ARF # 14537

United States Department of Energy

Savannah River Site

Record of Decision Remedial Alternative Selection for the M Area Inactive Process Sewer Lines Operable Unit (081-M) (U)

CERCLIS Number: 92

WSRC-RP-2006-4001

Revision 1

December 2006

Prepared by:
Washington Savannah River Company LLC
Savannah River Site
Aiken, SC 29808

Prepared for U.S. Department of Energy under Contract No. DE-AC09-96SR18500

DISCLAIMER

This report was prepared by Washington Savannah River Company LLC (WSRC) for the United States Department of Energy under Contract No. DE-AC09-96SR18500 and is an account of work performed under that contract. Reference herein to any specific commercial product, process, or services by trademark, name, manufacturer or otherwise does not necessarily constitute or imply endorsement, recommendation, or favoring of same by WSRC or the United States Government or any agency thereof.

Printed in the United States of America

Prepared for
U.S. Department of Energy
and
Washington Savannah River Company LLC
Aiken, South Carolina

RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION (U)

M Area Inactive Process Sewer Lines Operable Unit (081-M) (U)

CERCLIS Number: 92

WSRC-RP-2006-4001
Revision 1

December 2006

Savannah River Site
Aiken, South Carolina

Prepared by:

Washington Savannah River Company LLC
for the
U. S. Department of Energy under Contract DE-AC09-96SR18500
Savannah River Operations Office
Aiken, South Carolina

This page was intentionally left blank.

DECLARATION FOR THE RECORD OF DECISION

Unit Name and Location

M Area Inactive Process Sewer Lines Operable Unit (081-M)

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number: 92

Savannah River Site

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Identification Number: SC1 890 008 989

Aiken, South Carolina

United States Department of Energy

The M Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU) (081-M) is listed as a Resource Conservation and Recovery Act (RCRA) 3004(u) Solid Waste Management Unit/CERCLA unit in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS).

The FFA is a legally binding agreement between regulatory agencies [United States Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC)] and the regulated entity [United States Department of Energy (USDOE)] that establishes the responsibilities and schedules for the comprehensive remediation of SRS. The media associated with this OU is vadose zone soil. Groundwater is not considered part of the scope for the MIPSL OU. Any groundwater contamination resulting from the MIPSL OU is regulated by the SRS RCRA Part B Permit and addressed by the requirements of the M-Area and Metallurgical Laboratory Hazardous Waste Management Facilities Groundwater Monitoring and Corrective Action agreements.

Statement of Basis and Purpose

This decision document presents the selected remedy for the MIPSL OU, located in the northwest portion of SRS in Aiken County, South Carolina. The remedy was chosen in accordance with CERCLA, as amended by the Superfund Amendments Reauthorization Act

(SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record File for this site. USEPA, SCDHEC and USDOE concur with the selected remedy.

Assessment of the Site

Chlorinated solvents (i.e., trichloroethylene and tetrachloroethylene) at the MIPSL OU have been released to the environment. The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Description of the Selected Remedy

The selected remedy for the MIPSL OU is Alternative S-2, Phased Soil Vapor Extraction Enhanced with Soil Fracturing and Institutional Controls. This alternative has been selected because it effectively removes volatile organic compounds (VOCs) from the vadose zone and protects groundwater by depleting the source. No chemicals are used. Soil fracturing is used to increase the permeability of the formation, thereby increasing the effectiveness of soil vapor extraction (SVE). System air emissions do not require treatment and are vented to the atmosphere. Phased SVE will begin with active SVE. As mobile VOCs are depleted, less energy intensive SVE technologies will be deployed to complete the remediation. Institutional controls (ICs) will be used to limit access to the area. ICs will also include grouting of the manholes for access control. The future land use for the MIPSL OU is anticipated to be industrial.

The following Land Use Control (LUC) objectives are necessary to ensure protectiveness of the selected remedy:

- restrict worker access and prevent unauthorized contact, removal or excavation of contaminated media (i.e., vadose zone soils and pipelines)

- prohibit the development and use of property for residential housing, elementary schools, child care facilities and playgrounds

- maintain the integrity of any current or future remedial or monitoring system, such as SVE systems or groundwater monitoring wells

- prevent access to or use of the groundwater until cleanup levels are met (under the RCRA program)

The selected alternative to satisfies the statutory requirements in CERCLA Section 121(b) to (1) be protective of human health and the environment, (2) comply with applicable or relevant and appropriate requirements (ARARs), (3) be cost-effective, and (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The selected alternative satisfies the preference for treatment as a principal element of the remedy.

The SRS RCRA permit will be revised to reflect selection of the final remedy using the procedures under 40 Code of Federal Regulations (CFR) Part 270 and South Carolina Hazardous Waste Management Regulations R.61-79.264;270.

Statutory Determinations

Based on the unit RCRA Facility Investigation/Remedial Investigation with Baseline Risk Assessment (RFI/RI/BRA) report, the MIPSL OU poses a threat to human health and the environment. Therefore, Alternative S-2, Phased Soil Vapor Extraction Enhanced with Soil Fracturing and Institutional Controls, has been selected as the remedy for the MIPSL OU. The MIPSL OU is located in an area of historically heavy industrial and nuclear land use, and future industrial land use is anticipated.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy

is, and will continue to be, protective of human health and the environment. Five-year remedy reviews are required under CERCLA Section 121(c).

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of materials comprising principal threats through treatment).

In the long term, if the property is ever transferred to nonfederal ownership, the United States Government will take those actions necessary pursuant to Section 120(h) of CERCLA. Those actions will include a deed notification disclosing former waste management and disposal activities as well as remedial actions taken on the site. The contract for sale and the deed will contain the notification required by CERCLA Section 120(h). The deed notification shall notify any potential purchaser that the property has been used for the management and disposal of waste. These requirements are also consistent with the intent of the RCRA deed notification requirements at final closure of a RCRA facility if contamination will remain at the unit.

The deed shall also include deed restrictions precluding residential use of the property. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ and/or the residual contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for the deed restrictions will be done through an amended ROD with USEPA and SCDHEC review and approval.

In addition, if the site is ever transferred to nonfederal ownership, a survey plat of the OU will be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency.

The selected remedy for the MIPSL OU leaves hazardous substances in place that pose a potential future risk and will require that land use restrictions remain in place until the concentrations of hazardous substances in the soil and groundwater are at levels that allow for

unrestricted use and exposure. As agreed on March 30, 2000, among the USDOE, USEPA, and SCDHEC, SRS is implementing Land Use Control Assurance Plan (LUCAP) to ensure that the LUCs required by numerous remedial decisions at SRS are properly maintained and periodically verified. The unit-specific Land Use Control Implementation Plan (LUCIP), which is incorporated by reference into this ROD, will provide the details and specific measures required to implement and maintain the LUCs selected as part of this remedy. USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the Corrective Measures Implementation (CMI) / Remedial Action Implementation Plan (RAIP), as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA and the *SRS Federal Facility Agreement*. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the unit. The LUCIP will remain in effect until modifications are approved, as needed, to be protective of human health and the environment. LUCIP modifications will only occur through another CERCLA document.

Data Certification Checklist

This ROD provides the following information:

- Constituents of concern (COCs) and their respective concentrations
- Baseline risk represented by the COCs
- Cleanup levels established for the COCs and the basis for the levels
- Current and reasonably anticipated future land and groundwater use assumptions used in the BRA and ROD

- Potential land and groundwater use that will be available at the site as a result of the selected remedy

- Estimated capital, operation and maintenance, and total present worth cost; discount rate; and the number of years over which the remedy cost estimates are projected

- Key decision factor(s) that led to selecting the remedy (i.e., describe how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria)

- The manner in which source materials constituting principal threats are addressed

3/9/07
Date

Jeffrey M. Allison
Manager
U. S. Department of Energy
Savannah River Operations Office

4/9/07
Date

Franklin E. Hill
Acting Director
Superfund Division
U. S. Environmental Protection Agency - Region 4

4/20/07
Date

Robert W. King, Jr.
Deputy Commissioner
Environmental Quality Control
South Carolina Department of Health and Environmental Control

This page was intentionally left blank

DECISION SUMMARY
REMEDIAL ALTERNATIVE SELECTION (U)

M Area Inactive Process Sewer Lines Operable Unit (081-M)

CERCLIS Number: 92

WSRC-RP-2006-4001
Rev. 1

December 2006

Savannah River Site
Aiken, South Carolina

Prepared By:

Washington Savannah River Company LLC
for the
U. S. Department of Energy under Contract DE-AC09-96SR18500
Savannah River Operations Office
Aiken, South Carolina

This page was intentionally left blank

TABLE OF CONTENTS

SECTION PAGE

LIST OF FIGURES iv

LIST OF TABLES iv

LIST OF ACRONYMS AND ABBREVIATIONS v

I. SAVANNAH RIVER SITE AND OPERABLE UNIT NAME, LOCATION, AND DESCRIPTION 1

II. SITE AND OPERABLE UNIT COMPLIANCE HISTORY 2

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION 6

IV. SCOPE AND ROLE OF THE OPERABLE UNIT 8

V. OPERABLE UNIT CHARACTERISTICS 9

VI. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES 12

VII. SUMMARY OF OPERABLE UNIT RISKS 13

VIII. REMEDIAL ACTION OBJECTIVES AND REMEDIAL GOALS 17

IX. DESCRIPTION OF ALTERNATIVES 20

X. COMPARATIVE ANALYSIS OF ALTERNATIVES 26

XI. THE SELECTED REMEDY 31

XII. STATUTORY DETERMINATIONS 38

XIII. EXPLANATION OF SIGNIFICANT CHANGES 39

XIV. RESPONSIVENESS SUMMARY 39

XV. POST-ROD DOCUMENT SCHEDULE AND DESCRIPTION 39

XVI. REFERENCES 40

XVII. APPENDICES 41

APPENDIX A - Responsiveness Summary A-1

APPENDIX B - Applicable or Relevant and Appropriate Requirements B-1

APPENDIX C - Operational Trend of SVE Unit C-1

APPENDIX D - Cost Estimate for the Selected Remedy D-1

LIST OF FIGURES

FIGURE 1. LOCATION OF THE MIPSL OU IN M AREA WITHIN THE SAVANNAH RIVER SITE 45

FIGURE 2. LAYOUT OF THE MIPSL OU 47

FIGURE 3. SCHEMATIC OF MIPSL OU AREA VADOSE ZONE 49

FIGURE 4. LOCATION OF MIPSL OU WITHIN UPPER THREE RUNS WATERSHED 51

FIGURE 5. CONCEPTUAL SITE MODEL 53

FIGURE 6. LAND USE MAP FOR MIPSL OU 55

FIGURE 7. SUMMARY OF RGO EXCEEDANCES FOR PCE AND TCE AT MIPSL OU 57

FIGURE 8. ALTERNATIVE S-2: SVE ENHANCED WITH SOIL FRACTURING, INSTITUTIONAL CONTROLS 59

FIGURE 9. ALTERNATIVE S-6 AND S-7: OZONE OR METHANE TREATMENT, SVE ENHANCED WITH SOIL FRACTURING, INSTITUTIONAL CONTROLS 61

FIGURE 10. ALTERNATIVE S-11: REMOVAL AND OFF-SRS DISPOSAL 63

FIGURE 11. POST-ROD SCHEDULE 65

LIST OF TABLES

TABLE 1. SUMMARY OF REMEDIAL GOALS FOR THE MIPSL OU 69

TABLE 2. COMPARATIVE ANALYSIS SUMMARY FOR THE MIPSL OU 70

TABLE 3. LAND USE CONTROLS FOR THE MIPSL OU 71

LIST OF ACRONYMS AND ABBREVIATIONS

AOC	area of contamination
ARAR	applicable or relevant and appropriate requirement
BAF	bioaccumulation factor
bgs	below ground surface
bp	bottom of pipe
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
cm	centimeter
CM	contaminant migration
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
DNAPL	dense nonaqueous phase liquid
ECO	ecological
ERA	ecological risk assessment
ESD	explanation of significant difference
FFA	Federal Facility Agreement
FS	Feasibility Study
ft	foot
HBL	health-based limit
HDPE	high density polyethylene
HI	hazard index
HSWA	Hazardous and Solid Waste Amendments
IC	Institutional Controls
in	inch
IOU	integrated operable units
JCW	job control waste
LLC	Limited Liability Company
LUC	Land Use Control
LUCAP	Land Use Control Assurance Plan
LUCIP	Land Use Control Implementation Plan

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

m	meter
m^3	cubic meter
MCL	Maximum contaminant level
MEBR	methane-enhanced bioremediation
mg/kg	milligram per kilogram
mg/L	milligram per liter
MIPS	M Area Process Sewer
MIPSL	M Area Inactive Process Sewer Lines
NBN	no building number
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Protection Act
NPL	National Priorities List
O&M	operations and maintenance
OU	operable unit
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
PCR	Post-Construction Report
PPE	personal protective equipment
PRG	preliminary remediation goals
PTSM	principal threat source material
PW	present worth
RACR	Remedial Action Completion Report
RAIP	Remedial Action Implementation Plan
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RG	remedial goal
RGO	remedial goal objective
RI	Remedial Investigation
ROD	Record of Decision

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

SARA	Superfund Amendments Reauthorization Act
SB/PP	Statement of Basis/Proposed Plan
SCDHEC	South Carolina Department of Health and Environmental Control
scfm	standard cubic feet per minute
SCHWMR	South Carolina Hazardous Waste Management Regulations
SVE	soil vapor extraction
SRS	Savannah River Site
TBC	to be considered
TCA	1,1,1-trichloroethane
TCE	trichloroethylene
TSCA	Toxic Substance Control Act
UIC	underground injection control
URMA	underground radioactive material area
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
VZCOMML	Vadose Zone Contaminant Migration Multi-Layered Model™
WSRC	Washington Savannah River Company, LLC
yd^3	cubic yard

This page was intentionally left blank

I. SAVANNAH RIVER SITE AND OPERABLE UNIT NAME, LOCATION, AND DESCRIPTION

Unit Name, Location, and Brief Description

M Area Inactive Process Sewer Lines Operable Unit (081-M)

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number: 92

Savannah River Site

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Identification Number: SC1 890 008 989

Aiken, South Carolina

United States Department of Energy (USDOE)

The Savannah River Site (SRS) occupies approximately 310 square miles of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of South Carolina (Figure 1). SRS is located approximately 25 miles southeast of Augusta, Georgia, and 20 miles south of Aiken, South Carolina.

The USDOE owns SRS, which historically produced tritium, plutonium, and other special nuclear materials for national defense and the space program. Chemical and radioactive wastes are by-products of nuclear material production processes. Hazardous substances, as defined by the CERCLA, are currently present in the environment at SRS.

The Federal Facility Agreement (FFA) (FFA 1993) for SRS lists the M Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU) (081-M) as a Resource Conservation and Recovery Act (RCRA) Solid Waste Management Unit/Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) unit requiring further evaluation. The MIPSL OU was evaluated through an investigation process that integrates and combines the RCRA corrective action process with the CERCLA remedial process to determine the actual or potential impact to human health and the environment of releases of hazardous substances to the environment (WSRC 2005).

II. SITE AND OPERABLE UNIT COMPLIANCE HISTORY

SRS Operational and Compliance History

The primary mission of SRS has been to produce tritium, plutonium, and other special nuclear materials for our nation's defense programs. Production of nuclear materials for the defense program was discontinued in 1988. SRS has provided nuclear materials for the space program, as well as for medical, industrial, and research efforts up to the present. Chemical and radioactive wastes are by-products of nuclear material production processes. These wastes have been treated, stored, and in some cases, disposed of at SRS. Past disposal practices have resulted in soil and groundwater contamination.

Hazardous waste materials handled at SRS are managed under RCRA, a comprehensive law requiring responsible management of hazardous waste. Certain SRS activities require South Carolina Department of Health and Environmental Control (SCDHEC) operating or post-closure permits under RCRA. SRS received a RCRA hazardous waste permit from the SCDHEC, which was most recently renewed on September 30, 2003. Module VIII of the Hazardous and Solid Waste Amendments (HSWAs) portion of the RCRA permit mandates corrective action requirements for non-regulated solid waste management units subject to RCRA 3004(u).

On December 21, 1989, SRS was included on the National Priorities List (NPL). The inclusion created a need to integrate the established RCRA Facility Investigation (RFI) program with CERCLA requirements to provide for a focused environmental program. In accordance with Section 120 of CERCLA 42 United States Code Section 9620, USDOE has negotiated an FFA (FFA 1993) with United States Environmental Protection Agency (USEPA) and SCDHEC to coordinate remedial activities at SRS as one comprehensive strategy that fulfills these dual regulatory requirements. USDOE functions as the lead agency for remedial activities at SRS, with concurrence by the USEPA - Region 4 and the SCDHEC.

Operable Unit Operational and Compliance History

The MIPSL OU is located in the northwest portion of SRS in Aiken County, South Carolina (Figure 1). Within SRS, the OU is located in M Area and comprises portions of the M Area Settling Basin Inactive Process Sewer to Manhole 1 (MIPS; Building Number 081-M) (including the Southern Portions of the 313-M Inactive Clay Process Sewer Lines to Tims Branch, No Building Number [NBN] and the Southern Portions of the 320-M Inactive Clay Process Sewer Lines from the Building Slab to the Former Security Fence, NBN [313-MIPS]). This includes the segment of pipe from the slab of the 320-M Alloy Building to the Former Security Fence (passing through Manholes 3A, 2A, 1N, 1A, and 1) and the segment of pipeline starting adjacent to the slab of the 322-M Metallurgical Laboratory (starting just south of the pipeline between 322-M and Manhole 6A) and extending to the A-014 Outfall (passing through Manholes 8, 9, 10, 11, 12, 13, and 14) (Figure 2).

