the Surficial Soil, Ditches/Drainage Areas, and Agent Storage Medium Groups. Although a residual risk to biota exists from not addressing this soil, the magnitude of the residual risk is low, and the disturbance of habitat over wide-spread areas of RMA is avoided. The soil in this area is sampled periodically. No additional action other than monitoring is conducted for the aquatic lake sediments since an exposure pathway has not been established between the sediments and aquatic biota. The biota in these areas will be monitored by the USFWS and the SFS and additional remedial actions will be implemented if required based on the monitoring results.

20.3 SUMMARY OF LANDFILL SITEWIDE ALTERNATIVE

The Landfill Sitewide Alternative involves the containment of 3,400,000 BCY of contaminated soil in an on-post hazardous waste landfill. Approximately 100 acres of principal threat or human health exceedance soil areas are contained with a multilayer cap instead of being landfilled, and 300 acres are capped, after removing the human health exceedance volume and landfilling, to address residual contamination. The specific alternatives for each medium group/subgroup are shown in Table 20.0-1 and material volumes to be handled are listed in Table 20.0-2. Figure 20.3-1 identifies the 400 acres to be capped. Water and structures alternatives are as described in Section 20.0. The estimated remedial costs for this alternative are $576,000,000 for soil, $149,000,000 for structures, and $146,000,000 for groundwater. The total RMA cleanup cost (including pre-ROD costs and Army management during remediation) is $1.9 billion in 1995 dollars. Assuming no funding limitations, the implementation of the alternative requires 7 years for soil and structures with a high-year cost of nearly $210 million (see Appendix B.6). Long-term operation of groundwater extraction and treatment systems will continue for at least 30 years. If remediation funding is capped at $250 million per year due to Army budget limitations, this alternative will take 12 years to implement (see Appendix B.6). The uncertainties in the cost and time to implement this alternative are higher than Alternatives 1 and 2, because this alternative includes extensive excavation of highly contaminated soil, but lower than Alternatives 4 and 5 because complex treatment is not involved. Cost uncertainty factors are described in Section 20.6.7.

Contaminated soil from nearly all of the sites is landfilled under this alternative. The 3,400,000 BCY of contaminated soil are excavated and landfilled, which interrupts exposure pathways, and the landfill's leachate collection and treatment system ensures that no migration of contaminants to groundwater occurs. Any agent-contaminated soil identified during screening is treated by caustic washing and then landfilled. In addition, any UXO identified through geophysical surveys or other screening methods are excavated, packaged, and transported off post to an existing Army facility for detonation and disposal (unless it is unstable and must be detonated on post). The excavation of the Former Basin F, Buried M-1 Pits, Shell Trenches, and Hex Pit Subgroups requires the use of negative-pressure vapor enclosures to control and treat vapors and odors.

The sanitary sewer manholes are plugged to ensure that the sewer lines are not conduits for the migration of groundwater contamination, and the chemical sewers and associated contaminated soil are excavated and placed in the on-post hazardous waste landfill. The 87,000 BCY of human health exceedance volume from the Surficial Soil Medium Group, soil with human health exceedances in the Agent Storage Medium Group (2,900 BCY), and human health exceedances and soil that may pose a risk to biota from the Lake Sediments (including portions of Upper Derby Lake) and Ditches/Drainage Areas Medium Groups (90,000 BCY) are excavated and landfilled.

In order to ensure worker and community safety, the Basin F Wastepile and the Complex Trenches Subgroups are left in place and capped to prevent exposure to humans and biota from contaminated soil and to further reduce the migration of contaminants by limiting infiltration through the soil. The existing cover for the Basin F Wastepile is augmented to improve performance and meet EPA guidance governing caps and covers. Following the excavation and landfilling of human health exceedances, 390 acres in Section 36, South Plants Central Processing Area, and the Former Basin F are capped to contain residual contamination and soil that may pose a risk to biota, and eliminate airborne contaminant migration. Approximately 10,100,000 BCY of borrow materials are required as backfill and gradefill to achieve the design grades for capping, and an additional 3,860,000 BCY of borrow are required for construction of the cap.

Slurry walls are used in conjunction with the caps for the Complex Trenches Subgroup to augment the containment of this site. The groundwater inside the contained area is pumped, thereby lowering the water level inside the slurry walls so that contaminants do not migrate from the site.

Soil posing a potential risk to biota is generally excavated and landfilled as discussed above. No additional action is undertaken for soil that potentially poses risks to biota in the Surficial Soil Medium Group. Although a residual risk to biota exists from not landfilling this soil, the magnitude of the residual risk is low, and the disturbance of habitat over wide-spread areas of RMA is avoided. The soil in this area is sampled periodically. No additional action other than monitoring is conducted for the aquatic lake sediments since an exposure pathway has not been established between the sediments and aquatic biota. The USFWS/SFS will monitor biota in these areas and additional remedial actions will be implemented if required based on the monitoring results.

20.4 SUMMARY OF CONSOLIDATION/CAPS/TREATMENT/LANDFILL SITEWIDE ALTERNATIVE

The Consolidation/Caps/Treatment/Landfill Sitewide Alternative involves consolidation of 1,200,000 BCY of soil with low levels of contamination into Basin A, Former Basin F, and the South Plants Central Processing Area, capping or covering of 1,100 acres of contaminated soil, landfilling of 1,700,000 BCY of soil and debris, and treatment of 210,000 BCY of soil by solidification. This alternative also includes a 150,000-CY contingent soil volume that may be landfilled based on visual field observations such as soil stains, barrels, or newly discovered evidence of contamination. The location of samples and the volume of contingent soil to be excavated will be based on mutual agreement of all parties. In addition, up to 1,000 contingent confirmatory samples may be used to identify contingent soil volume requiring landfilling.

The specific alternatives for each medium group/subgroup are shown in Table 20.0-1 and material volumes to be handled are listed in Table 20.0-2. The areas addressed by treatment, landfilling and capping are shown in Figure 20.4-1. Water and structures alternatives are as described in Section 20.0. The estimated remedial costs for this alternative are \$570,000,000 for soil, \$150,000,000 for structures, and \$146,000,000 for groundwater. The total RMA cleanup cost (including pre-ROD costs and Army management during remediation) is \$2.0 billion in 1995 dollars. Assuming no funding limitations, approximately 9 years are required for implementation of the soil and structures alternatives, with a high-year cost of approximately \$180 million (see

Appendix B.6). Long-term operation of groundwater extraction and treatment systems will continue for at least 30 years. If remediation funding is capped at $125 million per year due to Army budget limitations, this alternative will take 13 years to implement (see Appendix B.6). The uncertainties in cost and time to implement this alternative are very high because large volumes of soil are excavated and treated. Cost uncertainty factors are discussed in Section 20.6.7.

Approximately 210,000 BCY of principal threat or human health exceedance soil from the Former Basin F and the Buried M-1 Pits are treated by solidification/stabilization. Solidification reduces the mobility of contaminants and if performed in situ, minimizes the potential for worker exposure to contaminants. In situ treatment of the Former Basin F will minimize the generation of vapors and odors. Excavation of the Buried M-1 Pits will be conducted under a negative pressure vapor enclosure to collect and treat any vapors and odors. Because of the unique nature of the Hex Pit, the remedial alternative cannot be selected without additional evaluation. Treatment technologies (including innovative technologies) will continue to be reviewed. The preferred alternative will be specified in the ROD, although treatibility studies may still be performed during the remedial design stage.

To provide maximum protection for the approximately 650,000 BCY of higher level contaminated soil from the Basin F Wastepile and the Section 36 Lime Basins Subgroups, the soil is excavated and landfilled in a triple-lined landfill cell within the on-post landfill. Soil from the Basin F Wastepile not passing the EPA paint filter test will be dried to achieve this performance criterion prior to landfilling. Approximately 1,000,000 BCY of human health exceedance soil from other sites throughout RMA as well as debris from UXO clearance operations are landfilled under this alternative. Landfilling interrupts exposure pathways, and the landfill's leachate collection and treatment system ensures that there is no migration of contaminants to groundwater. Any agent-contaminated soil identified during screening is treated by caustic washing and then landfilled. In addition, any identified UXO are excavated, packaged, and transported off-post to an existing

Army facility for detonation and disposal (unless it is unstable and must be detonated on post).

Slurry walls are used in conjunction with the caps for the Complex Trenches Subgroup to augment the containment of the sites. For the purposes of conceptual design and costing during the FS, it is assumed that the groundwater inside the contained area is pumped, thereby lowering the water level inside the slurry walls so that contaminants do not migrate from the sites. (This assumption will be reevaluated during the remedial design.) The sanitary sewer manholes are plugged to ensure that the sewer lines are not conduits for the migration of groundwater contamination. The chemical sewers located in the South Plants Central Processing Area and Complex Trenches are plugged and the remaining human health exceedance soil and sewer debris is excavated and placed in the landfill.

Soil posing a potential risk to biota within the Secondary Basins as well as the North Plants Manufacturing Area is capped in place. Soil posing a potential risk to biota within the Ditches/Drainage Areas, Sanitary Landfills, Section 36 Balance of Areas, South Plants, and some of the Lake Sediments and Surficial Soils medium groups/subgroups are consolidated as gradefill soil within Basin A, South Plants Central Processing Area, or Former Basin F and capped. The capping of these three areas requires approximately 5,700,000 BCY of gradefill to provide sufficient slope for the caps. This sitewide alternative generates approximately 1,200,000 BCY of soil with low levels of contamination which can be consolidated from other sites and used to supplement the required gradefill volume, decreasing the total volume of borrow material required. As a result, consolidation lowers the cost of obtaining gradefill and reduces the disturbance of natural habitat. Only 4,500,000 BCY of additional borrow materials are required as gradefill to achieve the design grades for capping in addition to the consolidated soil volume. Other sites require an additional 3,050,000 BCY of backfill and gradefill to achieve design grades for caps/covers. An additional 5,100,000 BCY of borrow material is required for construction of all caps/covers. Figure 20.4-1 shows the areas to be consolidated into the Basin A or South Plants Central Processing Area prior to capping.

Soil posing risk to biota is generally excavated and consolidated within the Basin A, South Plants Central Area caps, or Former Basin F. No additional action is undertaken for soil that potentially poses risks to biota that is located outside of this area, within the Lake Sediments or Surficial Soil Medium Groups. These areas are sampled periodically. No additional action (other than monitoring) is conducted for the aquatic lake sediments since an exposure pathway has not been demonstrated between the sediments and aquatic biota. Ongoing monitoring of the biota in these areas will be conducted by the USFWS and SFS and additional remedial actions will be implemented if required based on the monitoring results.

20.5 SUMMARY OF CAPS/TREATMENT/LANDFILL SITEWIDE ALTERNATIVE

The Caps/Treatment/Landfill Sitewide Alternative is composed of the following features: capping of 530 acres of contaminated soil, landfilling of 4,000,000 BCY of soil and debris, and treatment of 1,120,000 BCY of contaminated soil (Figure 20.5-1). The specific alternatives for each medium group/subgroup are shown in Table 20.0-1 and material volumes to be handled are listed in Table 20.0-2. The estimated remedial costs for this alternative are $1,010,000,000 for soil, $149,000,000 for structures, and $146,000,000 for groundwater. The water and structures alternatives are as described in Section 20.0. The total remediation cost (including pre-ROD costs and Army management during remediation) is $2.7 billion in 1995 dollars. Assuming no funding restrictions, approximately 14 years are required for implementing this alternative for soil and structures, with a high-year cost of nearly $170 million (see Appendix B.6). Long-term operations of groundwater extraction and treatment systems will continue for at least 30 years. If remediation funding is capped at $125 million per year due to Army budget limitations, the alternative will take 18 years to complete. The uncertainties in cost and time to complete this alternative are extremely high because large volumes of soil are excavated and treated. Cost uncertainty factors are discussed in Section 20.6.7.

Approximately 1,100,000 BCY of principal threat soil are treated by thermal desorption, incineration or solidification. The majority of the soil treated by thermal desorption is from the Basin F Wastepile, Former Basin F and South Plants Central Processing Area Subgroups. The excavation of soil from both the Basin F Wastepile and Former Basin F for treatment requires vapor enclosures to collect and treat vapors and odors. Soil in the Shell Trenches and Hex Pit Subgroups (103,000 BCY) is excavated and treated by incineration to vaporize and destroy contaminants in the soil. The excavation of both the Shell Trenches and Hex Pit requires the operation of vapor enclosures to collect and treat any vapors and odors generated during excavation. All soil treated by thermal desorption or incineration is placed in the on-post hazardous waste landfill.

The 27,000 BCY of soil contaminated with inorganic contaminants are treated by solidification. The majority of the soil to be solidified is excavated from the Buried M-1 Pits Subgroup, which requires a negative-pressure vapor enclosure to collect and treat vapors and odors during excavation.