From 1958 until 1985, several M Area facilities (313-M, 320-M, and 321-M) manufactured reactor fuel and target assemblies. Associated operations included support buildings, maintenance operations, laboratories, and infrastructure for managing waste. Effluents from M Area were transported through two separate networks of vitrified clay pipes (Figure 2). The MIPS network discharged waste to the M Area Settling Basin, and the 313-MIPS network released waste to the A-014 Outfall, which flowed to a tributary of Tims Branch. In May 1982, the 313-MIPS process waters were diverted from Tims Branch to conjoin with MIPS process waters already flowing to the M Area Settling Basin, increasing the flow from an average of 1.6 to 3 million liters per day (430,000 to 800,000 gallons per day). In November 1982, process waters from 313-MIPS were redirected back to Tims Branch, resulting in a reduction of the flow to the M Area Settling Basin to 950,000 liters per day (250,000 gallons per day) by the end of 1982 (WSRC 2003).

Pre-cast concrete or brick manholes along the MIPS and 313-MIPS allowed access to the pipelines for inspection, maintenance, effluent sampling, etc. The manholes are spaced

approximately 107 to 122 m (350 to 400 ft) apart along the MIPS and 313-MIPS sewer lines. An engineering review (WSRC 2003) examined the construction, effluent capacity, and operational history for the MIPS and 313-MIPS and found little probability of process overflows at the manholes.

M Area effluent wastes included chlorinated solvents (used for degreasing fuel and target assemblies), acids, caustics, heavy metals, and minor amounts of radioactive constituents. Specific constituents of interest include trichloroethylene (TCE), tetrachloroethylene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), aluminum, copper, iron, lead, magnesium, manganese, mercury, nickel, zinc, and uranium.

An RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan, prepared in 1992 and submitted in accordance with SRS's initial strategies for RCRA compliance, proposed characterization of 488 m (1,600 ft) of the MIPS to delineate the areal extent of hazardous constituents released to the soil. A portion of the proposed work (28 shallow soil-gas samples) was completed that same year. The units listed in SRS's FFA (FFA 1993), including the MIPS pipeline, were subsequently reprioritized using a hazard-ranking algorithm. The hazard rank for MIPS was relatively low compared to other waste units. As a result, the project schedule was revised and the remainder of the characterization Work Plan was not completed.

By May 2003, M Area facilities had been sufficiently deactivated and an additional 427 m (1,400 ft) of MIPS pipeline was added to the scope for the MIPSL OU. In June 2003, the 313-MIPS (2,042 m [6,700 ft]) was also included in the MIPSL OU. The RFI/RI Work Plan, RFI/RI Report with BRA, and CMS/FS (WSRC 2005) contains the detailed information and analytical data for all investigations conducted and samples taken for the MIPSL OU.

In January 2006, USDOE, USEPA, and SCDHEC agreed to limit the scope of the MIPSL OU per the USDOE letter titled *Revised Scope of the M Area Inactive Process Sewer Lines Operable Unit (081-M)* (USDOE 2006). Selected process sewer lines from the

2003 unit description were moved to the M Area OU. USDOE, USEPA, and SCDHEC believe that better and more cost-effective remedial decisions will be made by evaluating the remedial problems in M Area in this manner. From a regulatory document perspective, this redefined scope is first described in the Statement of Basis/Proposed Plan (SB/PP) for the MIPSL OU (WSRC 2006).

The MIPSL OU currently includes 391 m (1,283 ft) of the MIPS and 768 m (2,520 ft) of 313-MIPS, and extends from the edges of the buildings (or former buildings) to the downstream discharge points of each line (Figure 2). Sewer pipes are made of vitrified clay, diameters range from 30.5 to 76 cm (12 to 30 in), and pipe depths range from about 2.1 to 3.7 m (7 to 12 ft) below ground surface (bgs). High-density polyethylene (HDPE) pipe liner, installed inside portions of the MIPS and 313-MIPS pipelines in 1983, ranges from 15 to 30 cm (6 to 12 in) in diameter.

SRS sits atop the Atlantic Coastal Plain, a seaward-thickening wedge of unconsolidated and semi-consolidated sediment that rests unconformably on underlying Triassic sediments and Precambrian to Paleozoic crystalline basement rocks. The sedimentary sequence at SRS ranges from approximately 200 to 275 m (650 to 900 ft) thick, comprising late Cretaceous to Holocene age clastic and calcareous sediments deposited during a series of transgressions and regressions in depositional environments ranging from fluvial to marginal marine settings (Aadland et al. 1995; Fallaw and Price 1995; Siple 1967).

Soil and soil-gas samples were collected from sediments of the Tertiary age (Eocene) Barnwell Group, a 21-m (70-ft) thick deposit of quartz sand, sandy clay, and calcareous sand deposited in a lower delta plain or shallow shelf environment (Aadland et al. 1995). Sediments of the Barnwell Group are exposed at the ground surface in the MIPSL OU; in the uppermost 6 to 7.5 m (20 to 25 ft), these sediments have been extensively reworked and backfilled during operational activities.

Samples were taken from the uppermost part of the vadose zone. This section of unsaturated and semi-saturated sediments from the ground surface down to the water table is approximately 36 m (120 ft) thick beneath the MIPSL OU and includes Eocene age sediments of the Clinchfield, Dry Branch, and Tobacco Road Formations. The Upland Unit (poorly sorted silty, clayey sands and conglomerates) overlies the Tobacco Road Formation and is present across M Area. The uppermost aquifer beneath the MIPSL OU is the Steed Pond aquifer unit, which is developed in sections of the Black Mingo, Orangeburg, and Barnwell Groups. The Steed Pond aquifer unit is approximately 30 m (100 ft) thick in the study area (Figure 3).

The occurrence and flow of groundwater are influenced by the surface physiography and by the texture, composition, and bedding characteristics of the sedimentary sequence. The SRS regional hydrogeology, including aquifer and aquitard characteristics, groundwater flow, relationship to stratigraphic units, surface water and geomorphology, is described in detail in the *Hydrogeologic Framework of West-Central South Carolina* (Aadland et al. 1995).

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Both RCRA and CERCLA require the public to be given an opportunity to review and comment on the draft permit modification and proposed remedial alternative. Public participation requirements are listed in South Carolina Hazardous Waste Management Regulations (SCHWMR) R.61-79.124 and Sections 113 and 117 of CERCLA (42 United States Code Sections 9613 and 9617). These requirements include establishment of an Administrative Record File that documents the investigation and selection of the remedial alternative for addressing the MIPSL OU vadose zone soils. The Administrative Record File must be established at or near the facility at issue.

The SRS Public Involvement Plan (USDOE 1994) is designed to facilitate public involvement in the decision-making process for permitting, closure, and the selection of

remedial alternatives. The SRS Public Involvement Plan addresses the requirements of RCRA, CERCLA, and the National Environmental Policy Act, 1969 (NEPA).

SCHWMR R.61-79.124 and Section 117(a) of CERCLA, as amended, require the advertisement of the draft permit modification and notice of any proposed remedial action and provide the public an opportunity to participate in the selection of the remedial action. The *Statement of Basis/Proposed Plan for the M Area Inactive Process Sewer Lines Operable Unit (081-M)* (WSRC 2006), a part of the Administrative Record File, highlights key aspects of the investigation and identifies the preferred action for addressing the MIPSL OU.

The FFA Administrative Record File, which contains the information pertaining to the selection of the response action, is available at the following locations:

U.S. Department of Energy
Public Reading Room
Gregg-Graniteville Library
University of South Carolina – Aiken
171 University Parkway
Aiken, South Carolina 29801
(803) 641-3465

Thomas Cooper Library
Government Documents Department
University of South Carolina
Columbia, South Carolina 29208
(803) 777-4866

The RCRA Administrative Record File for SCDHEC is available for review by the public at the following locations:

The South Carolina Department of Health and Environmental Control
Bureau of Land and Waste Management
8911 Farrow Road
Columbia, South Carolina 29203
(803) 896-4000

The South Carolina Department of Health and Environmental Control – Region 5
Aiken Environmental Quality Control Office
206 Beaufort Street, Northeast
Aiken, South Carolina 29801
(803) 641-7670

The public was notified of the public comment period through the *SRS Environmental Bulletin*, a newsletter sent to citizens in South Carolina and Georgia, and through notices in the *Aiken Standard*, the *Allendale Citizen Leader*, the *Augusta Chronicle*, the *Barnwell*

People-Sentinel, and *The State* newspaper. The public comment period was also announced on local radio stations.

The SB/PP 45-day public comment period began on June 15, 2006, and ended on July 29, 2006. During the public comment period, a presentation of the selected remedial action was made at the July 18, 2006 SRS Citizens Advisory Board Facilities Disposition and Site Remediation Committee Meeting. A presentation was also made at the July 24, 2006 SRS Citizens Advisory Board Combined Committee Meeting. Based on this presentation, the Facilities Disposition and Site Remediation Committee sponsored Recommendation 236 regarding soil vapor extraction with soil fracturing (see Appendix A for the details of this Recommendation). A Responsiveness Summary, prepared to address any comments received during the public comment period, is provided in Appendix A of this document. A Responsiveness Summary will also be available with the final RCRA permit modification.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT

Due to the complexity of multiple contaminant areas, the SRS is divided into integrated operable units (IOUs) for the purpose of managing a comprehensive cleanup strategy. Waste units within an IOU are evaluated and remediated individually.

The MIPSL OU (Figure 4) is located within the Upper Three Runs IOU (Upper Three Runs Watershed). Upon disposition of all OUs within the watershed, a final comprehensive Record of Decision (ROD) for the Upper Three Runs IOU will be issued.

The overall strategy for addressing the MIPSL OU was to (1) characterize the waste unit, delineating nature and extent of contamination and identifying the media of concern (perform the RFI/RI); (2) perform a BRA to evaluate the media of concern, constituents of concern (COCs), and exposure pathways and characterize potential risks; and (3) evaluate and perform a final action to remediate, as needed, the identified media of concern.

The scope of the MIPSL OU remedial action is limited to vadose zone soils. The response actions discussed in this ROD are final remedial actions. Groundwater is not

considered part of the scope for the MIPSL OU. Any groundwater contamination resulting from the MIPSL OU will be regulated by the SRS RCRA Part B Permit and addressed by the requirements of the M Area and Metallurgical Laboratory Hazardous Waste Management Facilities Groundwater Monitoring and Corrective Action agreement.

V. OPERABLE UNIT CHARACTERISTICS

This section presents the conceptual site model (CSM) for the MIPSL OU, provides an overview of the characterization activities, and presents the characterization results and COCs.

Conceptual Site Model for the MIPSL OU

Exposure pathways describe "the course a chemical or physical agent takes from the source to the exposed individual" (USEPA 1989). The following five components comprise an exposure pathway:

- source (landfill, spill, etc.);
- exposure media (soil, groundwater, air, etc.);
- exposure point (drinking water well, shower, etc.);
- exposure route (ingestion, dermal contact, inhalation, etc.); and
- receptor (resident, worker, etc.).

If any of these elements is missing, the pathway is incomplete and is not considered further in the risk assessment. A pathway is complete when all five components are present to permit potential exposure of a receptor to a source of contamination.

The primary source of contamination at the MIPSL OU is the effluents transported through the process sewer lines from multiple facilities in M Area. The primary

contaminant release mechanism is process sewer line leaks. The secondary source of contamination is deep soil (greater than 1.2 m [4 ft] bgs). Surface soils and subsurface soils are excluded from consideration as potentially affected media and as secondary sources because all of the MIPSL OU sewer lines are buried deeper than 1.2 m (4 ft) bgs. Excavation of deep soils provides a potential exposure pathway for a future industrial worker. Leaching of contaminants from deep soil to groundwater constitutes a secondary contaminant release mechanism. Groundwater is not considered part of the MIPSL OU; any groundwater contaminated by the MIPSL OU will be regulated by the SRS RCRA Part B Permit.

Exposure analysis is conceptually important in terms of identifying all potentially complete exposure routes, understanding the nature and extent (as well as fate and transport) of contamination, and developing preliminary remedial alternatives. In a complete pathway, exposure occurs at exposure points that may represent only a small portion of the entire exposure route. If there is no exposure point, then there is no exposure, even if contaminants have been released into the environment.

The potentially complete pathways identified in the CSM are exposure to contaminated groundwater through ingestion (future industrial worker and future resident) and showering (future resident). Groundwater contamination is being addressed under the RCRA Corrective Action program for M Area as documented in the SRS RCRA Part B Permit and is not part of this OU; therefore the only complete pathway for human receptors is the excavation of deep soils scenario for a future industrial worker as part of the principal threat source material (PTSM) evaluation (Figure 5).

Media Assessment

The RFI/RI Work Plan, RFI/RI Report with BRA, and CMS/FS (WSRC 2005) contains the detailed information and analytical data for all investigations conducted and samples taken for the MIPSL OU (as well as the portions of the MIPSL that were moved to the

M Area OU scope in January 2006). This document is available in the Administrative Record File (see Section III of this document).

Media Assessment Results

PCE and TCE were identified as contaminant migration (CM) COCs in the vadose zone soil at the MIPSL OU.

Site Specific Factors

The MIPSL OU is an underground radioactive material area (URMA). The URMA designation is a site-specific factor requiring special consideration that might affect the remedial action for the MIPSL OU.

Contaminant Transport Analysis

The fate and transport of inorganic, organic, and radioactive compounds are functions of both compound-specific characteristics and the environmental media containing the compounds. The physical and chemical properties of contaminants that influence their behavior in the media include, but are not limited to, solubility in water; tendency to transform or degrade (usually described by a radiological half-life or an environmental half-life in a given medium); and chemical, physical, or electrostatic affinity for solids or organic matter.

Initial identification of CM constituents of potential concern (COPCs) used a relatively simple vadose zone analytical model (Vadose Zone Contaminant Migration Multi-Layered Model™ version 3 [VZCOMML™]) to estimate the maximum potential concentration of CM COPCs that could reach groundwater and to estimate the timing of CM COPC migration. Those CM COPCs that were predicted to have a mean travel time to groundwater within 1,000 years and to impact groundwater at concentrations exceeding maximum contaminant levels (MCLs) or preliminary remediation goals (PRGs) were retained.

PCE and TCE were found to be CM COCs at the MIPSL OU. The model simulation predicted that both PCE and TCE groundwater concentrations would exceed the MCL (0.005 mg/L) after 12 years. The PCE and TCE concentrations were predicted to increase to a maximum of 200.05 mg/L in 13.17 years and of 13.48 mg/L in 12.67 years respectively. The model is considered conservative since the worst case, upgradient portions of the MIPSL that are part of the M Area OU were included in the evaluation. The MIPSL OU vadose zone contaminant sources are very small in comparison to the release that caused the majority of the groundwater contamination in M Area.

VI. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Land Uses

The MIPSL OU is located in an area of historically heavy industrial and nuclear land use, and future industrial land use is anticipated (Figure 6). The Savannah River Site Long Range Comprehensive Plan (USDOE 2000) designates the MIPSL OU as being within the site industrial support area. Final remedial goals (RGs) are consistent with limited or industrial use.

Groundwater and Surface Water Uses

SRS does not use the water table aquifer for drinking water or irrigation purposes and currently controls any drilling in this area. Therefore, as long as USDOE maintains control of SRS, the aquifer beneath the MIPSL OU will not be used as a potential drinking water source or for irrigation.

Groundwater monitoring is on-going and is being addressed under the SRS RCRA Part B Permit. M Area's groundwater is regulated under a RCRA permit because of the high level of TCE and PCE contamination. Several large-scale groundwater treatment and removal systems have been deployed in the area, and these types of activities are expected to continue into the future.

VII. SUMMARY OF OPERABLE UNIT RISKS

Baseline Risk Assessment

As a component of the RFI/RI process, a BRA was performed to evaluate risks associated with the MIPSL OU (WSRC 2005). The BRA estimates the risks that the site would pose if no action were taken. It provides the bases for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The BRA includes human health and ecological risk assessments. This section of the ROD summarizes the results of the BRA for this OU.

Summary of Human Health Risk Assessment

The MIPSL OU is located in an area of historically heavy industrial and nuclear land use, and future industrial land use is anticipated. Because the inactive process sewer line and associated contamination are located at depths greater than 1.2 m (4 ft) bgs, there are no potentially exposed receptors under current or future land use scenarios. Therefore, the qualitative evaluation concluded that there are no problems warranting action from a human health risk perspective. The basis for taking action at this OU is the potential for contaminants to migrate to groundwater above MCLs. The model simulation predicted that both PCE and TCE groundwater concentrations would exceed the MCL (0.005 mg/L) after 12 years. Details are provided in Contaminant Transport Analysis (see Section V) and in Summary of the Fate and Transport Analysis (see Section VII).

Summary of Ecological Risk Assessment

The purpose of the ecological risk assessment (ERA) is to document the analysis of the potential for adverse effects associated with exposure to contaminants likely to be present at the unit. Based on a unit reconnaissance that is documented in an Ecological Assessment Checklist, the MIPSL OU does not provide adequate ecological habitat for community-level impacts. There is no natural cover, food, or water sources that would tend to attract wildlife receptors. In addition, the CSM for this waste unit indicates that

there is no potential for any significant exposure since the sewer lines occur in the deeper soils. Therefore, there are no potentially exposed ecological receptors at this waste unit. The qualitative evaluation concluded that there are no problems warranting action from an ecological risk perspective.

Summary of the Fate and Transport Analysis

PCE was determined to be a CM COC at the MIPSL OU. In the 0- to 0.6-m (0- to 2-ft) and 0.9- to 1.5-m (3- to 5-ft) intervals below the bottom of the pipe (bp), no concentrations were detected above the CM remedial goal objective (RGO) of 0.307 mg/kg. At the 2.4- to 3.0-m (8- to 10-ft) bp interval, one location (SB040-01) was above the CM RGO; this location had the highest concentration of PCE (0.767 mg/kg) at the MIPSL OU. At the 5.5- to 6.1-m (18- to 20-ft) bp interval, three locations (SB026-01, SB039-02, and SB-040-02) were above the RGO, with the highest concentration of 0.704 mg/kg detected at location SB039-02 (Figure 7).

TCE was also determined to be a CM COC at the MIPSL OU. In the 0- to 0.6-m (0- to 2-ft) and 0.9- to 1.5-m (3- to 5-ft) bp intervals, no concentrations were detected above the CM RGO of 0.0408 mg/kg. At the 2.4- to 3.0-m (8- to 10-ft) bp interval, one location (SB041-01) was above the CM RGO; this location had the highest concentration of TCE (0.411 mg/kg) at the MIPSL OU. At the 5.5- to 6.1-m (18- to 20-ft) bp interval, the same sample location (SB041-01) was also above the RGO, with a concentration of 0.127 mg/kg (Figure 7).

The CM RGO is the soil concentration that is predicted to not impact groundwater above MCLs based on site-specific parameter inputs using a computer model. Details are described in Appendix G of the RFI/RI Work Plan, RFI/RI Report with Baseline Risk Assessment, and Corrective Measures Study/Feasibility Study for the M-Area Inactive Process Sewer Lines (WSRC 2005).

Discussion of Principal Threat Source Material and Applicable or Relevant and Appropriate Requirements

Source materials are those materials that include or contain hazardous substances, which are pollutants that act as a source for direct exposure. PTSM is defined as those source materials that have a high toxicity or mobility and cannot be reliably contained or present significant risk to human health or the environment (USEPA 1991). Treatment alternatives should be considered for source materials with a toxicity of 1×10^{-3} or greater for carcinogens or cumulative hazard index (HI) of 10 or greater for noncarcinogens. An excavation of deep soil scenario for a future industrial worker was evaluated. For the MIPSL OU, the cumulative toxicity risk to the industrial worker was less than the threshold criteria. The evaluation concluded that there was no PTSM from a toxicity perspective.

Unit source data were compared to applicable or relevant and appropriate requirements (ARARs) or "to be considered" (TBC) information to determine if any of the constituents exceeded established soil criteria. If a constituent exceeded an ARAR or TBC criterion, then it was considered to be an ARAR COC. For soils, only the lead and polychlorinated biphenyl (PCB) limits were used for ARAR determination under federal and South Carolina regulations. These limits are based on RCRA/CERCLA screening values and the Toxic Substances Control Act (TSCA) (40 CFR 761). No constituents exceeded the TBC for lead in soil (400 mg/kg) at the MIPSL OU. PCBs did not exceed the ARAR value for soil (25 mg/kg) at the MIPSL OU.

The final rule for PCB disposal, effective 28 August 1998, addresses the residual levels of PCB remediation waste that can be left in place. The action levels are based on site-specific conditions and have been applied to the vadose zone contamination at the MIPSL OU as a conservative screening comparison. For high occupancy areas, the cleanup level for bulk PCB remediation waste, including soil, is 1 ppm PCBs per

40CFR761.61(a)(4)(i). No additional controls are required provided the soil is decontaminated to that level.

In low occupancy areas, PCB concentrations that fall within certain ranges (from ≤ 25 ppm and up to 100 ppm) are allowed with various conditions depending upon the concentration of PCBs that remain in the soil. No further conditions are required for soil that is cleaned to ≤ 25 ppm. Since future land use at the MIPSL OU is anticipated to be an industrial, nonresidential scenario, the PCB data were evaluated against the low occupancy criterion of 25 ppm. The highest concentration of PCBs at the MIPSL OU (Aroclor 1254 = 0.833 ppm) did not exceed the ARAR values of 25 ppm.

Conclusions

Actual or threatened releases of hazardous substances from this waste unit, if not addressed by the selected alternative or one of the other active measures considered, may present a current or potential threat to public health, welfare, or the environment.

- There are no human health COCs in soil.
- There are no ecological COCs in soil.
- PCE and TCE are CM COCs in vadose zone soil. The basis for taking action at this OU is the potential for these contaminants to migrate to groundwater above MCLs.
- There are no ARARs or PTSM COCs in soil.

The MIPSL OU is located in an area of historical heavy industrial and nuclear land use, and future industrial land use is anticipated.

VIII. REMEDIAL ACTION OBJECTIVES AND REMEDIAL GOALS

The goals of remedial actions are to protect human health and the environment and to mitigate the effects of contamination. USEPA has established a structured process to identify and evaluate technologies for remedial applications. This process involves developing and screening a range of appropriate remedial options and selecting the most suitable approaches for corrective measures and remedial actions.

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) specifies six criteria for developing this range of remedial technologies [40 Code of Federal Regulations (CFR) Part 300.430 (a) (1) (iii) (A) - (F)]:

- Whenever practical, use treatment to address principal threats posed by the unit.
- Use engineering controls for waste that poses a relatively low long-term risk or when treatment is impractical.
- Combine methods (for example, treatment plus engineering controls) to protect human health and the environment.
- Supplement engineering controls with institutional controls to prevent or limit exposure.
- Whenever practical, use innovative technologies.
- Return usable groundwater to beneficial uses or prevent further degradation.

Remedial action objectives (RAOs) are media or OU-specific objectives for protecting human health and the environment. RAOs usually specify potential receptors, exposure pathways, and are identified during scoping once the CSM is understood. RGOs are typically identified along with the RAOs. They represent the preliminary media-specific goals and serve as a standard by which to measure whether a selected remedial action has met its RAO.

RGOs can be qualitative statements or numerical values often expressed as concentrations in soils or groundwater, or actions (installation of engineered barriers, placement of caps and covers, etc.) that achieve the RAO. For the MIPSL OU, the CM RGO is the soil concentration of contaminants that is predicted not to impact groundwater above MCLs. The Summary of Fate and Transport Analysis (see Section VII) generically describes how the contaminant migration RGO soil concentration was calculated. RGOs become finalized as RGs after public comment and approval of the SB/PP and are documented in this ROD. Monitoring will be performed to ensure that RGs are met and to determine when the remedial action is complete.

The Corrective Measures Implementation/Remedial Action Implementation Plan (CMI/RAIP) will outline the design strategy for the remedial action (using the selected remedy) documented in this ROD. The CMI/RAIP will also discuss typical activities to be conducted during construction and implementation of the remedial action and the mechanism for demonstrating completion. For example, the intent of the soil vapor extraction (SVE) system at the MIPSL OU is to ultimately reduce the volatile organic compound (VOC) concentration in the groundwater to achieve the groundwater RG as documented in this ROD.

RAOs are unit-specific goals that establish the extent of cleanup required to protect human health and the environment and to mitigate the effects of contamination. RAOs are based on an evaluation of ARARs and TBC requirements [CERCLA 121(d)(2)(A)]. One RAO has been identified for the MIPSL OU:

- Prevent TCE and PCE from leaching to groundwater above MCLs.

This RAO is intended to protect current workers, future industrial workers, and future hypothetical residents; prevent the migration of contaminants to groundwater; and provide a framework for developing remedial alternatives for the waste unit. The basis for taking action at this OU is the potential for contaminants to migrate to groundwater above MCLs. The results of the model simulation predicted that both PCE and TCE

groundwater concentrations would exceed the MCL (0.005 mg/L) after 12 years. The proposed action attempts to restore groundwater usability.

Remedial Goal Options

A CM RGO was calculated for PCE and TCE (Table 1). The CM RGO is the soil concentration that is predicted not to impact groundwater above MCLs. The CM RGO became the final RG after the public comment period and approval of the SB/PP.

For PCE and TCE, the CM RGO is the final RG and represents the most restrictive cleanup goal since there were no other RGOs established based on the ARAR comparison, PTSM evaluation, human health risk assessment and ecological risk assessment. Final RGs are consistent with industrial land use, although prevention of contaminants leaching to groundwater above MCLs is also protective in a hypothetical residential scenario. The final RG for PCE is 0.307 mg/kg and the final RG for TCE is 0.0408 mg/kg. Figure 7 identifies the locations of the CM RGO exceedances of PCE and TCE.

The ultimate selection of COCs and RGs is subject to the approval of the risk managers for SRS. The risk managers are the key decision makers and include representatives from USDOE, SCDHEC, and USEPA. In addition, the Citizens Advisory Board and SRS Natural Resource Trustees serve the risk managers in an advisory role.

Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA, as amended by the Superfund Amendments Reauthorization Act (SARA), requires that remedial actions comply with requirements and standards set forth under federal and state environmental laws. Specifically, remedies must consider "any promulgated standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than any Federal standard, requirement, criteria or limitation" if the former is an ARAR for the site and associated remedial activities. SARA requires that the remedial action for a site meet all ARARs

unless a waiver is invoked. In addition to ARARs, many federal and state environmental and public health programs include criteria, guidance, and proposed standards that are not legally binding but provide useful approaches or recommendations. Such information is required TBC when developing RGs.

ARARs include action-specific, location-specific, and chemical-specific requirements, as follows:

Action-specific ARARs control or restrict the design, performance, and other aspects of implementation of specific remedial activities.

Location-specific ARARs reflect the physiographic and environmental characteristics of the unit or the immediate area, and may restrict or preclude remedial actions depending on the location or characteristics of the unit.

Chemical-specific ARARs are media-specific concentration limits promulgated under federal or state law. The NCP requires the development of health-based, site-specific levels for chemicals where such limits do not exist and where there is a concern with their potential health or environmental effects.

Appendix B summarizes potential ARARs for the MIPSL OU in a tabular format.

IX. DESCRIPTION OF ALTERNATIVES

This section summarizes the remedial alternatives studied in the detailed analysis phase (WSRC 2005). In accordance with the NCP, it is desirable, when practical, to offer a range of diverse alternatives to compare during the detailed analysis. The range of alternatives includes options that (1) immobilize chemicals, (2) reduce the contaminant volume or media, or (3) reduce the need for long-term, onsite management. Some alternatives have been developed that involve little or no treatment yet provide protection to human health and the environment by preventing or controlling exposure to or migration of the contaminants through engineered or institutional controls. Areas of the

MIPSL warranting remediation are identified based on those locations exceeding RGs (Figure 7). As required by the NCP, the No Action alternative is provided as a baseline for comparison. Detailed cost-estimates for all alternatives are summarized in Appendix A of the SB/PP for the MIPSL OU (WSRC 2006).

Remedy Components, Common Elements, and Distinguishing Features of Each Alternative

Alternative S-1: No Action

Total Capital Cost: $0

Present-Worth O&M Cost: $0

Total Present-Worth Cost: $0

The No Action alternative is required by the NCP to serve as a baseline for comparison with other remediation alternatives. Under this alternative, no efforts would be made to control access, limit exposure, or reduce contaminant toxicity, mobility, or volume at the MIPSL OU. This alternative would leave the MIPSL OU in its current condition with no additional controls.

This alternative is not effective in achieving the RAOs. The No Action alternative requires no construction, and implementability is not a consideration. There are no capital construction or system operation and maintenance (O&M) costs for the No Action alternative. This alternative does not entail five-year remedy reviews.

Alternative S-2 Phased Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls

Total Capital Cost: $1,910,146

Present-Worth O&M Cost: $3,606,071

Total Present-Worth Cost: $5,516,217

This alternative relies upon phased SVE to remove VOCs from the soil. Soil fracturing will be used to increase the soil permeability to allow SVE to function effectively. Phased SVE initially relies upon active SVE to establish a zone of influence within the contaminated soil. After mobile VOCs are depleted, less energy intensive SVE technologies will be deployed (see Figure C-1 in Appendix C). Monitoring results will be trended and the SVE performance results will be periodically analyzed to determine when the transition from active SVE to less energy intensive SVE is appropriate. Cyclic operation of the SVE unit, including the use of rebound tests, may be used to provide supplemental information. Prior to transitioning to a low energy alternative, this information will be presented to the Core Team for concurrence. Institutional controls will be used to limit access to the area. Institutional controls would include grouting of the manholes for access control. Five-year remedy reviews are included in this alternative. Soil fracturing wells will be installed in the contaminated area bracketing the contamination. Hydraulic jetting will be used to notch the formation to be fractured. The depths of the fracturing wells will be staggered to promote the layering of the fractures. Fracturing will use a naturally biodegradable, high strength, organic gel (such as guar gum) with an amendment (such as sand) to create and prop open fractures in the formation. Guar gum is a hydrophilic polysaccharide that will not dissolve or bind to non-polar (hydrophobic) solvents, such as TCE and PCE. The SVE well is located in the center of the fracturing wells and will be screened below the Upland Unit, as well as within it, in order to capture VOCs that may migrate down into the underlying permeable unit.

Within low permeability areas, soil fracturing would be used to increase the permeability, increase SVE efficiency, and decrease the time required to achieve RAOs and RGOs. SVE with fracturing would be effective for the low permeability zones, and SVE alone would effectively remove PCE and TCE from the more permeable zones. O&M would be necessary to sustain the effectiveness of the SVE system.

Specialized labor and equipment may be readily obtained from specialty contractors. Implementation would require obtaining an air permit and an Underground Injection Control (UIC) permit for the fracturing. SRS has had experience with design and operation of the technologies in this alternative; therefore, this alternative is considered readily implementable.

Institutional controls would be effective and readily implemented to restrict land use and control access.

Alternative S-6 – Ozone Treatment, Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls

Total Capital Cost: $3,882,864

Present-Worth O&M Cost: $1,959,617

Total Present-Worth Cost: $5,842,481

This alternative involves fracturing and injection of ozone at all areas warranting action. SVE would be used to address contamination in higher permeability zones and contamination remaining after soil fracturing and chemical amendments have been completed. Institutional controls are part of this remedy. Institutional controls would include grouting of the manholes for access control (Figure 9). Five-year remedy reviews are included in this alternative.

Soil fracturing with injection of ozone would be effective for all contamination areas warranting action. Soil fracturing would be used to increase permeability and improve delivery of ozone. Low energy and passive SVE would be used as a final polishing step for this alternative. Institutional controls would be implemented to restrict land use and control access.

A demonstration of ozone injection was conducted at SRS in 1999/2000. The demonstration site was a vadose zone dense non-aqueous phase liquid (DNAPL) plume. It was a 15-ft (4.6 m) radial area adjacent to the 321-M Solvent Storage Tank Pad. The treatment system involved injection and extraction wells. Treatment occurred over a 29-day period.

The concentration of TCE/PCE in the soil was determined by soil core sampling during pre/post-test characterization activities. The results indicated a high destruction rate of 92% in the treatment area. Soil core data indicated a reduction of approximately 300 pounds of DNAPL from the test site.

Well installation, UIC, and air permits must be obtained from SCDHEC before installation. Monitoring or sampling would need to be performed to determine the effectiveness of this remedy. Any specialized materials or equipment could be obtained from specialty contractors. This alternative could be readily implemented. Associated costs would include O&M of the fracturing and ozone delivery system, institutional controls, and five-year remedy reviews.

Alternative S-7 - Methane Treatment, Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls

Total Capital Cost: $4,694,665

Present-Worth O&M Cost: $1,453,356

Total Present-Worth Cost: $6,148,021

This alternative involves soil fracturing and injection of methane at all areas warranting action. SVE would be used in higher permeability contaminated zones and to address contamination that remains after soil fracturing and methane biotreatment has been completed. Institutional controls are part of this remedy (Figure 9). Five-year remedy reviews are included in this alternative.

A pilot-scale bioremediation study was conducted in the early 1990s. Methane-enhanced bioremediation (MEBR) was the technology tested in this study. It was shown that methane biotreatment can nourish bacteria existing in the soil column and increase the speed and efficiency of natural bioremediation.

Soil fracturing with injection of methane would be effective for all contamination areas warranting action. Soil fracturing would be used to increase permeability and improve delivery of methane. Low energy and passive SVE would be used as a final polishing step for this alternative. Institutional controls would be implemented to restrict land use and control access.

SVE has been readily implemented at SRS in the past. Well installation, UIC, and air permits must be obtained from SCDHEC before installation. Monitoring or sampling would need to be performed to determine the effectiveness of this remedy. Any specialized materials or equipment could be obtained from specialty contractors. This alternative could be readily implemented. Associated costs would include O&M of the fracturing and methane delivery system, institutional controls, and five-year remedy reviews.

Alternative S-11: Removal and Off-SRS Disposal

Total Capital Cost: $12,048,050

Present-Worth O&M Cost: $26,048

Total Present-Worth Cost: $12,074,098

This alternative involves the removal of overburden and excavation of all contaminated soil that warrants action. Approximately 59,462 m^3 (77,774 yd^3) of soil would require excavation. Of this volume, 430 m^3 (562 yd^3) exceeds the RG and would require disposal. Confirmatory samples would be taken from the area surrounding the excavation to ensure that the levels of PCE and TCE were below the RG. Once the contaminated soil was excavated, the area would be backfilled (Figure 10).

Excavation and off-SRS disposal of contaminated soil would be effective in eliminating contamination at the MIPSL OU.

Excavation of contaminated soils at the MIPSL OU would be difficult to implement due to the depth of contamination and the existence of underground interferences. Confirmatory sampling would be used to determine when the excavation will stop. Specific design details would be included in the CMI/RAIP. Also, since the MIPSL OU is located in an underground radiation material area (URMA), excavated soils containing PCE and TCE would be considered not only hazardous (according to RCRA) but also radioactive and would thus constitute a mixed waste stream for which limited off-SRS disposal facilities are available.