In order to ensure worker and community safety, the Complex Trenches Subgroup is left in place and contained with a cap to prevent exposure to humans and biota from contaminated soil and to further reduce the migration of contaminants by limiting infiltration through the soil. Slurry walls are used in conjunction with the caps to contain the Complex Trenches Subgroup and minimize the flow of groundwater through the disposal trenches. The groundwater inside the contained area is pumped, thereby lowering the water level inside the slurry walls and ensuring that contaminants do not migrate away from the site.

Following the excavation of human health exceedance volumes for treatment or disposal, 530 acres in Section 36, the South Plants Central Processing Area, and the Former Basin F are capped to contain residual contamination and soil that may pose a risk to biota. This prevents contact by humans and biota with contaminated soil, further reduces the migration of contaminants by limiting infiltration through the soil, and eliminates airborne migration. Approximately 10,500,000 BCY of borrow materials are required as gradefill to achieve the design grade for the cap, and an additional 3,850,000 BCY of borrow are required for construction of the caps.

Approximately 4,000,000 BCY of contaminated soil, primarily from sites outside of the central portions of RMA, as well as debris from UXO clearance operations, are landfilled under this alternative. Landfilling interrupts exposure pathways, and the landfill's leachate collection and treatment system ensures that there is no migration of contaminants to groundwater. The incinerated soil and debris and the thermally desorbed soil are placed in the on-post hazardous waste landfill. Any agent-contaminated soil identified during screening is treated by caustic washing and then landfilled. In addition, any identified UXO is excavated, packaged, and transported off-post to an existing Army facility for detonation and disposal (unless it is unstable and must be detonated on post). The sanitary sewer manholes are plugged to ensure that the sewer lines are not conduits for the migration of groundwater contamination. The chemical sewers and any associated contaminated soil are excavated and placed in the on-post hazardous waste landfill. The 87,000 BCY of human health exceedance volume from the Surficial Soil Medium Group are also landfilled.

Soil posing a potential risk to biota is generally excavated and landfilled. The remaining 1,600 acres of the Surficial Soil Medium Group are addressed through agricultural practices, which reduces the level of contamination in near-surface soil. Even though the implementation of agricultural practices is phased over a number of years and implemented using a checkerboard pattern, widespread portions of RMA habitat will be disturbed and will need to be revegetated. No additional action other than monitoring is conducted for the aquatic lake sediments since an exposure pathway has not been established between the sediments and aquatic biota. The USFWS and SFS will monitor biota in the Surficial Soil and Lake Sediments areas, and additional remedial actions will be implemented if required used on monitoring.

20.6 COMPARISON AND EVALUATION OF ALTERNATIVES

This section presents the evaluation of the five sitewide alternatives against the DAA criteria listed in the NCP (EPA 1990a). Table 20.6-1 summarizes this analysis in tabular format.

20.6.1 Overall Protection of Human Health and the Environment

The five alternatives provide overall protection of human health through a combination of containment and treatment. The Caps/Covers, Landfill/Caps, and Landfill alternatives provide for protection of human health primarily through containment of human health exceedances, which interrupts exposure pathways and reduces the migration of contaminants to groundwater and the atmosphere. The Consolidation/Caps/Treatment/Landfill and Caps/Treatment/Landfill alternatives address portions of the most contaminated soil through treatment, but rely on capping and landfilling to protect human health in the majority of the contaminated areas.

Under each of the five alternatives, the protection of wildlife is generally accomplished through containment of parts of the core areas of RMA which may pose a risk to biota, either by capping or landfilling. This interrupts the potential for biota exposure, and also prevents burrowing animals from coming into contact with contaminated soil. However, these alternatives address surficial soil with very low levels of contamination, outside of the central areas of RMA, using two different approaches. The Caps/Treatment/Landfill alternative includes the treatment of approximately 1,600 acres through agricultural practices, which reduces the level of OCPs in near-surface soil, but results in the disturbance of habitat over widespread areas of RMA. The other four alternatives address low-level surficial soil contamination by continued monitoring only, thereby avoiding the disruption of wildlife in these areas during remedial activities and habitat restoration.

20.6.2 Compliance with ARARs

Each of the five sitewide alternatives complies with ARARs both for the type of actions undertaken and for the location of activities (Table 20.6-1). The number of ARARs, and the difficulties associated with demonstrating compliance with these ARARs, are substantially higher for the Caps/Treatment/Landfill alternative based on the complexity of the alternative and the use of thermal treatment technologies.

20.6.3 Long-Term Effectiveness

Each of the five alternatives results in minimal residual risk based on the adequacy and reliability of controls offered by each alternative (Table 20.6-1). All five alternatives rely on containment of a significant portion of the contaminated soil to protect human health and the environment, resulting in long-term maintenance and monitoring activities to ensure effective containment. The Consolidation/Caps/Treatment/Landfill and Caps/Treatment/Landfill alternatives leave somewhat smaller volumes of contaminated soil (approximately 8 percent and 40 percent of the human health exceedance volume, respectively, are treated) with lower levels of contamination requiring long-term controls; however, these alternatives still rely on containment of large volumes of contaminated soil (92 and 60 percent, respectively). The Caps/Treatment/Landfill alternative also include the treatment of approximately 1,600 acres through agricultural practices, which reduces the level of OCPs in near-surface soil, but results in the disturbance of habitat over widespread areas of RMA. The containment systems for the five alternatives are adequate and reliable for long-term protection of human health and the environment.

The Caps/Covers alternative addresses both high levels of contamination and large volumes of contaminated soil through in-place containment. The installation of caps/covers provides adequate protection for human health and wildlife by eliminating exposure to contaminated soil. The caps provide long-term reduction in the migration of contaminants to groundwater. Based on the operation of the existing groundwater systems and the groundwater removal systems to be installed as part of the water preferred alternative, this alternative provides long-term effectiveness and a low residual risk. A low residual risk may remain for biota since surficial soil that may pose a risk to biota is left in place and monitored. However, the magnitude of this residual risk is low based on the low concentrations of OCPs that remain, and widespread areas of high-quality habitat are not disturbed to address this low risk.

The Landfill/Caps and Landfill alternatives both rely on containment systems that effectively protect humans and biota from exposure to contaminated soil. The bottom liner of a landfill controls the migration of leachate. Landfill covers and caps both provide long-term protection by preventing infiltration into the contaminated materials and releases to the atmosphere. These two alternatives provide similar levels of long-term protection and minimal long-term risks, although landfilling does provide, by virtue of the liner, a somewhat greater level of containment than does a cap. Both of these alternatives entail a low potential risk for biota since surficial soil that may pose a risk to biota is left in-place and monitored; however, the magnitude of this residual risk is low based on the low concentrations of OCPs in the soil. Finally, widespread areas of habitat are not disturbed to address this low risk.

The Consolidation/Caps/Treatment/Landfill and Caps/Treatment/Landfill alternative treat portions of the most contaminated soil, thereby reducing the level of contamination in the soil requiring long-term controls. However, both alternatives use similar containment systems as the other three alternatives to address large volumes of lower-level contamination (92 percent and 60 percent of the human health exceedance volume, respectively). The Caps/Treatment/Landfill alternative does treat a larger volume of soil by addressing the Basin F Wastepile, but still relies on containment of a large volume of soil to provide long-term protection. The Consolidation/Caps/Treatment/Landfill and Caps/Treatment/Landfill alternatives provide similar levels of long-term protection, but do not eliminate the need for long-term monitoring and maintenance of capped and landfilled areas.

20.6.4 Reduction of Toxicity, Mobility, or Volume

The Consolidation/Caps/Treatment/Landfill and Caps/Treatment/Landfill alternatives provide the greatest reduction in TMV (Table 20.6-1). These alternatives permanently reduce the TMV of contaminated soil through treatment of 210,000 and 1,120,000 BCY of soil, respectively. These alternatives reduce the mobility of contaminants in the remaining soil through containment with caps and landfills. The other three alternatives provide reduction in mobility through containment; however, the Caps/Covers alternative provides somewhat lower reduction in mobility since the Landfill/Caps and Landfill alternatives include landfilling of some of the contaminated soil, which provides some measure of additional containment of contaminants and reduction in mobility compared to capping. Ultimately, however, all containment alternatives rely on the effectiveness of the cap to prevent infiltration.

20.6.5 Short-Term Effectiveness

The short-term effectiveness of the five alternatives is primarily governed by the risks posed during remedial actions and the time required until remedial action objectives are achieved. Table 20.6-1 shows that the short-term effectiveness decreases as the alternatives become more complex. This decrease is a result of the increase in risks during remedial actions and the longer time frames for implementation of the more complex remedial alternatives.

The Caps/Covers and Landfill/Caps alternatives have minimal to low short-term risks since the central portions of RMA (with high levels of contamination) are capped in place. Thus, the risks to workers and the surrounding community from the excavation, transportation, and treatment/disposal of soil with high-level contamination are avoided. The implementation time of these alternatives is approximately 7 and 6 years, respectively (assuming no funding limitations). The Landfill/Caps alternative includes the landfilling of 2,000,000 BCY of contaminated soil (instead of containment in place), but the risks associated with excavation, transportation, and disposal of this soil are not significantly increased compared to capping based on the low levels of contamination in the soil to be landfilled. These two alternatives address soil in the central area of RMA that may pose a risk to biota through containment, but do not entail additional remedial actions for surficial soil that may pose a risk to biota, which is left in place and monitored. In this manner, widespread areas of habitat are not disturbed to address soil with a low residual risk.

The other three alternatives involve excavation and treatment/disposal of portions of the most contaminated soil, which increases the short-term risks to workers and the community. The Consolidation/Caps/Treatment/Landfill alternative removes a smaller volume of highly contaminated soil, and therefore exhibits lower risks due to excavation, transportation, and disposal activities than the Landfill or Cap/Treatment/Landfill alternative. The Landfill and the

Caps/Treatment/Landfill alternatives present the highest short-term risk to workers and the community. In these alternatives the largest volume of highly contaminated areas is excavated for treatment and/or disposal, requiring specialized containment to minimize the release of contaminants. The implementation time frame for the Caps/Treatment/Landfill alternative is the longest at approximately 14 years (assuming no funding limitations). Although steps can be taken to control short-term risks during remedial actions under these three alternatives, the short-term effectiveness for these alternatives is lower than for the Caps/Covers and Landfill/Caps alternatives. Negative-pressure vapor enclosures are constructed over several areas to be excavated under these alternatives to control vapors and odors. Work within these enclosures will require extensive worker protection and may present significant hazards to workers. Although the air within the enclosure is collected and treated, the short-term risks of contaminant release associated with excavating these areas cannot be completely eliminated.

20.6.6 Implementability

The implementability of the five alternatives varies from easy for the Caps/Covers and Landfill/Caps alternatives, which are readily constructed using common construction equipment, to difficult for the Caps/Treatment/Landfill alternative, which presents difficulties in the construction and operation of the treatment technologies, which have not been implemented at any other site in the country at the scale required at RMA. As shown in Table 20.6-1, the Landfill/Caps alternative is considered easy to implement, while the Landfill alternative and the Consolidation/Caps/ Treatment/Landfill alternative vary from moderate to difficult implementability.

The Caps/Covers and Landfill/Caps alternatives are both considered easy to implement because they consist of the proven and available technologies of capping and landfilling and because they do not require the use of vapor enclosures. The Landfill and Consolidation/Caps/Treatment/ Landfill alternatives involve a similar level of difficulty in the excavation, transportation and disposal of large volumes of soil with high levels of contamination. Treatment of soil by solidification/stabilization for the Consolidation/Caps/Treatment/Landfill alternative is moderately implementable. Consolidation of soil potentially posing risk to biota decreases the costs and disruption of habitat for borrow areas for this soil with lower levels of contamination. The Caps/Treatment/Landfill alternative is the most difficult to implement and requires the longest time frame based on the difficulties with implementation of vapor enclosures and treatment technologies. There is a high level of uncertainty in the performance of thermal technologies on the complex contaminant mixtures and high salt levels in some principal threat soil, leading to a potential for failure to meet the treatment specifications, and a potential for extensive shut-down time to modify and maintain the system. There are also potential permitting problems and a potential for public opposition to additional thermal treatment at RMA.

20.6.7 Cost

The FS process requires a comparison of costs to evaluate and select the most appropriate alternative. Because an FS is performed at a predesign stage using generally available information (supplemented with site-specific data and treatability studies, as available), and because of the extreme complexity of the RMA site, numerous assumptions are required in order to develop a cost estimate for each alternative. These assumptions are subject to a number of unquantifiable uncertainties, as described below:

- Base contingency factor—this is a standard contingency factor for probable cost growth within the general scope of the project that is included in all engineering estimates. This factor was included in the MCACES cost estimates developed in the DAA.

- Indirect cost uncertainty—contractor indirect (field) costs, overhead and profit are normally included in engineering cost estimates, and this factor was included in the MCACES cost estimates developed in the DAA. However, if the scope or technology application costs increase (see below), or the project is subject to delays, indirect costs will grow. This growth potential is not predictable and it was not included in the MCACES cost estimates developed in the DAA.

- Volume/waste characterization uncertainty—this factor addresses the uncertainties about the volumes of contaminated media and how well characterized the contamination is. The degree of uncertainty depends on volume estimation methods, sampling density, spatial inhomogeneities in contaminant distribution, and analytical method uncertainties. This phenomenon has been documented at the majority of CERCLA sites where contaminated soil or debris is excavated (Richardson et al., 1990). For a site like the Basin F Wastepile, the volume uncertainty is low, but the characterization uncertainty is very high;

for sites where the contaminant deposition is expected to have been relatively uniform (such as the Secondary Basins), the characterization uncertainty may be lower but the volume uncertainty is higher. This factor will only be known when actual excavation and waste feed characterization take place; for this reason, it was not included in the MCACES cost estimates developed in the DAA.

- Scope changes—this factor addresses changes in the scope of a project from feasibility study through design and implementation. It is caused by unexpected conditions requiring redesign or additional/changed construction of treatment/disposal facilities. For example, an offgas treatment system may be conceptually specified during the FS, but during the design it may need to be expanded, and based on the results of a trial burn it may require additional modification. This factor, which only becomes evident during final design or during actual implementation, is not quantifiable at the FS stage and it was not included in the MCACES cost estimates developed in the DAA.

- Technology application uncertainty—even with a well-defined scope, the actual construction and operating costs of a technology may vary from what was estimated in the FS or the design. For example, the operating costs of a thermal treatment process may increase due to lower throughput than anticipated because of materials handling problems or air emission limitations. This factor was not included in the MCACES cost estimates developed in the DAA.

- Regulatory/Litigation/Community Issues—additional cost uncertainty stems from potential delays related to regulatory issues (e.g., reperformance of trial burns; stop work actions during remediation), drawn-out litigation, or delays in the project related to community concerns. Such uncertainties are unpredictable and were not included in the DAA.

The greatest overall cost uncertainty is associated with the remediation of soil, and the uncertainty is higher for alternatives that include excavation (which leads to volume uncertainty) and treatment (which incorporates scope, technology application, waste characterization and regulatory uncertainties) than for alternatives that minimize the handling of highly-contaminated soil by using in-place capping. In general, the cost uncertainties for the water and structures media are lower due to the use of simpler technologies with more site-specific and general construction experience in their implementation.

Table 20.6-1 summarizes the costs for the five alternatives. The estimated costs for the Landfill/Caps alternative is the lowest, at $383 million for soil and a total RMA remediation cost of $1.7 billion. The estimated cost for the Caps/Treatment/Landfill alternative is the highest at

$1.01 billion for soil, and a total cost of $2.7 billion. The remaining alternatives have intermediate costs of $542–576 million for soil, and a total estimated costs between $1.9 billion and $2.0 billion.

The level of cost uncertainty is relatively low for the Caps/Covers, Landfill/Caps and the Consolidation/Caps/Treatment/Landfill alternatives since demonstrated construction and excavation technologies are used. However, intrusive activities are conducted in highly contaminated areas for the Consolidation/Caps/Treatment/Landfill alternative, and a higher uncertainty is presented. Most of the soil to be excavated and filled for these alternatives is clean gradefill. There is a low risk that the estimated soil volume will increase because primarily relatively well-defined sites with low levels of contamination are being excavated.

The cost uncertainty associated with the Landfill alternative is moderate since demonstrated technologies are used for containment, but the excavation of highly contaminated soil in the central portion of RMA requires the use of specialized vapor enclosures. In addition, large volumes of contaminated soil are to be excavated from sites that are not well characterized. Since these sites are not well defined, there is a high potential that the estimated contaminated soil volume will increase, thereby increasing the cost.

The Caps/Treatment/Landfill alternative entails the highest degree of cost uncertainty due to the use of complex treatment technologies and the excavation, transportation, treatment, and disposal of highly contaminated soil. The large volumes of contaminated soil to be excavated and treated also result in a high potential for cost growth. Based on experience at RMA and other sites, the final costs for this alternative may be more than double the costs estimated in the DAA.

It should also be noted that these costs are based on optimized remediation schedules of 6-14 years (depending on which soil alternative is selected), which require annual funding at levels (approximately $200 million) that may not be consistent with the Army's overall environmental restoration budget. If the funding level for cleanup of RMA was capped (for example, at $125 million per year), the time to complete the cleanup would extend to 9 to more than 18 years (see Appendix B.6), and the costs would increase substantially.

20.6.8 Summary of Alternative Evaluations

The Caps/Covers alternative provides the level of protection of human health and wildlife required under CERCLA by preventing exposures to contaminated soil. In addition, this alternative has minimal short-term risks since the central portions of RMA (with high levels of contamination) are capped in place, thereby avoiding the risks from excavation, transportation, and treatment/disposal of soil with high-level contamination. The mobility of the contaminants is reduced by minimizing the amount of infiltration that may mobilize the contaminants from the soil to the groundwater and eliminating the airborne migration pathway. However, no action is taken to reduce the toxicity or volume of the contaminated soil. The implementation time for this alternative is less than the other alternatives, although its cost is higher than the Landfill/Caps alternative. The overall effectiveness of this alternative is somewhat lower than the other sitewide alternatives based on the lower reduction in mobility resulting from capping as compared to landfilling or the destruction of contaminants through treatment of some contaminated soil. However, all alternatives rely on capping/landfilling of the majority of the contaminated soil to provide long-term risk reduction.

The Landfill/Caps alternative protects humans and biota by providing a physical barrier, through capping and landfilling, to prevent exposures and reduce the amount of infiltration that may mobilize contaminants to groundwater. Caps/covers and landfills provide effective containment of the contaminated soil. The contaminated soil that is landfilled poses a minor risk to workers and the community during excavation and transportation due to the low level of contamination in the soil. Soil with high levels of contamination (such as the Basin A, Disposal Trenches, and Basin F Medium Groups and South Plants Central Processing Area Subgroup) is left in place and capped. The mobility of the contaminants in these areas is further reduced by minimizing the infiltration through the contaminated soil, and eliminating the airborne migration pathway. The overall effectiveness of this alternative is high since this alternative provides effective containment of the contaminants while balancing the short-term risks of excavation with long-term effectiveness.

The Landfill alternative protects humans and biota by providing a physical barrier that prevents exposure. However, significant risks are posed to workers and the community during excavation and transportation. Although vapor enclosures are used to control vapors and odors during the excavation of several sites, the short-term risks associated with excavation of highly contaminated soil cannot be completely reduced, and site workers may be at risk if protective systems fail. The mobility of the contaminants is eliminated by placing the contaminated soil in the landfill, but no action is taken to reduce the toxicity or volume of the contaminated soil. The overall effectiveness of this alternative is moderate since the alternative provides low long-term risk but entails high short-term risks during excavation and transportation of highly contaminated soil.

The Consolidation/Caps/Treatment/Landfill alternative protects humans and biota by treating some principal threats and providing a physical barrier to prevent exposure through capping and landfilling. Mobility of the contaminants is reduced by minimizing the amount of infiltration into the contaminated soil below the caps or in the landfill. The toxicity and volume of contaminated soil is reduced through treatment of some principal threats by solidification/stabilization. High short-term risks are posed to workers and the community during excavation, transportation, and landfill of more highly contaminated soil. The risks associated with excavation are reduced, but are not eliminated, through the installation of vapor enclosures over several excavated areas. In addition, placement of soil excavated from the Basin F Wastepile and Section 36 Lime Basins in a triple-lined landfill cell provides additional assurance of containment. The consolidation of 1,200,000 BCY of contaminated soil in Basin A, Basin F, and the South Plants Central Processing Area prior to capping these sites lowers the cost of obtaining borrow materials and reduces the area disturbed for borrow. The implementability of this alternative is moderate because of the large volume of more highly contaminated soil to be excavated. However, the overall effectiveness of this alternative is high since the alternative provides low long-term risk which compensates for higher short-term risk during excavation.

The Caps/Treatment/Landfill alternative treats areas of high contamination, reducing the TMV of the contaminated soil. However, workers and the community are exposed to the highest short-term risks under this alternative (compared to other alternatives) during excavation, transportation, and treatment. Although vapor enclosures are used to control vapors and odors during the excavation of several sites, the short-term risks associated with excavation of highly contaminated soil cannot be completely eliminated and site workers may be at risk if protective systems fail. The mobility of the contaminants is eliminated by placing the contaminated soil in a landfill. However, this alternative has a low overall effectiveness based on the short-term risks during remedial actions and the longer time frame (a minimum of 14 years) until actions are completed. In addition, the implementability of this alternative is very difficult because of the large volume of highly contaminated soil (including the Basin F Wastepile) to be treated by thermal treatment.

20.7 SELECTION OF THE PREFERRED ALTERNATIVE

The selection of a preferred alternative is based on a comparison of the performance of the five alternatives as presented in the previous sections and summarized in Table 20.6-1. Section 3.4 of the Executive Summary (Volume I) presents a detailed discussion of EPA statutory requirements and preferences for selecting preferred alternatives. The statutory requirements are that the preferred alternative must accomplish the following:

- Protect human health and the environment
- Comply with ARARs
- Provide a cost-effective remedy by evaluating overall effectiveness and cost

EPA's preferences in selecting a preferred alternative are that it should:

- Utilize permanent solutions and alternative treatment technologies to the maximum extent practicable, and
- Satisfy the preference for treatment as a principal element or explain why this preference is not achieved.

The overall effectiveness of an alternative is a combination of the long-term effectiveness, reduction of TMV and short-term effectiveness. An alternative is considered cost effective if the costs are proportional to the overall effectiveness. A comparison of the five sitewide alternatives with the criteria for selecting the preferred alternative for contaminated soil is presented below.

20.7.1 Protection of Human Health and the Environment

As discussed in Section 20.6.1, all five sitewide alternatives provide overall protection of human health and the environment. The degree to which treatment is used in each of the alternatives varies, but ultimately, all five alternatives rely on containment to protect human health and the environment from the large volumes of contaminated soil. In the long term, maintenance of the caps/covers is the principal means to prevent exposure of humans and wildlife to, and migration of, the contaminants.

20.7.2 Compliance with ARARs

All five alternatives comply with ARARs, both for the type of actions undertaken and for the locations of the activities (Section 20.6.2). The number of ARARs and the difficulties associated with demonstrating compliance with these ARARs are substantially higher for treatment by thermal desorption than for the other alternatives. ARARs are presented in Appendix A of the Technology Descriptions Volume.

20.7.3 Cost-Effectiveness

The Landfill/Caps and Consolidation/Caps/Treatment/Landfill alternatives represent the best balance of overall effectiveness since both alternatives provide a high degree of long-term protection and minimal short-term impacts (Table 20.6-1). The cost effectiveness of the Landfill/Caps alternative is lower than for the Consolidation/Caps/Treatment/Landfill alternative based on the somewhat lower reduction in mobility provided by only landfilling and capping compared to treating some more highly contaminated soil and reducing the number of caps/covers via consolidation.

The Consolidation/Caps/Treatment/Landfill and Caps/Treatment/Landfill alternatives offer similar levels of overall effectiveness, although the Caps/Treatment/Landfill alternative entails more difficult implementability and higher costs since a number of sites are treated by thermal desorption (Table 20.6-1). These alternatives result in minimal long-term risks but they entail high short-term risks associated with excavation. Treatment by thermal desorption is difficult to implement. Both alternatives reduce the TMV of contaminated soil through treatment, and reduce mobility by containment of large volumes of contaminated soil and residual contamination in Section 36, South Plants, and the Former Basin F.

The Landfill alternative provides the lowest overall effectiveness since it entails similar long-term protection as the Caps/Covers and Landfill/Caps alternatives but results in high short-term impacts due to excavation, without reducing TMV through treatment.

The cost for the Landfill/Caps alternative is lower than the other four alternatives, and it entails minimal long-term risks (Table 20.6-1). However, for only a slight increase in cost, the Consolidation/Caps/Treatment/Landfill alternative provides a more permanent and higher degree of TMV reduction. As a result, the Consolidation/Caps/Treatment/Landfill alternative is considered to be the most cost-effective alternative for the remediation of contaminated soil at RMA.

20.7.4 Permanent Solutions and Alternative Treatment Technologies

Compared to the other three alternatives, the Consolidation/Caps/Treatment/Landfill and Caps/Treatment/Landfill alternatives address a greater volume of soil using permanent solutions and alternative treatment technologies through the use of solidification or thermal desorption. The Consolidation/Caps/Treatment/Landfill alternative uses solidification/stabilization which is more easily implemented. Also a smaller volume of soil is treated which results in a lower cost. The benefits of using thermal desorption for the larger soil volume do not significantly increase the overall protection of human health and the environment, over the containment used in the Consolidation/Caps/Treatment/Landfill alternative.