X. COMPARATIVE ANALYSIS OF ALTERNATIVES

Each of the remedial alternatives was assessed against evaluation criteria to provide the basis for selecting a remedy. The criteria are identified in 40 Code of Federal Regulations (CFR) 300.430(e)(9)(A-I) and are derived from the statutory requirements of CERCLA § 121. The nine criteria are divided into three categories: threshold, primary balancing, and modifying criteria.

Threshold Criteria

Threshold criteria are requirements that each alternative must achieve to be eligible for selection as a permanent remedy under CERCLA. The threshold criteria are:

- Overall protection of human health and the environment

- Compliance with applicable or relevant and appropriate requirements (ARARs).

Primary Balancing Criteria

Primary balancing criteria are factors that identify key trade-offs among alternatives. The primary balancing criteria are:

- Long-term effectiveness and permanence

- Reduction of toxicity, mobility, or volume through treatment

- Short-term effectiveness

- Implementability

- Cost

Modifying Criteria

Modifying criteria are also considered during remedy selection. These criteria were assessed formally after the public review and comment period on the SB/PP. The modifying criteria are:

- State acceptance

- Community acceptance

Analysis of MIPSL OU Alternatives

The purpose of source control corrective measures/remedial alternatives for the MIPSL OU is to address contaminants in soils that exceed CM RGs. In general, the remediation

strategy for MIPSL OU is to protect groundwater by preventing the migration of contaminants through the vadose zone. The following alternatives are considered for the MIPSL OU:

Alternative S-1 No Action

Alternative S-2 Phased Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls

Alternative S-6 Ozone Treatment, Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls

Alternative S-7 Methane Treatment, Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls

Alternative S-11 Removal and Off-SRS Disposal

Comparative Analysis of MIPSL OU Alternatives

The purpose of this section is to identify key advantages and disadvantages of each alternative relative to one another and in relation to the two threshold criteria and five primary balancing criteria. Emphasis is placed on the two threshold criteria: overall protection of human health and the environment and compliance with ARARs. However, key tradeoffs between alternatives are identified through a comparative evaluation against the five primary balancing criteria: long-term effectiveness and permanent reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The five primary balancing criteria were assigned subjective values to aid in performing the comparative analyses. The final two modifying criteria, state or support agency acceptance and community acceptance, were evaluated following the comment period for the SB/PP. A comparative analysis summary for the MIPSL OU is provided in Table 2. Appendix B provides the regulatory and/or statutory citations of potential ARARs for the MIPSL OU.

Overall Protection of Human Health and the Environment

With the exception of Alternative S-1, all alternatives (Alternatives S-2, S-6, S-7, and S-11) are protective of human health and the environment. Alternatives S-2, S-6, and S-7 address vadose zone VOC contamination with treatment or removal. Alternatives S-2, S-6, and S-7 employ institutional controls to restrict worker access and residential use. Alternatives S-2, S-6, S-7, and S-11 would achieve RAOs and RGs.

Compliance with ARARs

Chemical-Specific ARARs. There are no chemical-specific ARARs associated with Alternatives S-2, S-6, S-7, and S-11.

Location-Specific ARARs. Alternatives S-2, S-6, S-7, and S-11 would comply equally with the protection of the environment with respect to erosion control, wildlife, and migratory birds.

Action-Specific ARARs. Additionally, Alternatives S-2, S-6 and S-7 would equally meet SVE air emission ARARs. Alternatives S-2, S-6, and S-7 would meet UIC regulations. The disposal and transportation of waste generated from all alternatives would be handled in accordance with federal and state regulations (40 CFR 141, 143, and 260-269; and SC R61-79.253).

Long-Term Effectiveness and Permanence

Alternatives S-2, S-6, S-7, and S-11 are effective in the long-term and protect human health. Alternative S-11 offers the greatest degree of risk reduction, long-term effectiveness, and permanence since all contamination is removed from the unit. Alternatives S-6 and S-7 offer the next highest levels of effectiveness and permanence due to low residual risk and a high level of adequacy and reliability of controls. Alternative S-2 has the next highest level of effectiveness and permanence because it

relies on SVE alone without chemical treatment. Alternative S-1 has no long-term effectiveness or permanence.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives S-2, S-6, and S-7 reduce the mobility and volume through treatment using SVE, ozone, or methane while Alternative S-11 does not use treatment. Alternatives S-1 and S-11 do not reduce toxicity, mobility, or volume through treatment.

Short-Term Effectiveness

Alternative S-11 achieves RAOs in the shortest time period (1.5 years) however at the greatest risk to workers and the community because of extensive earthwork, handling, packaging, and transportation of wastes. Alternatives S-6 and S-7 achieve RAOs in a longer period of time (9 and 11 years respectively) with low risk to workers and the public. Alternative S-2 requires the longest time to achieve RAOs (15 years), however because no chemicals are involved, workers and the public are exposed to the least risk. Alternative S-1 has no short-term effectiveness.

Implementability

Alternatives S-2, S-6, and S-7 can be readily constructed and operated; however, Alternatives S-6 and S-7 each require a pilot-scale study. Alternative S-11 is more difficult to construct because of the volume of soil and excavation concerns (depth and interferences). Alternative S-2 is the most implementable because it is the simplest of the remedial actions proposed. Alternatives S-6 and S-7 are the next most implementable due to the additional complexity of components. Alternative S-11 is the most difficult to implement because of the volume of excavated materials.

Cost

The No Action, S-1, alternative is the least expensive of all the three alternatives ($0), followed by Alternative S-2 ($5,516,217). Alternative S-6 is the third least costly at $5,842,481 followed by Alternative S-7 ($6,148,021). Alternative S-11 is the most expensive of the alternatives ($12,074,098). Even assuming some of the excavated soil could be disposed of as hazardous instead of mixed waste, Alternative S-11 remains the most expensive.

XI. THE SELECTED REMEDY

Detailed Description of the Selected Remedy

The selected remedy for the MIPSL OU is Alternative S-2, Phased Soil Vapor Extraction Enhanced with Soil Fracturing, and Institutional Controls. This alternative was selected because it effectively treats contaminant migration through the vadose zone to groundwater. Alternative S-2 is protective of human health and the environment and complies with ARARs. Alternative S-2 provides the best balance of tradeoffs between alternatives because contaminant mobility and volume are reduced through treatment, and SVE is a readily implementable technology.

Phased SVE will be implemented to address contaminant migration along the MIPSL. Soil Fracturing will be used in conjunction with SVE. SVE is used to remove VOCs from the vadose zone. Vadose zone remediation using SVE reduces/removes the VOC source and is typically performed to manage the release of VOCs to groundwater by reducing the further migration of VOCs to the groundwater. A vadose zone soil RG was developed to improve or protect groundwater (Table 1). Every attempt will be made to meet the established RGs as finalized following public comment.

Fracturing wells will be installed to bracket the contaminated area. The wells will be installed by direct push technology. After the rods are pushed to the desired depth, the tip is disengaged and the rod is withdrawn approximately 15.2 cm (6 in) to create an

opening. A hydraulic lance (a water jet) is inserted into the well and rotated around the opening to cut a horizontal slot extending radially outward from the well. This serves as a starting point for the fractures, facilitating horizontal fracture growth. The lance is removed and a slurry pump is connected to the well to inject a guar gum/sand mixture under pressure. The depths of the fracturing wells will be staggered to encourage layers of fractures within the formation. The fractures will propagate outward from the initial slot; however, they may go up or down following the depositional plane of the media. After the fracturing, a high vacuum SVE unit is connected to the fracturing well and used to recover as much of the injected guar gum and water as possible. Residual guar gum will quickly degrade naturally and the sand will prop open the fissures. After the fracturing is completed, the SVE well is installed in the center of the grid.

The effect of VOC soil contamination on the groundwater depends on multiple factors, including concentration and mobility. For this reason, RGs may not be the sole indicator used to determine when the degradation to groundwater has been halted or the threat to groundwater has been eliminated. Additional data and information may be used by the Core Team to establish these conditions.

The SVE process will be optimized by matching the specific technology applied to each well to the amount of mobile contaminant present. Initially each well will be tested using a portable SVE unit capable of producing air flows of up to 100 scfm and vacuum levels of up to 15 inches of mercury. By monitoring the applied vacuum, air flow and the contaminant concentration in the exhausted soil gas, estimates can be made about the permeability of the formation and the extent and mobility of the soil contamination. This information will guide the selection of the specific equipment to be installed at each well.

The mass removal efficiency from the vadose zone will depend upon a variety of site-specific soil conditions and the type and amount of contaminant mass present. SVE performance is commonly monitored by the exhaust gas contaminant concentration over time.

SRS believes that it is important to review all the monitoring data including VOC concentrations in soil, soil-gas extracted by the SVE system, and groundwater concentrations to determine the effectiveness of a particular SVE technology in achieving RAOs. Performance parameters, such as SVE air flow, contaminant concentration in the exhaust air, and hours of operation will be monitored regularly to verify that the system is performing as designed and that the contaminants are being moved effectively. When trends in monitoring data indicate that remedial goals can be met with less energy intensive technology, SRS will provide the Core Team with an analysis of the data for review and concurrence prior to transitioning to a low energy alternative. USDOE, USEPA, and SCDHEC have agreed to jointly decide on significant changes in the operation of the SVE system (typically transitioning from active to passive extraction) taken to maintain the efficiency of the remedial system. Appendix C provides the operational trend information for an SVE unit. This process for transitioning from active to passive SVE technology will be discussed in detail in the CMI/RAIP.

Table 3 shows the land use controls for the MIPSL OU. Institutional controls will be implemented by:

- Providing access controls for onsite workers via the Site Use Program, Site Clearance Program, work control, worker training, worker briefing of health and safety requirements and identification signs located at the waste unit boundaries.

- Notifying USEPA and SCDHEC in advance of any changes in land use or excavation of waste.

- Providing access controls against trespassers as described in the 2000 RCRA Part B Permit Renewal Application, Volume I, Section F.1, which describes the security procedures and equipment, 24-hour surveillance system, artificial or natural barriers, control entry systems, and warning signs in place at the SRS boundary.

In the long term, if the property is ever transferred to nonfederal ownership, the U.S. Government will take those actions necessary pursuant to Section 120(h) of CERCLA. Those actions will include a deed notification disclosing former waste management and disposal activities as well as remedial actions taken on the site. The contract for sale and the deed will contain the notification required by CERCLA Section 120(h). The deed notification shall notify any potential purchaser that the property has been used for the management and disposal of waste. These requirements are also consistent with the intent of the RCRA deed notification requirements at final closure of a RCRA facility if contamination will remain at the unit.

The deed shall also include deed restrictions precluding residential use of the property. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ or the residual contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for the deed restrictions will be performed through an amended ROD with USEPA and SCDHEC review and approval.

In addition, if the site is ever transferred to nonfederal ownership, a survey plat of the OU will be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency.

The selected remedy for the MIPSL OU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure. As agreed on March 30, 2000, among the USDOE, USEPA and SCDHEC, SRS is implementing a Land Use Control Assurance Plan (LUCAP) to ensure that Land Use Controls (LUCs) required by numerous remedial decisions at SRS are properly maintained and periodically verified. The unit-specific Land Use Control Implementation Plan (LUCIP) referenced in this ROD will provide details and specific measures required to implement and maintain the LUCs selected as part of this remedy. USDOE is responsible for implementing, maintaining, monitoring,

reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the CMI/RAIP, as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the MIPSL OU ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA and the *SRS Federal Facility Agreement.* The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the unit. The LUCIP will remain in effect until modified as needed to be protective of human health and the environment. The deed shall contain provisions to ensure that appropriate LUCs remain with the affected area upon any and all transfers. The LUCs shall be maintained until the concentrations of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use. Approval by USEPA and SCDHEC is required for any modification or termination of institutional controls.

USDOE has recommended that residential use of SRS land be controlled; therefore, future residential land use and potential residential water usage will be restricted to ensure long-term protectiveness. LUCs, including institutional controls, will restrict the MIPSL OU to future industrial use and will prohibit residential use of the area. Unauthorized excavation will also be prohibited, and the waste unit will remain undisturbed. LUCs selected as part of this action will be maintained for as long as they are necessary and termination of any LUCs will be subject to CERCLA requirements for documenting changes in remedial actions.

The following LUC objectives are necessary to ensure protectiveness of the selected remedy:

- Restrict worker access and prevent unauthorized contact, removal or excavation of contaminated media (i.e., vadose zone soils and pipelines)

- Prohibit the development and use of property for residential housing, elementary and secondary schools, childcare facilities and playgrounds

- Maintain the integrity of any current or future remedial or monitoring system such as SVE or groundwater monitoring wells

- Prevent access to or use of the groundwater until cleanup levels are met (under the RCRA program)

Cost Estimate for the Selected Remedy

Alternative S-2, Phased Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls

Total Capital Cost: $1,910,146

Present-Worth O&M Cost: $3,606,071

Total Present-Worth Cost: $5,516,217

The information in the cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record File, an Explanation of Significant Difference (ESD), or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost.

A detailed cost estimate is presented in Appendix D of this document.

Estimated Outcomes of Selected Remedy

The expected condition after the preferred alternative is implemented is that the institutional controls will prevent access to human receptors, and that SVE enhanced with fracturing will prevent future leaching of CM COCs to groundwater above MCLs. The groundwater will be remediated as specified in the SRS RCRA Part B Permit and addressed by the requirements of the M Area and Metallurgical Laboratory Hazardous Waste Management Facilities Groundwater Monitoring and Corrective Action agreement. The MIPSL OU would be available for SRS use as an industrial area with land use restrictions.

Waste Disposal and Transport

The waste streams generated during the remedial action may include: condensate from SVE units, well drilling material (typically described as non-aqueous fluids), personal protective equipment (PPE)/job control waste (JCW), failed equipment (e.g., SVE system components), rinse and wash solutions, and decon liquids. Each of these waste streams has been previously dispositioned during the characterization phase of the MIPSL OU. Rinse and wash solutions will be dispositioned to the ground inside the area of contamination (AOC). PPE/JCW and equipment will be decontaminated in accordance with the alternative treatment standards and disposed of at a sanitary landfill. Soil from shallow borings (15 feet or less) will be returned to the borehole. Environmental media will be evaluated against appropriate Health Based Limits (HBLs) to determine if it must be managed as waste or may be returned to the unit. Waste that is considered hazardous under RCRA will be managed within the AOC in a Waste Storage Area. Final disposition will be to an appropriately permitted facility; this may include sending aqueous waste to a Clean Water Act permitted facility. Any unforeseen waste will be managed per existing SRS procedures and RCRA/CERCLA regulations. The MIPSL OU is primarily located in a designated AOC, which would preclude the need for RCRA hazardous waste satellite accumulation areas. Any hazardous waste generated outside the AOC will be appropriately stored in a satellite or staging area. Specific details regarding

waste disposal and transport will be described in the CMI/RAIP document and the project-specific Waste Management Plan.

XII. STATUTORY DETERMINATIONS

Based on the unit RFI/RI/BRA report, the MIPSL OU poses a threat to human health and the environment. Therefore, Alternative S-2, Phased Soil Vapor Extraction Enhanced with Soil Fracturing and Institutional Controls, has been selected as the remedy for the MIPSL OU. The MIPSL OU is located in an area of historically heavy industrial and nuclear land use, and future industrial land use is anticipated.

This alternative was selected because it effectively treats contaminant migration to groundwater. Alternative S-2 is protective of human health and the environment and complies with ARARs. It provides the best balance of tradeoffs between alternatives because contaminant mobility and volume is reduced through treatment, and SVE is a readily implementable technology. Phased SVE will be implemented to address contaminant migration to groundwater along the MIPSL. Soil fracturing will be used in conjunction with SVE.

The selected alternative to satisfies the statutory requirements in CERCLA Section 121(b) to (1) be protective of human health and the environment, (2) comply with ARARs, (3) be cost-effective, and (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The selected alternative satisfies the preference for treatment as a principal element of the remedy.

The SRS RCRA permit will be revised to reflect selection of the final remedy using the procedures under 40 CFR Part 270 and SCHWMR R.61-79.264;270.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to

ensure that the remedy is, and will continue to be, protective of human health and the environment. Five-year remedy reviews are required under CERCLA Section 121(c).

XIII. EXPLANATION OF SIGNIFICANT CHANGES

The SRS Citizens Advisory Board Facilities Disposition and Site Remediation Committee sponsored Recommendation 236 regarding the MIPSL OU remedial alternative (i.e., soil vapor extraction with soil fracturing). However, the recommendation did not result in any significant changes to the remedy selected in this ROD from the preferred alternative presented in the SB/PP.

XIV. RESPONSIVENESS SUMMARY

The Responsiveness Summary is included as Appendix A of this document.

XV. POST-ROD DOCUMENT SCHEDULE AND DESCRIPTION

A detailed schedule for the ROD and post-ROD activities is shown in Figure 11.

The forecast schedule for the post-ROD documentation is provided below.

- SRS submittal of Revision 0 CMI/RAIP and Revision 0 LUCIP is scheduled for November 27, 2006.
- USEPA and SCDHEC will receive 90 calendar days for review of the Revision 0 CMI/RAIP and Revision 0 LUCIP.
- The SRS revision of the CMI/RAIP and LUCIP will be completed 60 calendar days after receipt of all regulatory comments on each of the documents.
- USEPA and SCDHEC will receive 30 days for final review and approval of the CMI/RAIP and LUCIP.
- The projected Remedial Action start date is June 7, 2007.