20.7.5 Preference for Treatment as a Principal Element

All alternatives include treatment of groundwater (currently 1 billion gallons per year), and agent-contaminated soil, as a principal element of the alternative, and more than 11 million gallons of Basin F liquids have been treated by the Basin F IRA. The Consolidation/Caps/Treatment/Landfill and Caps/Treatment/Landfill alternatives provide additional reduction in TMV by treating soil with higher levels of contamination. These alternatives still rely on containment to protect human health and the environment for large volumes of soil (92 and 60 percent of the human health exceedance volume, respectively) and include similar sizes of landfilled or capped areas after treatment. As a result, achieving the preference for treatment would not eliminate the need for long-term maintenance and monitoring, and does not substantially increase the protection of human health and the environment since the use of treatment technologies results in higher short-term risks.

20.7.6 Selection of the Preferred Alternative

Based on the evaluation of the DAA criteria, the Consolidation/Caps/Treatment/Landfill Sitewide Alternative was selected as the preferred alternative. It is overall the most cost effective, it is protective of human health and the environment, and it complies with ARARs. As discussed in the previous two sections, achieving the conditional requirements to a greater extent than is achieved for this alternative would not significantly increase the protectiveness or reduce the long-term monitoring and maintenance requirements.

The Consolidation/Caps/Treatment/Landfill Sitewide Alternative involves treating 210,000 BCY by solidification/stabilization, landfilling 1,700,000 BCY of soil and installing caps or covers over 1,100 acres in the central portion of RMA (Figure 20.2-1). Soil within these areas with agent/UXO presence is treated. The cost of this alternative for the cleanup of contaminated soil is estimated to be $570 million, and it is estimated that the implementation of this alternative requires 9 years (if there are no funding restrictions).

Medium Groups/Subgroups	Caps/Covers[1]	Landfill/Caps	Landfill	Consolidation/Caps/ Treatment/Landfill	Caps/Treatment/ Landfill
Munitions Testing	Munitions screening; off-post detonation of unexploded ordnance (UXO); landfill debris and soil above TCLP (89,000 BCY). (Alternative U4a; Section 5.2.4).	Munitions screening; off-post detonation of UXO; landfill debris and soil above TCLP (89,000 BCY). (Alternative U4a; Section 5.2.4).	Munitions screening; off-post detonation of UXO; landfill debris and soil above TCLP (89,000 BCY). (Alternative U4a; Section 5.2.4).	Munitions screening; off-post detonation of UXO; landfill debris and soil above TCLP (89,000 BCY). (Alternative U4a; Section 5.2.4).	Munitions screening; off-post detonation of UXO; landfill debris and soil above TCLP (89,000 BCY). (Alternative U4a; Section 5.2.4).
North Plants	Landfill human health exceedance (220 BCY); agent screening during excavation; caustic solution washing; cap/cover (soil cover) soil posing risk to biota and processing area footprint (160,000 SY). (Alternative A3; Section 6.2.3).	Landfill human health exceedance (220 BCY); agent screening during excavation; caustic solution washing; cap/cover (soil cover) soil posing risk to biota and processing area footprint (160,000 SY). (Alternative A3; Section 6.2.3).	Landfill human health exceedance (220 BCY); agent screening during excavation; caustic solution washing; cap/cover (soil cover) soil posing risk to biota and processing area footprint (160,000 SY). (Alternative A3; Section 6.2.3).	Landfill human health exceedance (220 BCY); agent screening during excavation; caustic solution washing; cap/cover (soil cover) soil posing risk to biota and processing area footprint (160,000 SY). (Alternative A3; Section 6.2.3).	Landfill human health exceedance (220 BCY); agent screening during excavation; caustic solution washing; cap/cover (soil cover) soil posing risk to biota and processing area footprint (160,000 SY). (Alternative A3; Section 6.2.3).
Toxic Storage Yards	Landfill human health exceedance (2,600 BCY); utilize New Toxic Storage Yard for borrow area; agent screening during site excavation and preparation; caustic washing. (Alternative A3; Section 6.5.3).	Landfill human health exceedance (2,600 BCY); utilize New Toxic Storage Yard for borrow area; agent screening during site excavation and preparation; caustic washing. (Alternative A3; Section 6.5.3).	Landfill human health exceedance (2,600 BCY); utilize New Toxic Storage Yard for borrow area; agent screening during site excavation and preparation; caustic washing. (Alternative A3; Section 6.5.3).	Landfill human health exceedance (2,600 BCY); utilize New Toxic Storage Yard for borrow area; agent screening during site excavation and preparation; caustic washing. (Alternative A3; Section 6.5.3).	Landfill human health exceedance (2,600 BCY); utilize New Toxic Storage Yard for borrow area; agent screening during site excavation and preparation; caustic washing. (Alternative A3; Section 6.5.3).
Lake Sediments	Landfill human health exceedances (19,000 BCY); deferral to USFWS for remainder of site. (Alternative B1a; Section 7.2.2).	Landfill human health exceedances (19,000 BCY); deferral to USFWS for remainder of site. (Alternative B1a; Section 7.2.2).	Landfill human health exceedances and soil posing risk to biota (38,000 BCY) (Upper Derby Lake); deferral to USFWS for aquatic sediment. (Alternative B3; Section 7.2.3).	Landfill human health exceedances (19,000 BCY) and consolidate soil posing risk to biota (19,000 BCY) (Upper Derby Lake); deferral to USFWS for aquatic sediment. (Alternative B5a; Section 7.2.4).	Landfill human health exceedances and soil posing risk to biota (38,000 BCY) (Upper Derby Lake); deferral to USFWS for aquatic sediment. (Alternative B3; Section 7.2.3).

Medium Groups/Subgroups	Caps/Covers[1]	Landfill/Caps	Landfill	Consolidation/Caps/ Treatment/Landfill	Caps/Treatment/ Landfill
Surficial Soil	Landfill human health exceedances (87,000 BCY); Parties to determine action in accordance with Conceptual Remedy for remainder of site. (Alternative B1a; Section 8.2.2).	Landfill human health exceedances (87,000 BCY); Parties to determine action in accordance with Conceptual Remedy for remainder of site. (Alternative B1a; Section 8.2.2).	Landfill human health exceedances (87,000 BCY); Parties to determine action in accordance with Conceptual Remedy for remainder of site. (Alternative B1a; Section 8.2.2).	Landfill human health exceedances (87,000 BCY); consolidate soil posing risk to biota in Basin A/Former Basin F/South Plants (450,000 BCY); Parties to determine action in accordance with Conceptual Remedy for remainder of site. (Alternative B5a; Section 8.2.4).	Agricultural practices for soil posing risks to biota (1,600 acres) and landfill human health exceedances (87,000 BCY). (Alternative B9a; Section 8.2.5).
Ditches/Drainage Areas	Parties to determine action in accordance with Conceptual Remedy. (Alternative B1; Section 9.2.1).	Parties to determine action in accordance with Conceptual Remedy. (Alternative B1; Section 9.2.1).	Landfill soil posing risk to biota (52,000 BCY). (Alternative B3; Section 9.2.3).	Consolidate soil posing risk to biota in Basin A (52,000 BCY). (Alternative B5a; Section 9.2.4).	Landfill soil posing risk to biota (52,000 BCY). (Alternative B3; Section 9.2.3).
Basin A	Cap/cover principle threat and human health exceedances and soil posing risk to biota (670,000 SY). (Alternative 6; Section 10.2.5).	Cap/cover principle threat and human health exceedances and soil posing risk to biota (670,000 SY). (Alternative 6; Section 10.2.5).	Landfill principle threat and human health exceedances (180,000 BCY); cap/cover entire site including soil posing risk to biota (670,000 SY).[1,2] (Alternative 3b; Section 10.2.3).	Cap/cover (concrete/soil cap) principle threat and human health exceedances and soil posing risk to biota (670,000 SY); consolidate soil posing risk to biota (800,000 BCY) and structural debris (160,000 BCY) from other sites. (Alternative 6; Section 10.2.5).	Thermal desorption of principal threat soil (32,000 BCY); landfill human health exceedances including treated soil (180,000 BCY); cap/cover entire site including soil posing risk to biota (670,000 SY).[1,2] (Alternative 3c; Section 10.2.4).
Basin F Wastepile	Modify existing cap/cover according to RCRA requirements (75,000 SY). (Alternative 6d; Section 11.2.4)	Modify existing cap/cover according to RCRA requirements (75,000 SY). (Alternative 6d; Section 11.2.4)	Modify existing cap/cover according to RCRA requirements (75,000 SY). (Alternative 6d; Section 11.2.4)	Landfill entire wastepile (principle threat exceedance) (600,000 BCY) in triple-lined cell (with vapor controls) after drying saturated materials. (Alternative 3; Section 11.2.3)	Thermal desorption of entire wastepile (principle threat exceedance) (with vapor controls); landfill treated soil (600,000 BCY). (Alternative 13b; Section 11.2.6).

Medium Groups/Subgroups	Caps/Covers[1]	Landfill/Caps	Landfill	Consolidation/Caps/ Treatment/Landfill	Caps/Treatment/ Landfill
Former Basin F	Modify existing cap/cover to RCRA-equivalent cap/cover (450,000 SY). (Alternative 6; Section 11.5.6).	Modify existing cap/cover to RCRA-equivalent cap/cover (450,000 SY). (Alternative 6; Section 11.5.6).	Landfill principle threat and human health exceedances (740,000 BCY) (with vapor controls); cap/cover entire site (450,000 SY). (Alternative 3b; Section 11.5.4).	In situ solidification of principal threat volume (180,000 BCY); cap/cover entire site (including Basin F Wastepile footprint) (525,000 SY). (Alternative 6b; Section 11.5.7).	Thermal desorption of principal threat soil (250,000 BCY) (with vapor controls); landfill human health exceedances including treated soil (740,000 BCY); cap/cover entire site (including Basin F Wastepile footprint) (525,000 SY). (Alternative 3c; Section 11.5.5).
Secondary Basins	Caps/cover human health exceedances and soil posing risk to biota (500,000 SY). (Alternative 6; Section 12.2.6).	Landfill human health exceedances and soil posing risk to biota (170,000 BCY). (Alternative 3; Section 12.2.3).	Landfill human health exceedances and soil posing risk to biota (170,000 BCY). (Alternative 3; Section 12.2.3).	Landfill human health exceedances (32,000 BCY); cap/cover (soil cover) soil posing risk to biota (500,000 SY). (Alternative 3b; Section 12.2.4).	Landfill human health exceedances and soil posing risk to biota (170,000 BCY). (Alternative 3; Section 12.2.3).
Sanitary/Process Water Sewers	Plug remaining manholes. (Alternative 2; Section 13.2.2).	Plug remaining manholes. (Alternative 2; Section 13.2.2).	Landfill sewer lines (12,000 BCY). (Alternative 3; Section 13.2.3).	Plug remaining manholes. (Alternative 2; Section 13.2.2)	Plug remaining manholes. (Alternative 2; Section 13.2.2).
Chemical Sewers	Plug sewer lines. (Alternative 2; Section 13.5.3).	Plug sewer lines in South Plants Central Processing Area and Complex Trenches; landfill remaining principle threat and human health exceedances (62,000 BCY).[1] (Alternative 3e; Section 13.5.7).	Landfill principle threat and human health exceedances (82,000 BCY).[1] (Alternative 3; Section 13.5.5).	Plug sewer lines in South Plants Central Processing Area and Complex Trenches; landfill remaining principle threat and human health exceedances (62,000 BCY).[1] (Alternative 3e; Section 13.5.7).	Thermal desorption of principal threat soil (47,000 BCY); landfill human health exceedances including treated principle threat soil (82,000 BCY).[1] (Alternative 3a; Section 13.5.6).