- The Revision 0 Post-Construction Report will be submitted to USEPA and SCDHEC after completion of the remedial action in accordance with the implementation schedule in the approved MIPSL OU CMI/RAIP.

XVI. REFERENCES

Aadland, R.K., J.A. Gellici, and P.A. Thayer, 1995. *Hydrogeologic Framework of West-Central South Carolina*, State of South Carolina, Department of Natural Resources, Water resources Division, Report 5

Fallaw and Price, 1995. *Stratigraphy of the Savannah River Site and Vicinity,* Southeastern Geology, v.35, no. 1

FFA, 1993. *Federal Facility Agreement for the Savannah River Site,* Administrative Docket No. 89-05-FF (Effective Date: August 16, 1993)

Siple, 1967. *Geology and Ground Water of the Savannah River Plant and Vicinity,* South Carolina, U.S. Geological Water and Supply Paper 1841

USDOE, 1994. *Public Involvement, A Plan for the Savannah River Site,* Savannah River Operations Office, Aiken, SC

USDOE, 2000. *Long Range Comprehensive Plan,* United States Department of Energy, Savannah River Operations Office, Aiken, SC

USDOE, 2006. Hennessey to Gorman and Taylor, January 24, 2006, Letter # SGP-06-162, Department of Energy, Savannah River Operations Office, Aiken, SC

USEPA, 1989. *Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part A),* EPA/540/1-89/002, United States Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC

USEPA, 1991. *A Guide to Principal Threat and Low-Level Threat Wastes, United States Department of Energy,* Office of Emergency and Remedial Response, Superfund. Publication 9380.3-06FS, Washington DC

WSRC, 2002. Revised Discount Factors for Use in Cost Estimates for Corrective Measure Study/Feasibility Study, Technical Memorandum ERTEC-2002-00011, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2003. *M Area Inactive Process Sewer Line (MIPSL) and 313 M Area Inactive Process Sewer (313-MIPS) Manhole Overflow Evaluation (U),* ERD-EN-2003-0169, (October)

WSRC, 2005. *RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan, RFI/RI Report with Baseline Risk Assessment, and Corrective Measures Study/Feasibility Study (CMS/FS) for the M Area Inactive Process Sewer Lines (081-M) (U),* WSRC-RP-2004-4214, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC (December)

WSRC, 2006. *Statement of Basis/Proposed Plan for the M Area Inactive Process Sewer Lines Operable Unit (081-M) (U),* WSRC-RP-2005-4076, Revision 1.1, Washington Savannah River Company, Savannah River Site, Aiken, SC (April)