Medium Groups/Subgroups	Caps/Covers[1]	Landfill/Caps	Landfill	Consolidation/Caps/ Treatment/Landfill	Caps/Treatment/ Landfill
Complex Trenches	Cap/cover principle threat and human health exceedances and soil posing risk to biota (390,000 SY) and install a slurry wall around disposal trenches. (Alternative 5, Section 14.2.2).	Cap/cover principle threat and human health exceedances and soil posing risk to biota (390,000 SY) and install a slurry wall around disposal trenches. (Alternative 5, Section 14.2.2).	Cap/cover principle threat and human health exceedances and soil posing risk to biota (390,000 SY) and install a slurry wall around disposal trenches. (Alternative 5, Section 14.2.2).	Cap/cover (concrete/soil RCRA-equivalent cap) principle threat and human health exceedances and soil posing risk to biota (390,000 SY) and install a slurry wall around disposal trenches. (Alternative 5, Section 14.2.2).	Cap/cover principle threat and human health exceedances and soil posing risk to biota (390,000 SY) and install a slurry wall around disposal trenches. (Alternative 5, Section 14.2.2).
Shell Trenches	Modify existing cap/cover (32,000 SY) and install slurry wall around trenches. (Alternative 5a; Section 14.5.3).	Modify existing cap/cover (32,000 SY) and install slurry wall around trenches. (Alternative 5a; Section 14.5.3).	Landfill trenches (100,000 BCY) after materials handling (with vapor controls). (Alternative 3; Section 14.5.2).	Modify existing cap/cover to be RCRA equivalent (32,000 SY) and modify existing slurry wall around trenches. (Alternative 5a; Section 14.5.3).	Incinerate trenches (100,000 BCY); landfill treated soil (with vapor controls). (Alternative 14; Section 14.5.4).
Hex Pit	Install cap/cover (900 SY) and slurry wall around trenches. (Alternative 5; Section 14.8.3).	Install cap/cover (900 SY) and slurry wall around trenches. (Alternative 5; Section 14.8.3).	Landfill disposal pit after materials handling (3,300 BCY) (with vapor controls). (Alternative 3; Section 14.8.2).	Treatment technologies (including innovative technologies) to be reviewed and remedy to be determined prior to ROD (3,300 BCY).	Incinerate disposal pit (3,300 BCY); landfill treated soil (with vapor controls). (Alternative 14; Section 14.8.4).
Sanitary Landfill	Cap/cover entire site. (Alternative 6; Section 15.2.5).	Landfill human health exceedances, debris, and soil posing risk to biota (420,000 BCY). (Alternative 3; Section 15.2.3).	Landfill human health exceedances, debris, and soil posing risk to biota (420,000 BCY). (Alternative 3; Section 15.2.3).	Landfill human health exceedances (14,000 BCY); consolidate debris and soil posing risk to biota in Basin A (410,000 BCY). (Alternative 3f; Section 15.2.4).	Landfill human health exceedances, debris, and soil posing risk to biota (420,000 BCY). (Alternative 3; Section 15.2.3).
Section 36 Lime Basins	Modify existing cap/cover (62,000 SY). (Alternative 6; Section 16.7.3).	Modify existing cap/cover (62,000 SY). (Alternative 6; Section 16.7.3).	Landfill principle threat and human health exceedances (54,000 BCY); cap/cover entire site (62,000 SY).[2] (Alternative 3b; Section 16.2.2).	Landfill principle threat and human health exceedances in triple-lined cell (54,000 BCY); repair existing soil cover.[2] (Alternative 3b; Section 16.2.2).	Landfill principle threat and human health exceedances (54,000 BCY); cap/cover entire site (62,000 SY).[2] (Alternative 3b; Section 16.2.2).

Medium Groups/Subgroups	Caps/Covers[1]	Landfill/Caps	Landfill	Consolidation/Caps/ Treatment/Landfill	Caps/Treatment/ Landfill
Buried M-1 Pits	Install cap/cover (8,700 SY) and slurry wall around entire site. (Alternative 5; Section 16.5.3).	Install cap/cover (8,700 SY) and slurry wall around entire site. (Alternative 5; Section 16.5.3).	Landfill principle threat and human health exceedances (26,000 BCY) (with vapor controls).[2] (Alternative 3; Section 16.5.2).	Solidification of principle threat and human health exceedances (26,000 BCY) and landfill (with vapor controls).[2] (Alternative 10; Section 16.5.4).	Solidification of principle threat and human health and landfill exceedances (26,000 BCY) (with vapor controls).[2] (Alternative 10; Section 16.5.4).
South Plants Central Processing Area	Cap/cover principle threat and human health exceedances and soil posing risk to biota (220,000 SY). (Alternative 6; Section 17.2.5).	Cap/cover principle threat and human health exceedances and soil posing risk to biota (220,000 SY). (Alternative 6; Section 17.2.5).	Landfill principle threat and human health exceedances (110,000 BCY); cap/cover entire site including soil posing risk to biota (220,000 SY).[2] (Alternative 3b; Section 17.2.3).	Landfill principle threat and human health exceedances (110,000 BCY); cap/cover (soil cover) entire site including soil posing risk to biota (220,000 SY); consolidate soil posing risk to biota from other sites (380,000 BCY).[2] (Alternative 3b; Section 17.2.3).	Thermal desorption and solidification of principal threats (38,000 BCY); landfill human health exceedances including treated principle threat soil (110,000 BCY); cap/cover entire site including soil posing risk to biota (27,000 BCY).[2] (Alternative 3d; Section 17.2.4).
South Plants Ditches	Cap/cover principle threat and human health exceedances and soil posing risk to biota (120,000 SY). (Alternative 6; Section 17.5.6).	Landfill principle threat and human health exceedances and soil posing risk to biota (56,000 SY). (Alternative 3; Section 17.5.3).	Landfill principle threat and human health exceedances and soil posing risk to biota (56,000 SY). (Alternative 3; Section 17.5.3).	Landfill principle threat and human health exceedances (33,000 BCY); consolidate soil posing risk to biota into excavated areas or South Plants Central Processing Area (23,000 BCY); cap/cover (soil cover) entire site (120,000 SY). (Alternative 3g; Section 17.5.5).	Thermal desorption of principal threat soil (3,400 BCY); landfill human health exceedances, including treated principle threat soil, and soil posing risk to biota (56,000 BCY). (Alternative 3a; Section 17.5.4).

Medium Groups/Subgroups	Caps/Covers[1]	Landfill/Caps	Landfill	Consolidation/Caps/ Treatment/Landfill	Caps/Treatment/ Landfill
South Plants Balance of Areas	Cap/cover principle threat and human health exceedances and soil posing risk to biota (1,700,000 SY). (Alternative 6; Section 17.8.6).	Landfill principle threat and human health exceedances and soil posing risk to biota (640,000 BCY).[2,3] (Alternative 3; Section 17.8.3).	Landfill principle threat and human health exceedances and soil posing risk to biota (640,000 BCY).[2,3] (Alternative 3; Section 17.8.3).	Landfill principle threat and human health exceedances (130,000 BCY); consolidate soil posing risk to biota into excavated areas or South Plants Central Processing Area (510,000 BCY); cap/cover (soil cover) entire site (1,700,000 SY).[2,3] (Alternative 3g; Section 17.8.5).	Thermal desorption of principal threat soil (11,000 BCY); landfill human health exceedances, including treated principal threat soil, and soil posing risk to biota (640,000 BCY).[2,3] (Alternative 3a; Section 17.8.4).
Buried Sediments	Cap/cover human health exceedances (7,900 SY). (Alternative 6; Section 18.2.4).	Landfill human health exceedances (16,000 BCY). (Alternative 3; Section 18.2.3).	Landfill human health exceedances (16,000 BCY). (Alternative 3; Section 18.2.3).	Landfill human health exceedances (16,000 BCY). (Alternative 3; Section 18.2.3).	Landfill human health exceedances (16,000 BCY). (Alternative 3; Section 18.2.3).
Sand Creek Lateral	Cap/cover human health exceedances and soil posing risk to biota (300,000 SY). (Alternative 6; Section 18.5.4).	Landfill human health exceedances and soil posing risk to biota (110,000 BCY). (Alternative 3; Section 18.5.2).	Landfill human health exceedances and soil posing risk to biota (110,000 BCY). (Alternative 3; Section 18.5.2).	Landfill human health exceedances (15,000 BCY); consolidate soil posing risk to biota into Basin A (90,000 BCY). (Alternative 3f; Section 18.5.3).	Landfill human health exceedances and soil posing risk to biota (110,000 BCY). (Alternative 3; Section 18.5.2).
Section 36 Balance of Areas	Cap/cover human health exceedances and soil posing risk to biota (710,000 SY). (Alternative 6; Section 19.2.5).	Landfill human health exceedances, soil posing risk to biota, and debris (290,000 BCY).[2,3] (Alternative 3; Section 19.2.3).	Landfill human health exceedances, soil posing risk to biota, and debris (290,000 BCY).[2,3] (Alternative 3; Section 19.2.3).	Landfill human health exceedances and debris (140,000 BCY); consolidate soil posing risk to biota into Basin A (200,000 BCY); cap/cover (soil cover) entire site (710,000 SY).[2,3] (Alternative 3g; Section 19.2.4).	Landfill human health exceedances and soil posing risk to biota (270,000 BCY).[2,3] (Alternative 3; Section 19.2.3).
Burial Trenches	Landfill human health exceedances and debris (85,000 BCY).[2,3] (Alternative 3; Section 19.5.2).	Landfill human health exceedances and debris (85,000 BCY).[2,3] (Alternative 3; Section 19.5.2).	Landfill human health exceedances and debris (85,000 BCY).[2,3] (Alternative 3; Section 19.5.2).	Landfill human health exceedances and debris (85,000 BCY).[2,3] (Alternative 3; Section 19.5.2).	Landfill human health exceedances and debris (85,000 BCY).[2,3] (Alternative 3; Section 19.5.2).

[1] The Cap/Covers alternative consists of a clay/soil cap (multilayer cap) unless noted.
[2] Agent screening during excavation and treatment of any soil containing agent by caustic solution washing.
[3] Munitions screening prior to excavation, off-post detonation of any munitions encountered, and landfill munitions debris/soil above TCLP.

Table 20.0-2 Material Volumes for Sitewide Soil Alternatives

Alternative	Treated Volume (bcy)	Landfill Volume (bcy)	Consolidation (bcy)	Borrow Volume for Backfill/Gradefill (bcy)	Borrow Volume for Caps/Covers (bcy)
Caps/Covers	730	290,000	0	17,800,000	11,300,000
Landfill/Caps	2,200	2,000,000	0	8,790,000	3,930,000
Landfill	3,200	3,400,000	0	10,100,000	3,860,000
Consolidation/Caps/Treatment/Landfill	210,000	1,700,000	1,200,000	8,750,000	5,100,000
Caps/Treatment/Landfill	1,120,000	4,000,000	0	10,500,000	3,850,000

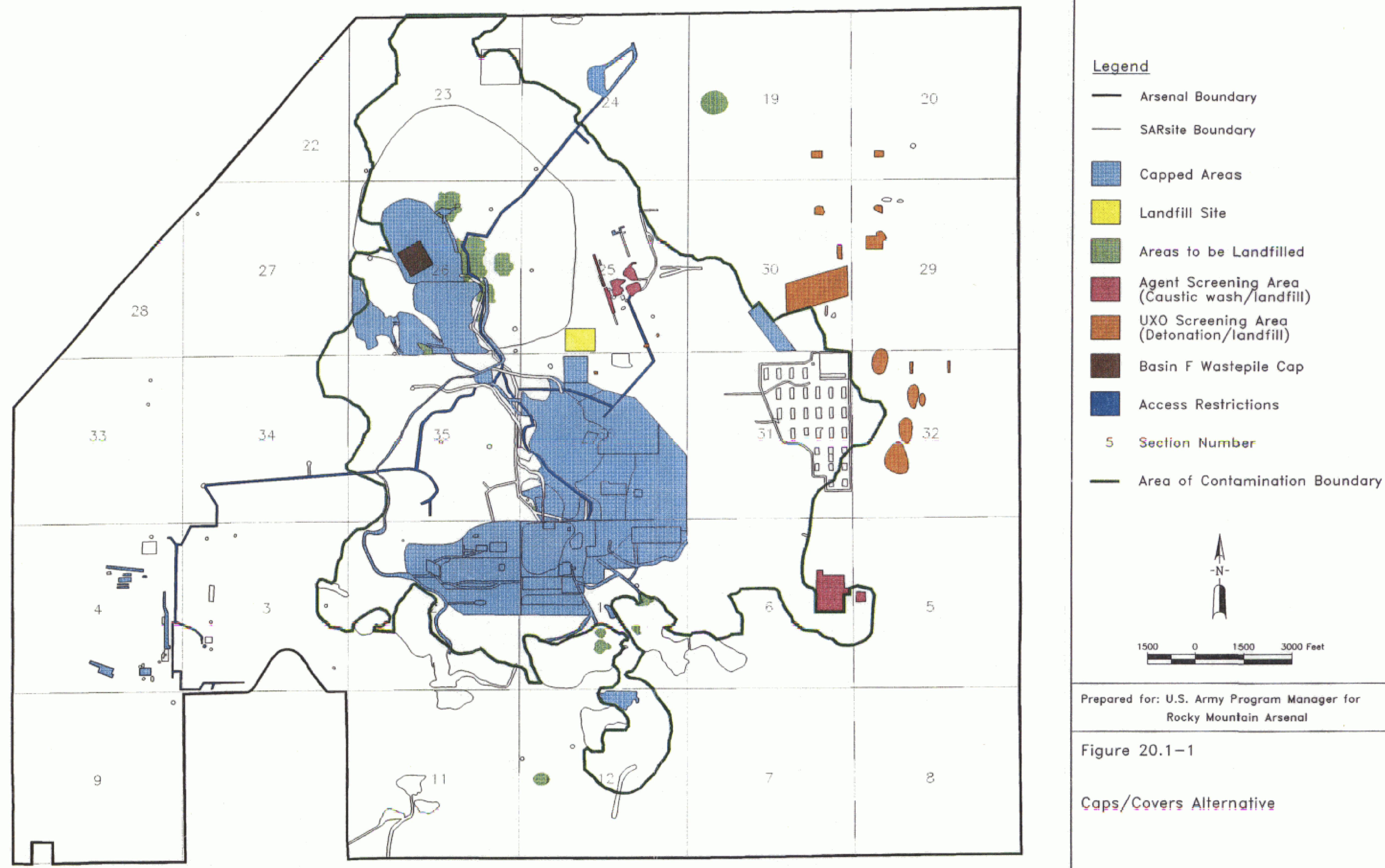
Alternative	Excavation Area[1] (acres)	Cap/Cover Area[2] (acres)	Borrow Area[3] (acres)	Ag Practice Area [4] (acres)	Total Disturbed Area (acres)
Caps/Covers	150	1,200	600	0	2,000
Landfill/Caps	650	490	260	0	1,400
Landfill	1,200	520	290	0	2,000
Consolidation/Caps/Treatment/Landfill	270	1,100	290	0	1,700
Caps/Treatment/Landfill	1,100	530	300	1,600	3,500

[1]Includes areas excavated for treatment or landfill outside cap/cover or borrow areas.
[2]Includes soil covers, multilayer caps, composite caps, and landfill areas.
[3]Assumes 30-ft depth of borrow area.
[4]Agricultural practice for biota risk management.

Table 20.6-1 Summary of Comparative Analysis of Sitewide Soil Alternatives

	Caps/Covers[1]	Landfill/Caps	Landfill	Consolidation/Caps/ Treatment/Landfill	Caps/Treatment/ Landfill
Overall protection of human health and the environment	*Protective.* Exposures to humans and biota prevented by containing contaminated soil in place.	*Protective.* Exposures to humans and biota prevented by containing contaminated soil in place.	*Protective.* Exposures to humans and biota prevented by containing contaminated soil in place.	*Protective.* Exposures to humans and biota prevented by containing contaminated soil in place and by treating some of the principal threat volume.	*Protective.* Exposures to humans and biota prevented by containing contaminated soil in place and by treating principal threat volume.
Compliance with ARARs	*Complies.*	*Complies.*	*Complies.*	*Complies.*	*Complies.* More difficult due to action-specific ARARs regarding treatment.
Long-term effectiveness and permanence	*Minimal residual risk.* Relies on caps and groundwater controls to prevent migration and exposure.	*Minimal residual risk.* Relies primarily on caps and groundwater controls, with some landfilling, to prevent migration and exposure.	*Minimal residual risk.* Relies on landfilling with some caps, and groundwater controls, to prevent migration and exposure.	*Minimal residual risk.* Relies on treatment of some highly contaminated soil, groundwater controls, and capping/ landfilling to prevent migration and exposure.	*Minimal residual risk.* Relies on treatment of most of the highly contaminated soil and landfilling/capping to prevent migration and exposure.
Reduction in Toxicity, Mobility, or Volume	Mobility reduced through containment; no toxicity or volume reduction.	Mobility reduced through containment; no toxicity or volume reduction.	Mobility reduced through containment; no toxicity or volume reduction	Toxicity, mobility, or volume of some highly contaminated soil reduced through treatment; relies on containment for most mobility reduction.	Toxicity, mobility, or volume of the most highly contaminated soil reduced through treatment; relies on containment for additional mobility reduction.
Short-term effectiveness	*Minimal short-term risk.* No excavation or potential releases.	*Low short-term risk.* High-risk sites not excavated; minimal potential releases.	*Moderate short-term risk.* All sites excavated and transported with potential for releases.	*Moderate short-term risk.* Some high-risk sites excavated and transported; potential for releases.	*Higher short-term risk.* Most high-risk sites excavated, transported, and treated; large volumes of less contaminated soil moved; high potential for releases.

	Caps/Covers[1]	Landfill/Caps	Landfill	Consolidation/Caps/ Treatment/Landfill	Caps/Treatment/ Landfill
Implementability	*Implementable.* Easy to construct caps/covers on schedule; short time to complete.	*Implementable.* Easy to construct caps/covers and landfill for soil with low levels of contamination; short time to complete.	*Moderate implementability.* Construction and permitting of large landfill for highly contaminated material may delay schedule.	*Moderate implementability.* Construction and permitting of large landfill for highly contaminated material may delay schedule.	*Difficult implementability.* Construction and permitting of large landfill and thermal treatment facility may delay schedule. Problems in excavation, treatment, and emissions control; longest time to complete.
Cost	*Moderate cost.* Least uncertainty in total implementation cost.	*Low cost.* Low uncertainty.	*Moderate cost.* Moderate uncertainty due to excavation and landfilling.	*Moderate cost.* Moderate uncertainty due to excavation and landfilling.	*Highest cost.* High uncertainty due to excavation/treatment of large volumes of highly-contaminated materials.
	Total: $542,000,000	Total: $383,000,000	Total: $576,000,000	Total: $570,000,000	Total: $1,010,000,000
Present Worth Cost	$429,000,000	$308,000,000	$484,000,000	$451,000,000	$812,000,000
Summary	*Not selected.* Higher long-term risks and no substantial cost savings compared to other alternatives.	*Not selected.* Higher long-term risk, although low cost.	*Not selected.* High short-term risks without improving long-term protection, which ultimately relies on containment.	*Selected.* Cost effective; balances short-term risks with higher long-term protection.	*Not selected.* High cost, short-term risks, and difficult to implement.



Prepared for: U.S. Army Program Manager for Rocky Mountain Arsenal

Figure 20.1-1

Caps/Covers Alternative

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Revision NO. 3
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Date 10/06/95
Drawn by XG
Approved by
Checked by

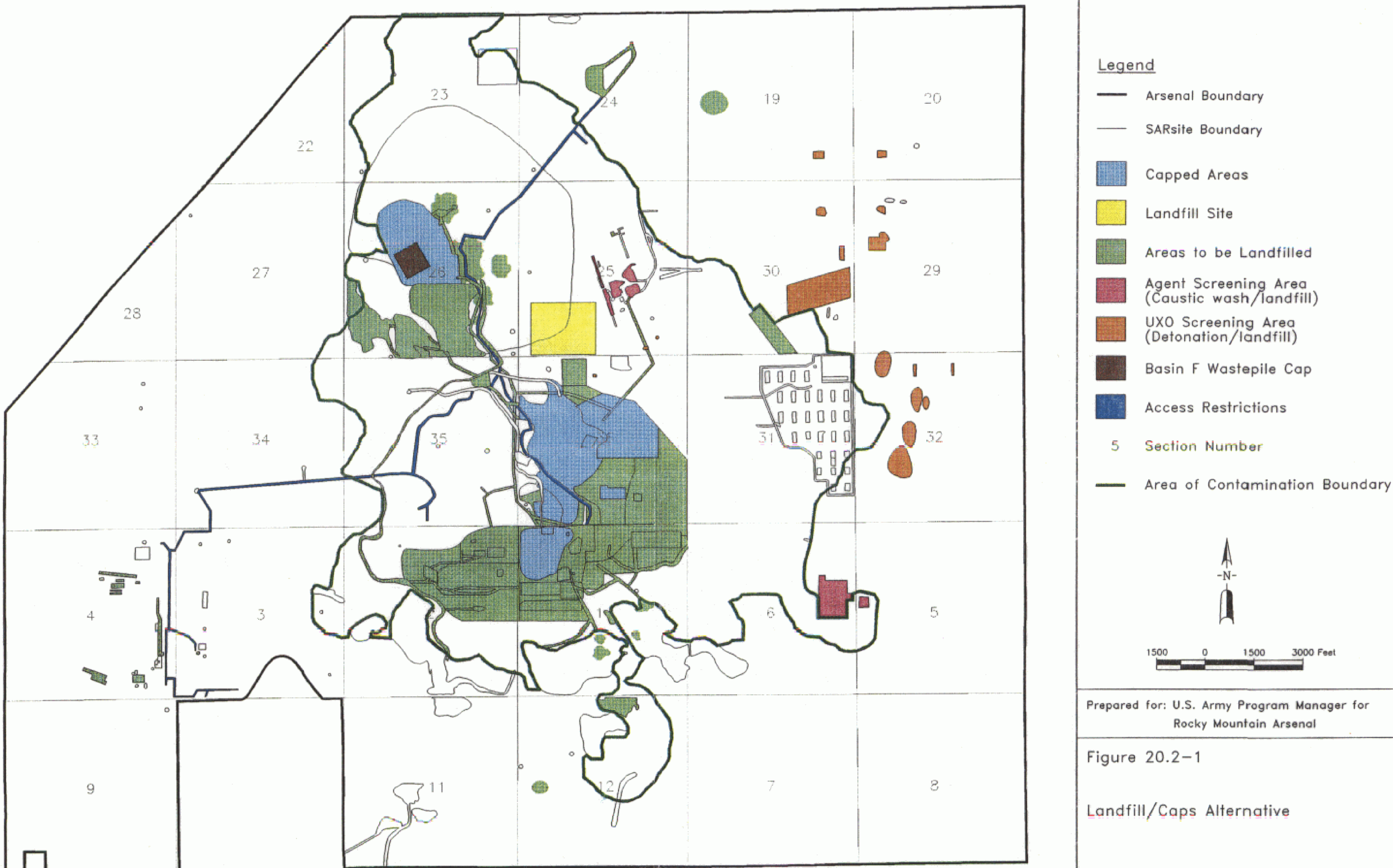

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Figure 20.2-1

Landfill/Caps Alternative

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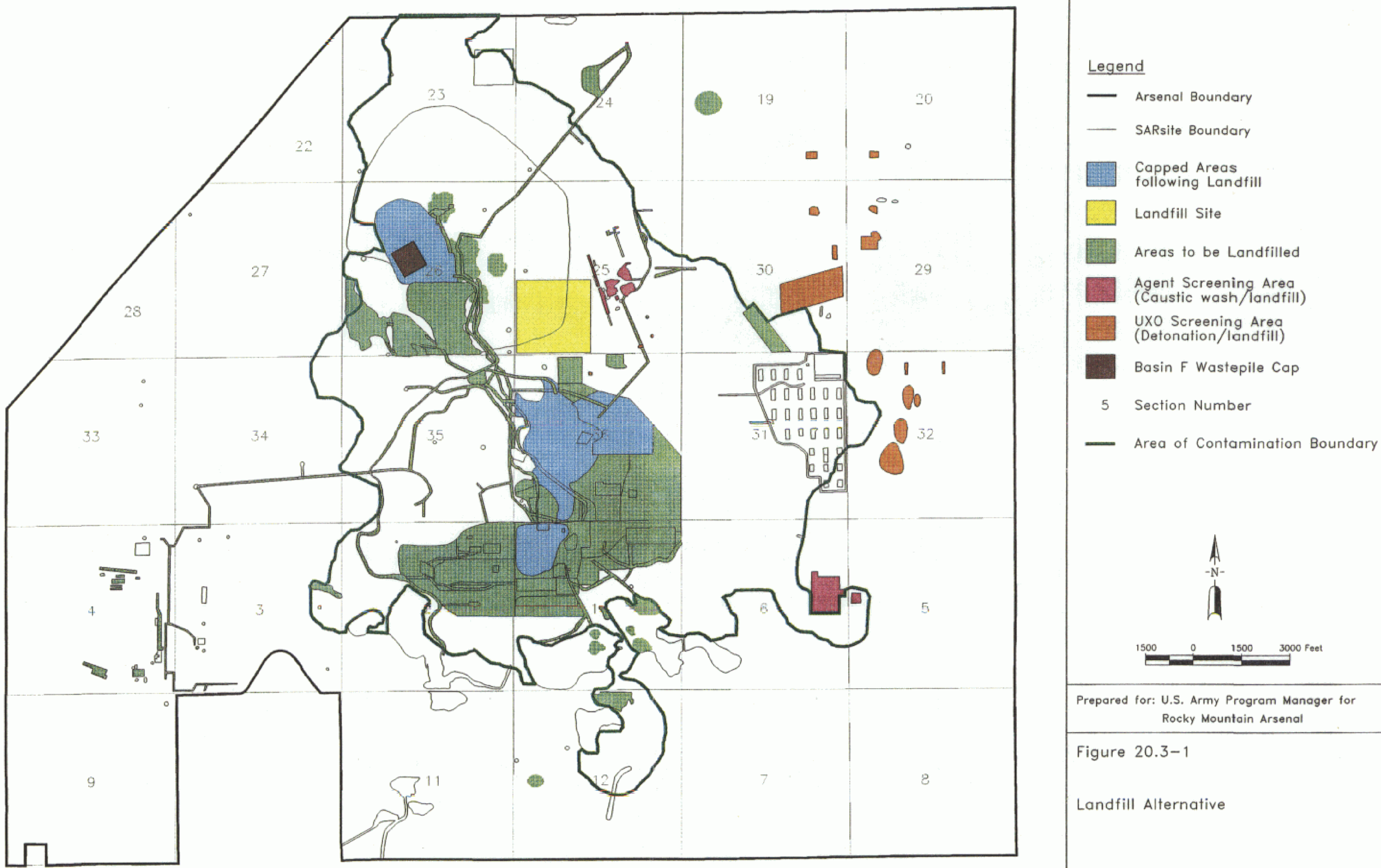