XVII. APPENDICES

Appendix A Responsiveness Summary

Appendix B Applicable or Relevant and Appropriate Requirements

Appendix C Operational Trend of SVE Unit

Appendix D Cost Estimate for the Selected Remedy

This page was intentionally left blank

FIGURES

This page was intentionally left blank

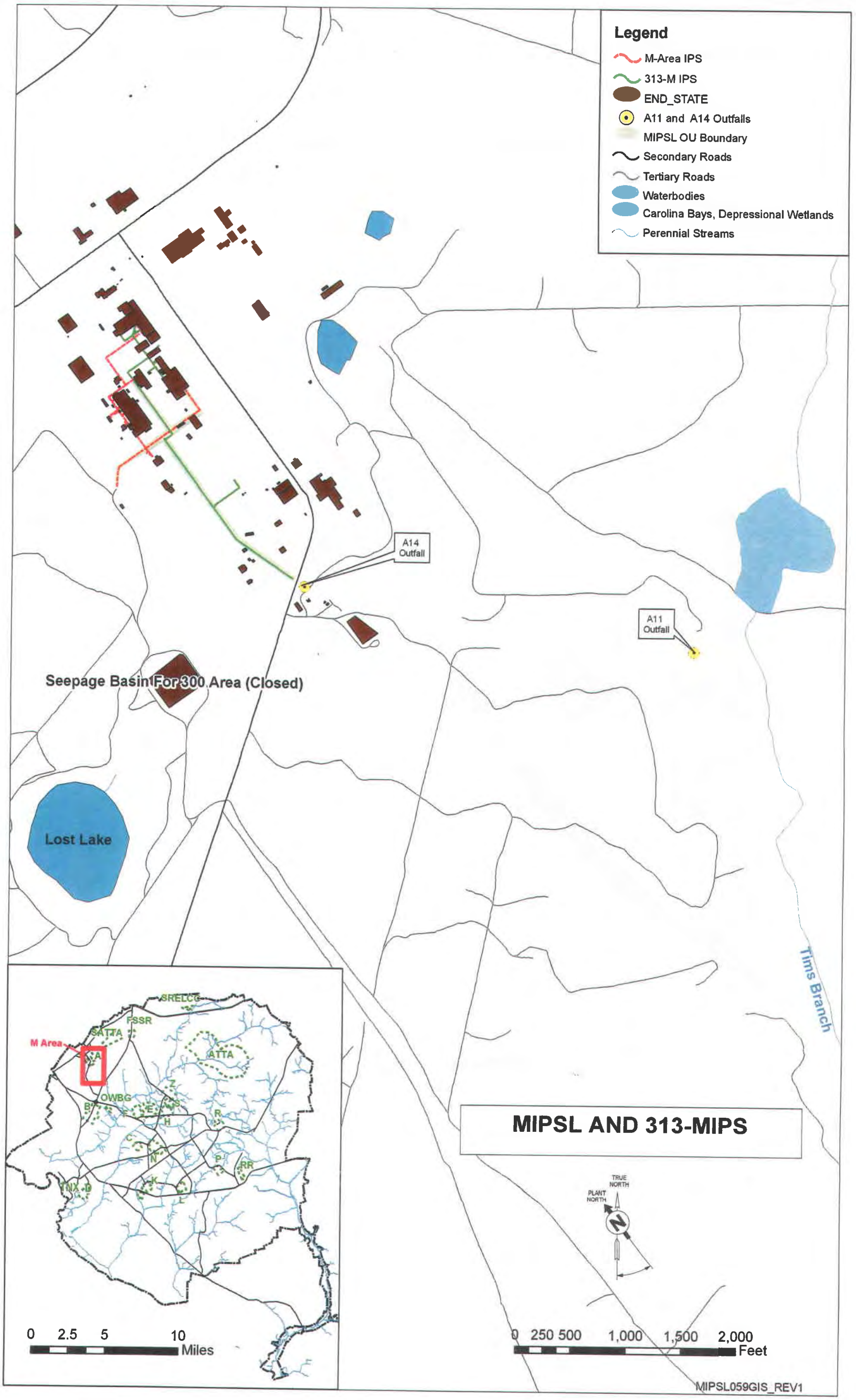


Figure 1. **Location of the MIPSL OU in M Area within the Savannah River Site**

This page was intentionally left blank

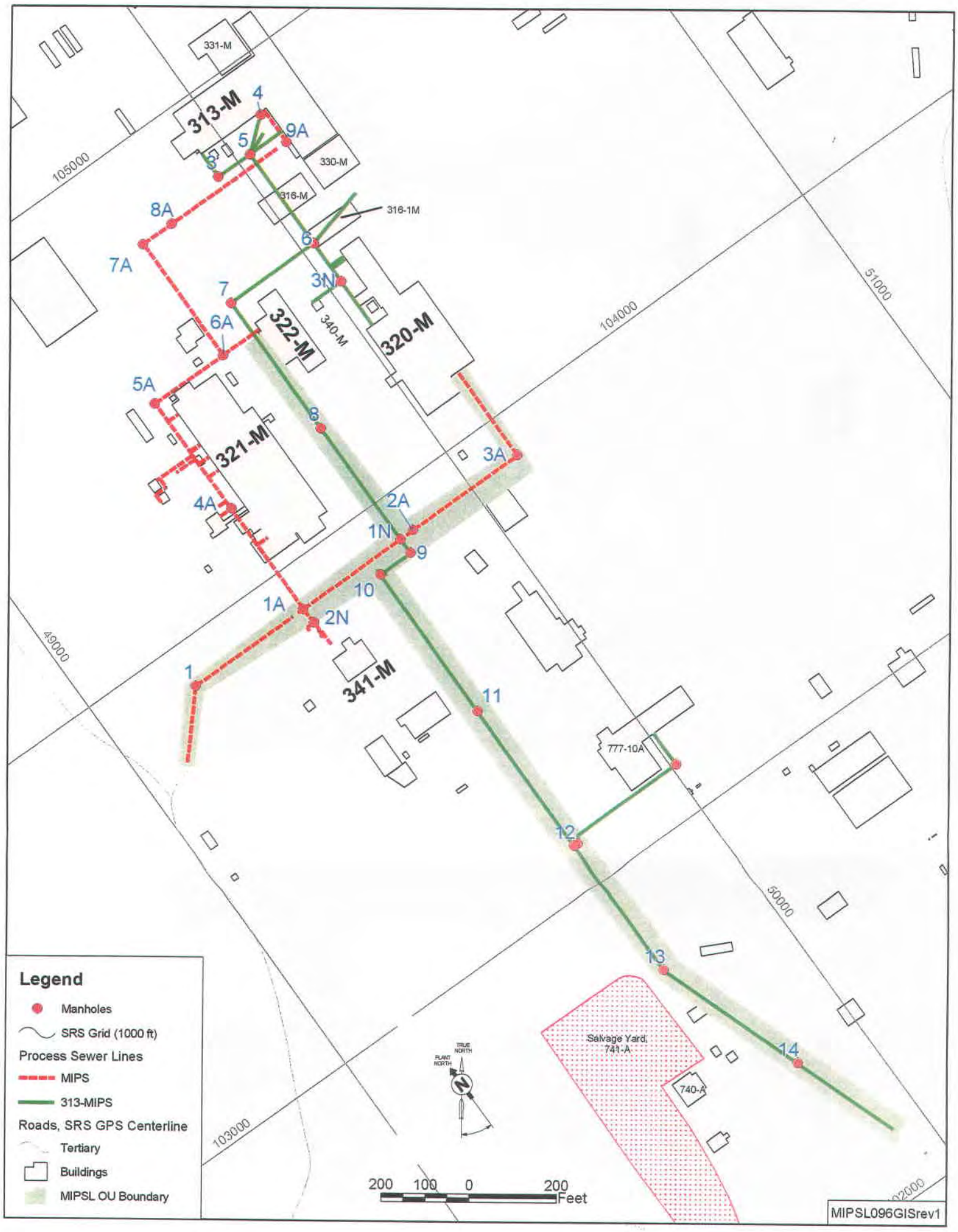


Figure 2. Layout of the MIPSL OU

This page was intentionally left blank

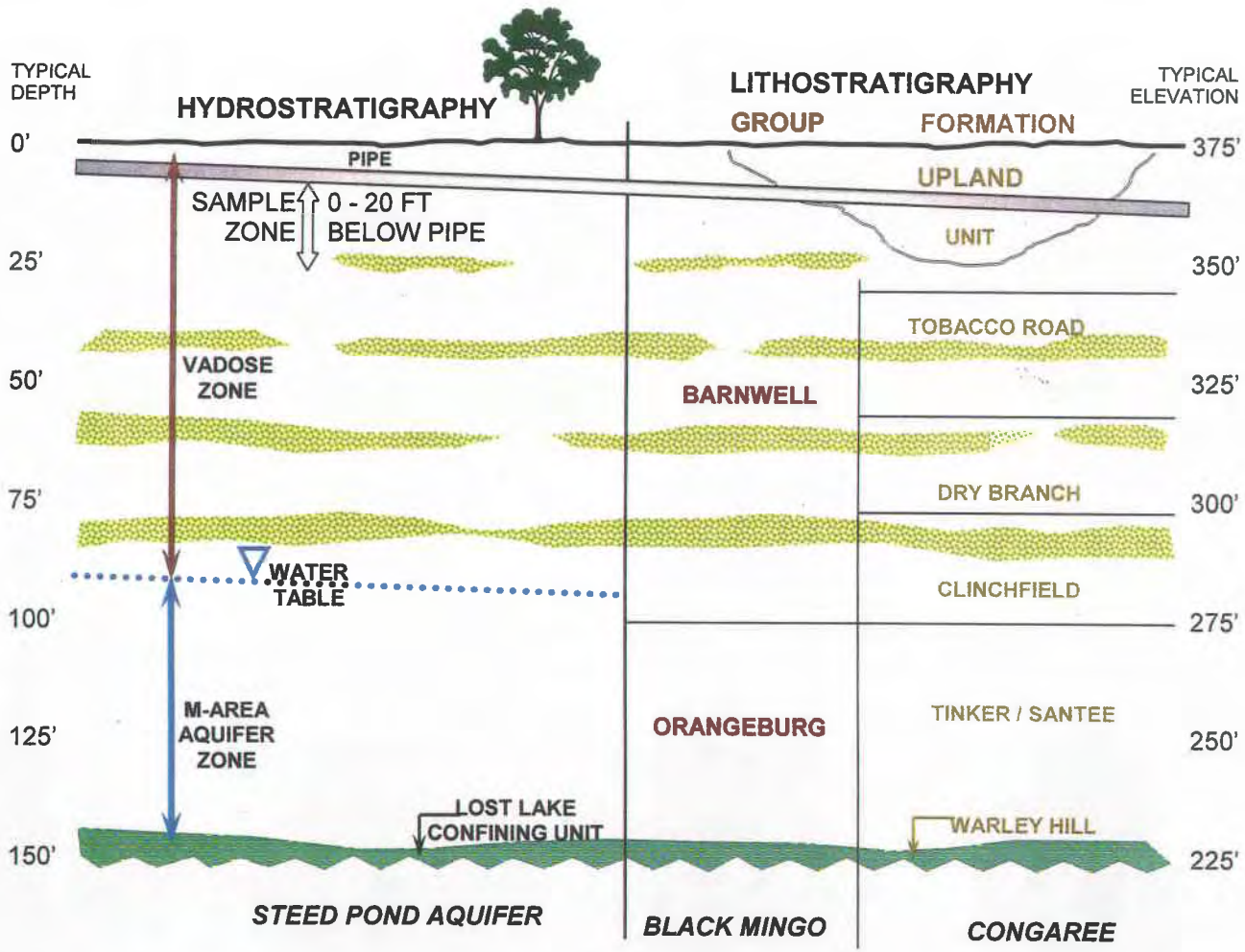


Figure 3. Schematic of MIPSL OU Area Vadose Zone

This page was intentionally left blank

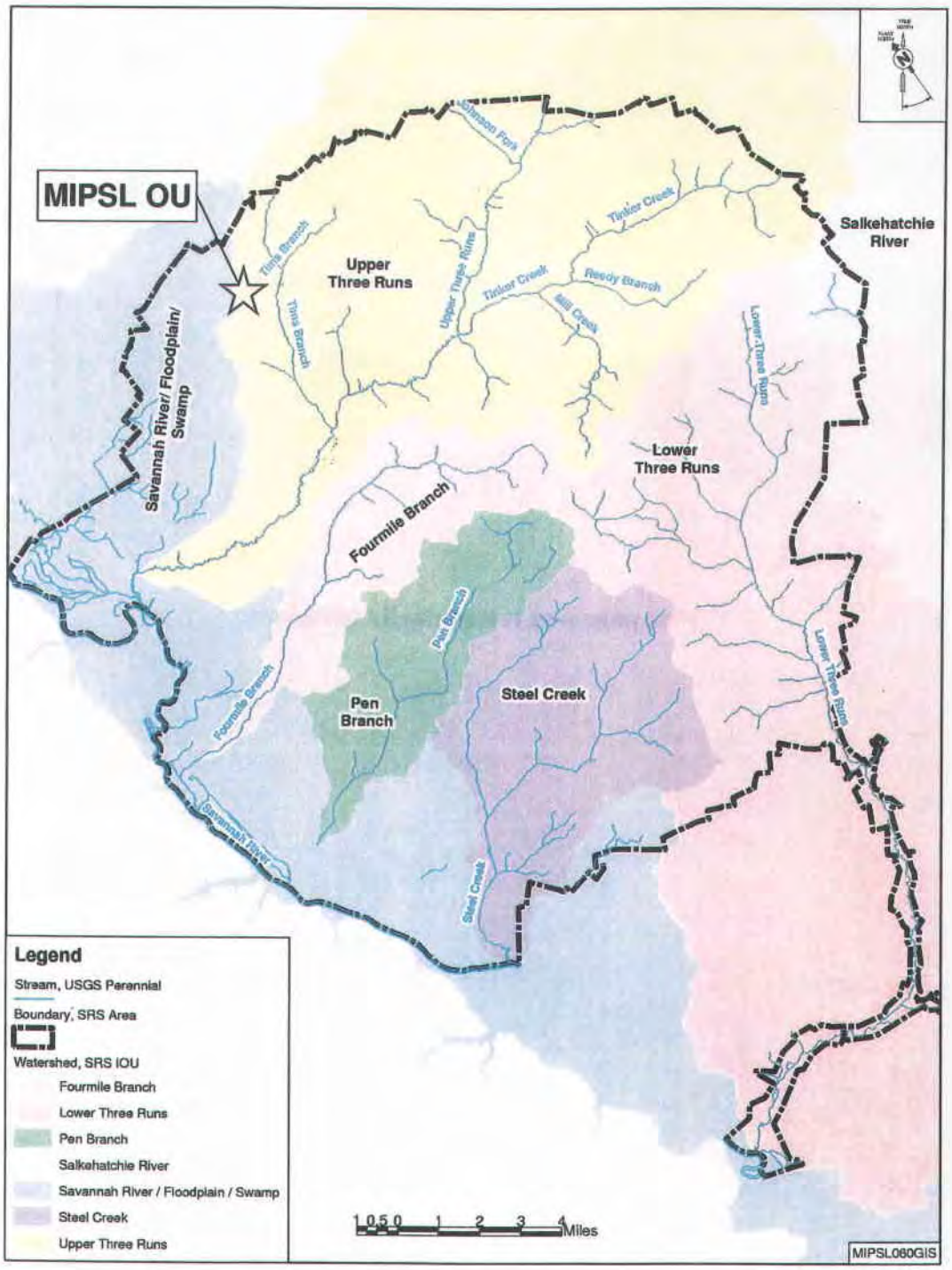
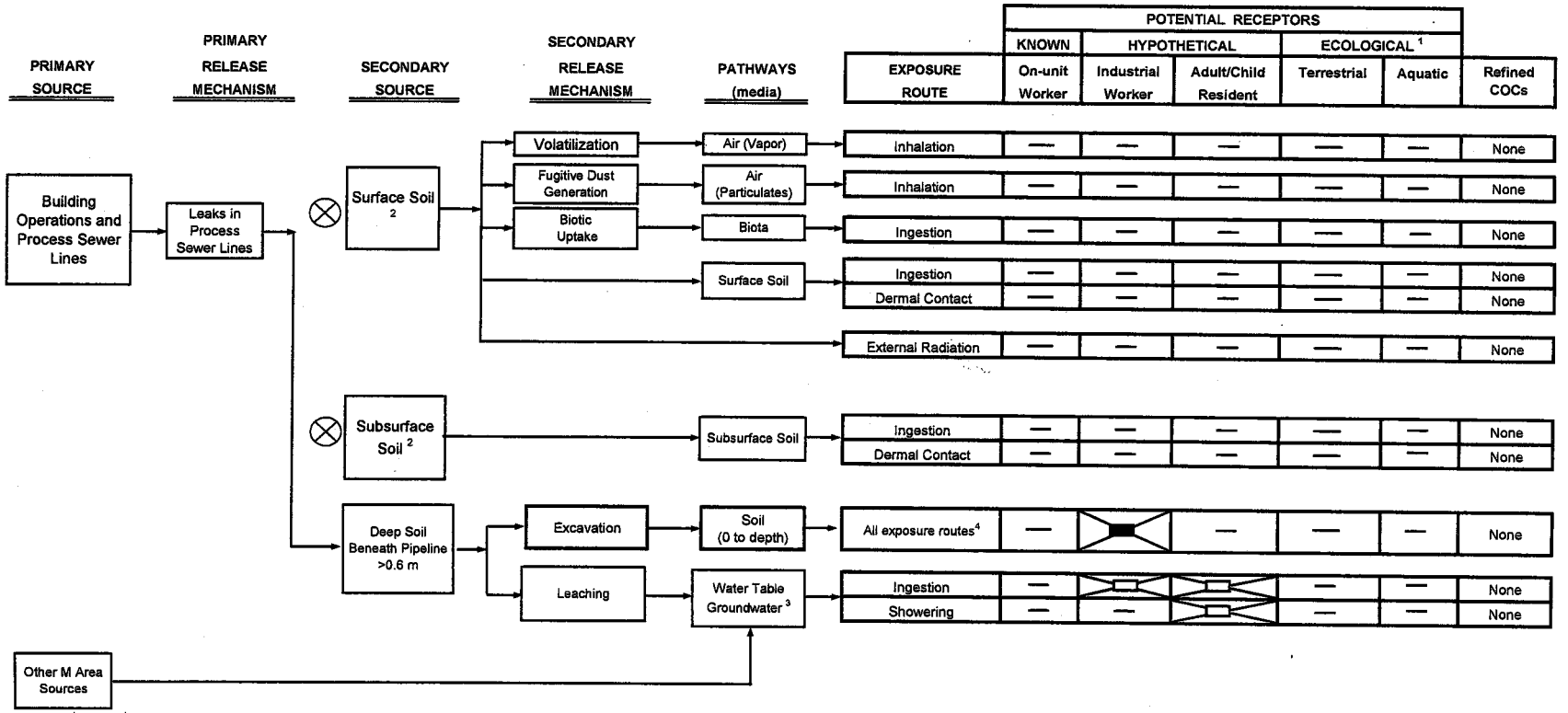


Figure 4. Location of MIPSL OU within Upper Three Runs Watershed

This page was intentionally left blank



Pathways, current, future, and historical

Pathway for qualitative evaluation, no RCOCs

Incomplete exposure pathway, no RCOCs

Incomplete contamination pathway, no RCOCs

Pathway for quantitative evaluation, no RCOCs identified

1 - Based on the ecological assessment, site conditions, and depth of the pipeline, there is no exposure scenario for ecological receptors.

2 -Because the pipeline is greater than 1 ft deep, the pathway for human exposure does not exist.

3 - Groundwater is managed as part of corrective actions for the M-Area Hazardous Waste Management Facility.

4 - All exposure routes include inhalation, ingestion, dermal contact, and external radiation pathways that are considered in the PTSM evaluation for toxicity.

Figure 5. Conceptual Site Model

This page was intentionally left blank

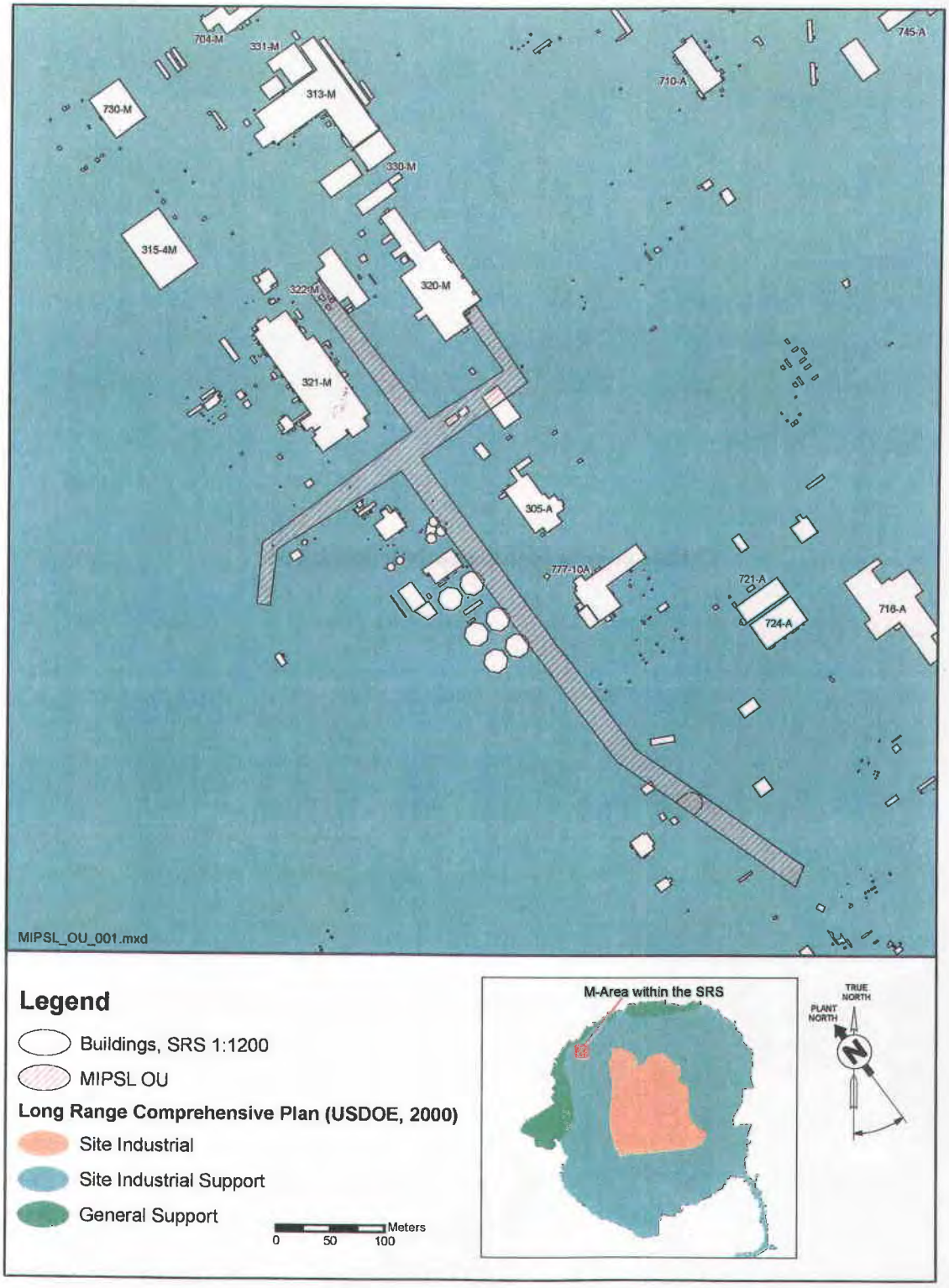


Figure 6. Land Use Map for MIPSL OU

This page was intentionally left blank

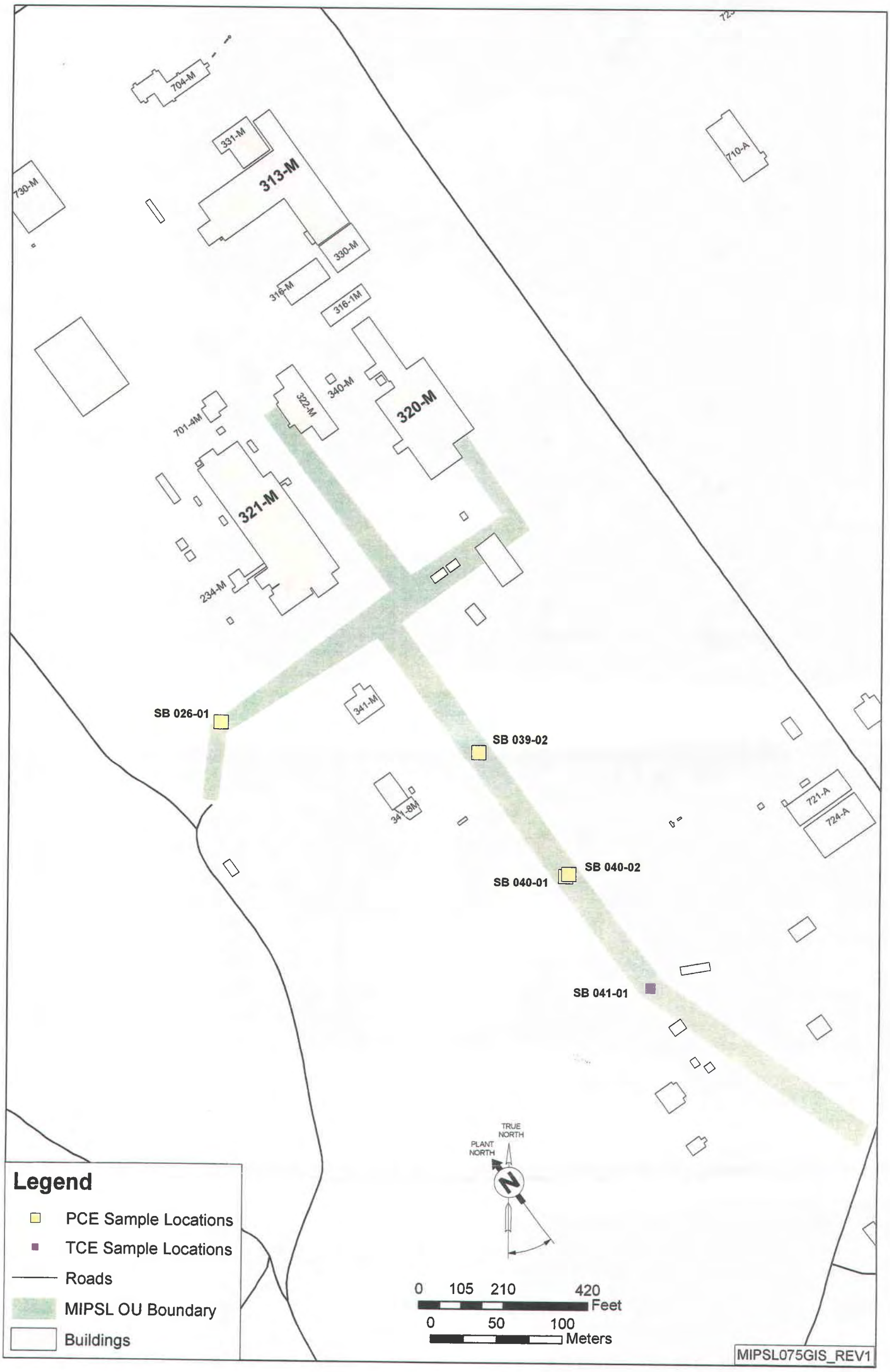


Figure 7. Summary of RGO Exceedances for PCE and TCE at MIPSL OU

This page was intentionally left blank

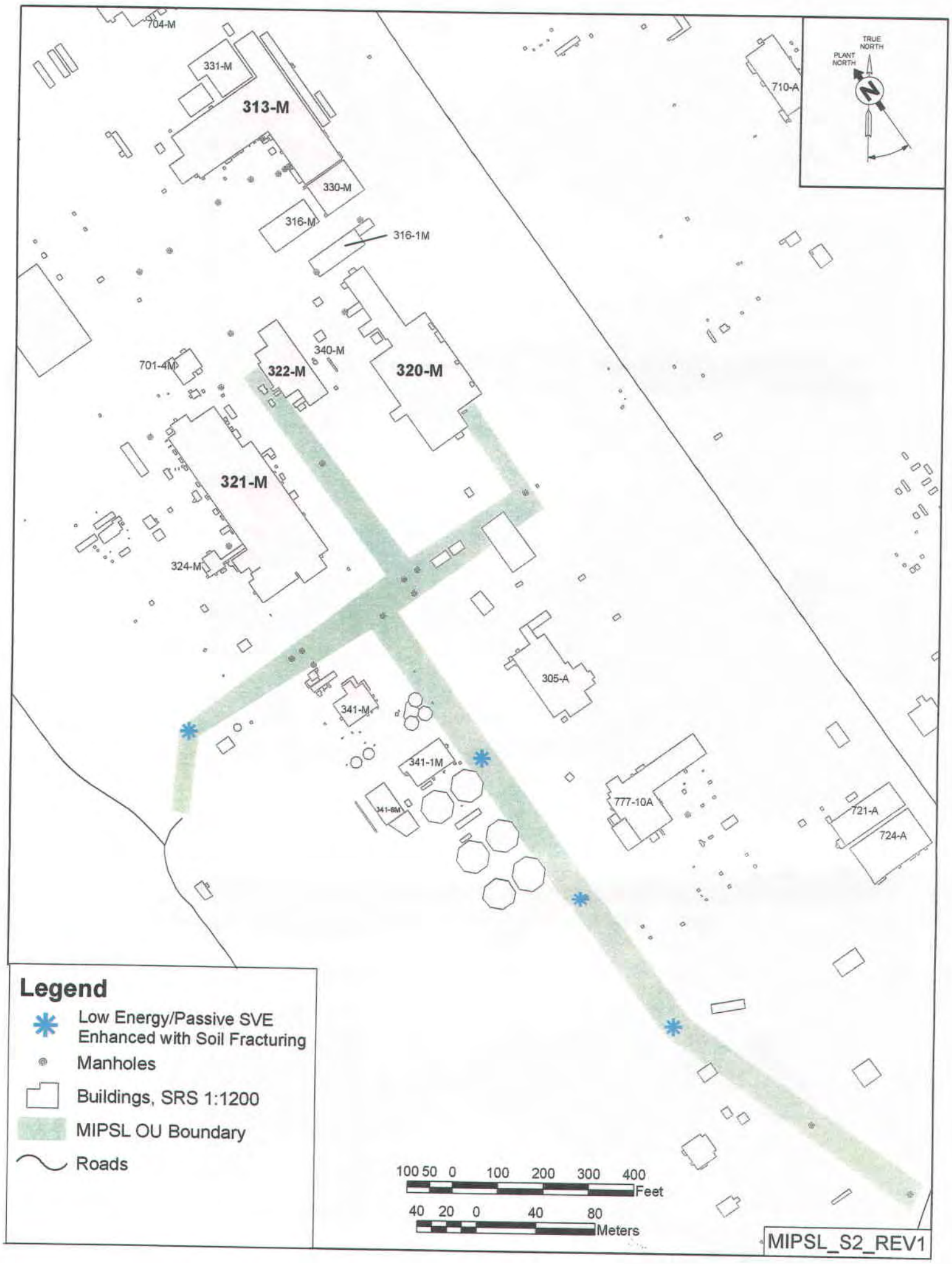


Figure 8. **Alternative S-2: SVE Enhanced with Soil Fracturing, Institutional Controls**