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Figure 20.3–1

Landfill Alternative

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Date 10/06/95
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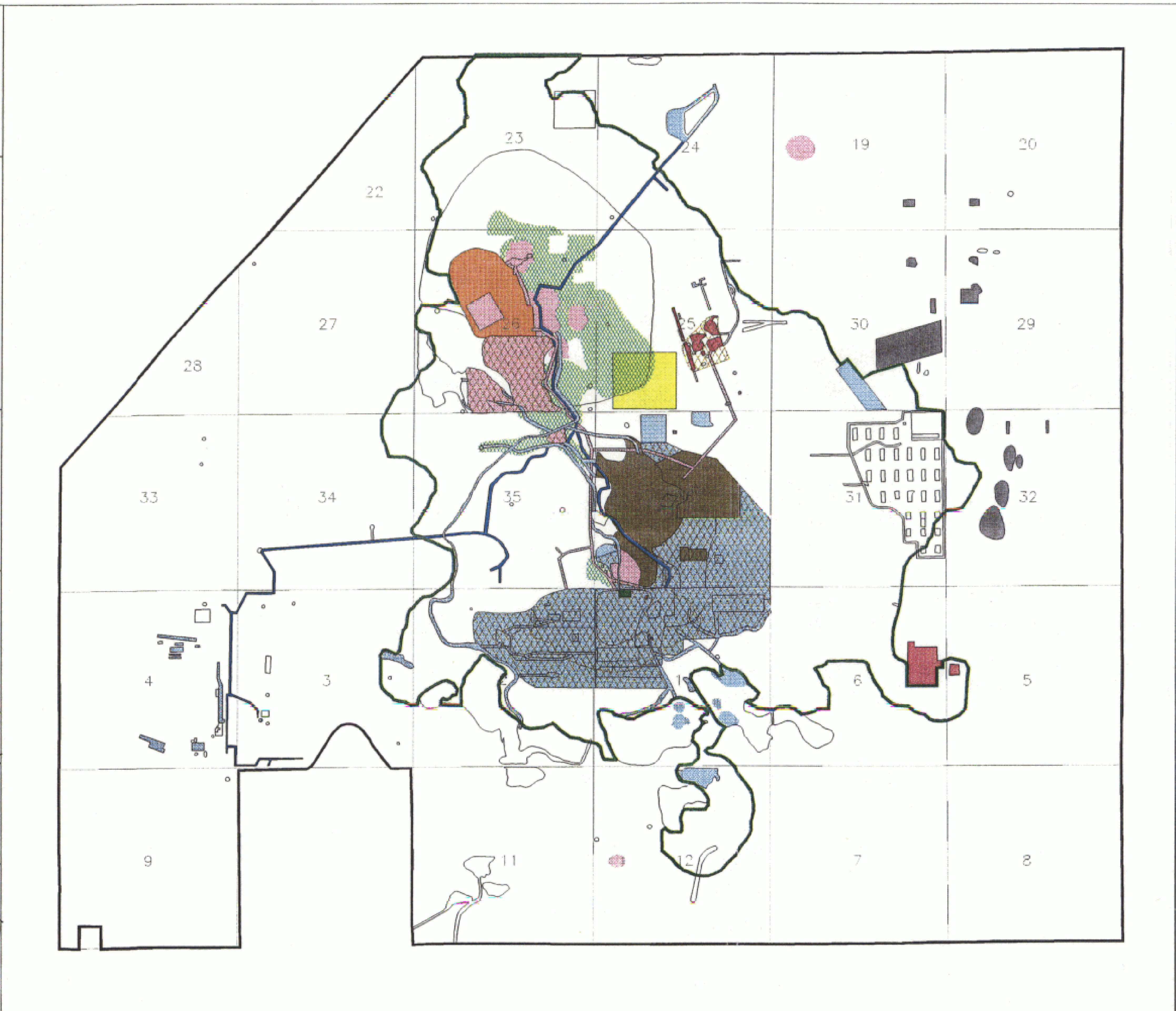

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Figure 20.4-1

Consolidation/Caps/Treatment/ Landfill Alternative

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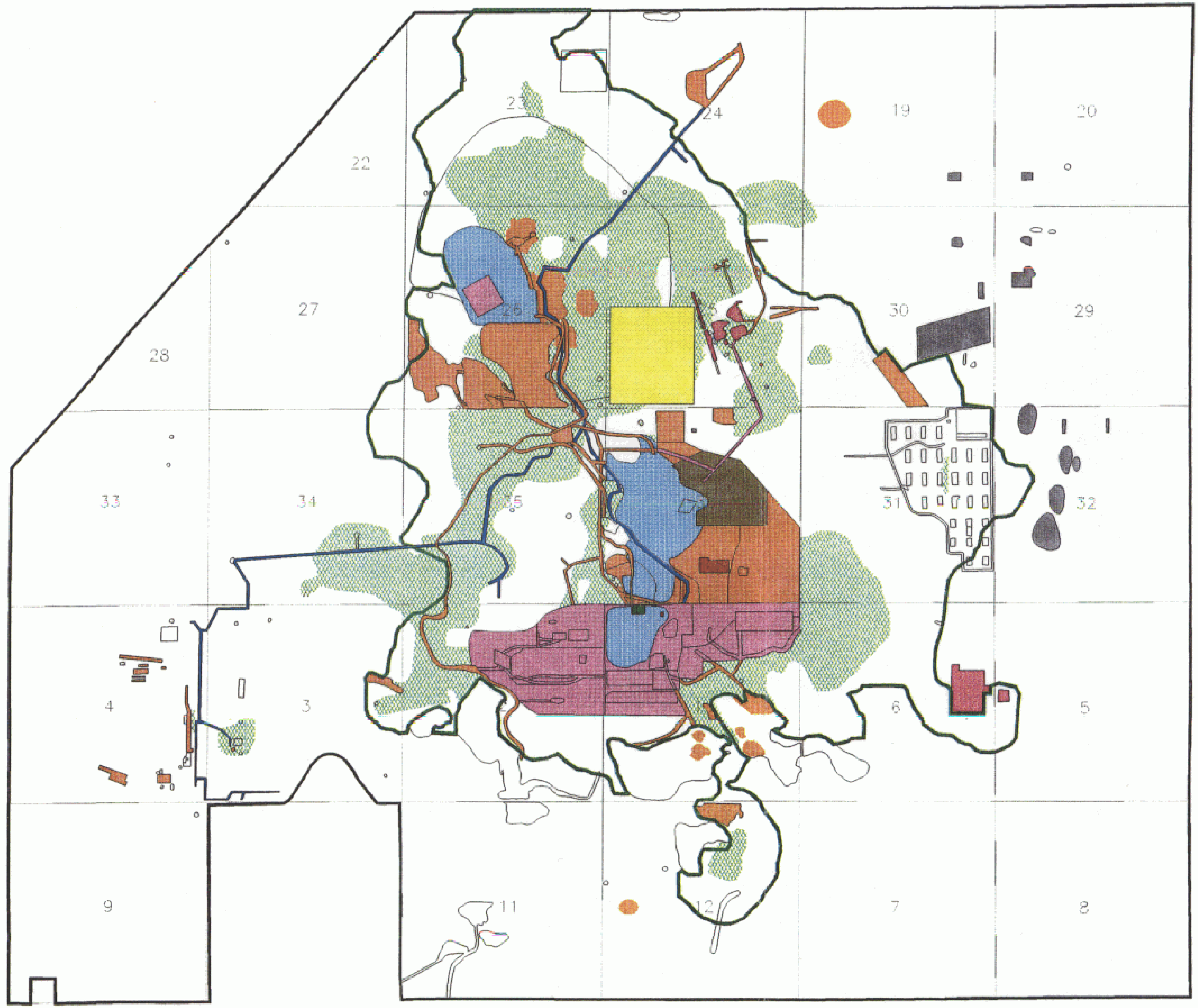

Legend

- Arsenal Boundary
- SARsite Boundary
- Area of Contamination Boundary
- Landfill and Cap following[1] Thermal Desorption of Principal Threat Volumes in Basin A, Former Basin F, South Plants Central Processing
- Thermal Desorption of Wastepile or Principal Threat Volume; Landfill
- Incineration
- Landfill Site
- Areas to be Landfilled
- Cap
- Direct Solidification/Stabilization
- Agent Screening Area (Caustic wash/landfill)
- UXO Screening Area (Detonation/landfill)
- In Situ Agricultural Practices
- Access Restrictions
- 5 Section Number

[1] Solidification/Stabilization of Principal Threat Volume with inorganic exceedance for South Plants Central Processing Area

-N-

1500 0 1500 3000 Feet

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Figure 20.5-1

Caps/Treatment/Landfill Alternative

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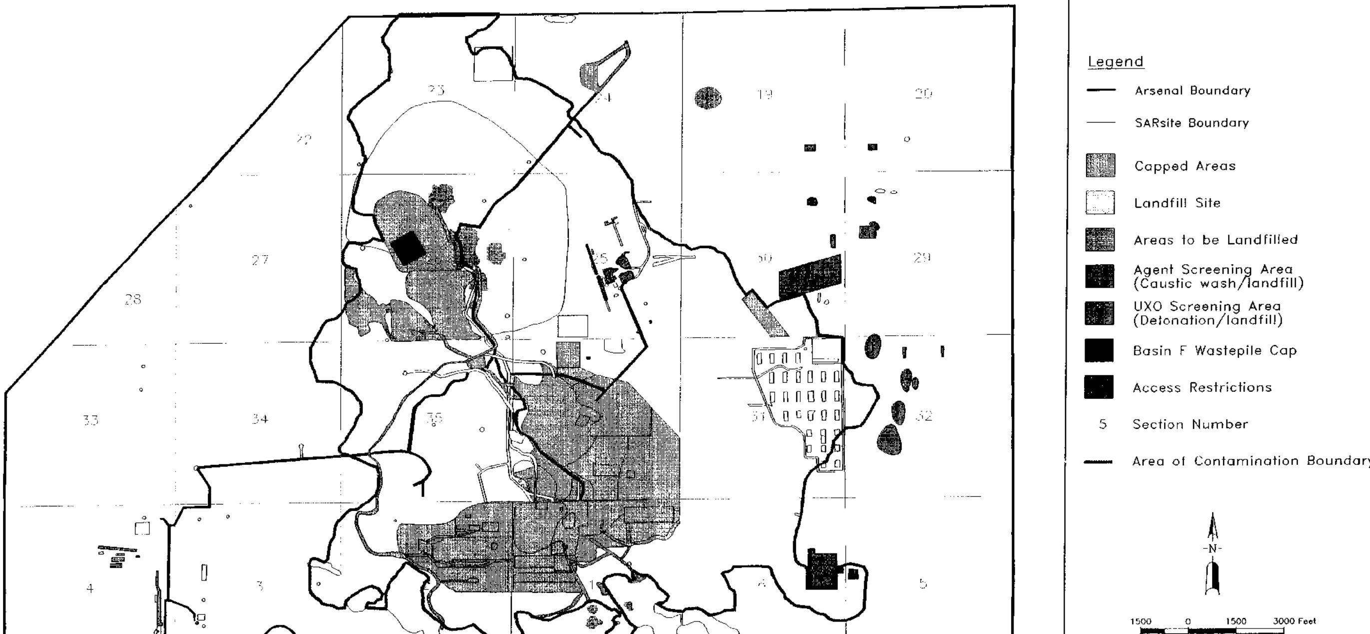