This page was intentionally left blank

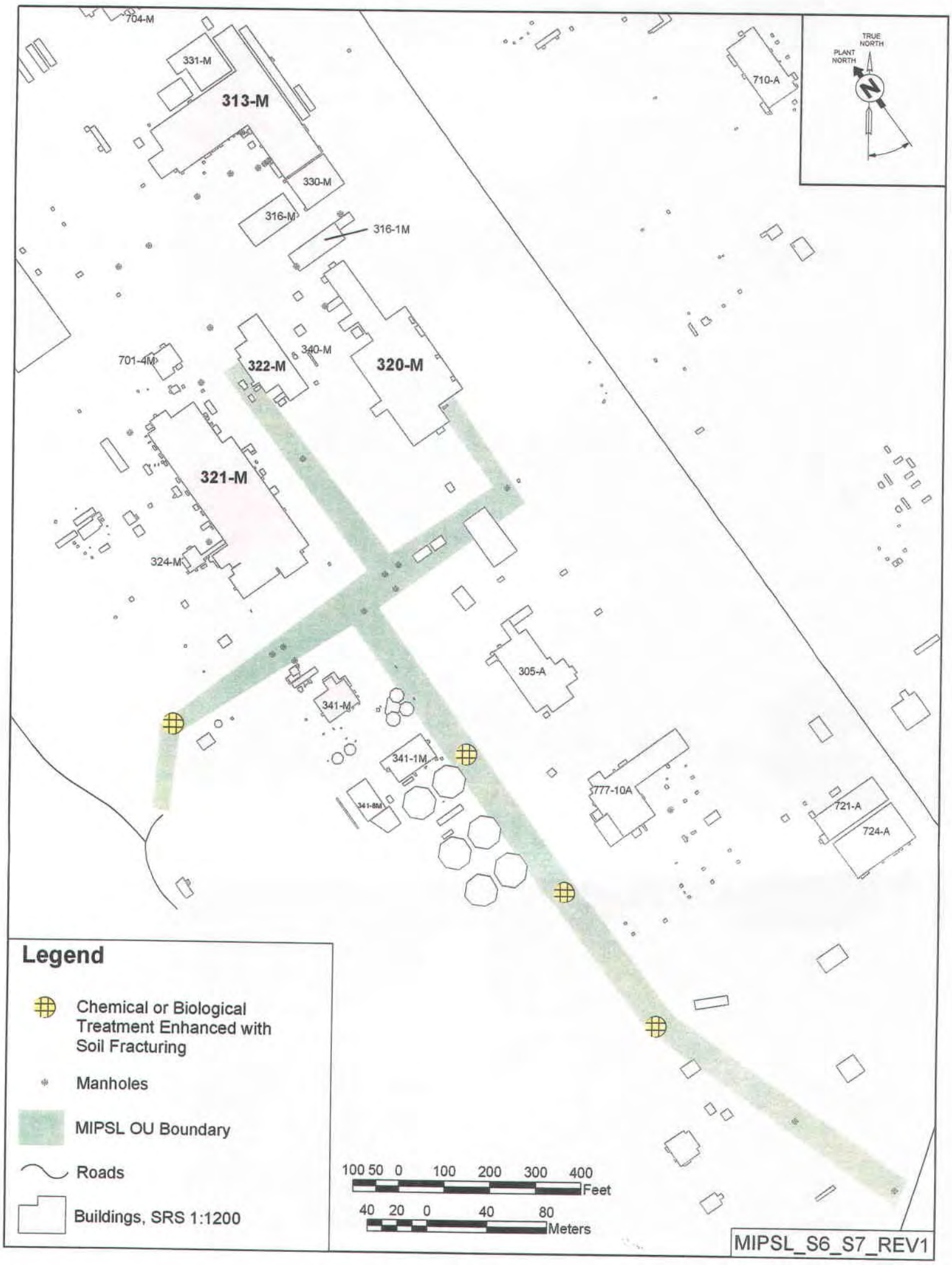


Figure 9. **Alternative S-6 and S-7: Ozone or Methane Treatment, SVE Enhanced with Soil Fracturing, Institutional Controls**

This page was intentionally left blank

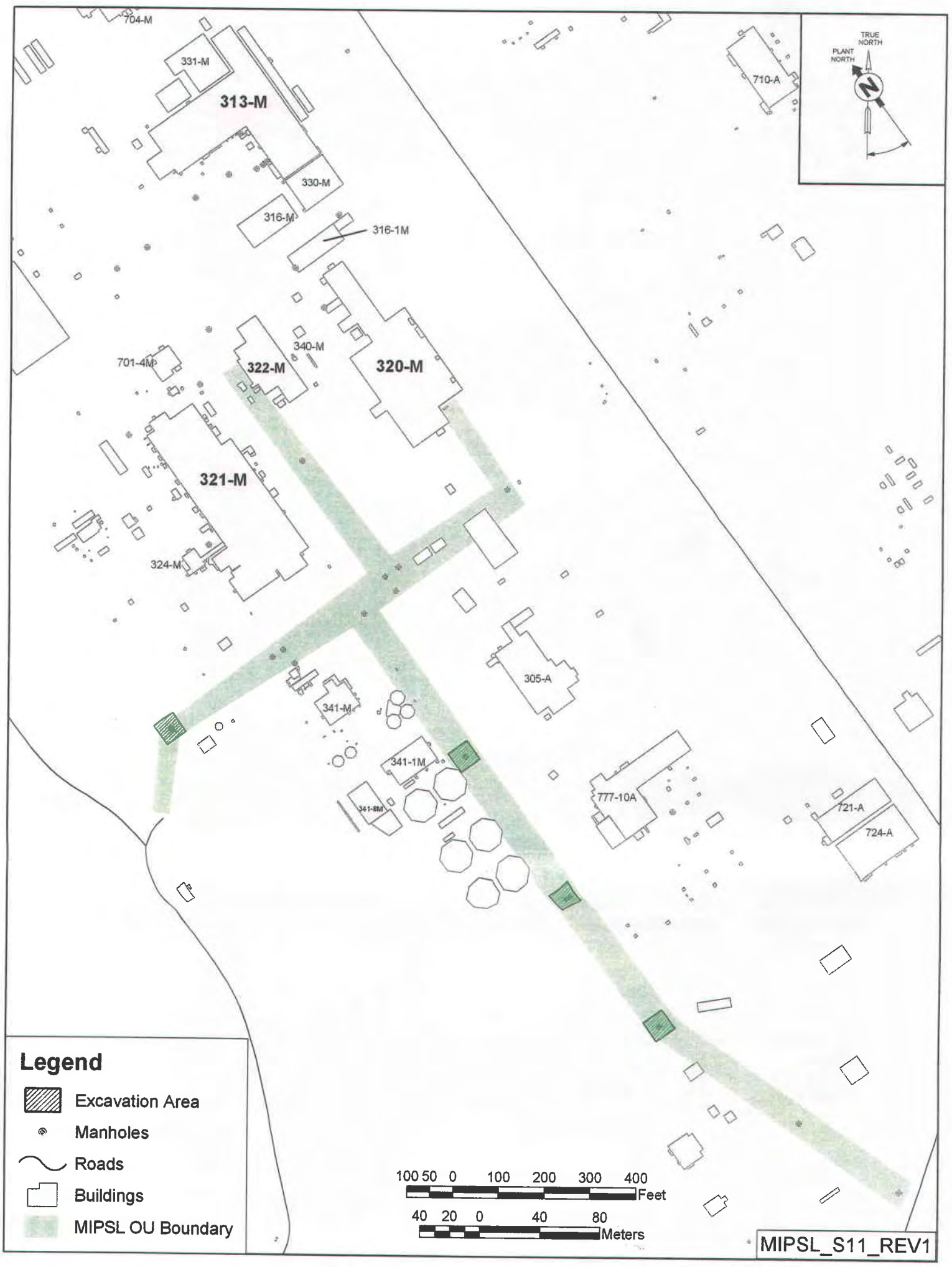
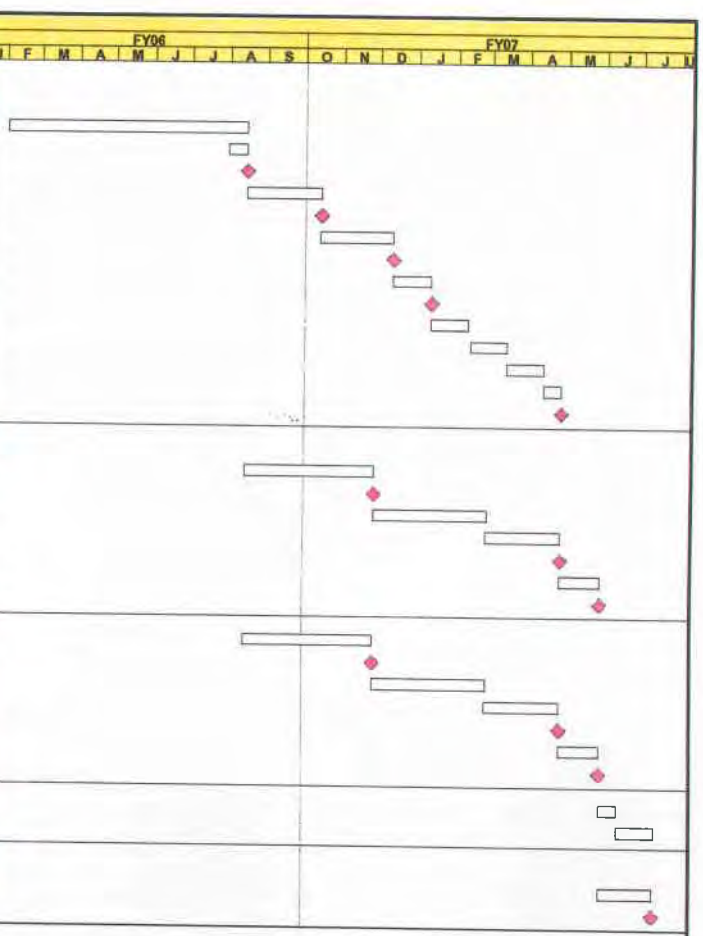


Figure 10. Alternative S-11: Removal and Off-SRS Disposal

This page was intentionally left blank

Activity ID	Activity Description	Early Start	Early Finish	Orig Dur
CA 1112 M-AREA INACTIVE PROCESS SEWE				
LCS 14 - STATEMENT OF BASIS/PROPOSED PLAN & ROD				
Record of Decision				
DHP0614500	SRS Develop Rev. 0 ROD	02FEB06	14AUG06	134
DHP0614160	Responsiveness Summary & Approvals	31JUL06	14AUG06	15
DHP0614510	SRS Submit Rev. 0 ROD		14AUG06	0
DHP0614515	USEPA/SCDHEC Review of Rev. 0 ROD	15AUG06	13OCT06	60
DHP0614520	USEPA/SCDHEC Return comments		13OCT06	0
DHP0614525	SRS Incorporates USEPA/SCDHEC comments	13OCT06	11DEC06	60
DHP0614535	SRS Submit Redline Rev.1 ROD		11DEC06	0
DHP0614540	USEPA/SCDHEC Final Review & Approval	12DEC06	10JAN07	30
DHP0614545	Receipt of ROD approval		10JAN07	0
DHP0614550	USDOE obtain signature on ROD	11JAN07	09FEB07	30
DHP0614555	USEPA obtain signature on ROD	12FEB07	13MAR07	30
DHP0614560	SCDHEC obtain signature on ROD	14MAR07	12APR07	30
DHP0614565	Prepare for Public Notice	13APR07	26APR07	14
DHP0614570	Issue ROD		26APR07	0
LCS 15 - DETAILED ENG & PRECONST ACTIVITIES				
CMI/RAIP				
DHP0615000	SRS Develop Rev. 0 CMI/RAIP	15AUG06	27NOV06	72
DHP0615005	SRS Submit Rev. 0 CMI/RAIP		27NOV06	0
DHP0615010	USEPA/SCDHEC Review of Rev. 0 CMI/RAIP	28NOV06	26FEB07	91
DHP0615020	SRS Incorporates USEPA/SCDHEC comments	26FEB07	26APR07	60
DHP0615025	SRS Submit Redline Rev.1 CMI/RAIP		26APR07	0
DHP0615030	USEPA/SCDHEC Final Review & Approval	27APR07	28MAY07	32
DHP0615035	Receipt of CMI/RAIP Approval		28MAY07	0
LUCIP				
DPH0617000	SRS Develop Rev. 0 LUCIP	15AUG06	27NOV06	72
DPH0617005	SRS Submit Rev. 0 LUCIP		27NOV06	0
DPH0617010	USEPA/SCDHEC Review of Rev. 0 LUCIP	28NOV06	26FEB07	91
DPH0617020	SRS Incorporates USEPA/SCDHEC comments	26FEB07	26APR07	60
DPH0617025	SRS Submit Redline Rev.1 LUCIP		26APR07	0
DPH0617030	USEPA/SCDHEC Final Review & Approval	27APR07	28MAY07	32
DPH0617035	Receipt of LUCIP Approval		28MAY07	0
Pre-Con Briefing Fact Sheet				
DHP0615040	Notification of Pre-Con Briefing Fact Sheet	29MAY07	11JUN07	14
DHP0615045	Pre-Con Briefing Fact Sheet Public Review Period	12JUN07	11JUL07	30
LCS 16 - REMEDIAL ACTION IMPLEMENTATION				
DHP0616001	Construction Submittals & Mobilization	29MAY07	10JUL07	30
DHP0616005	Remedial Action Start	11JUL07		0



Start Date 01OCT92
Finish Date 11JUL07
Data Date 01SEP06
Run Date 11JUL06 09:17

Early Bar
Progress Bar
Critical Activity

© Primavera Systems, Inc.

IMP2
Sheet 1 of 1
SOIL & GROUNDWATER CLOSURE PROJECTS
M-AREA INACTIVE PROCESS SEWER LINES
Implementation Schedule

S&G
SOIL AND GROUNDWATER CLOSURE PROJECTS

Date	Revision	Checked	Approved

Figure 11. Post-ROD Schedule

This page was intentionally left blank

TABLES

This page was intentionally left blank

Table 1. Summary of Remedial Goals for the MIPSL OU

RCOC			Risk-Based RGOs					
	Units	Maximum Detected Value	ARAR RGO	CM RGO[a]	PTSM RGO	HH RGO	ECO RGO	Final RG[b]
Tetrachloroethylene (PCE)	mg/kg	7.67E-01	--	3.07E-01	--	--	--	3.07E-01
Trichloroethylene (TCE)	mg/kg	4.11E-01	--	4.08E-02	--	--	--	4.08E-02

[a] CM RGO was calculated in Appendix G for the MIPSL Combined Document (WSRC 2005).

[b] Final RG is based upon the most conservative (smallest) calculated RGO presented in the table.

Table 2. Comparative Analysis Summary for the MIPSL OU

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short-Term Effectiveness	Implementability	Cost
S – 1 No Action	No	NA	NA	NA	NA	NA	$0
S – 2 Phased Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls	Yes	Yes	4	4	3	5	$5,516,217
S – 6 Ozone Treatment, Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls	Yes	Yes	4	4	4	3	$5,842,481
S – 7 Methane Treatment, Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls	Yes	Yes	4	4	4	4	$6,148,021
S – 11 Removal and Off-SRS Disposal	Yes	Yes	5	1	4	1	$12,074,098

Note: Numeric range 1 – 5, where 1 = worst and 5 = best

Table 3. Land Use Controls for the MIPSL OU

Type of Control	Purpose of Control	Duration	Implementation	Affected Areas[a]
1. Property Record Notices[b]	Provide notice to anyone searching records about the existence and location of contaminated areas.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Notice recorded by DOE in accordance with state laws at County Register of Deeds office if the property or any portion thereof is ever transferred to non-federal ownership.	All waste management areas and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions.
2. Property record restrictions[c]: A. Land Use B. Groundwater	Restrict use of property by imposing limitations. Prohibit the use of groundwater.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Drafted and implemented by DOE upon transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office.	All waste management areas and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions.
3. Other Notices[d]	Provide notice to city &/or county about the existence and location of waste disposal and residual contamination areas for zoning/planning purposes.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Notice recorded by DOE in accordance with state laws at County Register of Deeds office if the property or any portion thereof is ever transferred to non-federal ownership.	All waste management areas and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions.
4. Site Use Program[e]	Provide notice to worker/developer (i.e., permit requestor) on extent of contamination and prohibit or limit excavation/penetration activity.	As long as property remains under DOE control.	Implemented by DOE and site contractors. Initiated by permit request.	Remediation systems, all waste management areas, and areas where levels requiring land use and / or groundwater restrictions.

Table 3. Land Use Controls for the MIPSL OU (Continued)

Type of Control	Purpose of Control	Duration	Implementation	Affected Areas[a]
5. Physical Access Controls[f] (e.g., fences, gates, portals)	Control and restrict access to workers and the public to prevent unauthorized access.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Controls maintained by DOE.	At select locations throughout SRS.
6. Warning Signs[g]	Provide notice or warning to prevent unauthorized uses.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Signage maintained by DOE.	At select locations throughout SRS.
7. Security Surveillance Measures	Control and monitor access by workers/public.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Established and maintained by DOE. Necessity of patrols evaluated upon completion of remedial actions.	Patrol of selected area throughout SRS, as necessary.

[a]Affected areas – Specific locations identified in the SRS LUCIP or subsequent post-ROD documents.

[b]Property Record Notices – Refers to any non-enforceable, purely informational document recorded along with the original property acquisition records of DOE and its predecessor agencies that alerts anyone searching property records to important information about residual contamination; waste disposal areas in the property.

[c]Property Record Restrictions – Includes conditions and/or covenants that restrict or prohibit certain uses of real property and are recoded along with original property acquisition records of DOE and its predecessor agencies.

[d]Other Notices – Includes information on the location of waste disposal areas and residual contamination depicted on as survey plat, which is provided to a zoning authority (i.e., city planning commission) for consideration in appropriate zoning decisions for non-DOE property.

[e]Site Use Program – Refers to the internal DOE/DOE contractor administrative program(s) that requires the permit requestor to obtain authorization, usually in the form of a permit, before beginning any excavation/penetration activity (e.g., well drilling) for the purpose of ensuring that the proposed activity will not affect underground utilities/structures, or in the case contaminated soil or groundwater, will not disturb the affected areas without the appropriate precautions and safeguards.

[f]Physical Access Controls – Physical barriers or restrictions to entry.

[g]Signs – Posted command, warning or direction.