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Figure 20.1-1

Caps/Covers Alternative

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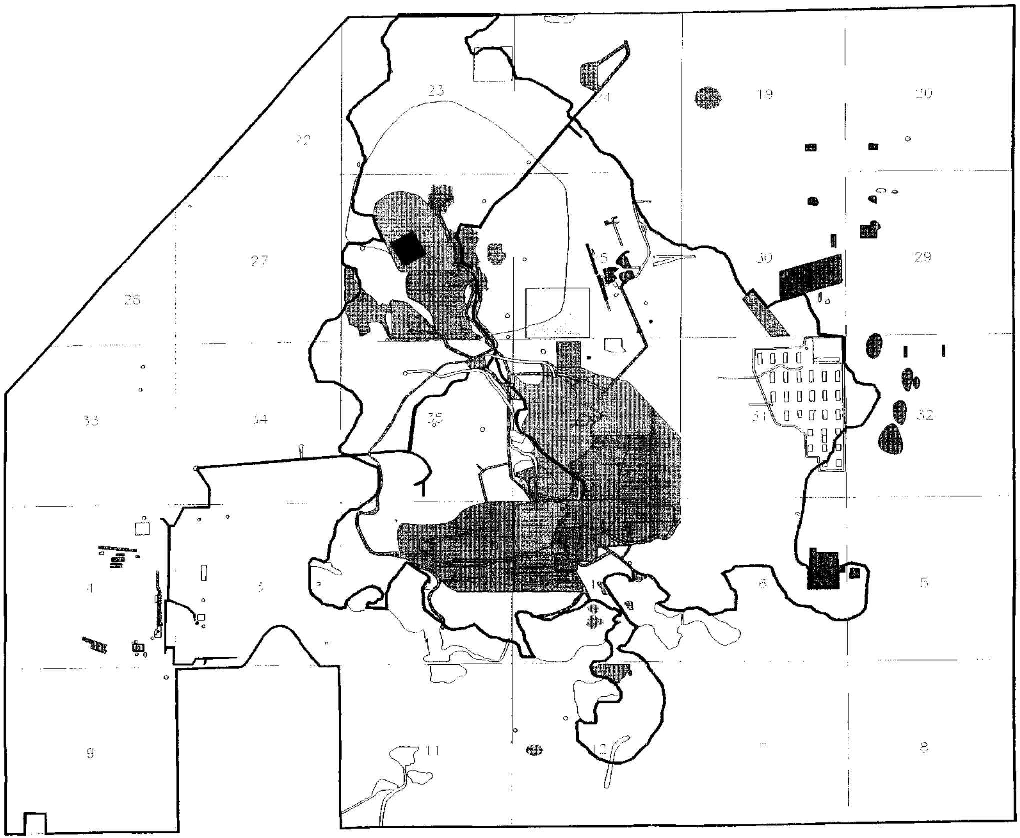

Legend

Arsenal Boundary

SARsite Boundary

Capped Areas

Landfill Site

Areas to be Landfilled

Agent Screening Area (Caustic wash/landfill)

UXO Screening Area (Detonation/landfill)

Basin F Wastepile Cap

Access Restrictions

5 Section Number

Area of Contamination Boundary

N

1500 0 1500 3000 Feet

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Figure 20.2-1

Landfill/Caps Alternative

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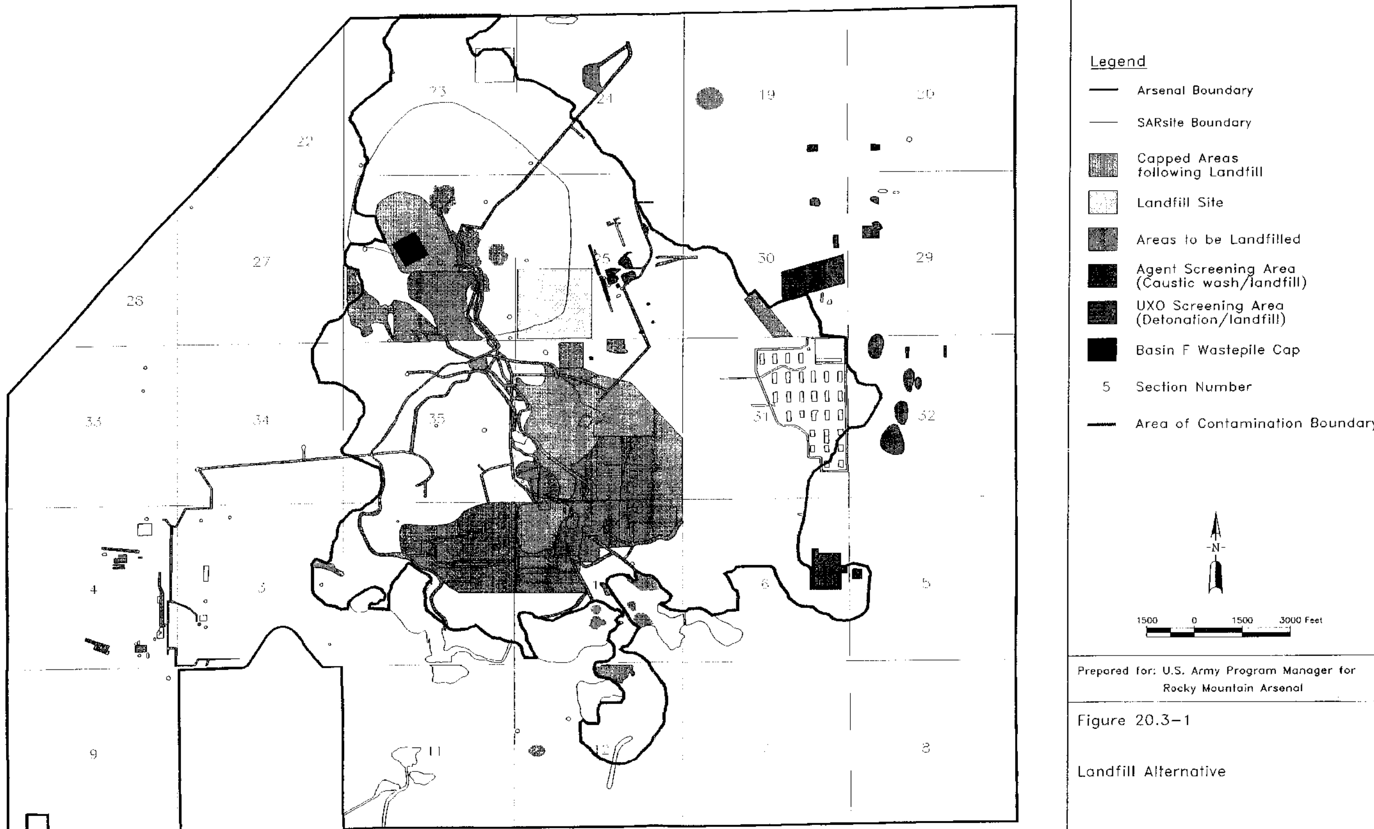

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Figure 20.3–1

Landfill Alternative

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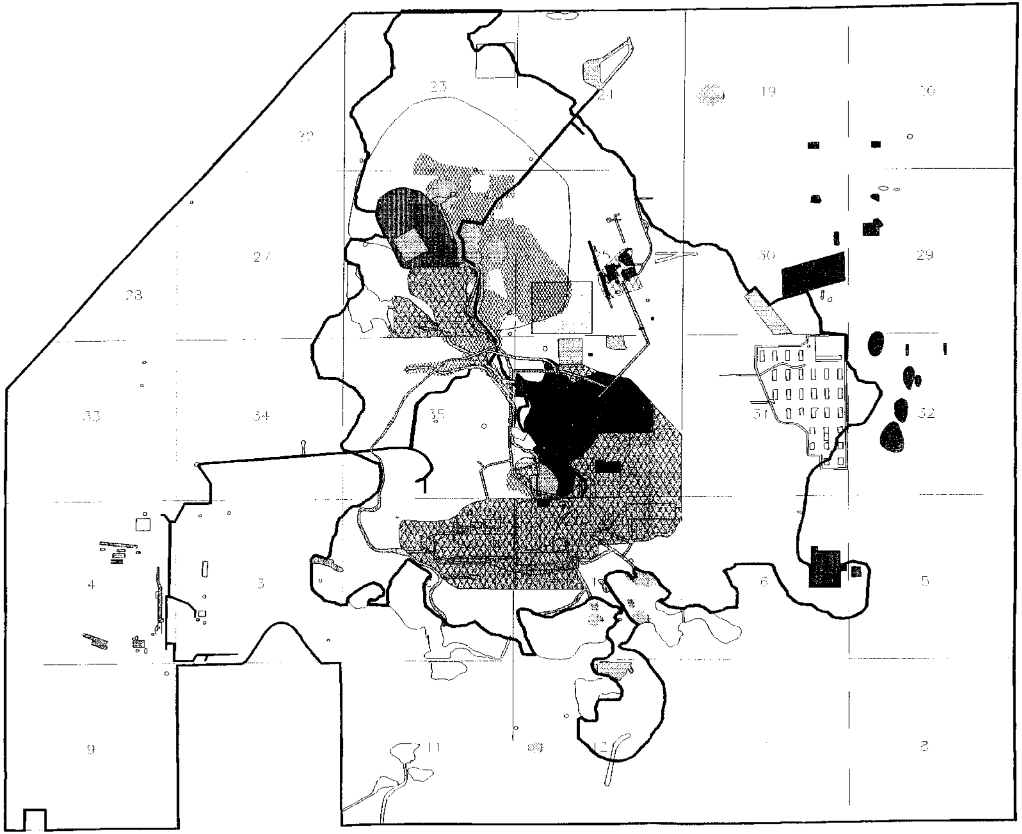

Legend

- Arsenal Boundary
- SARsite Boundary
- Area of Contamination Boundary
- In-situ Solidification of Principal Threat Volume; RCRA-equivalent Cap
- Caps/Covers
- Direct Solidification/Stabilization
- Hex Pit Treatment
- Landfill Human Health Soil,[1] Consolidation of Biota Soil
- Landfill Human Health Soil[2]
- Landfill Site
- Soil Covers
- Agent Screening Area (Caustic wash/landfill)
- UXO Screening Area (Detonation/landfill)
- Surficial Soil Consolidation
- Access Restrictions
- 5 Section Number

[1] Refuse from the Sanitary Landfills Medium Group will be consolidated

[2] Wastepile material will be dried prior to landfilling if paint filter test is failed

N

1500 0 1500 3000 Feet

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Figure 20.4-1

Consolidation/Caps/Treatment/ Landfill Alternative

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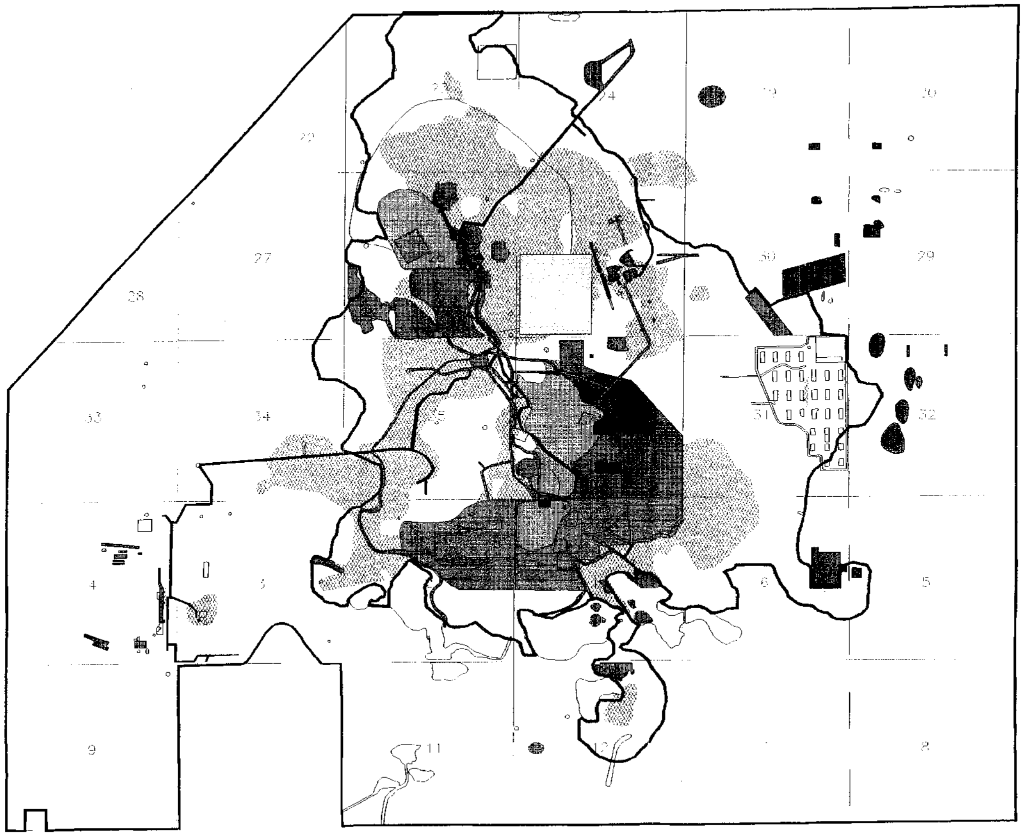

Legend

- Arsenal Boundary
- SARsite Boundary
- Area of Contamination Boundary
- Landfill and Cap following[1] Thermal Desorption of Principal Threat Volumes in Basin A, Former Basin F, South Plants Central Processing
- Thermal Desorption of Wastepile or Principal Threat Volume; Landfill
- Incineration
- Landfill Site
- Areas to be Landfilled
- Cap
- Direct Solidification/Stabilization
- Agent Screening Area (Caustic wash/landfill)
- UXO Screening Area (Detonation/landfill)
- In Situ Agricultural Practices
- Access Restrictions
- 5 Section Number

[1] Solidification/Stabilization of Principal Threat Volume with inorganic exceedance for South Plants Central Processing Area

N

1500 0 1500 3000 Feet

Prepared for: U.S. Army Program Manager for Rocky Mountain Arsenal

Figure 20.5-1

Caps/Treatment/Landfill Alternative

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October 1995

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