APPENDIX A -

RESPONSIVENESS SUMMARY

This page was intentionally left blank

Responsiveness Summary

The 45-day public comment period for the Statement of Basis/Proposed Plan for the MIPSL OU (081-M) began on June 15, 2006, and ended on July 29, 2006. During the public comment period, a presentation of the selected remedial action was made at the July 18, 2006 SRS Citizens Advisory Board Facilities Disposition and Site Remediation Committee Meeting. A presentation was also made at the July 24, 2006 SRS Citizens Advisory Board Combined Committee Meeting.

Public Comments

Based on the July 24, 2006 presentation, the Facilities Disposition and Site Remediation Committee sponsored Recommendation 236 - Soil Vapor Extraction with Soil Fracturing.

Comment

The SRS CAB has been supportive of the continued development and implementation of innovative technologies at SRS that reduce both cost and time to achieve cleanup. The Facilities Disposition and Site Remediation Committee first heard about the potential to use the soil fracturing technology in January 2006, when an update was given on soil and groundwater accomplishments in FY 05 and future plans for FY 06.

The use of the soil fracturing technology is a first for the SRS and the SRS CAB is very interested in its success, especially since the M-Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU) is the closest unit to the site boundary and easily accessible to the public. Therefore, the SRS CAB wants DOE to closely monitor this new technology to make sure that the fracturing does not open new pathways for the unwanted spread of contaminants. There is also a concern that pockets of low permeability soils with contamination may still remain after using this technology and spending over $5 million.

Recommendations

The SRS CAB supports the use of the proposed remedial alternative for the M-Area Inactive Process Sewer Lines (phased soil vapor extraction enhanced with soil fracturing, and institutional controls) and offers the following recommendations in order to assure its success:

1. DOE provide annual updates on the potential spread of contaminants from the M-Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU) and the amount of VOC mass removed by the remedial alternative.

2. DOE conduct an investigation into the likelihood that pockets of low permeability soils with contamination may exist after the remedial technology is deployed and report the findings to the SRS CAB during the annual updates.

Draft Responses to Recommendations

Response to Recommendation #1

DOE will provide annual updates; however, the construction start for the remedial action at the MIPSL OU is not scheduled until July 2007. Monitoring data from the action is not anticipated to be available until after December 2008. An annual update of VOC mass removed by the SVE and fracturing should be available about January 2009.

The chlorinated solvents released from the MIPSL OU have been present for many years and are trapped in a low permeability silt and clay layer. Contaminants from this source are unlikely to spread during the remedial action because the mode of transport in the environment is through volatilization. SVE coupled with fracturing will remove volatilized contaminants and reduce the potential for contaminants to migrate. Further characterization of the source is not likely to yield new knowledge on the migration of

the contaminants because they have been present for many years and are in relative equilibrium with the environment.

SRS has observed changes in the groundwater concentration due to the operation of SVE and removal of significant quantities of VOCs in the vadose zone. Because groundwater protection is the goal of the remedial action, DOE believes that reporting changes in the groundwater concentration below the source would be a better measure of the effects of the remedial action.

Response to Recommendation #2

Pockets of contaminated soil are expected to be present between fractures after SVE operations are complete. To manage this condition, lower cost systems (such as Microblowers™ and Baroballs™) will be implemented over an estimated 15 years to facilitate the gradual release of all of remaining VOCs. The source area will be sampled to demonstrate that remedial goals have been achieved after the system operations are complete. Annual updates will be provided after January 2009, after the system is fully operational.

This page was intentionally left blank

APPENDIX B -

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This page was intentionally left blank

Table B-1. Summary of Potential ARARs for the MIPSL OU

Citation	Status	Requirement Summary	Reason for Inclusion	Remedial Alternative
Chemical-specific ARARs				
40 CFR 122 National Pollutant Discharge Elimination System (NPDES) or Water Pollution Control Permits SC R.61-9	Potentially Applicable	Regulates discharges of pollutants from any point source into waters of the US and SC	Applicable if water from the MIPSL OU will be discharged to land or streams, rivers or lakes	S-2, S-6, S-7, S-11
40 CFR 141 National Primary Drinking Water Regulations	Potentially Applicable	Standards for maintaining water quality	Generally applicable for maintaining groundwater quality	S-1, S-2, S-6, S-7, S-11
40 CFR 268 Land Disposal Regulations	Potentially Applicable	Identifies land disposal restrictions	Applicable if water is discharged to land	S-2, S-6, S-7, S-11
Action-specific ARARs				
40 CFR 50.6 National Primary and Secondary Ambient Air Quality Standards	Potentially Applicable	Regulates concentration of particulate matter in ambient air not to exceed 50 $\mu g/m^3$ (annual arithmetic mean) or 150 $\mu g/m^3$ (24-hour average concentration)	Dust suppression likely required to minimize dust emissions during construction/remedial action.	S-2, S-6, S-7, S-11
SC R.61-62.6 Control of Fugitive or Particulate Matter	Potentially Applicable	Regulates fugitive particulate emissions	Dust suppression likely required to minimize dust emissions during construction/remedial action.	S-2, S-6, S-7, S-11
SC R72-300 and 400 Standards for Stormwater Management and Sediment Reduction	Potentially Applicable	Regulates stormwater management and sediment control during land disturbing activities	Land will be disturbed during construction/remedial action	S-2, S-6, S-7, S-11
40 CFR 257-258 Disposal of Nonhazardous Waste	Potentially Applicable	Governs the management of (sanitary and construction/ demolition) non-hazardous waste	Sanitary waste may be produced from remedial actions	S-2, S-6, S-7, S-11

Table B-1. Summary of Potential ARARs for the MIPSL OU (Continued)

Citation	Status	Requirement Summary	Reason for Inclusion	Remedial Alternative
Action-specific ARARs (continued)				
SC R72-300 and 400 Erosion Control and Stormwater Discharges	Potentially Applicable	Erosion and runoff control measures	Potential ARAR because runoff and erosion may be applicable to remedial responses.	S-2, S-6, S-7, S-11
40 CFR 260, 261, 262, 264, and 268 SC R.79.260, 261 and 268 Federal and State Hazardous Waste Regulations	Potentially Applicable	Defines criteria for determining whether a waste is RCRA hazardous waste and provides treatment, storage, and disposal requirements.	Would be applicable if hazardous waste is found to be present at the MIPSL OU and removed from area of contamination.	S-1, S-2, S-6, S-7, S-11
SC R61-62.5 Standard 8	Potentially Applicable	Toxic Air Pollutants. Identifies air concentrations and permit requirements for air emissions of toxic chemicals for new and existing sources	Would be applicable if soil vapor extraction (SVE) is used as a remedial action	S-2, S-6, S-7
SC R61-58.1 and 58.2 Construction and Operations Permits – Groundwater Sources and Treatment	Potentially Applicable	Prescribes minimum standards for the construction of groundwater sources and treatment facilities	Would be applicable to well construction and remediation	S-2, S-6, S-7
SC R61-87 Underground Injection Control Regulations	Potentially Applicable	Specific requirements for controlling underground injections	May be applicable if underground injection is utilized as remedial action	S-2, S-6, S-7
Location-specific ARARs				
50 CFR 17, 50 CFR 450, 451 and 452 Endangered and Threatened Wildlife and Plants	Potentially Applicable	The remedial action must be conducted in a manner to conserve threatened, endangered and sensitive (TES) species.	There may be TES in the surrounding area.	S-1, S-2, S-6, S-7, S-11
16 USC 2901 to 2911 Fish and Wildlife Conservation	Potentially Applicable	The remedial action must be conducted in a manner to protect fish or wildlife.	This remedial action has the potential to affect wildlife in the vicinity of the MIPSL OU.	S-1, S-2, S-6, S-7, S-11
16 USC 703 to 712 Migratory Bird Treaty Act	Potentially Applicable	The remedial action must be conducted in a manner that minimizes effects on migratory birds and their habitats.	Migratory bird populations may be present in the vicinity of the MIPSL OU.	S-1, S-2, S-6, S-7, S-11

APPENDIX C -

OPERATIONAL TREND OF SVE UNIT

Operational Trend of SVE Unit

Initially, an active SVE unit would establish a rapidly declining exponential exhaust gas concentration trend. As the initial pore gas volume is removed from the contamination area, the exponential trend would flatten slightly and continue to decline.

It is important to note the difference between an active and passive system. An active system relies on exhaust blower driven by an electric motor. A passive system relies on barometric fluctuation or solar powered blowers to withdraw soil gas from the formation.

An effective method to measure the decline in residual contamination is to perform periodic rebound tests. They measure the amount of residual VOCs in the formation. Each spike represents an increase in the concentration of the soil gas contaminants diffuse into the soil gas after the SVE unit is shut down. As contaminant mass is removed from the formation, subsequent peaks will decline.

As the concentration trend approaches a limit, less energy intensive SVE technologies such as solar-powered Microblowers™ or passive SVE using Baroballs ™ can be employed. These less intensive technologies can effectively complete remedial efforts while still preventing an impact to underlying groundwater.

The monitoring data used in this example in Figure C-1 will be used as a template to discern when this transition from active to passive takes place. An appropriate transition point can be identified based upon the exhaust gas concentration and the slope of the concentration trend. These transition points should be based on definitive data. In this example, the initial transition from active to passive operation may be appropriate when the normalized concentration drops below 25 ppmv and the slope falls below -0.01 ppmv/day. However, the transition points should be site specific.

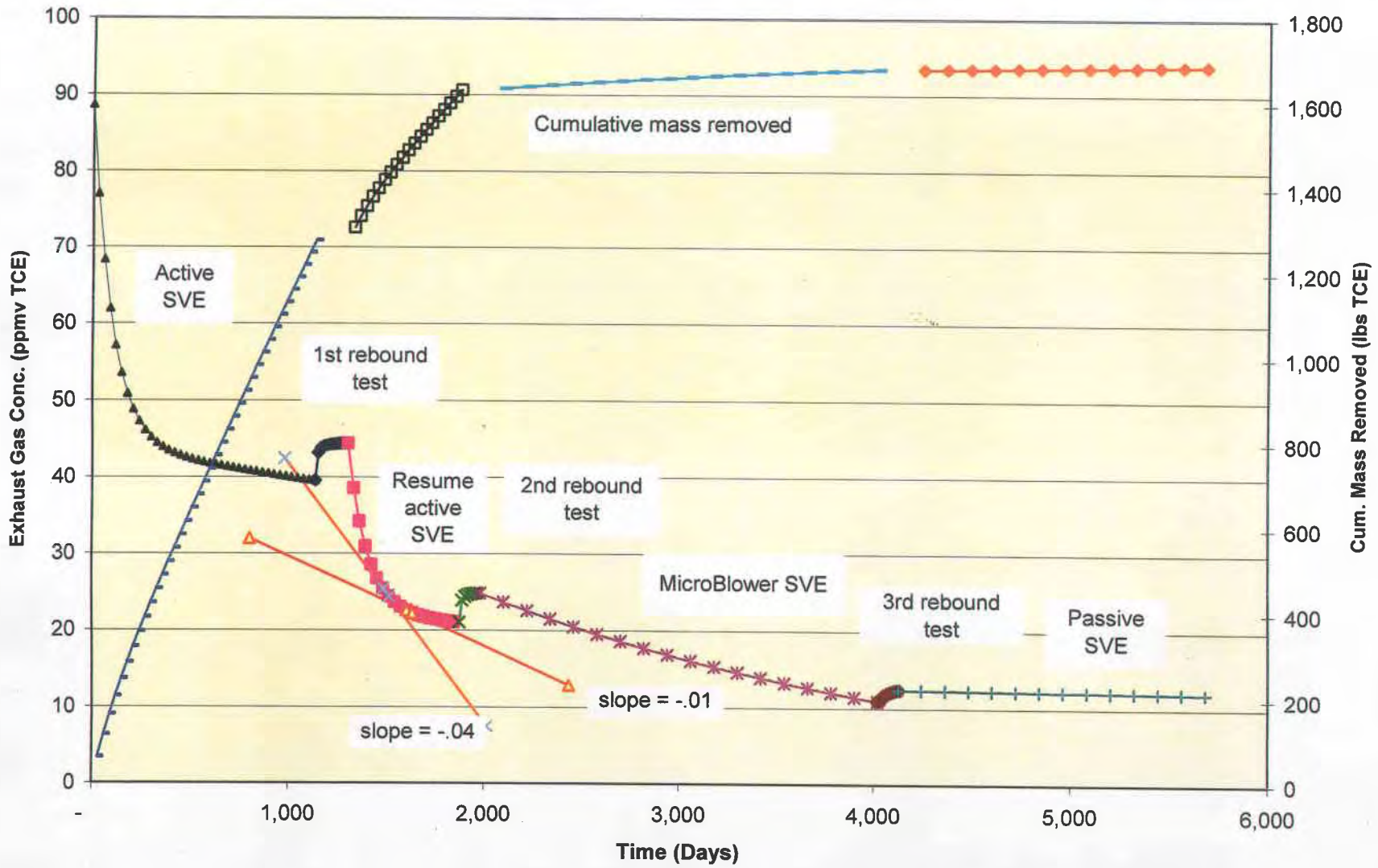


Figure C-1. Hypothetical Phased Soil Vapor Extraction Strategy (Based upon typical SVE response)

This Page Intentionally Left Blank

APPENDIX D -

COST ESTIMATE FOR THE SELECTED REMEDY

This page was intentionally left blank

Table D-1. Alternative S-2, Phased Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls

Item	Quantity	Units	Unit Cost	Total Cost	
Direct Capital Costs					
Soil Fracturing (No Treatments)					
Soil Fracture Well Points (30 ft depth)	15	ea	$10,000	$150,000	
Soil Fracture Cost (2 per well, $1500 per fracture)	15	ea	$3,000	$45,000	
Install Vadose Zone Treatment System & Supporting Systems					
Portable Soil Vapor Extraction Unit w/Piping - Active	2	ea	$100,000	$200,000	
4" Extraction Wells @ 90 feet (SVE) - Active	6	ea	$20,000	$120,000	
4" Extraction Wells @ 90 feet (Microblower) - Active Low Energy	8	ea	$25,000	$200,000	
Plug Manhole Inverts and Grout Manholes	26	ea	$2,000	$52,000	
Institutional Controls					
Posting of Warning Signs	20	ea	$50	$1,000	
Land Use Control Implementation Plan	1	ea	$5,000	$5,000	
Deed Restrictions	1	ea	$5,000	$5,000	
Subtotal - Direct Capital Cost				$778,000	*
Mobilization/Demobilization	12%	of subtotal direct capital		$93,360	*
Site Preparation/Site Restoration	12%	of subtotal direct capital		$93,360	*
Total Direct Capital Cost		(sum of * items)		**$964,720**	
Indirect Capital Costs					
Engineering & Design	18%	of direct capital		$173,650	
Project/Construction Management	25%	of direct capital		$241,180	
Health & Safety	5%	of direct capital		$48,236	
Overhead	30%	of direct capital		$289,416	
Contingency	20%	of direct capital		$192,944	
Total Indirect Capital Cost				**$945,426**	
Total Estimated Capital Cost				**$1,910,146**	
Direct O&M Costs	3.9%	discount rate for costs > 30 years duration[1]			
Annual Costs (Existing System during Post-ROD Design & Const)	2	years O&M		*Years 2005 - 2007*	
Access Controls	1	ea	$500	$500	
Subtotal - Annual Costs				$500	
Present Worth Annual Costs (2.1% Discount Rate)				$969	
Annual Costs (Soil Vapor Extraction / Microblower Operation Period)	7	years O&M		*Years 2007 - 2014*	
Access Controls	1	ea	$500	$500	
Performance Monitoring	2	ea	$10,000	$20,000	
Soil Vapor Extraction / Microblower Operation / Maintenance	2	ea	$60,000	$120,000	
Diesel Electric Generator- Rental (2 Units)	24	month	$1,000	$24,000	
Diesel for Electric Generator (365 days/yr, 24 hr/d, 2 gph x 2, $2/gal)	35040	gallon	$2	$70,080	
Performance Analysis Report	1	ea	$40,000	$40,000	
Subtotal - Annual Costs				$274,580	
Present Worth Annual Costs (3.1% Discount Rate)				$1,603,335	

Table D-1. Alternative S-2, Phased Soil Vapor Extraction Enhanced with Soil Fracturing, Institutional Controls (Continued)

Annual Costs (Passive Soil Vapor Extraction Operation - Baroballs)		8 years O&M		*Years 2014 - 2021*
Access Controls	1	ea	$500	$500
Performance Monitoring	1	ea	$10,000	$10,000
Baroball Operation / Maintenance	1	ea	$5,000	$5,000
Performance Analysis Report	1	ea	$25,000	$25,000
Subtotal - Annual Costs				$40,500
Present Worth Annual Costs (3.4% Discount Rate)				$206,915
Five Year Costs		4		
Remedy Review	1	ea	$15,000	$15,000
Subtotal - Five Year O&M Costs				$15,000
Present Worth Five Year Costs				$38,049
Total Present Worth Direct O&M Cost				**$1,849,267**
Indirect O&M Costs				
Project/Admin Management	40%	of direct O&M		$739,707
Health & Safety	10%	of direct O&M		$184,927
Overhead	30%	of direct O&M		$554,780
Contingency	15%	of direct O&M		$277,390
Total Present Worth Indirect O&M Cost				**$1,756,804**
Total Estimated Present Worth O&M Cost				**$3,606,071**
TOTAL ESTIMATED COST				**$5,516,217**

1. Interest rate for costs with duration < 30 years (i.e., before 2034) is based on WSRC's 16 April 2002 Technical Memorandum.

The number across from five year costs represent the projected number of reviews for the alternative.